S. 1.

RECEIPT NUMBER
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25
Exh. A-B

UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF MICHIGAN
SOUTHERN DIVISION

NARTRON CORPORATION,

Plaintiff,

vs.

E.G.O. NORTH AMERICA, INC., and WHIRLPOOL CORPORATION

Defendants.

JUDGE : O'Meara, John Corbett
DECK : S. Division Civil Deck
DATE : 11/09/2004 @ 10:52:07
CASE NUMBER : 2:04CV74367
CMP NARTRON CORP V EGO N AME INC
ET AL (DH)

MAGISTRATE JUDGE KOMIVES

ERNIE L. BROOKS (P22875)
JOHN E. NEMAZI (P33285)
SANGEETA G. SHAH (P49242)
THOMAS W. CUNNINGHAM (P57899)
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Attorneys for Plaintiff

COMPLAINT FOR PATENT INFRINGEMENT AND JURY DEMAND

Plaintiff, Nartron Corporation, alleges against defendants, E.G.O. North America, Inc. and Whirlpool Corporation, the following:

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I. THE PARTIES

1. Plaintiff, Nartron Corporation ("Nartron"), is a Michigan corporation having a principal place of business at 5000 North U.S. 131, Reed City, Michigan 49677.

2. Defendant, E.G.O. North America, Inc.("E.G.O."), is a Georgia corporation with its principal place of business at 83 Hillwood Circle, Newnan, Georgia 30263.

3. Defendant, Whirlpool Corporation ("Whirlpool"), is a Delaware corporation with its principal place of business at 2000 North M-63, Benton Harbor, Michigan 49022-2692.

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II. JURISDICTION AND VENUE

4. This action arises under Title 35 of the United States Code.

5. Jurisdiction is based on 28 U.S.C. §§ 1338 and 1367.

6. Venue is proper in this judicial district pursuant to 28 U.S.C. § 1391(c).

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III. COUNT I — PATENT INFRINGEMENT UNDER 35 U.S.C. § 271

7. On February 11, 1992, U.S. Patent No. 5,087,825 ("the '825 patent") was duly and lawfully issued to Nartron for a "Capacity Responsive Keyboard" (copy attached as Exhibit A). Since that date, Nartron has been and still is the owner of that patent.

8. On July 19, 1988, U.S. Patent No. 4,758,735 ("the '735 patent") was duly and lawfully issued to Nartron for a "DC Touch Control Switch Circuit" (copy attached as Exhibit B). Since that date, Nartron has been and still is the owner of that patent.

9. On information and belief, defendant Whirlpool makes, uses, sells and offers to sell appliances throughout the United States, including within this judicial district. Whirlpool has been, and still is, willfully infringing, actively inducing infringement of, and contributorily infringing, the '825 and '735 patents by making, using, offering to sell, and selling appliances that include unlicensed capacitive touch switches.

10. On information and belief, defendant E.G.O. makes, uses, sells and offers to sell capacitive touch switches throughout the United States, including within this judicial district. E.G.O. has been, and still is, willfully infringing and actively inducing infringement of, and/or contributorily infringing, the '825 and '735 patents by making, using, offering to sell, and/or selling its capacitive touch switches.

11. Nartron has been, and will continue to be, irreparably harmed by defendants' infringement unless defendants are enjoined by this Court.

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12. For the infringement, Nartron seeks damages in an amount adequate to compensate for defendants' infringement.

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IV. DEMAND FOR RELIEF

WHEREFORE, Nartron asks the Court to:

A. enter a preliminary and permanent injunction to enjoin defendants from infringing the '825 and '735 patents;

B award Nartron damages against defendants adequate to compensate for the infringement;

C. award Nartron damages for willful infringement in accordance with 35 U.S.C. § 284;

D. award Nartron reasonable attorney fees in accordance with 35 U.S.C. § 285;

E. award Nartron interest and costs; and

F. award Nartron such other relief as is just.

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V. DEMAND FOR JURY TRIAL

Nartron hereby demands a trial by jury for all issues so triable.

Respectfully submitted,

BROOKS KUSHMAN P.C.

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US005087825A

United States Patent [19]

Ingraham

[11] Patent Number: 5,087,825

[45] Date of Patent: Feb. 11, 1992

[54] CAPACITY RESPONSIVE KEYBOARD

[75] Inventor: Ronald D. Ingraham, Quincy, Mich.

[73] Assignee: Nartron Corporation, Reed City, Mich.

[21] Appl. No.: 480,293

[22] Filed: Feb. 15, 1990

[51] Int. Cl.[5] H01H 47/00; H01H 35/00

[52] U.S. Cl. ..... 307/132 EA; 307/116; 307/132 R; 200/511; 361/280

[58] Field of Search ..... 307/116, 125, 132 R, 307/132 E, 132 EA, 132 M, 139; 200/5 A, 511, 512, 600, DIG. 1; 361/280; 178/18; 341/22, 33

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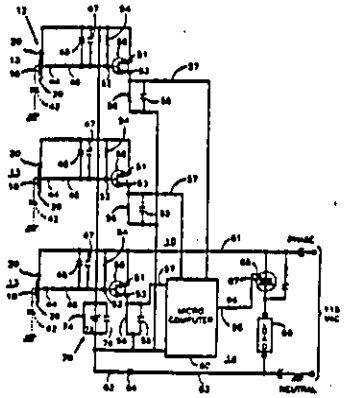
Assistant Examiner—Jeffrey A. Gaffin

Attorney, Agent, or Firm—Price, Heneveld, Cooper, DeWitt & Litton

[57] ABSTRACT

A capacity responsive keyboard which eliminates the necessity for metal films on the touch surface includes an insulated substrate having a plurality of electrically conductive plate members mounted thereon and a dielectric member positioned over the plate members. A piece of compressible, electrically-conductive foam is compressed between each plate member and the dielectric member to eliminate air from the electrical path between the dielectric member and the plate members. A grid of conductor segments separates the plate members defining a guard band to reduce interference between the switches. The guard band is connected with one power supply line of a switching circuit which produces outputs in response to capacity changes caused by a user touching the dielectric member.

18 Claims, 2 Drawing Sheets



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Primary Examiner—A. D. Pellinen

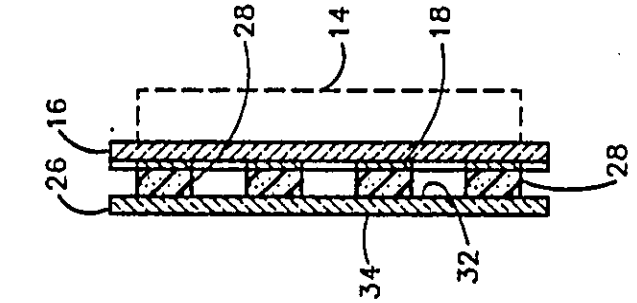
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FIG. 2

