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(54) ELECTRICAL APPARATUSES, AND METHODS OF FORMING ELECTRICAL APPARATUSES

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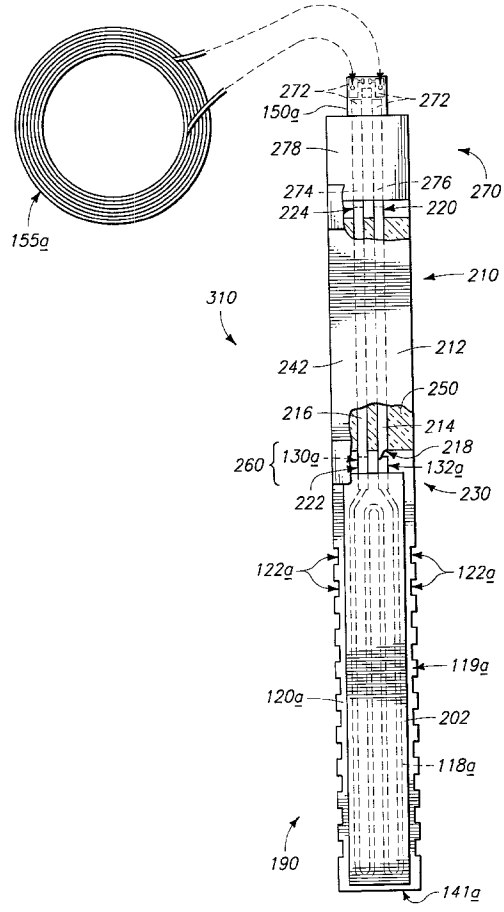
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(57) **ABSTRACT**

The invention encompasses an electrical apparatus. Such apparatus comprises a first substrate having first circuitry thereon. The first circuitry has a terminal extending therefrom, and the terminal defines a first electrical node. The apparatus further comprises a first dielectric material covering a predominate portion of the first circuitry and not covering the first electrical node. Additionally, the apparatus comprises a second substrate having second circuitry thereon. The second circuitry has a terminal extending therefrom, and such terminal defines a second electrical node. A second dielectric material covers a predominate portion of the second circuitry, but does not cover the second electrical node. The second substrate comprises a different material than the first substrate. A portion of the second substrate is over a portion of the first substrate to define an overlap between the first and second substrates. The second electrical node overlaps the first electrical node in the overlap between the first and second substrates. A conductive material is within the overlap between the first and second substrates and electrically bonds the first and second electrical nodes to one another. The invention also encompasses termite sensing devices, methods of forming electrical apparatuses, and methods of sensing termites.



