

SPECIFICATION **Electrostatic Voltmeter**

The present invention relates to non-contacting electrostatic voltmeters.

- 5 Non-contacting electrostatic voltmeters measure an electrostatic potential on a surface without physical contact therewith. Typical non-contacting electrostatic voltmeters are described in U.S. patent specification no. 3,525,936, and in
10 U.S. patent specification no. 3,611,127. These voltmeters have mechanical devices for varying the capacitance between a detector and the surface. This varying capacitance produces an alternating current error signal on the detector
15 proportional to the difference between the DC voltage of the detector and the potential on the surface. A feedback circuit is coupled to the detector for causing the DC voltage of the detector to be adjusted to a value equal to the
20 potential of the surface in response to the error signal. The potential on the surface is determined by measuring the DC voltage on the detector. However, the mechanical devices required to vary the detector-surface capacitance are undesirably
25 complex. Further, in order to adjust the DC detector voltage, an undesirably expensive, adjustable high-voltage power supply is required.

- Other typical non-contacting electrostatic voltmeters have detectors capacitively coupled to
30 the surface and to ground. The potential of the surface can be determined from the DC voltage of the detector and the values of the detector-to-surface and the detector-to-ground capacitances. However, it is undesirably difficult to accurately
35 determine the detector-to-surface capacitance. Without accurately determining this capacitance the potential of the surface cannot be precisely measured with this type of voltmeter.

- The present invention provides apparatus for
40 producing a signal related to an electrostatic potential of a member comprising: alternating current means having first and second terminals, the first terminal AC coupled to the member for providing a predetermined AC voltage between
45 the member and the second terminal; a non-contacting electrode supported in spaced relationship to the member and capacitively coupled thereto for providing an electrode signal having AC and DC components; capacitance
50 coupling means having a predetermined capacitance for capacitively coupling the second terminal of the alternating current means to the non-contacting electrode; and detector means coupled to the non-contacting electrode for
55 providing a detect signal having AC and DC components related to the electrostatic potential of the member.

- In an apparatus as set forth in the last preceding paragraph, it is preferred that said
60 capacitance coupling means comprises a capacitor capacitively coupled between the non-contacting electrode and the second terminal.

An apparatus as set forth in the last preceding paragraph may further comprise output means

- 65 coupled to receive the detect signal and coupled to the second terminal for providing a DC output signal representative of the electrostatic potential of the member in response to the DC and AC components of the detect signal and to the signal on the second terminal.

- In an apparatus as set forth in the last preceding paragraph, it is preferred that the output means further comprises a variable gain amplifier having a first input coupled to receive
75 the detect signal and having a second input coupled to the second terminal for providing an amplified signal in response to the received detect signal on the second input, the amplification of the variable gain amplifier being variable in
80 response to the AC component of the detect signal for establishing a predefined ratio between the values of the AC component of the amplified signal and the predetermined AC voltage.

- In an apparatus as set forth in the last preceding paragraph, it is preferred that the alternating current means is coupled between the capacitor and ground.

- In an apparatus as set forth in the last preceding paragraph, it is preferred that the output means further comprises a first differential amplifier having a first input terminal coupled to receive the amplified signal, a second input
90 terminal coupled to the second terminal and having an output for providing a difference signal on the output referenced to the second terminal,
95 the output AC coupled to the variable gain amplifier, wherein the amplification of the variable gain amplifier is responsive to the AC component of the difference signal.

- In an apparatus as set forth in the last preceding paragraph, it is preferred that the output means further comprises synchronizer means having a first input terminal coupled to the
100 second terminal, a second input terminal AC coupled to receive the difference signal, and an output coupled to the variable gain amplifier for providing a DC signal in response to the value of the AC component of the detect signal.

- An apparatus as set forth in the last preceding paragraph but one may further comprise a second differential amplifier having one terminal coupled to receive the difference signal and another
110 terminal coupled to the second terminal for providing a direct current output signal proportional to the electrostatic potential of the member.