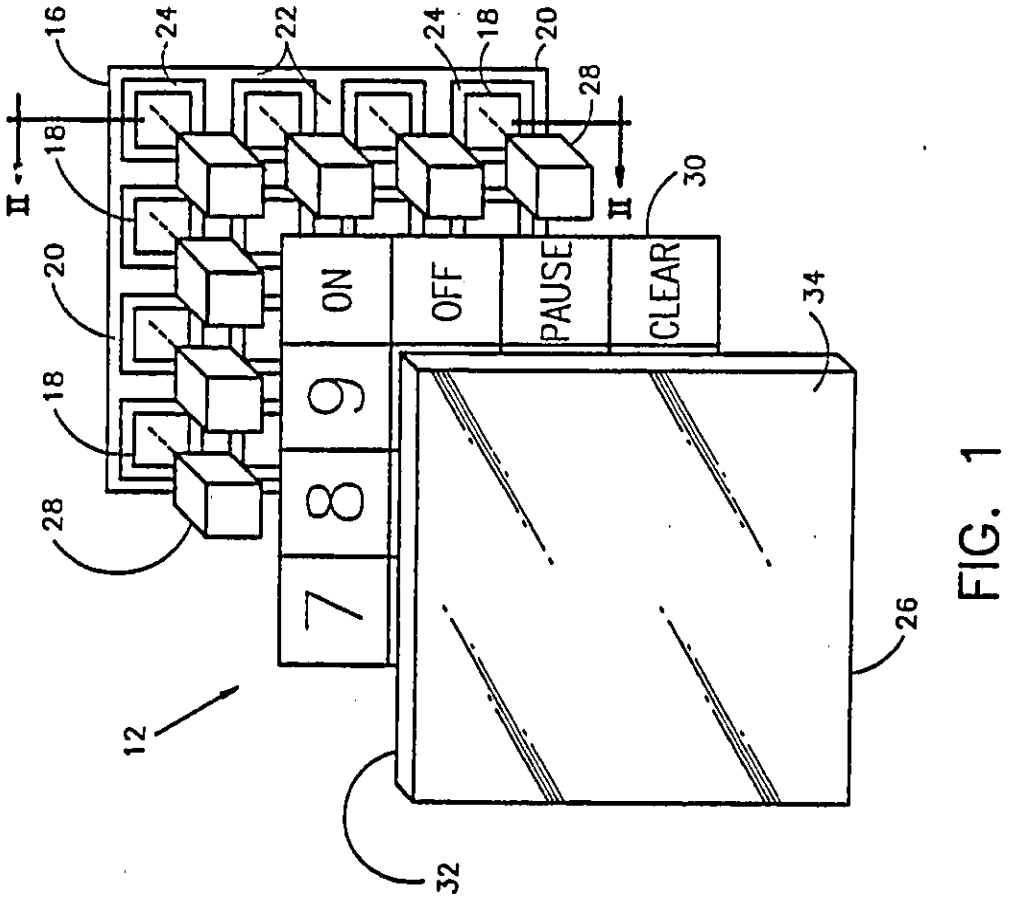
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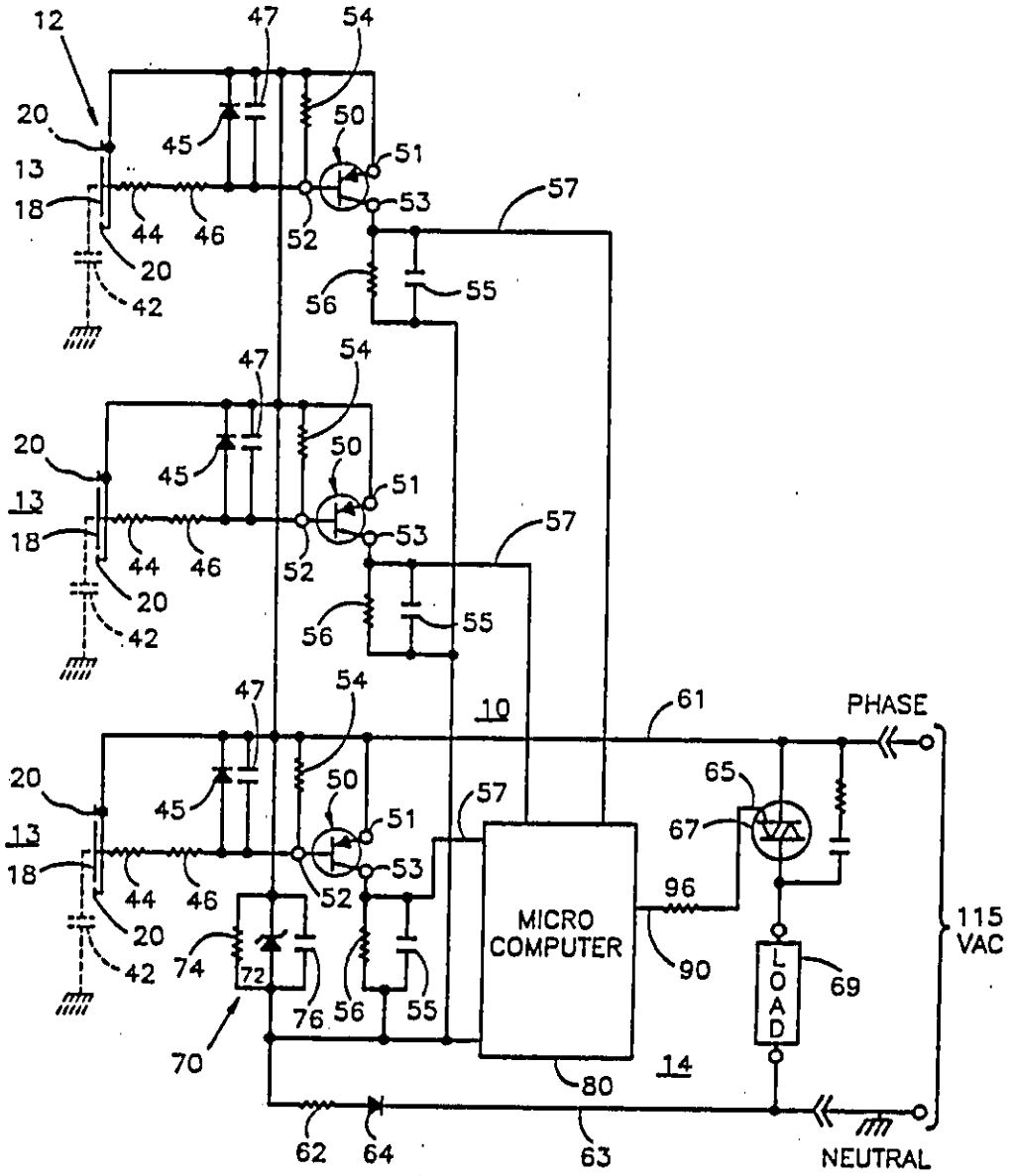
FIG. 1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PHASE
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MICRO COMPUTER
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115 VAC
LOAD
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72
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64
63
NEUTRAL

FIG. 3

CAPACITY RESPONSIVE KEYBOARD

BACKGROUND OF THE INVENTION

This invention relates to switches that respond to the change in capacity from a user touching a surface portion of the switch. The invention is especially adapted for a keyboard made up of a plurality of such capacity responsive switches.

