United States Patent [19]

Ikeda et al.

[11] **3,902,040**

[45] **Aug. 26, 1975**

[54] **TEMPERATURE COMPENSATING VEHICLE WINDOW HEATING SYSTEM**

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[22] Filed: **Jan. 30, 1974**

[21] Appl. No.: **437,979**

[30] **Foreign Application Priority Data**

Feb. 7, 1973 Japan 48-14799

[52] **U.S. Cl.** **219/203;** 52/171; 73/336.5; 200/61.05; 219/501; 219/522; 219/547; 340/235

[51] **Int. Cl.**[2] **H05B 1/02;** E06B 7/12

[58] **Field of Search** 219/202, 203, 219, 522, 219/547, 509, 501; 52/171; 340/234, 235; 73/336.5; 338/35; 200/61.05

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[57] **ABSTRACT**

A vehicle window heating system for eliminating moisture deposited on the surface of a vehicle window is provided with a moisture detecting circuit having a temperature sensitive element adapted to compensate for temperature-dependent variation in impedance between a pair of dew-drop detecting electrodes. The deposit of dew drops between the aforesaid electrodes lowers impedance therebetween, whereupon moisture eliminating heating means operates due to such lowered impedance. A decrease in ambient temperature increases impedance, and the aforesaid moisture eliminating heating means will not operate unless a more pronounced dew depositing condition results. This device, however, compensates for such a temperature-dependent variation in impedance and thus may operate substantially in a temperature independent dew-depositing condition.