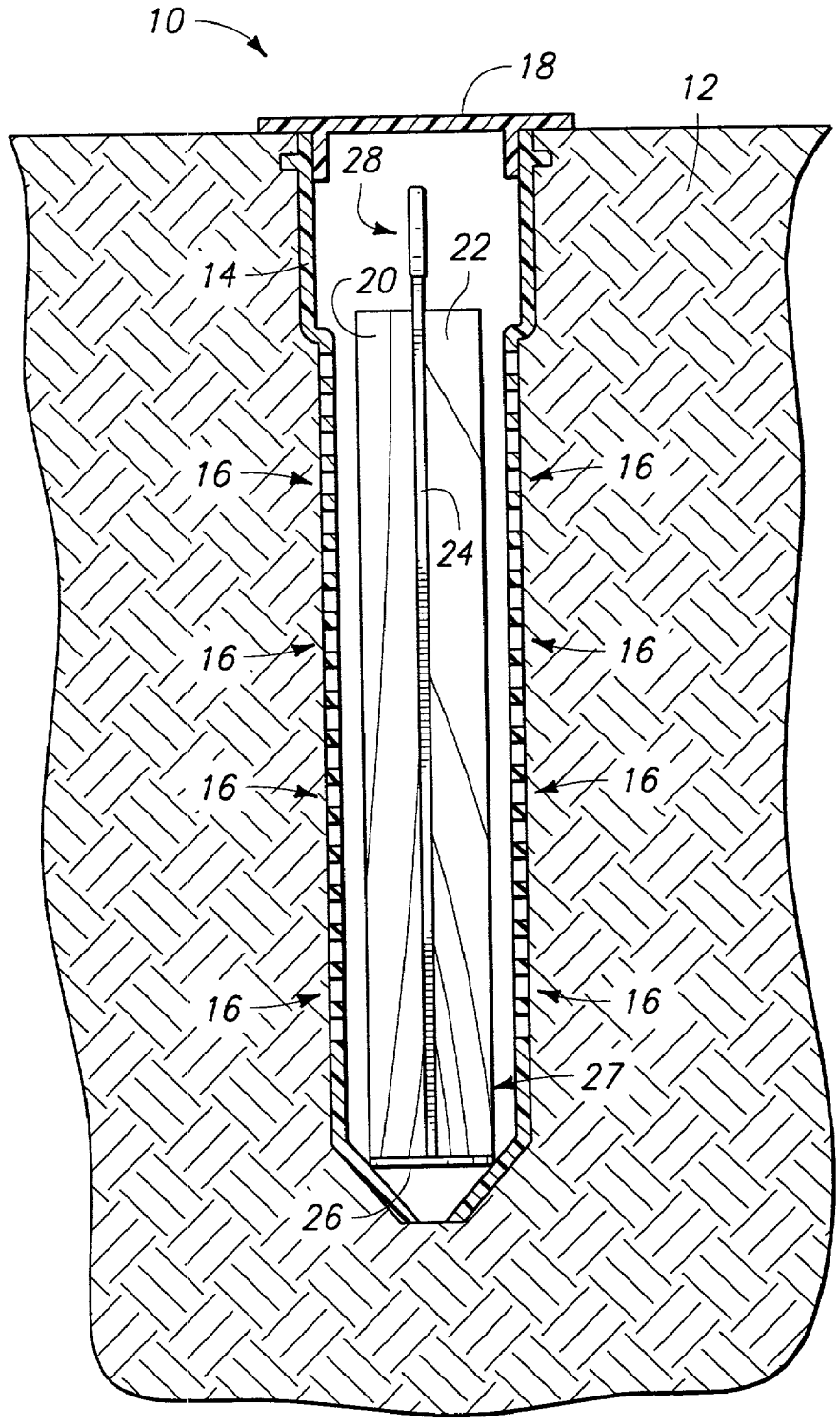


Fig 1
PRIOR ART

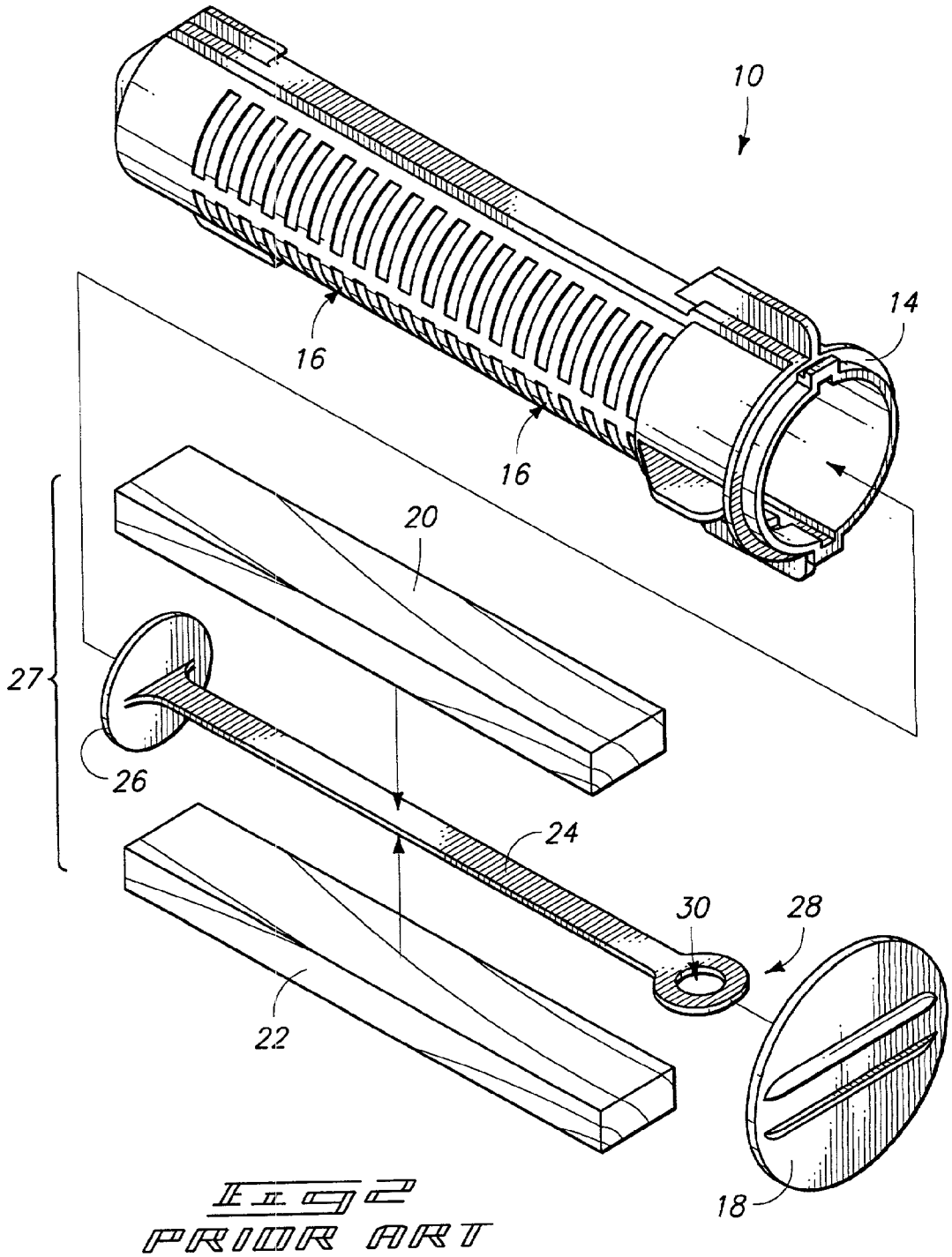


FIG 2
PRIOR ART

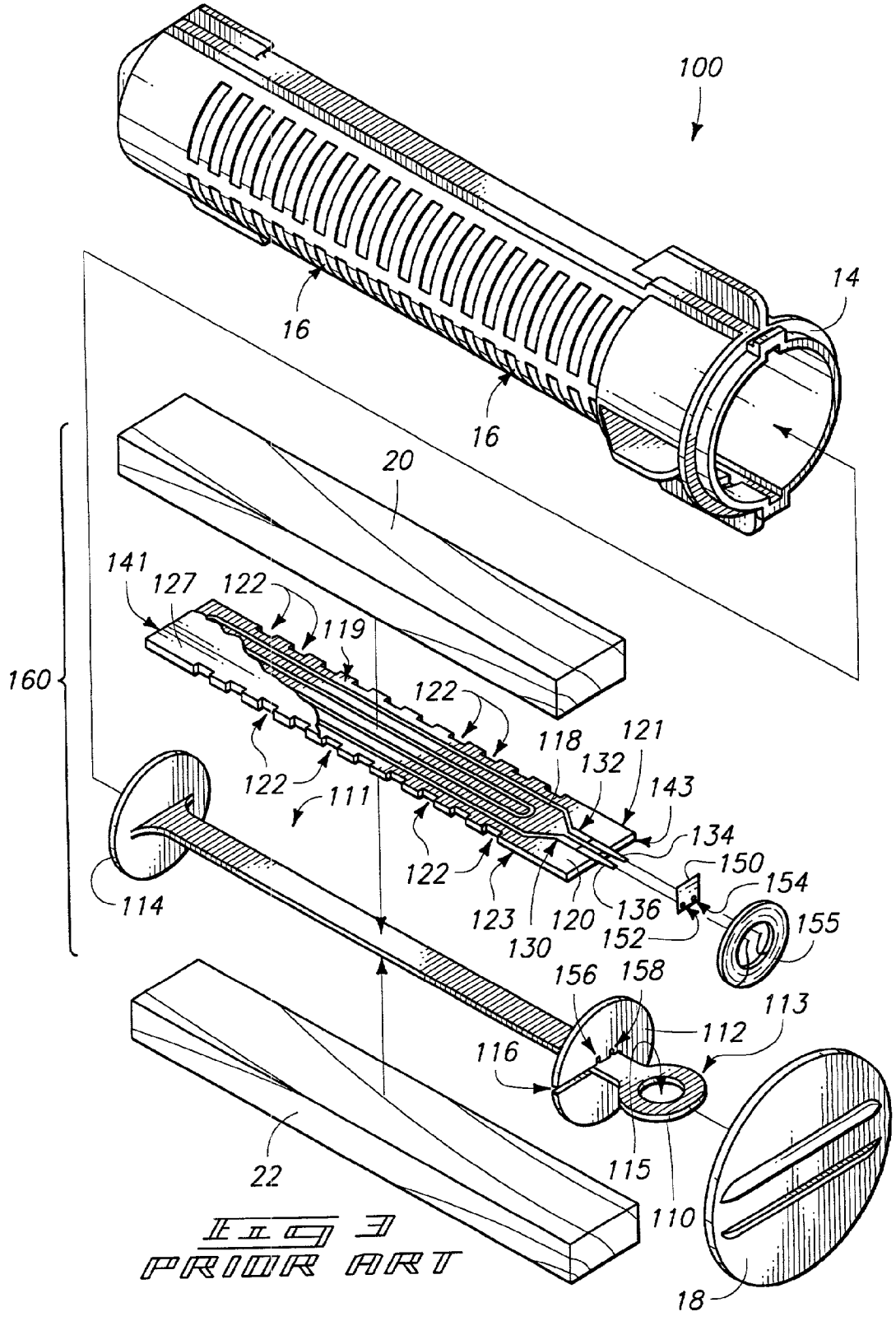


FIG 3
PRIOR ART

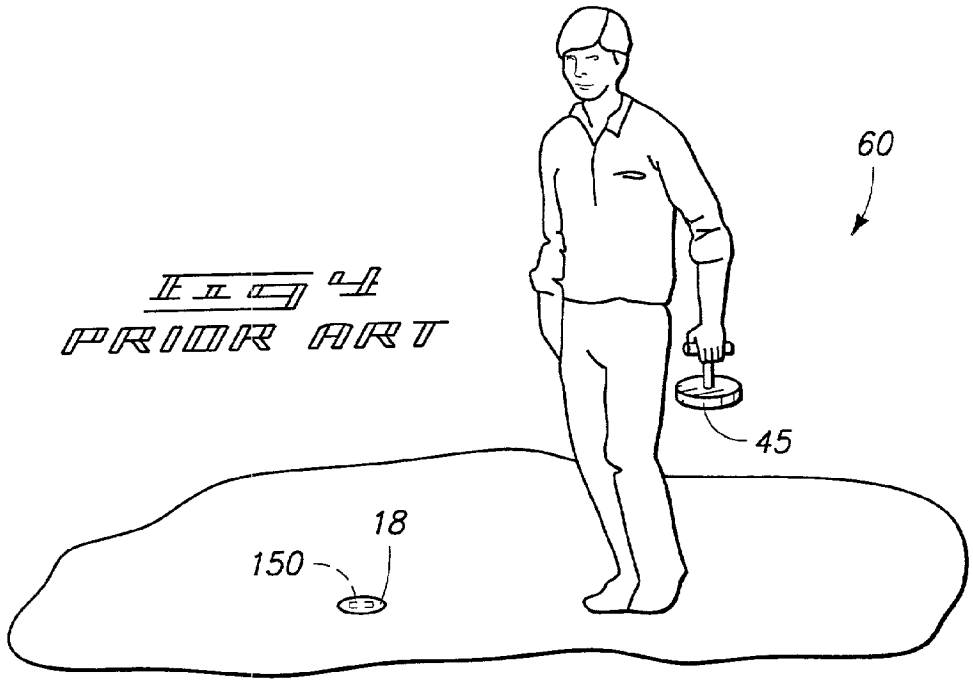