Touch-responsive switches in the form of "capacitive glass" are common in the appliance field. This special glass has conductive elements fired on each side in a manner that forms a pair of series-connected capacitors having input and output terminals on the glass surface facing away from the user. A common plate of the two capacitors is formed on the outer glass surface facing the user. A high frequency oscillator applies pulses to the capacitors. A switching circuit connected with the capacitors interprets the presence of pulses as a no-input condition. When a user touches the capacitor plate on the outer surface of the glass, the high frequency pulses are shunted to ground through the user. The switch circuit interprets the absence of pulses as a positive input condition and responds by actuating an output device. Such a switch system is illustrated in U.S. Pat. No. 4,308,443, issued to Tucker et al.

Such "capacitive-glass" switch systems are not truly capacity responsive but require physical contact by the user with the electrically-conductive common plate of the series capacitors. This requires a metal film, such as tin oxide, be deposited on the outer surface of the glass. Such metal film is subject to abrasion by repeated cleaning and may even abrade to the point of erratic operation. A further problem with such system is that a failure of the high frequency oscillator causes a no-pulse condition, to which the switching circuit may detrimentally respond by energizing one or more outputs.

In my U.S. Pat. Nos. 4,731,548 and 4,758,735 I disclose touch control switch circuits which respond to a change in the capacity-to-ground of a plate member as a result of contact by the body of a user. Such circuits do not require a metal film on the surface portion contacted by the user so the problem of metal film abrasion is avoided. Further, the circuits disclosed in my patents are not subject to the catastrophic failure of erroneous output switching caused by the failure of an oscillator.

SUMMARY OF THE INVENTION

The present invention is directed to a keyboard system incorporating a plurality of capacity responsive switches in a keyboard assembly that may be used with a control circuit that embodies the principles of my aforementioned patents. The present invention may be embodied in a capacity responsive keyboard system having a planar substrate with a plurality of electrically conductive plate members mounted thereto and insulated from each other. A substantially rigid planar dielectric member overlies the conductive members and has a surface facing the conductive members. A plurality of flexible electrically conductive transmission members extend between the dielectric member and individual conductive members. The transmission members are sized to provide airtight interfaces with the dielectric member and the associated plate member. Circuit means connected with the plate members respond to capacity between the plate members and ground for producing a signal indicative of a change in capacity between plate members and ground.

Another problem overcome by the present invention is the tendency of capacity responsive switches that are closely positioned in a keyboard system to inadvertently become actuated even though the user is touching an adjacent switch. This problem is overcome by a keyboard system which embodies the present invention and in which an electrically conductive guard band is provided on the substrate between adjacent plate members. The guard band is connected with a reference voltage of the control circuit to isolate the capacity change caused by the user to only one switch. These and other objects, advantages and features of this invention will become apparent upon review of the following specification in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an exploded perspective view of a capacitive responsive keyboard embodying the invention;

FIG. 2 is a side elevation of the keyboard in FIG. 1; and

FIG. 3 is a schematic diagram of a control circuit useful with the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now specifically to the drawings, and the illustrative embodiments depicted therein, a capacity responsive keyboard system 10 includes a touch plate assembly 12 and a control circuit 14 connected with touch plate assembly 12 (FIG. 3). FIG. 3 illustrates a plurality of input portions 13 of touch plate assembly 12 and a control circuit 14 that actuates a single load 69 such as an electric motor. However, it should be understood that the keyboard system 10 may include a greater or lesser number of input portions 13 than illustrated, depending on the number and variety of modes in which load 69 may be controlled. Additionally, more than one load 69 may be controlled. Touch plate assembly 12 includes a substrate 16 on which a plurality of electrically conductive plate members 18 are mounted on one surface thereof. Substrate 16 is an insulator and plates 18 are spaced apart in order to insulate plates 18 from one another and from ground. Also positioned on substrate 16 is a guard band, generally shown at 20. Guard band 20 is a grid of conductor segments 22 extending between adjacent pairs of plate members 18. All conductor segments 22 are physically and electrically interconnected to define a plurality of spaces 24 with one plate member 18 positioned centrally within each space 24. Components of control circuit 14 may be positioned on the side of substrate 16 opposite plate members 18 and guard band 20 (FIG. 2).

A planar dielectric member 26 is spaced from substrate 16 facing plate members 18. Dielectric member 26 is made from a non-porous insulating material such as polycarbonate or glass. A plurality of flexible, electrically conductive transmission members 28 are sandwiched between a surface 32 of dielectric member 26 and substrate 16. Each transmission member 28 has a cross section approximately the size of plate members 18 and is positioned to overlie one of the plate members 18. An indicia layer 30 may be adhered to surface 32 of dielectric member 26 which faces substrate 16. The purpose of indicia layer 30 is to provide an indication of the function of each input portion 13.

Touch plate assembly 10 is adapted to providing a capacity interface with a user. When a user touches outwardly-facing surface 34 of dielectric member 26, the capacity-to-ground for the corresponding plate member 18 is increased substantially, as illustrated by capacitor 42 in FIG. 3. Because the dielectric constant of air is much greater than that of dielectric member 26, it has been found to be necessary to exclude substantially all of the air from the electrical path between plate members 18 and dielectric member 26. This is the function of flexible transmission members 28. In the illustrated embodiment, transmission members 28 are made from compressible, conducting polymeric foam and are dimensioned to be under compression when dielectric member 34 and substrate 16 are positioned as illustrated in FIG. 2. Because transmission members 28 are under compression, air is excluded from the interface between the transmission members and their respective plate members 18 and between the transmission members and surface 32 of dielectric member 26.

A detailed description of control circuit 14 is provided in U.S. Pat. No. 4,731,548, issued Mar. 15, 1988 to Ronald Ingraham, the disclosure of which is hereby incorporated herein by reference. Although a complete description of the operation of circuit 14 will not be repeated herein, suffice it to say that a voltage divider is established between a capacitor 47 and the capacity 42 of the user touching one input portion 13. Capacitor 47 extends between one power line 61 and the base 52 of a PNP transistor 50. Thus, when a user is not touching the particular touch input portion 13, capacitor 47 pulls base 52 of transistor 50 to a high level which reverse-biases the base-emitter junction of the transistor. Thus, transistor 50 will not be conducting. When an individual touches input portion 13, the voltage level on base 52 drops sufficiently to establish a forward-biased base emitter junction for the transistor. This causes transistor 50 to conduct, which provides an input signal on line 57 to a microcomputer 80. Microcomputer 80 has an output port 90 connected through resistor 96 to the gate 65 of a triac 67. Triac 67 is connected in series with a load 69 that is proportional to the phase angle provided by microcomputer 80 with respect to line 61. The signal produced on output port 90 is determined by the program logic of microcomputer 80. Thus, when a user touches an input portion, the current to load 69 is either started, stopped, increased or decreased.

In order to accommodate close spacing between individual switches in touch plate assembly 12, a guard band 20 is provided to electrostatically separate plate members 18 from each other. All conductor segments 22 which make up the grid-like arrangement of guard band 20 are electrically interconnected and are connected to emitter 51 of transistor 50 which, in the illustrated embodiment, coincides with power source line 61. With this guard band arrangement, the increase in capacity for one plate member 18 does not result in a corresponding increase in the capacity of adjacent plate members 18. There is no requirement for an electrically conductive transmission member between guard band 20 and dielectric member 26. However, one or more isolation resistors similar to resistors 44, 46 that isolate plate member 18 for ensuring safety, may also be provided between guard band 20 and emitter 51. Guard band 20 may also be extended to the physical space, separating lines 57 extending to microcomputer 80.