3 Claims, 5 Drawing Figures

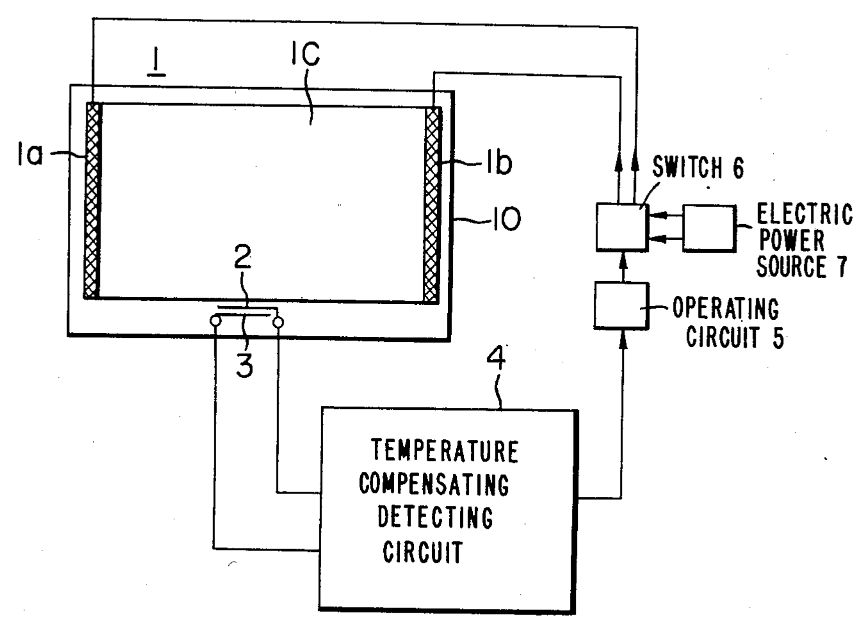


FIG. 1

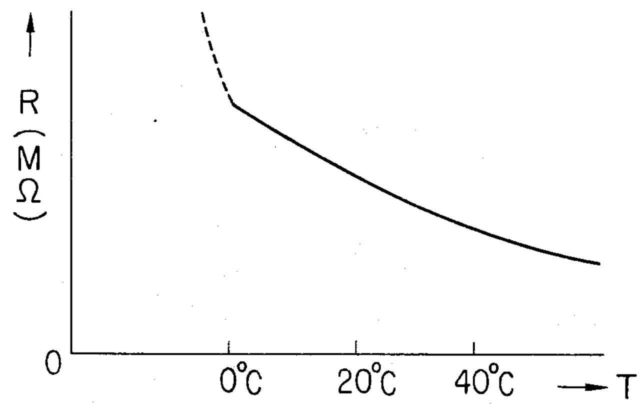

R (MΩ)
0
0°C
20°C
40°C
T

FIG. 2

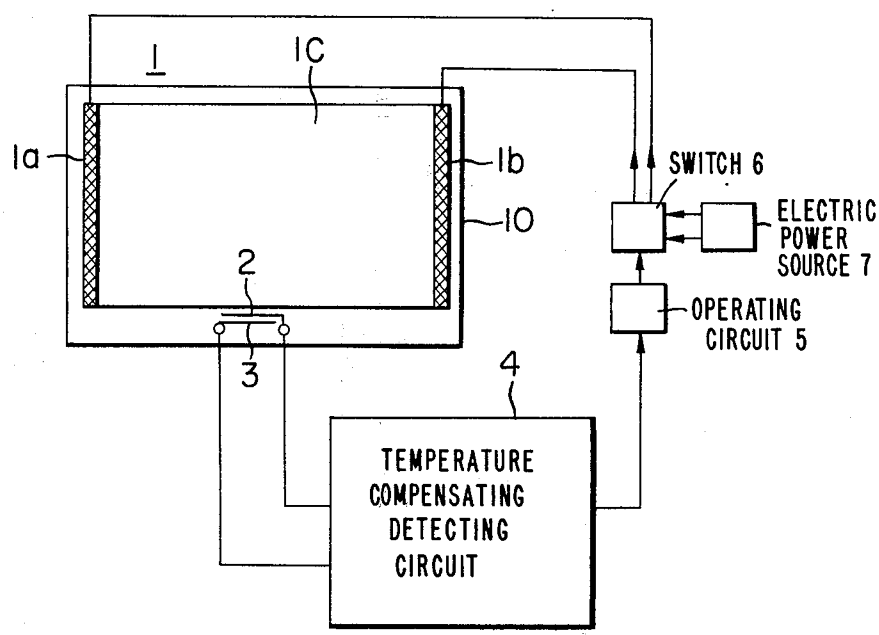

1
1C
1a
1b
10
2
3
4
SWITCH 6
ELECTRIC POWER SOURCE 7
OPERATING CIRCUIT 5
TEMPERATURE COMPENSATING DETECTING CIRCUIT

FIG. 3

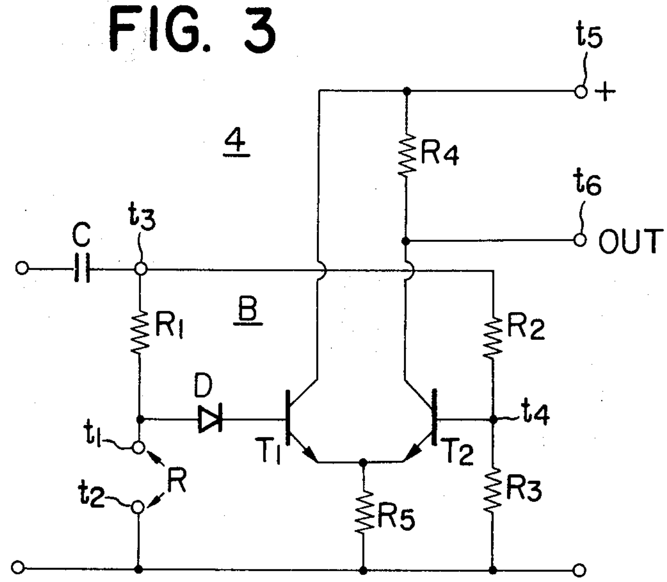

t5
+
4
R4
t6
OUT
C
t3
B
R1
R2
D
t4
t1
T1
T2
R
t2
R3
R5

FIG. 4

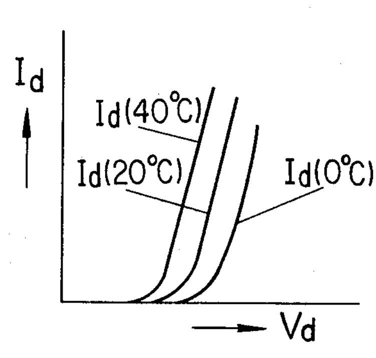