FIG 4
PRIOR ART

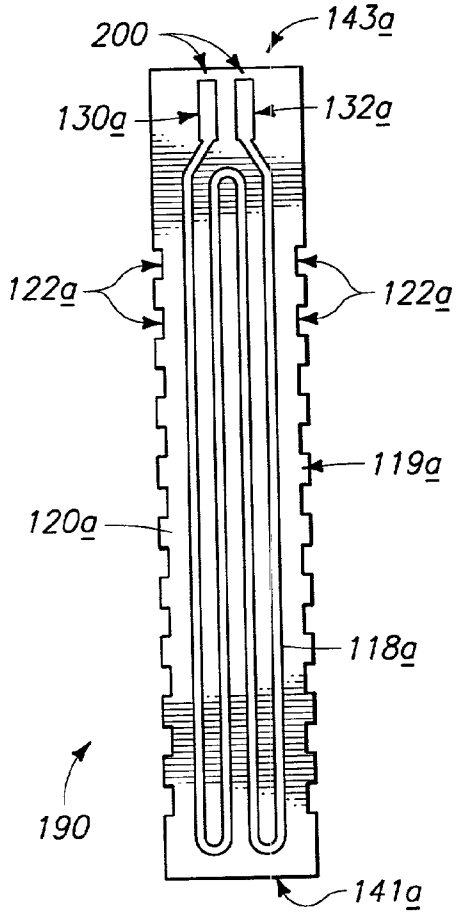


FIG 5

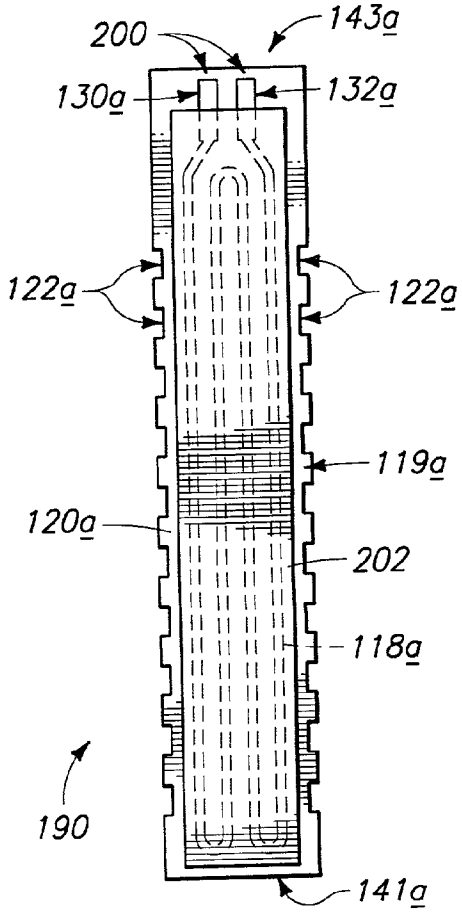


FIG 6

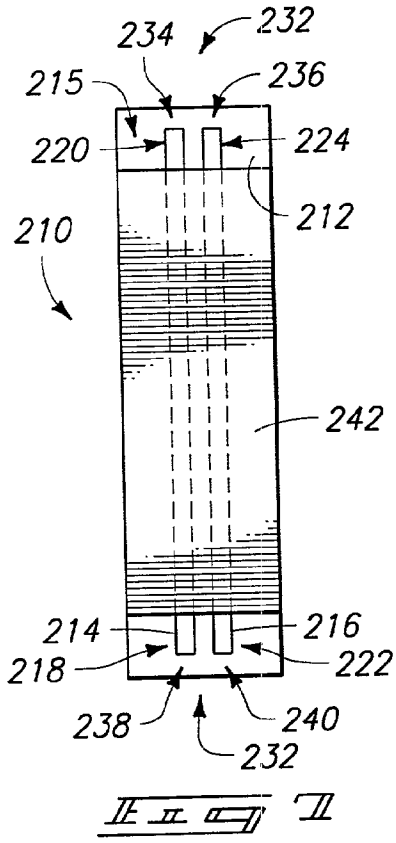


FIG. 7

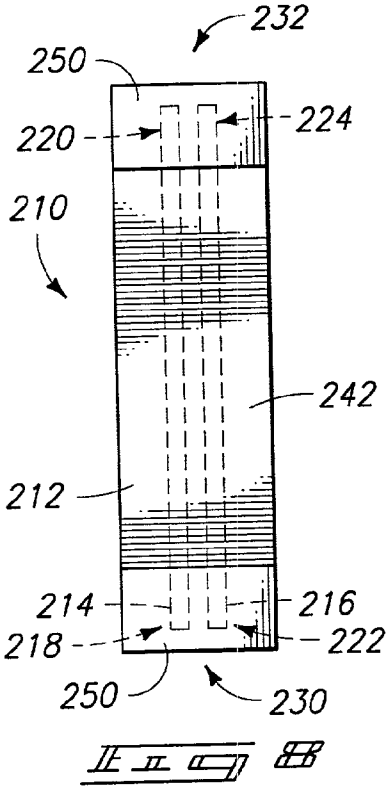