In the illustrated embodiment, substrate 16 is a conventional printed circuit board with plate members 18 and guard band 20 etched from one conductive surface thereof. Dielectric member 26 is preferably polycarbonate in order to reduce its susceptibility to breakage. In a preferred embodiment, the thickness of dielectric member 26 is 0.1" but the thickness may extend up to one-half and even three-quarter inches. Glass is a suitable alternative to polycarbonate. Compressible, conductive transmission members 28 may be made from any compressible open-cell or closed-cell polymeric foam in which a high percentage of carbon particles are mixed with the binder. Such foams are commercially available and are sold by Wescorp under the WESTAT foam trademark, Model Series W-2700. In the illustrated embodiment, indicia layer 30 is screened and dried on surface 32 of dielectric member 36 but may optionally be applied to outer surface 34. Transmission members 28 may be electrically connected with the corresponding plate members 18 or may contact a conformal coating covering the entire surface of substrate 16 facing dielectric member 26. The primary requirement is that air be eliminated from the interface between transmission members 28 and substrate 16. It has been found that the response of the keyboard system may be "tuned" by adjusting the values of capacitor 47 for each input portion 13 to provide equal sensitivity.

The present invention overcomes the difficulties of assembling true capacity-responsive switching devices in a keyboard assembly. The ability to eliminate an air-entrapped interface between the pad members and the dielectric member in a keyboard presents planar alignment problems because of the multitude of switch members. The present invention overcomes this difficulty without the necessity of physically attaching terminals to the back of the dielectric member. Furthermore, the use of a guard band around the pad members and connected to one of the power sources of the control circuit, allows a close spacing of the individual switch members.

Changes and modifications to the specifically described embodiments can be carried out without departing from the principles of the invention which is intended to be limited only by the scope of the appended claims, as interpreted according to the principles of patent law, including the doctrine of equivalents.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A capacity responsive keyboard system comprising:

a substrate having a plurality of electrically conductive plate members mounted thereto, said plate members being insulated from each other;

a substantially rigid dielectric member overlying said plate members having a surface facing said plate members;

a plurality of electrically conductive transmission members, each of said transmission members being a compressible conductive polymer extending between said dielectric member and one of said plate members in order to provide an airtight interface with said dielectric member and with the associated one of said plate members; and

circuit means connected with said plate members and responsive to capacity between said plate members and ground for providing a signal indicative of a change in capacity between at least one of said plate members and ground.

2. The keyboard system in claim 1 in which said circuit means includes a plurality of voltage responsive switch means, each of said switch means having an input connected with one of said plate members and means responsive to a change in voltage of said input for producing a signal.

3. The keyboard system in claim 2 further including a reference voltage and at least one capacitor having a first terminal connected to said reference voltage and a second terminal connected to one said input such that the voltage across said one capacitor produced by said reference voltage is changed when the capacity between the associated one of said plate members and ground is changed.

4. The keyboard system in claim 3 further including an electrically conductive guard member extending between at least two of said plate members, said guard member being connected to said reference voltage.

5. The keyboard system in claim 1 further including an indicia layer adhered to said surface of said dielectric member facing said plate members.

6. The keyboard system in claim 1 wherein said dielectric member is made from polycarbonate.

7. A capacity responsive keyboard system comprising:

a planar substrate having a plurality of electrically conductive plate members mounted thereto, said plate members being insulated from each other;

a substantially rigid planar dielectric member overlying said plate members and having a surface facing said plate members and spaced a predetermined distance therefrom;

a plurality of electrically conductive transmission members between said dielectric member and said planar substrate, each of said transmission members made from compressible conductive polymer and extending between said dielectric member and one of said plate members, each of said transmission members having a length greater than said predetermined distance such that said transmission members will be compressed between said dielectric member and said plate members; and

circuit means connected with said plate members and responsive to the value of capacity between said plate members and ground for producing output signals in response to changes in capacity between said plate members and ground.

8. The keyboard system in claim 7 in which said circuit means includes a plurality of voltage responsive switch means, each of said switch means having an input connected with one of said plate members and means responsive to a change in voltage of said input for producing an output signal.

9. The keyboard system in claim 8 further including a reference voltage and at least one capacitor associated with each of said switch means and having a first terminal connected to said reference voltage and a second terminal connected to the input of the corresponding said switch means such that the voltage across said one capacitor produced by said reference voltage is changed when the capacity between the associated one of said plate members and ground is changed.

10. The keyboard system in claim 9 further including an electrically conductive guard member extending between each adjacent pair of said plate members, said guard members being connected to said reference voltage.

11. The keyboard system in claim 7 further including an indicia layer adhered to said surface of said dielectric member facing said plate members.

12. The keyboard system in claim 7 wherein said dielectric member is made from polycarbonate.

13. A capacity responsive keyboard system comprising:

a planar substrate having an isolation grid thereon, said grid including a plurality of interconnected intersecting electrical conductor segments defining spaces between said conductor segments;

a plurality of electrically conductive plate members mounted to said planar substrate within said grid with one of said plate members in each of said spaces between conductor segments;

a substantially rigid planar dielectric member overlying said plate members and having a surface facing said plate members and spaced a predetermined distance therefrom;

a plurality of electrically plate transmission members between said dielectric member and said planar substrate, each of said transmission members made from compressible conductive polymer and extending between said dielectric member and one of said plate members, each of said transmission members having a length greater than said predetermined distance such that said transmission members will be compressed between said dielectric member and said plate members; and

circuit means connected with said plate members and said isolation grid for producing distinct output signals in response to changes in capacity between each of said plate members and ground, said circuit means including a reference voltage, said isolation grid being connected with said reference voltage.

14. The keyboard system in claim 13 in which said circuit means includes a plurality of voltage responsive switch means, each of said switch means having an input connected with one of said plate members and means responsive to a change in voltage of said input for producing one of said distinct output signal.

15. The keyboard system in claim 14 further including at least one capacitor associated with each of said switch means and having a first terminal connected to said reference voltage and a second terminal connected to the input of the corresponding said switch means such that the voltage across said one capacitor produced by said reference voltage is changed when the capacity between the associated one of said plate members and ground is changed.

16. The keyboard system in claim 13 further including an indicia layer adhered to said surface of said dielectric member facing said plate members.

17. The keyboard system in claim 13 wherein said dielectric member is made from polycarbonate.

18. The keyboard system in claim 13 wherein said dielectric member is made from glass.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 5,087,825

DATED : February 11, 1992

INVENTOR(S) : Ronald D. Ingraham

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

Column 6, Claim 13, Line 25:

After "electrically" insert -- conductive --.