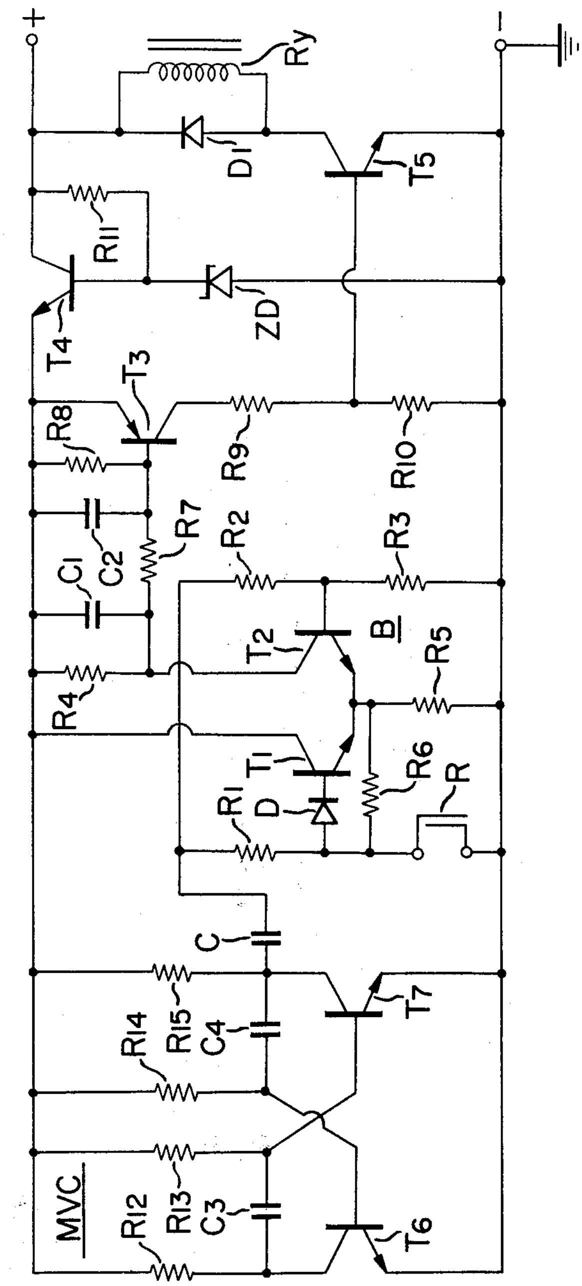

Id
Id(40°C)
Id(20°C)
Id(0°C)
Vd

FIG. 5


+
-
Ry
D1
T5
R11
ZD
T4
T3
R8
R9
R10
C1
C2
R7
R2
R3
T2
B
R5
R4
T1
R1
D
R6
R
C
R14
R15
C4
T7
MVC
R12
R13
C3
T6

TEMPERATURE COMPENSATING VEHICLE WINDOW HEATING SYSTEM

BACKGROUND OF THE INVENTION

This invention relates to a moisture preventive device for glass which device automatically eliminates the moisture deposited on the surface of glass such as windows of an automobile.