FIG. 8

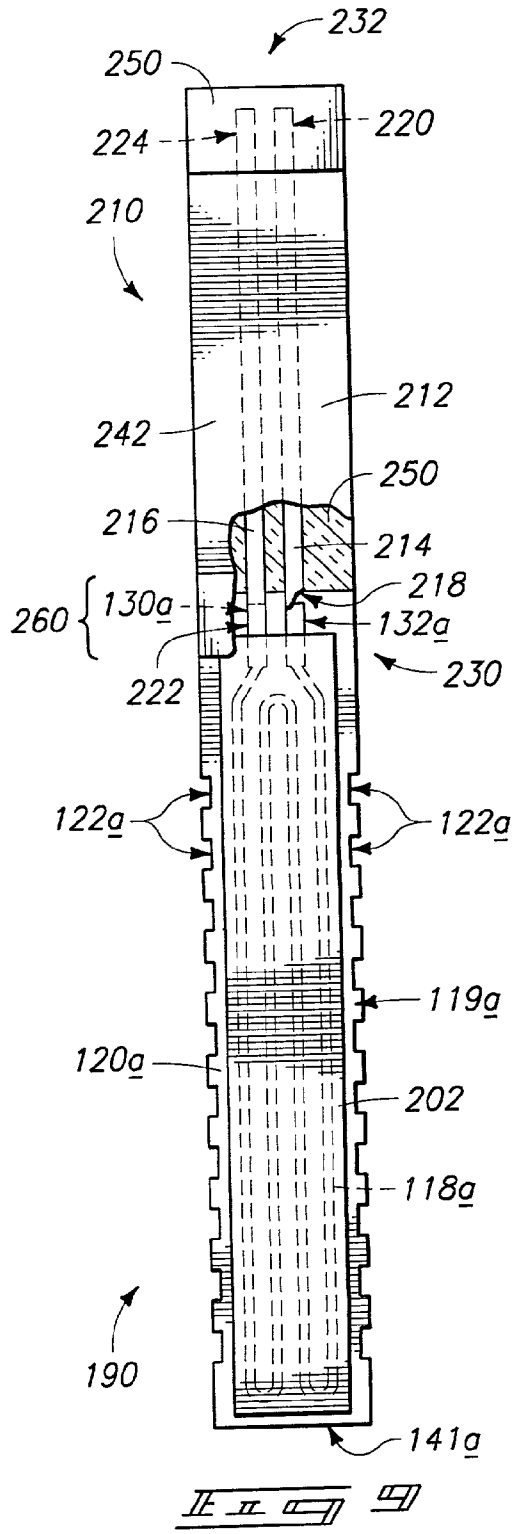


FIG. 9

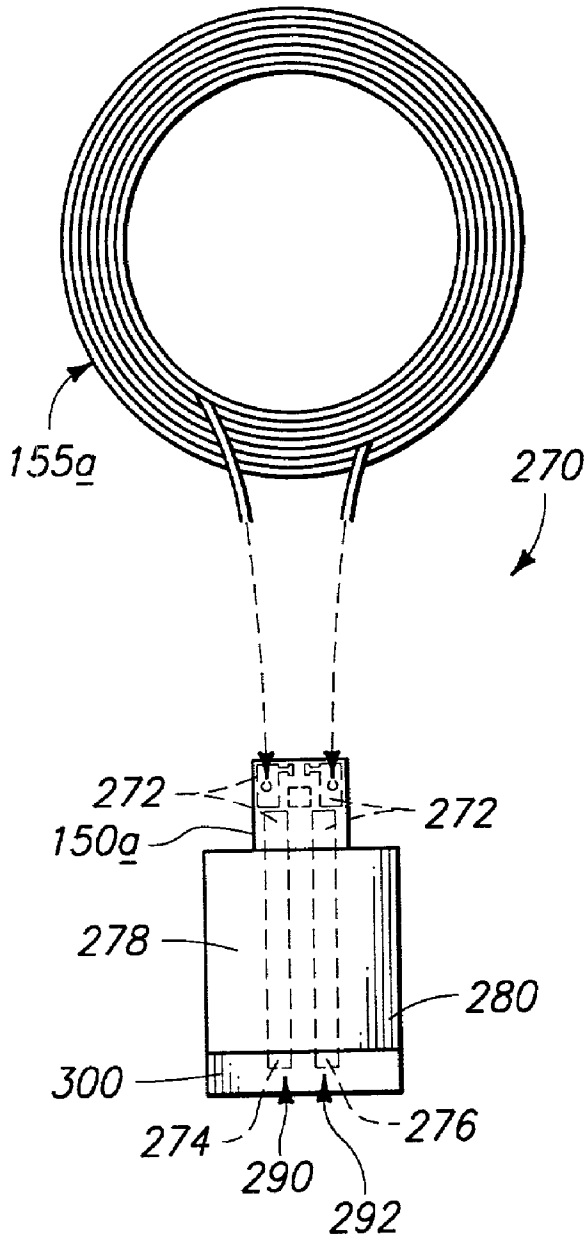


Fig. 11

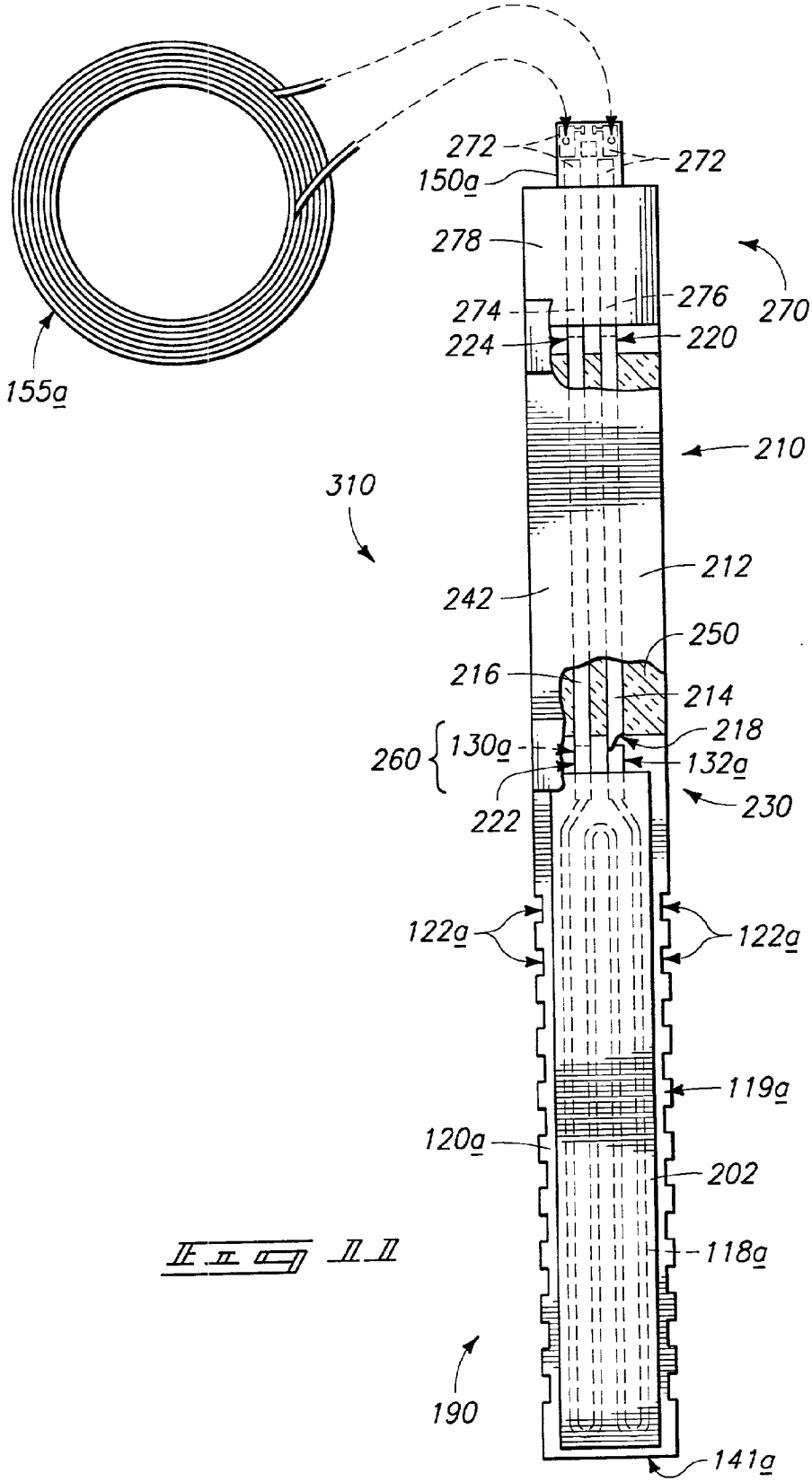

272
272
150a
278
276
270
274
224
220
155a
210
310
212
242
250
216
214