Signed and Sealed this

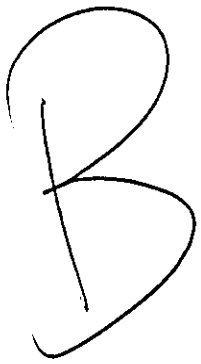
Twenty-sixth Day of October, 1993

Attest:

BRUCE LEHMAN

Attesting Officer

Commissioner of Patents and Trademarks



United States Patent [19]

Ingraham

[11] **Patent Number: 4,758,735**

[45] **Date of Patent: Jul. 19, 1988**

[54] **DC TOUCH CONTROL SWITCH CIRCUIT**

[75] Inventor: **Ronald D. Ingraham, Quincy, Mich.**

[73] Assignee: **Nartron Corporation, Reed City, Mich.**

[21] Appl. No.: **38,832**

[22] Filed: **Apr. 15, 1987**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 913,084, Sep. 29, 1986.

[51] **Int. Cl.**[4] **H01H 35/00; H05B 37/02**

[52] **U.S. Cl.** **307/116; 307/308; 307/632; 315/362; 328/5**

[58] **Field of Search** ..... 307/116, 125, 252 B, 307/308; 315/34, 74, 208, 246, 362; 318/345, 446; 323/19, 24; 328/5

[56] **References Cited**

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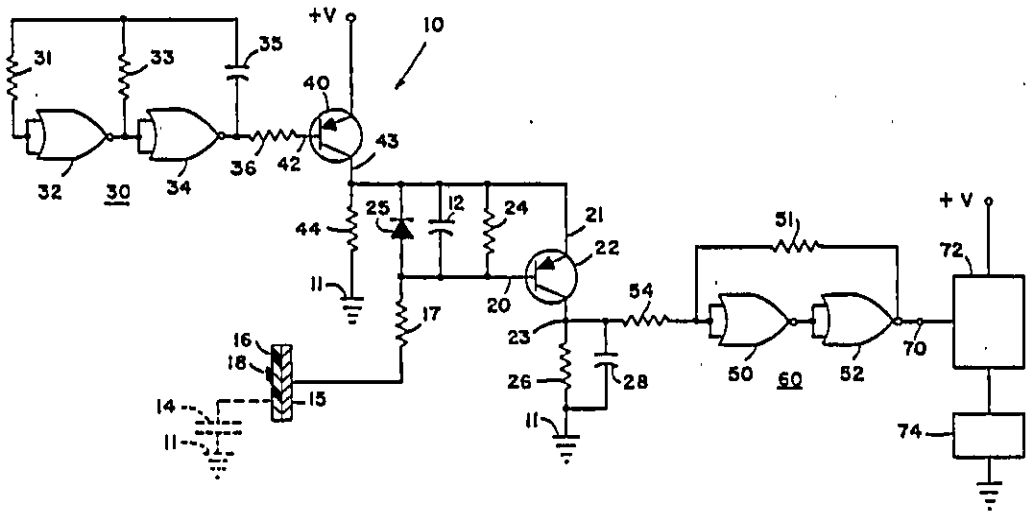
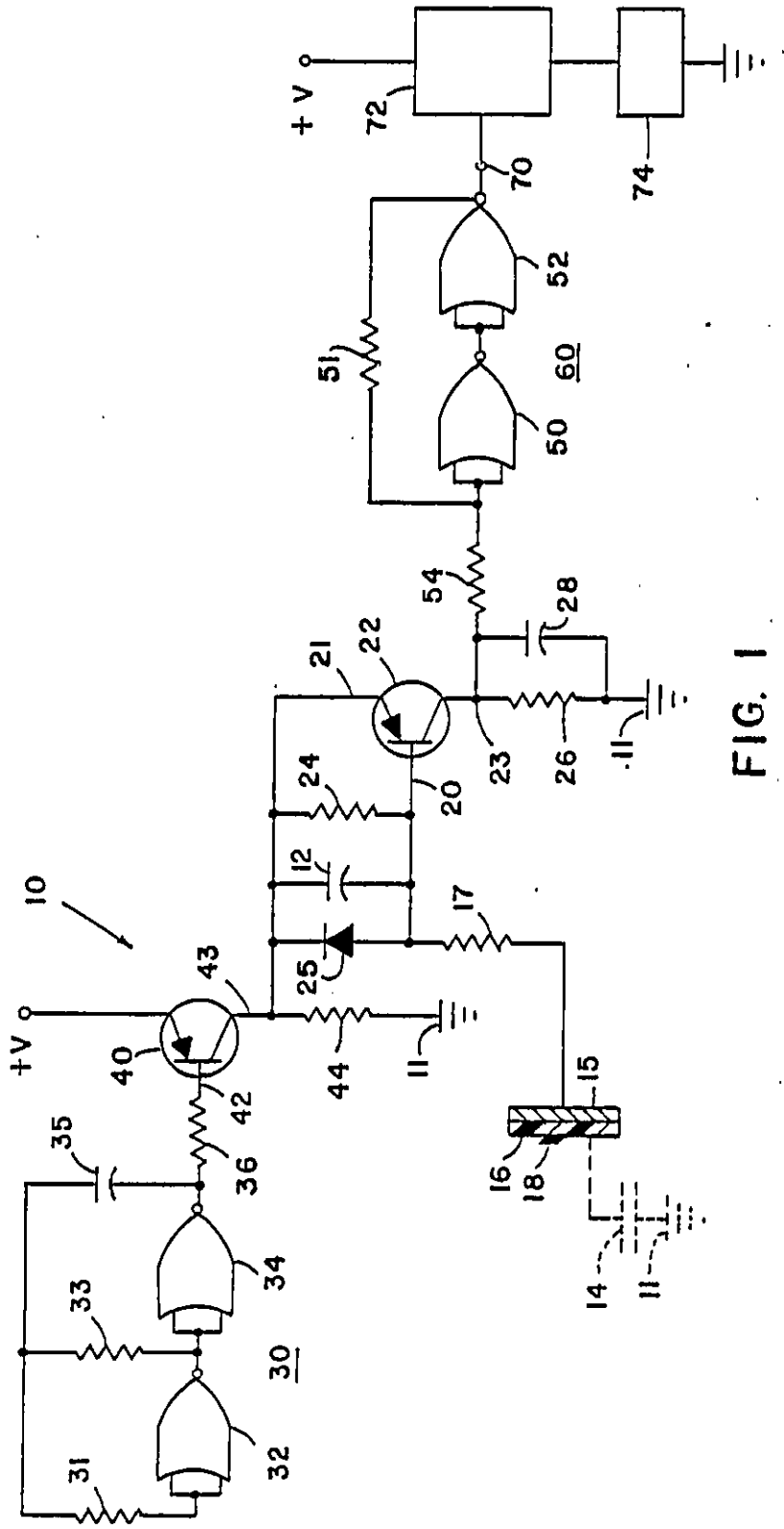
Primary Examiner—William M. Shoop, Jr.
Assistant Examiner—Sharon D. Logan
Attorney, Agent, or Firm—Price, Heneveld, Cooper, DeWitt & Litton

[57] **ABSTRACT**

A switching circuit includes a source of direct current for operating an oscillator which in turn applies a signal to a detector circuit including a touch plate. The detector includes a voltage dividing capacitive system or, in one embodiment, a phase detector circuit. In either embodiments, the output signal from the phase detector circuit or the voltage divider provides a control signal which can be used for actuating a solid-state switch such as a transistor or the like for providing control functions.