It is of supreme importance to insure good visibility for a driver for the sake of safe driving of a vehicle, particularly of an automobile. Accordingly, moisture prevention on a front windshield as well as a back window is important, when backing an automobile or for watching a following vehicle. The term "moisture preventive" as used herein signifies the prevention of dimness or fogging of glass caused by moisture or dew deposited thereon, as well. Furthermore, the back window glass of an automobile is rarely designed to extend in a vertical direction, and is in most cases inclined, and accordingly particular consideration should be paid to insure good visibility for a driver. Hitherto, an automatic moisture preventive device is known, in which dew-drop detecting electrodes are attached on the surface of glass for detecting a dew depositing condition by using variation in impedance between a pair of detecting electrodes and a heating device or warm air blowing device mounted on a glass surface may be operated according to the results of detection. However, such a moisture preventive device suffers from disadvantages in that, if it is preset so as to operate in a given dew depositing condition which is suited for a warm environment, then it will not operate in a cold environment, even if a considerable degree of moisture or dew is deposited on the surface of glass. Conversely, if it is preset so as to operate in a given dew depositing condition which is suited for a cold environment, it is apt to operate in such a faint dew depositing condition which would not hinder the safe in driving a warm environment. This results in useless consumption of energy in batteries.

SUMMARY OF THE INVENTION

It is accordingly an object of the invention to provide a moisture preventive device for glass which device may operate substantially in the same dew depositing condition either in a cold environment or in a warm environment.

It is another object of the invention to provide a moisture preventive device for glass which device is simple in construction.

The results of experiments made by the inventors reveal that the temperature-dependent variation in impedance between dew drop detecting electrodes is responsible for the variation in an operating point of a moisture preventive device, the aforesaid impedance being representative of a dew depositing condition.

According to the present invention, there is provided a moisture preventive device for glass, in which there is used a temperature sensitive element which is adapted to vary impedance depending on varying temperature or vary its induced voltage, whereby the aforesaid temperature sensitive element may compensate for temperature-dependent variation in impedance to insure consistent operation of a moisture preventive device substantially in a constant dew depositing condition throughout cold and hot environments.

The degree, to which the aforesaid compensation is accomplished may be complete, or excessive. For example, when a car is started in the winter or in a cold area, dew is apt to be deposited on the window glass because of insufficient heating in the car and because of the reduced environmental temperature in the car. Therefore, it is advisable in heating the window glass prior to the deposit of dew, for the temperature sensitive element to make an excessive temperature compensation to prevent the deposit of moisture.

BRIEF DESCRIPTION OF THE DRAWINGS

Additional objects and advantages of the invention will be apparent from the following description regarding the specific embodiments of the invention, when read in connection with the accompanying drawings, in which:

FIG. 1 is a plot showing a resistance-versus-temperature characteristic;

FIG. 2 is a block diagram illustrating the construction of a moisture preventive device for glass, which device embodies the present invention;

FIG. 3 is a circuit diagram representing one example of temperature compensating means according to the present invention;

FIG. 4 is a plot showing a voltage-versus-current characteristics of diodes at different temperatures; and

FIG. 5 is a circuit diagram showing one example of a detecting circuit and an operating circuit.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. 1, there is shown variation in resistance R (MΩ) between a pair of detecting electrodes versus ambient temperature T. As can be seen from this plot, the resistance decreases with the decrease in temperature. In FIG. 1, logarithmic scale is presented as an ordinate and an equally spaced scale is indicated as an abscissa. If dew is deposited on the surface of glass having a pair of detecting electrodes, a lowered resistance R will result. On the other hand, if the falling of the resistance below a preset value is employed to activate a moisture preventive device, in the case of increased resistance due to the low environmental temperature, the moisture preventive device will not be operated, unless a marked dew deposition condition takes place, where a constant preset value is used. To this end, according to the present invention, there is provided a temperature sensitive element which is adapted to vary the resistance or induced voltage depending on varying temperatures, whereby the temperature-dependent variation in resistance R may be compensated for by means of this temperature sensitive element.

FIG. 2 shows the construction of an automatic moisture preventive device for use with a window glass of an automobile. Shown at **10** is a window glass and generally at **1** is a heating device which consists of electrodes **1***a* and **1***b* which are bonded in the form of a band to the window glass **10** along its opposite edges, and a transparent, electrically conductive film **1***c* which covers the area between the electrodes **1***a* and **1***b*. The electrically conductive film **1***c* is normally positioned in contact relation to the inner surface of the window glass **10** thereon, but may be interposed between two laminated glasses, acting as a heating means. Alternatively, a plurality of lines or tapes, which are electrically conductive, may be used in place of the aforesaid electrically conductive film 1*c*.