- An apparatus as set forth in the last preceding paragraph may further comprise a voltage divider coupled between the second terminal and ground
120 and having an output coupled to the second input terminal of the first differential amplifier for providing a signal having a predefined ratio to the predetermined AC voltage.

- The present invention further provides a
125 method of measuring an electrostatic potential on a member using a non-contacting electrode having a capacitance element coupled thereto, comprising the steps of: applying an AC voltage in series circuit between the member and the

capacitance element; capacitively coupling the electrode to the member for providing an electrode signal having a DC component related to the electrostatic potential and having an AC component responsive to the AC voltage; determining a gain factor in response to the AC component of the electrode signal; and determining the electrostatic potential on the member in response to the gain factor and the DC component of the electrode signal.

The present invention further provides a method of measuring an electrostatic potential of a member using a non-contacting electrode having a capacitance element coupled thereto, the method comprising the steps of: applying an AC voltage in series circuit between the member and the capacitance element; and determining the electrostatic potential on the member in response to the AC and DC components of the signal on the non-contacting electrode.

A method as set forth in the last preceding paragraph may further comprise the steps of: amplifying the signal on the non-contacting electrode by a variable gain; and adjusting the variable gain in response to the AC component of the signal on the electrode to establish a predetermined relationship between the electrostatic potential and the DC component of the signal on the electrode.

The present invention further provides apparatus for producing a signal related to an electrostatic potential of a member comprising: a non-contacting electrode capacitively coupled to the member for providing an electrode signal responsive to the electrostatic potential and AC voltage of the member; coupling means having a predetermined capacitance coupled to said non-contacting electrode; alternating current means coupled in series between the member and said coupling means for providing the AC voltage on the member; and means for determining the electrostatic potential on the member in response to the AC and DC components of the electrode signal.

In accordance with the illustrated preferred embodiments, an electrostatic voltmeter has a detector capacitively coupled to a photosensitive drum and to a source of reference potential for providing a detector voltage in response to the electrostatic potential of the drum. Further, an alternating current (AC) voltage source is coupled for applying a reference AC signal across the series combination of the surface-to-detector and detector-to-source capacitance. Specifically, this AC voltage source may be coupled between the source of reference potential and ground. Circuitry coupled to the detector determines the ratio of the magnitude of the reference AC signal to the magnitude of the AC component of the detector voltage.

The electrostatic potential of the surface is thereafter determined by multiplying the value of the direct current (DC) component of the detector voltage by this ratio. In one of the illustrated

preferred embodiments, a variable gain amplifier is coupled to the detector. The gain of this amplifier is adjusted to provide a predetermined ratio of the reference AC signal to the amplified AC voltage component of the detector output signal. The electrostatic potential of the surface is thus the product of the amplified DC voltage component of the detector output signal and the predetermined ratio.

There now flows a detailed description which is to be read with reference to the accompanying drawings of various embodiments of the present invention which have been selected for description to illustrate the invention by way of example.

In the accompanying drawings:—

Figure 1 is a block diagram of an electrostatic voltmeter according to a first preferred embodiment of the present invention;

Figure 2 is a block diagram of an electrostatic voltmeter according to a second preferred embodiment of the present invention;

Figure 3 is a detailed schematic drawing of the synchronous detector of the voltmeter shown in Figure 2;

Figure 4 is a detailed schematic drawing of the adjustable gain amplifier of the voltmeter shown in Figure 2; and

Figure 5 is a detailed schematic drawing of the preamplifier of the voltmeter shown in Figure 2.

As shown in Figure 1, a detector 11 has an electrode 13 capacitively coupled to a member 15 for measuring the electrostatic potential V_s of the member. The member 15 is AC-coupled to ground. For illustrative purposes, the electrostatic potential V_s and the AC-coupling to ground are represented by a battery 17 coupled between the member 15 and ground. Typical values for the electrostatic potential V_s are between -50 and 600V. Specifically, in one preferred embodiment, the member 15 is a rotating photosensitive drum of an electrophotographic printer comprising a "Mylar" insulator deposited upon a cadmium sulfide photoconductor ("Mylar" is a Registered Trade Mark). The photoconductor is deposited upon an aluminum core which is coupled to ground. The capacitances across the insulator and the photoconductor are approximately 107 pf/sq. cm and 89 pf/sq. cm respectively. These capacitances can be treated as negligibly low impedances to the AC signal under the operating conditions of the present invention, thus providing the AC-coupling of the member 15 to ground.