15 Claims, 2 Drawing Sheets

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72
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+V
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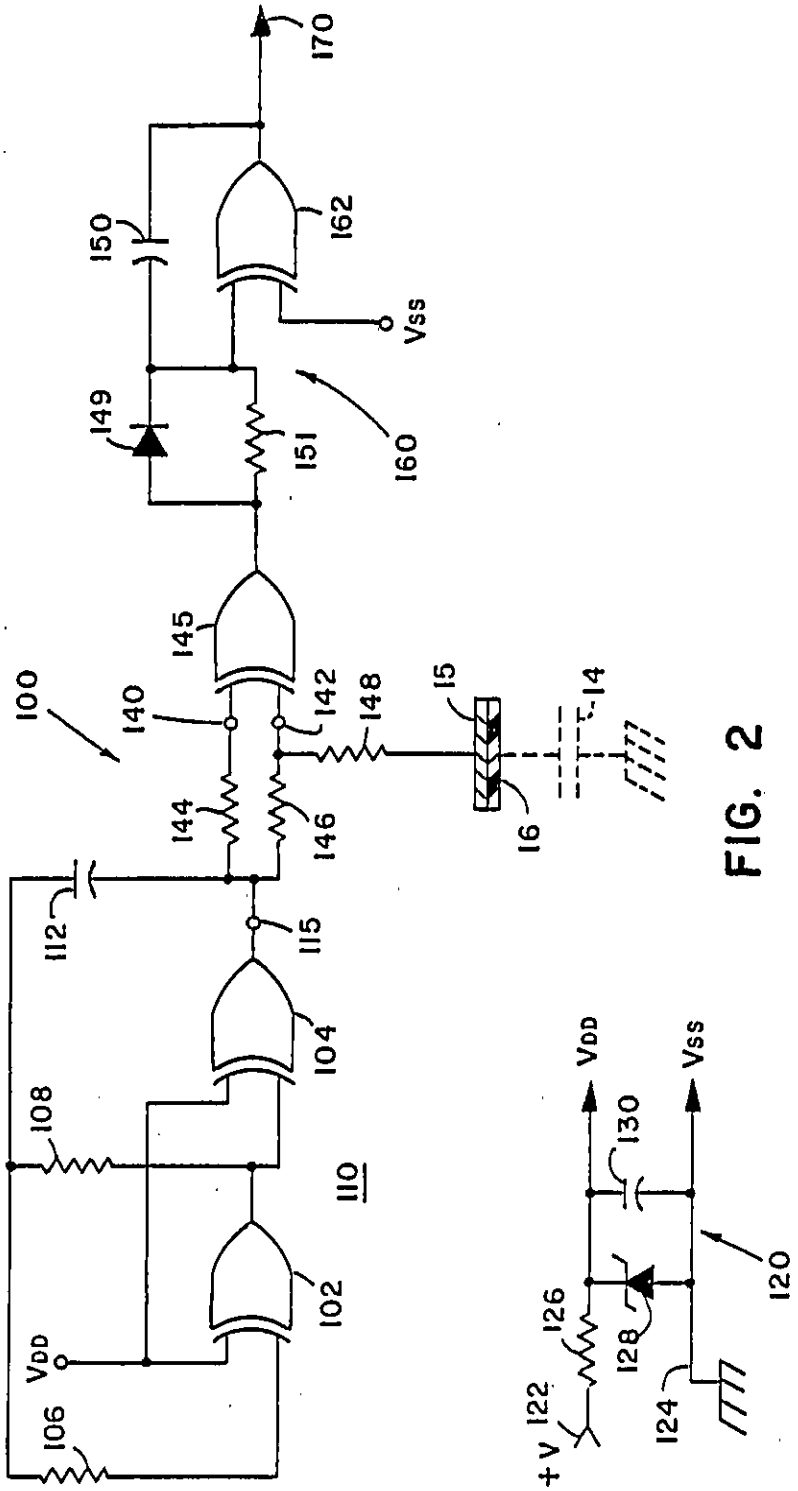
31

FIG. 1


170
162
150
Vss
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151
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145
100
140
142
148
15
14
144
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16
112
115
104
108
110
102
VDD
106
VDD
Vss
130
120
126
128
122
124
+V

FIG. 2

DC TOUCH CONTROL SWITCH CIRCUIT

The present application is a continuation-in-part application of pending application Ser. No. 06/913,084 filed Sept. 29, 1986 entitled "Touch Control Switch Circuit" to Ingraham. The subject matter of this prior application is incorporated herein by reference.

BACKGROUND OF THE INVENTION

The present invention relates to an electrical circuit and particularly to a touch controlled electrical switching circuit for portable direct current operation.

There exists a variety of electrical switching circuits which respond to a person's touch on a touch pad which may be in the form of a lamp base or a specific surface area of an electrical appliance to be actuated. These circuits represent a convenient manner in which a consumer can easily operate an appliance without the need for manually actuating a conventional toggle or push-button switch. U.S. Pat. Nos. 4,119,864 and 4,360,737 are representative of existing touch control switch circuits. Many of these circuits and other similar circuits require the utilization of 60 Hz line voltage for their operation. In some cases the circuits require a 60 Hz induction field which induces a voltage applied to the circuit by the human body operating as an antenna for generating a control signal.

SUMMARY OF THE PRESENT INVENTION

The system of the present invention does not rely upon the utilization of a line frequency voltage source and as such can be operated as a portable touch control switch circuit where no alternating current voltage is available. Applications for the system of the present invention include vehicles such as automobiles, trucks, boats and airplanes. The system is not necessarily limited to, however, portable applications since it can likewise be used where ac power is available.

Systems embodying the present invention include a source of direct current for operating an oscillator which in turn applies a signal to a touch plate coupled to a detector circuit. The detector includes a voltage dividing capacitive system or, in one embodiment, a phase detector circuit. In either embodiments, the output signal from the phase detector circuit or the voltage divider provides a control signal which can be used for actuating a solid-state switch such as triac or the like for providing control functions. When used in vehicles such as automobiles, the system can be used for actuating door locks, power windows, or other accessories. Thus, the touch control circuit of the present invention can be used in environments where alternating current voltage is not generally available.

These and other features, objects and advantages of the present invention can best be understood by reference to the following description thereof together with the accompanying drawings in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an electrical circuit diagram in block and schematic form of a first embodiment of the present invention; and

FIG. 2 is an electrical circuit diagram in block and schematic form of an alternative embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring initially to FIG. 1 there as shown, a direct current (dc) powered touch control switch system 10 which utilizes a detector circuit including a voltage dividing capacitive circuit having a first capacitor 12 coupled in series with the body capacitance 14 of a person touching a touch plate 15. Plate 15 is electrically coupled to base terminal 20 of PNP switch transistor 22 by a current limiting resistor 17. The touch plate 15 can be made of an electrically conductive material such as aluminum or the like and may be covered by a plastic overlie 16 which can carry printed indicia 18 thereon identifying for example, the switch function. Thus, it is not necessary for the operator to actually touch the electrically conductive plate 15 but only come sufficiently close to add the body capacitance 14 in series with the voltage dividing capacitor 12 which is coupled to an oscillator circuit 30 including a drive transistor 40. Oscillator 30 is an astable multi-vibrator comprising a pair of OR gates 32 and 34 coupled as invertors and cross-coupled by resistors 31, 33 and a capacitor 35 in a conventional manner as shown in the diagram.