Attached to the lower edge of a window glass **10** but in a position which will not hinder the field of view of the driver are a pair of dew drop detecting electrodes **2** and **3**. The dew drop detecting electrodes **2** and **3** consist of a pair of electrodes which extend in parallel and are spaced a small distance from each other.

Between the two electrodes **2** and **3**, there exist electric resistance and electrostatic capacity. Particularly, the electric resistance varies depending on a dew depositing condition present in the detecting electrode portion on a window glass, whereby an electrical signal representing a dew depositing condition may be issued. The element designated **4** is a detecting circuit adapted to detect variation in impedance between the detecting electrodes **2** and **3**, and shown at **5** is an operating circuit, at **6** a switch which is adapted to pass or interrupt the flow of an electric current to be supplied to the heating device **1** provided on the window glass, from an electric power source **7**.

With the aforesaid arrangement, if dew is deposited on the surface of the window glass **10** and hence the glass becomes dim with dew, then there will result a lowered impedance, particularly resistance R between the detecting electrodes **2** and **3**, whereupon the detecting circuit **4** issues an output of a level commensurate with variation in resistance R. If the level of the variation in resistance R exceeds a predetermined value, the operating circuit **5** issues an output to close the switch **6**, whereby an electric current is supplied to the heating device on the surface of the window glass from the electric power source, such as a battery, to heat the window glass, thereby eliminating dimness or moisture therefrom. When the dimness or moisture is removed, the impedance between the detecting electrodes **2** and **3** will be increased, whereby the detecting circuit **4** as well as operating circuit cease issuing outputs to thereby open the switch **6**. By repeating this, the window glass may be maintained free from moistened or dim condition.

The circuitry may be designed so that the detecting circuit **4** issues an on-output, when the resistance R between detecting electrodes goes below a predetermined value, and that the operating circuit **5** simply amplifies the aforesaid output to close the switch **6**. Thus, the circuits **4, 5** and **6** may be modified to a desired mode, as required.

As has been described, with such an arrangement, the resistance R between the detecting electrodes **2** and **3** varies with the variation in temperature. According to the present invention, there is provided a temperature sensitive element for compensating such a variation, thereby enhancing the sensitivity of a moisture preventive device for glass in a cold environment, in an attempt to cause a window glass heating device to be energized, when substantially the same dew depositing condition results, irrespective of cold and warm environmental conditions. There are various kinds of temperature sensitive elements among which thermistors and semiconductor diodes are particularly suitable.

FIG. **3** shows one example of an essential part of the detecting circuit **4** which uses a semiconductor diode as a temperature sensitive element. Shown at **T1** and **T2** are transistors constituting a differential amplifying circuit and at **R1** to **R5** are resistors. The detecting electrodes are connected to terminals *t*1 and *t*2, and thus resistance R between detecting electrodes and resistors R1 to R3 constitute a bridge circuit B.

A.C. voltage is impressed by way of a capacitor C across the electric power source terminals *t*2 and *t*3 of the bridge circuit from an oscillator, and the bases of transistors T1 and T2 are connected to the detecting terminals *t*1 and *t*2 therebetween. A semiconductor diode D serving as an temperature sensitive element is connected between the base of the transistor T1 and the detecting terminal *t*1. Output comes from the terminal *t*6 connected to the collector of the transistor T2, and D.C. voltage is impressed on operating power source terminals *t*5 and *t*2 provided for the transistors T1 and T2.