In this first preferred embodiment, the electrode 13 has a surface area of 0.30 sq. cm and is spaced 4 mm away from the member 15. The capacitance C_1 between the electrode 13 and the member 15 is preferably 0.03 picofarads (pf).

In this first preferred embodiment, a capacitor 19 having a capacitance C_2 of 180 pf is coupled between the electrode 13 and a circuit common CC. However, the capacitance C_2 does not need to be provided by a discrete component as illustrated, but may be provided by residual

capacitances between the electrode 13 and the circuit common.

An AC voltage source 21 is preferably coupled between the circuit common CC and ground for providing an AC signal having a voltage of magnitude V_{AC} across the series combination of the capacitances C_1 and C_2 . A 5 KHz, 20 volt peak-to-peak square-wave is used in the preferred embodiment.

An amplifier 23 is coupled to the electrode 13 for receiving the voltage V_o on the electrode. The amplifier 23 is referenced to the circuit common CC, i.e., $V_{out} = V_o A$ where A is the amplification of the amplifier 23 and V_{out} and V_o are both measured relative to the circuit common CC. The illustrated coupling in Figure 1 of the amplifier 23 to the circuit common CC is symbolic of the coupling which references the amplifier 23 to the circuit common CC. This symbol for referencing amplifiers to the circuit common is also used in subsequent Figures.

An AC filter 25 is coupled to the amplifier 23 and to the circuit common CC. This filter passes the AC component, $V_{out}(AC)$, of the output signal V_{out} . A DC filter 27, coupled to the amplifier 23 and the circuit common CC, passes the DC component, $V_{out}(DC)$, of the output signal V_{out} . The AC component $V_{out}(AC)$, and a signal, KV_{AC} , provided by an amplifier 28 are applied to a divider 29. The divider provides a quotient signal V_o , representative of the value of KV_{AC} divided by $V_{out}(AC)$. A multiplier 31 is coupled to the divider 29 and to the DC filter 27 for multiplying the quotient from the divider 29 by the value of the detected DC component, $V_{out}(DC)$. The product determined by the multiplier 31 has a value equal to KV_o , a fraction of the electrostatic potential V_s . The value of K is known, thus, the electrostatic potential V_s of the member 15 can be determined.

Specifically, in the preferred embodiment illustrated in Figure 1, the electrostatic potential V_s and the AC signal V_{AC} are amplified equally by the detector 11. This can be shown by superposition, i.e.:

$$V_o = V_s \left(\frac{C_1}{C_1 + C_2} \right) + V_{AC} \left(\frac{C_1}{C_1 + C_2} \right); \quad (1)$$

Further,

$$V_{out} = AV_o; \quad (2)$$

$$V_{out}(AC) = \frac{AC_1}{C_1 + C_2} V_{AC} = MV_{AC}; \quad (3)$$

$$V_{out}(DC) = \frac{AC_1}{C_1 + C_2} V_s = MV_s; \quad (4)$$

$$V_o = \frac{KV_{AC}}{V_{out}(AC)} = K/M; \quad (5)$$

and

$$V_M = V_{out}(DC) \times V_o = KV_s \quad (6)$$

Since K is known, the electrostatic potential V_s can be determined by measuring the gain of the detector 11 in response to the AC signal V_{AC} and by dividing the DC output $V_{out}(DC)$ of the detector 11 by this gain.

In operation, the present invention provides for measurement of an electrostatic potential V_s on the member 15. This measurement may be made without directly coupling the AC voltage source 21 to the member 15. Further, this measurement is insensitive to probe size, probe placement and amplifier gain.