Resistor 36 applies the square wave output signal from the output of gate 34 to the base terminal 42 of PNP transistor 40 which has an emitter terminal coupled to the +V supply. The +V supply represents the positive terminal of a dc supply voltage such as a vehicle battery. Transistor 40 has a collector terminal 43 coupled to ground 11 which for example, is the negative terminal of the +V source (i.e. vehicle battery) by means of resistor 44. Ground 11 typically will comprise a relatively large conductive area such as the vehicle chassis coupled to the negative terminal of the vehicle battery which is necessary for operation of the system. Circuits 32 and 34 are part of an integrated circuit which is supplied operating power from the +V supply in a conventional manner. A circuit such as a commercially available model CD 4070 BE or MC 14070 BCP can be employed for circuits 32 and 34 and the remaining invertor circuits 50 and 52 coupled as a Schmitt trigger as described below.

The square wave signal applied to base terminal 42 of transistor 40 causes transistor 40 to conduct providing a positive going signal to the junction of capacitor 12 with collector terminal 43 which is coupled to the emitter terminal 21 of transistor 22. Base terminal 20 is coupled to the emitter terminal 21 by resistor 24 such that unless capacitance 14 is present by the user touching or coming proximate to touch plate 15, transistor 22 will not be forward biased and will not conduct. Thus, when plate 15 is not touched, the output signal at collector terminal 23 and across a pulse stretcher circuit comprising resistor 26 and capacitor 28 will be zero volts. When, however, a person touches plate 15 thereby coupling capacitor 14 in series with capacitor 12, the ac voltage applied to base terminal 20 will be lower than the voltage applied to the emitter 21 thereby forward biasing transistor 22 into pulsed conduction. This tends to charge capacitor 28 providing a positive dc voltage to the Schmitt trigger circuit 60. A diode 25 is coupled across the base to emitter junction of transistor 22 to provide protection against reverse breakover voltage.

The Schmitt trigger 60 comprises serially coupled inverter circuits 50 and 52 with feedback resistor 51 coupled from the output of invertor 52 to the input of invertor 50 and to capacitor 28 through resistor 54.

Thus, when plate 15 or its coating 16 is touched, the dc level across to the input of Schmitt trigger 60 will rise to a level sufficient for the Schmitt trigger circuit to trigger providing a positive going output pulse at output terminal 70 of the circuit. This control output signal can be employed as a control input for a conventional solid-state switch circuit 72 shown in block form in the figure which may include a transistor or the like coupled between the +V supply and a load 74 such as a power window motor, door lock or the like. The system can also be employed for controlling an alternating current (ac) load 74 by coupling the load and switching circuit 72 to the ac supply independently of the +V supply.

In the preferred embodiment of the invention Resistors 31 and 33 are 10 megohms and 1 megohm, respectively while capacitor 35 is 0.001 microfarad (mfd). Resistors 36 and 44 are 4.7 kilo-ohms and 1 kilo-ohm, respectively while resistor 17 was 10 megohms. Resistor 24 was 4.7 megohms while capacitor 12 was 100 picofarads. The body capacitance 14 typically ranges from 100–300 picofarads. Resistor 26 is 100 kilo-ohms while capacitor 28 is 0.01 microfarads. Resistor 54 is 100 kilo-ohms, while resistor 51 is 1 megohm.

Referring now to the FIG. 2 embodiment of the invention, circuit 100 like circuit 10 includes an oscillator circuit 110 comprising a pair of exclusive OR gates 102 and 104 each having one input terminal coupled to a dc voltage suppl V_{DD}. The remaining input terminals of gates 102 and 104 are coupled to each other by resistors 106 and 108 the junction of which are coupled to the output terminal 115 of gate 104 by feedback capacitor 112. Oscillator 110 provides at output terminal 115 a 1 kHz square wave signal.

A power supply 120 is coupled to the +V supply such as the battery of a vehicle at one input terminal 122 and to the chassis ground 124 of the vehicle. An input resistor 126 couples the +V source to a voltage regulating Zener diode 128 for regulating the dc voltage thereacross. The voltage is filtered by a capacitor 130 in a conventional manner to provide the V_{DD} output voltage which is somewhat lower than the input voltage. The ground terminal of supply 120 comprises the V_{SS} supply indicated in circuit 100.

Output terminal 115 of oscillator 110 is commonly coupled to the two input terminals 140 and 142 of a detector circuit including an exclusive OR gate 145 by series coupled resistors 144 and 146. The square wave signals applied to input terminals 140 and 142 will be substantially in exact phase when the touch plate 15 is not touched by a person and therefore body capacitance 14 not in the circuit. The exclusive OR gate in such circumstance will provide a logic "0" output for all polarities of these identical voltages applied to input terminals 140 and 142.

Upon touching the touch plate 15 or coating 16 the body capacitance 14 couples terminal 142 to ground by means of resistor 148 to cause a slight phase shift of the signal applied to input terminal 142. Thus, during at least a portion of each cycle of the input voltage, gate 145 will provide a dc output or a logic "1" output pulse which is applied to charge capacitor 150 through the forward biased diode 149. Typically, gate 145 will detect the dissimilar voltages applied during the leading edge of the square wave 1 kHz signals supplied by oscillator 110. The output signal from gate 145 thus, will be 1 kHz dc pulses when capacitance 14 is in the circuit or 0 volts when plate 15 is not touched. These output signals are applied to a pulse stretcher circuit 160 which includes an exclusive OR gate 162 having one terminal coupled to the junction of diode 149 and capacitor 150 and the remaining input terminal coupled to V_{SS}. A 10 megohm resistor 151 is coupled across diode 149 to permit the discharge of capacitor 150.

The pulse stretcher circuit 160 responds to the positive output pulses from gate 145 to initially trigger gate 162 through the application of voltage from diode 149. As the gate 145 output returns to a zero logic state, capacitor 150 which now is partially charged maintains the input terminal 161 of gate 162 high thereby maintaining the output at terminal 170 at a logic "1" level until such time as the pulsing signal from gate 145 discontinues when the operator releases contact with touch plate 15 and allows capacitor 150 to fully discharge.

The output signal at terminal 170 like the signal at terminal 70 of the FIG. 1 embodiment is coupled to the control input terminal of a suitable solid-state switch such as switch 72 as shown in FIG. 1 which is suitably coupled to a load 74 for providing a desired control function.

Thus, in both of the embodiments, a soft touch capacitive type switch control system is provided which can be operated from a dc voltage source without the need for an alternating current source. These circuits are particularly well adapted for use in the automotive environment or for other vehicles. It will become apparent to those skilled in the art that various modifications to the preferred embodiments of the invention as disclosed herein can be made without departing from the spirit or scope thereof as defined by the appended claims.