218
260
130a
132a
230
222
122a
122a
119a
120a
202
118a
190
141a

Fig. 11

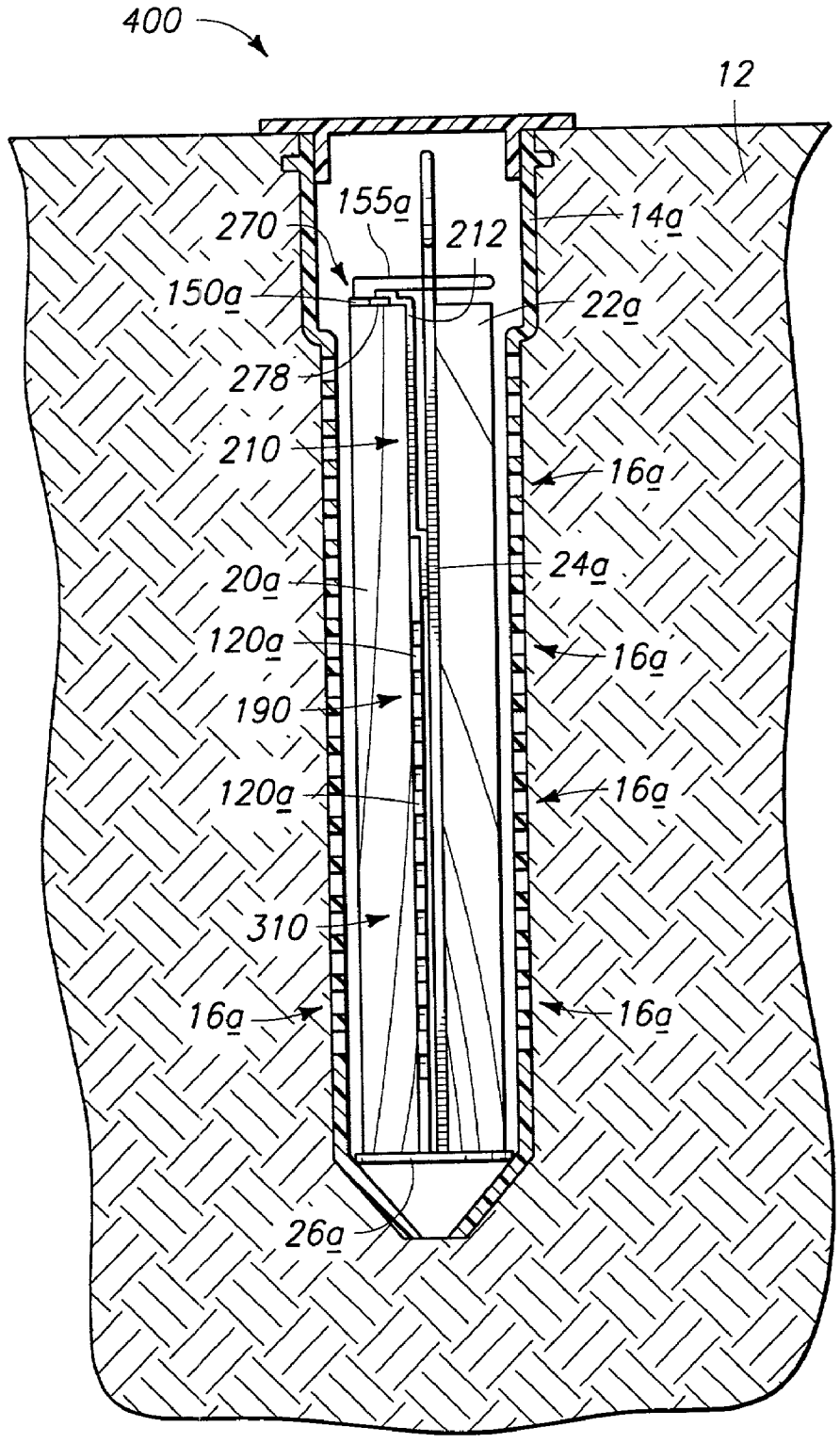

400
12
155a
212
270
14a
150a
22a
278
210
16a
24a
20a
120a
16a
190
120a
16a
310
16a
16a
26a

Fig 12

ELECTRICAL APPARATUSES, AND METHODS OF FORMING ELECTRICAL APPARATUSES

TECHNICAL FIELD

[0001] The invention pertains to electrical apparatuses, termite sensing apparatuses, and methods of forming electrical apparatuses.