According to the preferred embodiment illustrated in Figure 2, the member 15 is selectively capacitively coupled to the detector 11 as above. Similarly, the AC voltage source 21 is coupled between the circuit common CC and ground for maintaining the circuit common at a voltage V_{AC} relative to ground. The amplifier 23 of the detector 11 comprises a high impedance unity gain preamplifier. This amplifier is coupled to an adjustable gain amplifier 35 having a gain adjustable from 1 to 24. The amplifier 35 is coupled to an inverting input of a differential amplifier 37 and provides an output signal V_1 thereto having a DC component related to the electrostatic potential and having an AC component related to the AC signal V_{AC} . The preferred gain of the amplifier 37 is 5. A voltage divider 39 is coupled between the circuit common CC and ground to provide an AC signal V_2 to a non-inverting input of the amplifier 37. The AC signal V_2 is a known fraction of the AC signal V_{AC} . Preferably, $V_2 = 0.0014 V_{AC}$, where V_2 is measured relative to the circuit common CC. The output of the amplifier 37 is AC-coupled through a capacitor 41 to a synchronous detector 43.

The synchronous detector 43, described in more detail below, is further coupled to the circuit common CC and to the amplifier 35 for adjusting the gain of the amplifier 35 in response to the AC component of the output signal V_1 from the amplifier 35 such that the AC component of the output signal V_1 equals the AC signal V_2 provided by the divider 39. Thus, the gain of the amplifier 35 is adjusted so that the ratio of the AC component of the output signal V_1 to the AC signal V_{AC} is equal to 0.0014. The DC component of the output signal V_1 measured relative to the circuit common CC is therefore 0.0014 times the electrostatic potential V_s .

The amplifier 37 and the circuit common CC are coupled to a differential amplifier 45. The amplifier 45 provides a DC output signal V_{output} referenced to ground.

Thus, since the gain of the illustrated circuit is adjusted to a known value, the output of the amplifier 45 is a known fraction of the electrostatic potential V_s .

As illustrated in Figure 3, the capacitor 41 is coupled to the non-inverting input of an amplifier 47 of the synchronous detector 43. The amplifier 47 amplifies the signal input thereto by a preferred factor of 6.1. The amplifier 47 is coupled to a synchronizer 49. The synchronizer

49 has a selectable gain of either +1 or -1. The gain is selected in response to the level of the AC signal V_{AC} on the circuit common CC. A switch 51 is closed in response to the AC signal V_{AC} being at its high voltage level which causes the gain of the synchronizer 49 to become -1. The switch 51 is opened in response to V_{AC} being at its low voltage level which causes the gain of the synchronizer 49 to become 1. Thus, if the voltage of the output signal V_1 from the amplifier 35 is greater than the voltage of the signal V_2 from the divider 39, the input signal V_{IN} to the synchronous detector 43 is out of phase with the AC signal V_{AC} . When the input signal V_{IN} is out of phase with the signal V_{AC} , the output signal V_{SYNC} from the synchronizer 49 is always positive, indicating that the gain of the amplifier 35 is too high. If the voltage of the output signal V_1 is less than the voltage of the signal V_2 , the output signal V_{SYNC} from the synchronizer 49 is negative, indicating that the gain of the amplifier 35 is too low. Finally, if the voltage V_1 equals the voltage V_2 , the output signal V_{SYNC} from the synchronizer 49 is zero, indicating that the gain of the amplifier 35 is correct. When the output signal V_{SYNC} of the synchronizer 49 stabilizes at a voltage of zero, the AC component of the output signal V_1 equals $0.0014 V_{AC}$.

The output signal V_{SYNC} from the synchronizer 49 is coupled to a low pass filter 53, which is coupled to an integrator 55 which integrates the filtered signal input thereto and applies an integrated control signal CS to the amplifier 35 for adjusting the gain thereof.

As illustrated in Figure 4, the gate of a field effect transistor (FET) 57 of the adjustable gain amplifier 35 is coupled to the synchronous detector 43 for receiving the control signal CS. The resistance between the drain and source of the FET 57 is responsive to the voltage of the control signal CS. The gain of the amplifier 35 is responsive to the resistance of the FET 57. Thus, the control signal CS from the synchronous detector 43 controls the gain of the amplifier 35.