The embodiments of the invention in which an exclusive property or priviledge is claimed are defined as follows:

1. A direct current powered touch controlled switching circuit comprising:
   - a source of direct current power;
   - an oscillator coupled to said source for providing periodic output signals therefrom;
   - a series voltage divider circuit coupled to said oscillator for receiving said periodic output signals therefrom, said voltage dividing circuit including at least one capacitor and an input touch terminal for coupling a person's body capacitance in series with said at least one capacitor such that the voltage at the junction of said at least one capacitor and said touch terminal will vary upon a person touching said touch terminal; and
   - a control circuit coupled to the junction of said at least one capacitor and said touch terminal and responsive to a change in voltage thereat for providing a control output signal in response to the touching of said touch terminal.

2. A circuit as defined in claim 1 wherein said control circuit includes a pulse stretcher circuit coupled to the junction of said one capacitor and said touch terminal for providing output pulses having a duration longer than said periodic output signals of said oscillator.

3. A circuit as defined in claim 2 wherein said control circuit includes a Schmitt trigger circuit.

4. A direct current powered touch controlled switching circuit comprising:
   - a source of direct current power;
   - an oscillator coupled to said source and providing periodic output signals;

a comparator circuit including first and second input terminals each coupled to said oscillator; and

an input touch terminal for coupling a person's body capacitance when touched to one of said input terminals of said comparator such that the periodic signal thereat will be varied when said touch terminal is touched wherein said comparator responds to the signal variation to provide an output control signal indicating the touching of said touch terminal.

5. A circuit as defined in claim 4 wherein said comparator comprises an exclusive OR gate.

6. A circuit as defined in claim 5 and further including a pulse stretcher circuit having an input coupled to the output of said OR gate and responsive to said output control signal for providing a predetermined logic output signal when said touch terminal is touched.

7. A circuit as defined in claim 6 and further including a switch circuit having a control input terminal coupled to the output of said pulse stretcher circuit and switch terminals coupling a load to a source of power.

8. A direct current powered touch controlled switching circuit comprising:

a source of direct current power;

an oscillator coupled to said source for providing periodic output signals therefrom; and

a detector circuit coupled to said oscillator for receiving said periodic output signals therefrom, said detector circuit including an input touch terminal said detector circuit responsive to signals from said oscillator circuit and the simultaneous presence of a person's body capacitance coupled to said touch terminal when touched by a person to provide a control output signal in response to the touching of said touch terminal.

9. A circuit as defined in claim 8 wherein said detector circuit comprises a series voltage divider circuit including at least one capacitor coupled to said touch terminal for coupling a person's body capacitance in series with said at least one capacitor, and a control circuit coupled to the junction of said at least one capacitor and said touch terminal and responsive to the change in voltage at said junction when said touch terminal is touched for providing a control output signal in response to the touching of said touch terminal.

10. A circuit as defined in claim 9 wherein said control circuit includes a pulse stretcher circuit coupled to the junction of said one capacitor and said touch terminal for providing output pulses having a duration longer than said periodic output signals of said oscillator.

11. A circuit as defined in claim 10 wherein said control circuit further includes a Schmitt trigger circuit coupled to said pulse stretcher circuit and responsive to output pulses therefrom to provide a predetermined logic output signal when said touch terminal is touched.

12. A circuit as defined in claim 9 wherein said detector circuit comprises a comparator circuit including first and second input terminals each coupled to said oscillator and one of said input terminals of said comparator coupled to said touch terminal such that the body capacitance when coupled to the touch terminal will effect a change in voltage at said one input terminal resulting in the generation of said control output signal by said comparator circuit.

13. A circuit as defined in claim 12 wherein said comparator comprises an exclusive OR gate.

14. A circuit as defined in claim 13 and further including a pulse stretcher circuit having an input coupled to the output of said OR gate for providing a predetermined logic output signal in response to the receipt of a control output signal from said OR gate.

15. A circuit as defined in claim 14 and further including a switch circuit having a control input terminal coupled to the output of said pulse stretcher circuit and switch terminals coupling a load to a source of power.

* * * * *

JS 44 11/99

CIVIL COVER SHEET

COUNTY IN WHICH THIS ACTION AROSE: Lapeer 26087

The JS-44 civil cover sheet and the information contained herein neither replace nor supplement the filing and service of pleadings or other papers as required by law, except as provided by local rules of court. This form, approved by the Judicial Conference of the United States in September 1974, is required for use of the Clerk of Court for the purpose of initiating the civil docket sheet.

I. (a) PLAINTIFFS

Nartron Corporation

(b) County of Residence of First Listed: Osceola 28183

(C) Attorney's (Firm Name, Address, and Telephone Number)
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Southfield, Michigan 48075 (248) 358-4400

DEFENDANTS 04-74367

E.G.O. North America, Inc., and Whirlpool Corporation

County of Residence of First Listed

NOTE: IN LAND CONDEMNATION CASES, USE THE LOCATION OF THE LAND INVOLVED.

Attorneys (If Known)
JOHN CORBETT O'MEARA
MAGISTRATE JUDGE KOMIVES

II. BASIS OF JURISDICTION (Place an "X" in One Box Only)

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- ☒ 3 Federal Question (U.S. Government Not a Party)
- ☐ 2 U.S. Government Defendant
- ☐ 4 Diversity (Indicate Citizenship of Parties in Item III)

III. CITIZENSHIP OF PRINCIPAL PARTIES (Place an "X" in One Box for Plaintiff and One Box for Defendant)
(For Diversity Cases Only)

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- ☐ 625 Drug Related Seizure of Property 21: 881
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- ☐ 640 R.R. & Truck
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- ☐ 660 Occupational Safety/Health
- ☐ 690 Other

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- ☐ 790 Other Labor Litigation
- ☐ 791 Empl. Ret. Inc. Security Act

BANKRUPTCY
- ☐ 422 Appeal 28 USC 158
- ☐ 423 Withdrawal 28 USC 157

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- ☒ 830 Patent
- ☐ 840 Trademark

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- ☐ 862 Black Lung (923)
- ☐ 863 DIWC/DIWW (405(g))
- ☐ 864 SSID Title XVI
- ☐ 865 RSI (405(g))

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- ☐ 894 Energy Allocation Act
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- ☐ 535 Death Penalty
- ☐ 540 Mandamus & Other
- ☐ 550 Civil Rights
- ☐ 555 Prison Condition

V. ORIGIN (PLACE AN "X" IN ONE BOX ONLY)

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VI. CAUSE OF ACTION (Cite the U.S. Civil Statute under which you are filing and write brief statement of cause. Do not cite jurisdictional statutes unless diversity.)

Patent Infringement Under Title 35 of the United States Code

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CHECK YES only if demanded in complaint: JURY DEMAND: ☒ Yes ☐ No

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DATE 11-4-04

SIGNATURE OF ATTORNEY OF RECORD John Nemazi

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   Case No.: _____

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2. Other than stated above, are there any pending or previously discontinued or dismissed companion cases in this or any other court, including state court? (Companion cases are matters in which it appears substantially similar evidence will be offered or the same or related parties are present and the cases arise out of the same transaction or occurrence.) ☐ YES ☒ NO

   If **yes**, give the following information:

   Court: _____

   Case No.: _____

   Judge: _____

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