The operation of the detecting circuit as shown in FIG. **3** is as follows: Suppose that the ambient temperature is maintained at a normal value and that there is no deposited dew on the surface of a window glass, yet in terms of the absence of a diode D, then the bridge circuit B composed of resistors R, R1 to R3 is maintained in equilibrium, and an electric current of a certain amount flows through transistors **T1** and **T2**. When dew is deposited on the surface of glass under such a condition, the resistance R will be lowered, with the result of the decrease in amount of electric current passing through the transistor **T1**, while the electric current passing through the transistor **T2** increases, whereby the voltage drop at the collector resistance R_4 increases, and then the aforesaid voltage serves as an output voltage for the detecting circuit. The operating circuit **5** receives this output voltage and closes the switch **6**, when the aforesaid output voltage reaches a predetermined value. When the window glass is heated and as a result the moisture present on the surface thereof has been eliminated, then the resistance R resumes the initial value and the bridge circuit B is brought to an equilibrium condition to open the switch **6**.

Suppose that the ambient temperature decreases. In this case, the resistance R is increased to a value higher than the normal value, such that the bridge circuit B is maintained out of equilibrium in a manner that the electric current through the transistor **T1** is increased and the electric current through the transistor **T2** is decreased. As a result, the bridge circuit B has to first come into equilibrium and then out of equilibrium in a reversed direction, before the switch **6** is activated, even if the resistance R begins decreasing. This takes a certain period of time until a considerable degree of dew is deposited, whereby the resistance R is reduced. However, in the presence of a diode D, because the characteristic of the voltage V*d* impressed to the diode versus electric current I*d* past the diode, varies depending on ambient temperature as shown in FIG. **4**, and because the resistance of the diode increases as temperature goes down, the variation in the resistance R caused by the fluctuation or variation in the ambient temperature may be cancelled by the variation in resistance of the diode D. In other words, the resistance of the diode D is increased together with the increase of resistance R in a cold environment, whereby the variation in the input current at the base of transistor **T1** may be suppressed to prevent variation in electric current at the collector-emitter of the aforesaid transistor.

Taking into consideration the value of resistances R, R1 and the temperature-dependent variation in resistance R, if the resistance-temperature characteristic of diode D, number or type of diode used and the resistance values of series and parallel resistances are properly selected, then the variation in an operating point of the aforesaid circuit due to the temperature-dependent variation in resistance R may be exactly compensated, undercompensated or overcompensated.

FIG. 5 shows one embodiment of the detecting circuit 4 and operating circuit 5. In this figure, the similar reference numerals denote similar parts throughout FIGS. 3 and 4. Shown at R6 is a resistor connected in parallel with the baseemitter pass of transistor T1 and diode D. Connected in parallel to the output resistor R4 of the differential amplifier is a capacitor C1, while the output from the amplifier is fed by way of resistor R7 to the base of amplifying transistor T3. Connected in parallel between the base and emitter of transistor T3 are a resistor R8 and a capacitor C2, while resistors R9 and R10 are connected in series to the collector thereof. The base of a transistor T5 adapted to control a relay Ry is connected to the junction of the resistors R9 and R10, while a diode D1 for absorbing a counter electromotive force is connected to the relay Ry connected to the aforesaid collector. Coupled with zener diode ZD connected between the base of the transistor T4 and the ground, as well as coupled with resistor R11 connected in parallel between the base and the collector of the transistor T4, the transistor T4 constitutes a constant voltage circuit. On the other hand, transistors T6 and T7 constitute an a stable multi-vibrator circuit MVC, coupled with resistors R12, R13, R12 and R15 plus capacitors C3 and C4.

In this circuit, the multi-vibrator MVC oscillates to impress A.C. voltage by way of capacitor C to the bridge circuit B, while the differential amplifying circuit output, which is produced upon decrease in resistance R between the detecting electrodes due to the deposited dew, brings the transistor T3 in electrically conductive condition by way of resistor R7, whereby the transistor T5 is also brought into an electrically conductive condition. When the conductivity of the transistor T5 reaches a predetermined value, then the relay Ry is actuated to close contacts (not shown) which constitute the switch 6 to supply an electric current to the heating device 1.