In operation, when the synchronous detector 43 senses that the AC component of the output signal V_1 from the amplifier 35 is greater than the signal V_2 provided by the divider 39, the control signal CS becomes more negative.

A more negative control signal CS causes the resistance of the FET 57 to increase. As the resistance of the FET 57 increases, the gain of the amplifier 35 is decreased until the AC component of the signal V_1 equals the value of the signal V_2 . Similarly, the gain of the amplifier 35 is adjusted to equalize the AC components of the signals V_1 and V_2 if the AC component of the signal V_1 is initially less than the value of the signal V_2 .

Once the gain of the amplifier 35 is stabilized as above, the overall gain of the detector 11 and the amplifiers 35, 37 and 45 is equal to a predetermined value. Thus, the electrostatic potential V_s of the surface is simply a known multiple of the value of the DC output signal V_{output} of the differential amplifier 45 illustrated in Figure 2.

As illustrated in Figure 5, the electrode 13 is coupled to the gate of an FET 59. The FET 59 is coupled to the amplifier 35 which is selectably coupled by a switch 61 to a negative feedback loop comprising a capacitor 63 and an amplifier 65. The negative feedback loop is coupled to the FET 59 for providing a bias current thereto for causing the output voltage of the amplifier 35 to equal the voltage of circuit common.

In operation, the amplifier 23 is operated in cooperation with a shutter 67, a switch 61, and switch 69 to automatically compensate for offset voltages. Initially, the switches 61 and 69 are closed and the shutter 67, which is electrically coupled to the circuit common CC, is positioned between and capacitively decouples the member 15 and the electrode 13. In this initial mode of operation, the electrode 13 and the capacitor 19 are discharged. The switch 69 is thereafter opened. Since the switch 61 is still closed, the negative feedback loop maintains the output voltage from the amplifier 35 at a value equal to the voltage of circuit common, i.e., V_{AC} , by charging the capacitor 63 to a steady state compensating voltage. Finally, the switch 61 is opened and the shutter 67 is repositioned to couple capacitively the member 15 and the electrode 13. The capacitor 63 maintains the steady state compensating voltage and thereby corrects the output of the amplifier 35 for offset voltages. The output signal V_1 from the amplifier 35 is thus corrected for any offset errors and is proportional to the electrostatic potential V_s of the member 15 as desired.

100 Claims

1. Apparatus for producing a signal related to an electrostatic potential of a member comprising:

alternating current means having first and second terminals, the first terminal AC coupled to the member for providing a predetermined AC voltage between the member and the second terminal;

a non-contacting electrode supported in spaced relationship to the member and capacitively coupled thereto for providing an electrode signal having AC and DC components; capacitance coupling means having a predetermined capacitance for capacitively coupling the second terminal of the alternating current means to the non-contacting electrode; and

detector means coupled to the non-contacting electrode for providing a detect signal having AC and DC components related to the electrostatic potential of the member.

2. Apparatus as in claim 1 wherein said capacitance coupling means comprises a capacitor capacitively coupled between the non-contacting electrode and the second terminal.

3. Apparatus as in claim 2 further comprising output means coupled to receive the detect signal and coupled to the second terminal for providing a DC output signal representative of the

49 has a selectable gain of either +1 or -1. The gain is selected in response to the level of the AC signal V_{AC} on the circuit common CC. A switch 51 is closed in response to the AC signal V_{AC} being at its high voltage level which causes the gain of the synchronizer 49 to become -1. The switch 51 is opened in response to V_{AC} being at its low voltage level which causes the gain of the synchronizer 49 to become 1. Thus, if the voltage of the output signal V_1 from the amplifier 35 is greater than the voltage of the signal V_2 from the divider 39, the input signal V_{IN} to the synchronous detector 43 is out of phase with the AC signal V_{AC} . When the input signal V_{IN} is out of phase with the signal V_{AC} , the output signal V_{SYNC} from the synchronizer 49 is always positive, indicating that the gain of the amplifier 35 is too high. If the voltage of the output signal V_1 is less than the voltage of the signal V_2 , the output signal V_{SYNC} from the synchronizer 49 is negative, indicating that the gain of the amplifier 35 is too low. Finally, if the voltage V_1 equals the voltage V_2 , the output signal V_{SYNC} from the synchronizer 49 is zero, indicating that the gain of the amplifier 35 is correct. When the output signal V_{SYNC} of the synchronizer 49 stabilizes at a voltage of zero, the AC component of the output signal V_1 equals $0.0014 V_{AC}$.