BACKGROUND OF THE INVENTION

[0002] A prior art apparatus and method for detecting termite infestation is described with reference to FIGS. **1** and **2**. Specifically, a termite detection device **10** is shown in an assembled configuration and inserted within the ground **12** in **FIG. 1**, and is shown in a disassembled configuration in **FIG. 2**. Device **10** comprises an outer receptacle **14** having a plurality of orifices **16** (only some of which are labeled) extending therethrough. A cap (or a lid) **18** is provided to cover the top of receptacle **14**. Preferably, receptacle **14** is inserted into the ground to a depth at which cap **18** will rest approximately at a surface of the ground.

[0003] A pair of wooden blocks **20** and **22** are provided within receptacle **14**, and constitute "bait" for termites proximate to device **10**. A holder **24** is provided between blocks of wood **20** and **22** and comprises a shelf **26** upon which blocks **20** and **22** rest. Holder **24** and blocks **20** and **22** together comprise an assembly **27** which can be removably inserted into receptacle **14**.

[0004] Holder **24** comprises a portion **28** which protrudes upwardly beyond blocks **20** and **22** in the assembled configuration of **FIG. 1**. Portion **28** comprises an eye **30** (shown in **FIG. 2**) which can simplify removal of assembly **27** from receptacle **14** using a tool with a hook.

[0005] In operation, receptacle **14** is inserted into ground **12**, and blocks **20** and **22** are subsequently left in receptacle **14** for a period of time. Blocks **20** and **22** function as a sensing apparatus to determine if a termite infestation is present in an area proximate device **10**. Specifically, if termites are present, such will penetrate through orifice **16** to reach wooden blocks **20** and **22**. The termites will then burrow into the wooden blocks **20** and **22**.

[0006] At regular intervals, cap **18** is removed and blocks **20** and **22** withdrawn from device **14**. Blocks **20** and **22** are then surveyed for termite-inflicted damage, and possibly a presence of termites themselves.

[0007] Generally, a number of apparatuses **10** will be spread around a given location, such as, for example, a house or other wooden structure. Each of the apparatuses will be checked at a regular interval to determine if a termite infestation is occurring proximate the structure. Also, each of the devices will be mapped relative to one another, and relative to the structure. A comparison of the amount of termite-inflicted damage occurring at the respective devices **10** can then enable a person to determine an approximate localized region of any occurring termite infestation. It can be advantageous to pinpoint a localized region of infestation as such can limit an amount of pesticide utilized for destroying the termites.

[0008] Difficulties can occur in monitoring the amount of termite-inflicted damage occurring at each of the many devices **10** provided around a structure. For instance, it can be difficult to regularly and accurately document the amount of damage at each of the devices. As an example, it can be difficult to remember exactly which of the various devices correlates to a specific location on a map of the devices. As another example, it can be difficult to accurately record a reading of termite-inflicted damage associated with an individual device. As yet another example, it can be tedious and time-consuming to open all of the receptacles **14** proximate the given structure and manually check the blocks **20** and **22** within the receptacles for termite-inflicted damage.

[0009] One method of reducing the above-discussed difficulties is to provide bar codes on the lids **18** of receptacles **14**. Such bar codes can be scanned to specifically identify a particular device which can simplify correlating the devices to locations on a map of the devices. However, ascertaining an amount of termite-inflicted damage can still be time-consuming in that the receptacles still have to be opened and the blocks of wood manually checked to determine if termite-inflicted damage has occurred to the wood.

[0010] A recently proposed improvement for monitoring an amount of termite-inflicted damage in a device similar to device **10** is described with reference to FIGS. **3** and **4**. Referring to **FIG. 3**, a device **100** comprises a receptacle **14** of the type described above with reference to **FIG. 1**, and comprises a cap **18** configured to be received over an open type of receptacle **14**. Device **100** further comprises the pair of wooden blocks **20** and **22**, and a holder **110** similar to the holder **24** described above with reference to **FIG. 1**. Holder **110** can comprise, for example, plastic, and differs from holder **24** in that it comprises both a top shelf **112** and a bottom shelf **114**, whereas holder **24** only comprised a bottom shelf. In the shown embodiment, shelf **112** is configured with a slit **116** so that shelf **112** can be slid over a prior holding device (such as the device **24** of **FIG. 1**) to form the holding device **110**. Slit **116** is optional, and shelf **112** can be molded in one piece with the other components of holder **110**. Holder **110** can be considered as comprising a pillar **111** extending between shelves **112** and **114**, and an extension **113** protruding above shelf **112**. Extension **113** is configured to enable a person to lift holder **110** by the extension, and in the shown embodiment comprises an eye **115** extending therethrough. Shelf **112** can comprise an electrically insulative material, such as, for example, plastic (for instance, polypropylene).

[0011] Device **100** further comprises an electronic termite sensing loop **118** of conductive material. Loop **118** is formed on a substantially planar substrate **120**, and is preferably formed of material which can be removed by termites. Exemplary materials are printable materials comprising conductive particles, such as, for example, metal particles or carbon particles. Suitable materials are, for example, silver-filled printed thick film ink and silver-filled epoxy. An exemplary silver-filled ink is Dupont Electronics 5028™ (available from Dupont Electronics of Wilmington, Del.), which is a silver polymer conductor. Another suitable material for loop **118** is a carbon-particle-containing ink (typically the particles will consist essentially of carbon), such as, for example, a material marked by Dupont Electronics as 7102™ Carbon Polymer Conductor (available from Dupont Electronics of Wilmington, Del.). Carbon-particle-containing inks can be cheaper than other inks, better accepted by pests (i.e., apparently more palatable to the pests), and less subject to environmental damage. Further, the inclusion of

carbon inks in a circuit can lower an electrical conductivity (i.e., raise a resistivity) of the circuit. The lowered conductivity can increase the reliability of data obtained from the circuit. More specifically, the inclusion of carbon-particle-containing inks in loop **118** can render the circuit of loop **118** less susceptible to registering false negative readings if mud or water bridges an opening in the circuit.