The use of a capacitor for coupling the oscillator to the bridge circuit renders the moisture preventive device more compact and lighter in weight as compared with the conventional device using a transformer. The frequency of A.C. voltage to be impressed on the bridge circuit B is preferably in the range from 100 to 1,000 Hertz. In case the frequency is below 100 Hz, then special electrolytic corrosion on detecting electrodes will be caused, while if it is greater than 1,000 Hz, there will be a danger of causing malfunctioning due to the influence of stray capacitance.

As is apparent from the foregoing description, according to the present invention that, the trigger level of the differential amplifying circuit having a temperature sensitive element in its detecting circuit is high in a cold environment and low in a warm environment, such that the moisture preventive device of the invention is best suited for the output condition of bridge circuit including detecting electrodes. As a result, the moisture preventive device may be operated under a constant dew depositing condition, irrespective of the summer season and winter season, daytime and early morning, or south and north of a country, thereby insuring desired transparency for a window glass with improved driving safety and savings in electric power.

The temperature sensitive element D may be connected other suitable positions, besides those shown in FIGS. 3 and 5. While description has been thus far directed to the window glass of an automobile, it should not be construed that present invention is limited to the aforesaid embodiments. The invention may be applied to window glass in any type of vehicle or building for the prevention of moisture thereon. In addition, the moisture preventive device of the present invention a warm air blower may be used in place of the aforesaid heating element.

It will be understood that the above description is merely illustrative of preferred embodiments of the invention. Additional modifications and improvements utilizing the discoveries of the present invention can be readily anticipated by those skilled in the art from the present disclosure, and such modifications and improvements may fairly be presumed to be within the scope and purview of the invention as defined by the claims that follow.

What is claimed is:

1. A moisture preventive device for a window glass of an automobile, which device has a pair of dew drop detecting electrodes mounted on the surface of glass, a circuit for detecting the variation in impedance between said electrodes and a moisture preventive means operating by means of the output from said detecting circuit, wherein the improvement comprises:

said dew drop detecting electrodes including a pair of electrodes extending in parallel with each other and mounted in a position on the window glass of an automobile which will not hinder the field of view of a driver;

said detecting circuit being provided with a resistor bridge circuit which incorporates said detecting electrodes therein, and a differential amplifying circuit, one of whose input terminals is directly connected to one of the detecting terminals of said bridge circuit and the other of which input terminals is connected to the other of said detecting terminals by way of a temperature sensitive semiconductor diode exposed to the same ambient temperature as are the detecting electrodes such that the variation in resistance of said diode cancels out the variation in resistance between the detecting electrodes caused by ambient temperature variation;

means for impressing A.C. voltage on said bridge circuit; and

said moisture preventive means being provided with heating means for heating said window glass, switch means for connecting an electric power source or said heating means and operating circuit means for closing or opening said switch means by the output from a differential amplifier.

2. A moisture preventive device for glass, as set forth in claim 1, wherein said voltage impressing means is an oscillator and said detecting circuit is connected to said oscillator by way of a capacitor.

3. A moisture preventive device for glass, as set forth in claim 2, wherein said oscillator oscillates A.C. voltage of a frequency of 100 to 1,000 Hertz.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,902,040 Dated August 26, 1975

Inventor(s) Tsutomu Ikeda et al

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the Abstract, line 16, after "a" insert --constant--;

Column 1, line 38, delete "such";

Column 1, line 39, delete "the" and change "in driving" to --driving in--;

Column 4, line 8, delete "an" and insert --a--;

Column 5, line 10, change "baseemitter" to --base-emitter--;

Column 5, line 28, change "a stable" to --astable--.

Column 5, line 29, change "R12" (second occurrence) to --R14--;

Column 6, lines 4 and 5, after "connected" insert --at--; and

Column 6, line 11, after "addition," insert --for--.

Signed and Sealed this

fifteenth **Day of** *June 1976*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks

UNITED STATES PATENT OFFICE
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