The output signal V_{SYNC} from the synchronizer 49 is coupled to a low pass filter 53, which is coupled to an integrator 55 which integrates the filtered signal input thereto and applies an integrated control signal CS to the amplifier 35 for adjusting the gain thereof.

As illustrated in Figure 4, the gate of a field effect transistor (FET) 57 of the adjustable gain amplifier 35 is coupled to the synchronous detector 43 for receiving the control signal CS. The resistance between the drain and source of the FET 57 is responsive to the voltage of the control signal CS. The gain of the amplifier 35 is responsive to the resistance of the FET 57. Thus, the control signal CS from the synchronous detector 43 controls the gain of the amplifier 35.

In operation, when the synchronous detector 43 senses that the AC component of the output signal V_1 from the amplifier 35 is greater than the signal V_2 provided by the divider 39, the control signal CS becomes more negative.

A more negative control signal CS causes the resistance of the FET 57 to increase. As the resistance of the FET 57 increases, the gain of the amplifier 35 is decreased until the AC component of the signal V_1 equals the value of the signal V_2 . Similarly, the gain of the amplifier 35 is adjusted to equalize the AC components of the signals V_1 and V_2 if the AC component of the signal V_1 is initially less than the value of the signal V_2 .

Once the gain of the amplifier 35 is stabilized as above, the overall gain of the detector 11 and the amplifiers 35, 37 and 45 is equal to a predetermined value. Thus, the electrostatic potential V_s of the surface is simply a known multiple of the value of the DC output signal V_{output} of the differential amplifier 45 illustrated in Figure 2.

As illustrated in Figure 5, the electrode 13 is coupled to the gate of an FET 59. The FET 59 is coupled to the amplifier 35 which is selectively coupled by a switch 61 to a negative feedback loop comprising a capacitor 63 and an amplifier 65. The negative feedback loop is coupled to the FET 59 for providing a bias current thereto for causing the output voltage of the amplifier 35 to equal the voltage of circuit common.

In operation, the amplifier 23 is operated in cooperation with a shutter 67, a switch 61, and switch 69 to automatically compensate for offset voltages. Initially, the switches 61 and 69 are closed and the shutter 67, which is electrically coupled to the circuit common CC, is positioned between and capacitively decouples the member 15 and the electrode 13. In this initial mode of operation, the electrode 13 and the capacitor 19 are discharged. The switch 69 is thereafter opened. Since the switch 61 is still closed, the negative feedback loop maintains the output voltage from the amplifier 35 at a value equal to the voltage of circuit common, i.e., V_{AC} , by charging the capacitor 63 to a steady state compensating voltage. Finally, the switch 61 is opened and the shutter 67 is repositioned to couple capacitively the member 15 and the electrode 13. The capacitor 63 maintains the steady state compensating voltage and thereby corrects the output of the amplifier 35 for offset voltages. The output signal V_1 from the amplifier 35 is thus corrected for any offset errors and is proportional to the electrostatic potential V_s of the member 15 as desired.

100 Claims

1. Apparatus for producing a signal related to an electrostatic potential of a member comprising:

alternating current means having first and second terminals, the first terminal AC coupled to the member for providing a predetermined AC voltage between the member and the second terminal;

a non-contacting electrode supported in spaced relationship to the member and capacitively coupled thereto for providing an electrode signal having AC and DC components; capacitance coupling means having a predetermined capacitance for capacitively coupling the second terminal of the alternating current means to the non-contacting electrode; and

detector means coupled to the non-contacting electrode for providing a detect signal having AC and DC components related to the electrostatic potential of the member.

2. Apparatus as in claim 1 wherein said capacitance coupling means comprises a capacitor capacitively coupled between the non-contacting electrode and the second terminal.

3. Apparatus as in claim 2 further comprising output means coupled to receive the detect signal and coupled to the second terminal for providing a DC output signal representative of the

electrostatic potential of the member in response to the DC and AC components of the detect signal and to the signal on the second terminal.

4. Apparatus as in claim 3 wherein the output means further comprises a variable gain amplifier having a first input coupled to receive the detect signal and having a second input coupled to the second terminal for providing an amplifier signal in response to the received detect signal
 10 referenced to the signal on the second input, the amplification of the variable gain amplifier being variable in response to the AC component of the detect signal for establishing a predefined ratio between the values of the AC component of the amplified signal and the predetermined AC
 15 voltage.

5. Apparatus as in claim 4 where the alternating current means is coupled between the capacitor and ground.

- 20 6. Apparatus as in claim 5 wherein the output means further comprises a first differential amplifier having a first input terminal coupled to receive the amplifier signal, a second input terminal coupled to the second terminal and
 25 having an output for providing a difference signal on the output referenced to the second terminal, the output AC coupled to the variable gain amplifier, wherein the amplification of the variable gain amplifier is responsive to the AC component
 30 of the difference signal.

7. Apparatus as in claim 6 wherein the output means further comprises synchronizer means having a first input terminal coupled to the second terminal, a second input terminal AC coupled to
 35 receive the difference signal, and an output coupled to the variable gain amplifier for providing a DC signal in response to the value of the AC component of the detect signal.

8. Apparatus as in claim 6 further comprising a
 40 second differential amplifier having one terminal coupled to receive the difference signal and another terminal coupled to the second terminal for providing a direct current output signal proportional to the electrostatic potential of the
 45 member.

9. Apparatus as in claim 8 further comprising a voltage divider coupled between the second terminal and ground and having an output coupled to the second input terminal of the first
 50 differential amplifier for providing a signal having a predefined ratio to the predetermined AC voltage.

10. A method of measuring an electrostatic potential on a member using a non-contacting
 55 electrode having a capacitance element coupled thereto, comprising the steps of:
 applying an AC voltage in series circuit

between the member and the capacitance element;

- 60 capacitively coupling the electrode to the member for providing an electrode signal having a DC component related to the electrostatic potential and having an AC component responsive to the AC voltage;

- 65 determining a gain factor in response to the AC component of the electrode signal; and
 determining the electrostatic potential on the member in response to the gain factor and the DC component of the electrode signal.

- 70 11. A method of measuring an electrostatic potential of a member using a non-contacting electrode having a capacitance element coupled thereto, the method comprising the steps of:
 applying an AC voltage in series circuit

- 75 between the member and the capacitance element; and
 determining the electrostatic potential on the member in response to the AC and DC components of the signal on the non-contacting

- 80 electrode.

12. A method as in claim 11 further comprising the steps of:

amplifying the signal on the non-contacting electrode by a variable gain; and

- 85 adjusting the variable gain in response to the AC component of the signal on the electrode to establish a predetermined relationship between the electrostatic potential and the DC component of the signal on the electrode.

- 90 13. Apparatus for producing a signal related to an electrostatic potential of a member comprising:

a non-contacting electrode capacitively coupled to the member for providing an electrode
 95 signal responsive to the electrostatic potential and AC voltage of the member;

coupling means having a predetermined capacitance coupled to said non-contacting electrode;

- 100 alternating current means coupled in series between the member and said coupling means for providing the AC voltage on the member; and
 means for determining the electrostatic potential on the member in response to the AC
 105 and DC components of the electrode signal.

14. A method of measuring an electrostatic potential on a member substantially as hereinbefore described with reference to Figure 1 of the accompanying drawings.

- 110 15. A method of measuring an electrostatic potential on a member substantially as hereinbefore described with reference to Figures 2, 3, 4, and 5 of the accompanying drawings.