[**0012**] Substrate **120** is preferably formed of material which can be removed by termites. Exemplary materials are polyethylene foam and polyester. The conductive material of loop **118** can be directly applied to substrate **120** using, for example, screen printing methods. Substrate **120** can be pretreated prior to applying the conductive material of loop **118** over substrate **120**. Such pretreatment can comprise, for example, flame pretreatment to promote adhesion of the conductive material to the foam.

[**0013**] An electrically insulative protective material **127** (only some of which is shown in **FIG. 3**) is provided over loop **118** and substrate **120**. Protective material **127** can protect conductive loop **118** from water, abrasion or other environmental damage. The insulative protective material can comprise, for example, a resin which is provided as a liquid and cured by exposure to one or more of heat, ultraviolet light and oxygen. A suitable insulative protective material is a material selected from the general class of epoxy resins (such as, for example, a two-part epoxy resin). Another suitable insulative protective material is a material selected for the general class of thick film inks. Exemplary insulative protective materials are Dupont 5015™ and 5018™ (available from Dupont Electronics of Wilmington, Del.), with 5018™ being an ultraviolet light curable dielectric material. Another exemplary insulative protective material is a tape adhered over loop **118** with an adhesive.

[**0014**] A termite attractant (such as, for example, a suitable pheromone) can be provided in addition to the insulative protective material. Such attractant can, for example, be formed over the insulative protective material or blended within the insulative protective material.

[**0015**] In the shown configuration, substrate **120** comprises a pair of opposing sidewall edges **121** and **123**, and a plurality of notches **122** extending into sidewall edges **121** and **123**. Notches **122** are provided to form crevices within which the termites can burrow.

[**0016**] Conductive loop **118** comprises a pair of ends (**130** and **132**), with end **132** connected to a first prong **134** and end **130** connected to a second prong **136**. Device **100** further comprises a circuit board **150** having circuitry (not shown in **FIG. 3**) supported thereby and a pair of orifices (**152** and **154**) extending therethrough. Board **150** can be considered as a circuit support. Shelf **112** has a pair of orifices **156** and **158** extending therethrough, and configured to be aligned with orifices **152** and **154** of circuit board **150**. In operation, device **100** is assembled by providing substrate **120** within holder **114** such that prongs **134** and **136** extend through orifices **156**, **158**, **152** and **154** to retain circuit board **150** atop shelf **112**. Circuit board **150** can then be adhered to shelf **112** and/or prongs **134** and **136**. Blocks **20** and **22** are subsequently provided within holder **110** to form an assembly **160** which can be removably inserted within receptacle **14**.

[**0017**] The circuitry supported by circuit board **150** can comprise at least a portion of a transponder unit and is configured to be incorporated into a passive radio frequency identification device (RFID) system. The transponder unit can comprise, for example, a parallel resonant LC circuit, with such circuit being resonant at a carrier frequency of an interrogator. The transponder unit is in electrical connection with an antenna **155** provided externally of the circuitry supported by board **150**. Exemplary circuit board/transponder unit assemblies are described in U.S. patent application Ser. No. 08/705,043, filed Aug. 29, 1996, which is assigned to the assignee of the present invention and hereby incorporated by reference.

[**0018**] Referring to **FIG. 4**, an RFID system **60** comprises the transponder supported by a structure **150** (which can comprise, for example, a circuit board) and an interrogator **45** configured to be passed over such transponder unit. Interrogator **45** comprises a coil antenna configured to stimulate the transponder unit. Such coil antenna consists of one or more coils of conductive material provided within a single plane, and can be in the form of, for example, a loop antenna.

[**0019**] In operation, interrogator **45** provides a carrier signal which powers (stimulates) the transponder unit supported by board **150** and causes a signal to be transmitted from the transponder unit. The signal comprises data which identifies the transponder unit. Such signal can also identify if the conductive loop **118** is broken. The signal is received by interrogator **45**, and eventually provided to a processing system configured to decode and interpret the data. Such processing system can be provided in a portable unit with interrogator **45**, or can be provided in a separate unit to which data from interrogator **45** is subsequently downloaded.

[**0020**] By having a signal from the transponder unit change with a break in circuit **118**, device **100** can indicate if damage has occurred to loop **118** through a signal sent to an interrogator. Such can enable persons utilizing the device to ascertain if termites are present without having to remove blocks **20** and **22** from receptacle **14**, and even without having to remove the lid **18** from receptacle **14**. Once damage to circuit **118** is detected with an interrogator, persons can remove assembly **160** and quantitate an amount of damage occurring within blocks **20** and **22** to determine an extent of termite infestation.

[**0021**] The device **160** is suitable for many applications in which it is desired to detect termite infestation. However, the device can be difficult to assemble and utilize in particular applications. Accordingly, it would be desirable to develop alternative devices for detecting termite infestation.

SUMMARY OF THE INVENTION

[**0022**] In one aspect, the invention encompasses an electrical apparatus. Such apparatus comprises a first substrate having first circuitry thereon. The first circuitry has a terminal extending therefrom, and the terminal defines a first electrical node. The apparatus further comprises a first dielectric material covering a predominate portion of the first circuitry and not covering the first electrical node. Additionally, the apparatus comprises a second substrate having second circuitry thereon. The second circuitry has a terminal extending therefrom, and such terminal defines a second electrical node. A second dielectric material covers a predominate portion of the second circuitry, but does not

cover the second electrical node. The second substrate comprises a different material than the first substrate. A portion of the second substrate is over a portion of the first substrate to define an overlap between the first and second substrates. The second electrical node overlaps the first electrical node in the overlap between the first and second substrates. A conductive material is within the overlap between the first and second substrates and electrically bonds the first and second electrical nodes to one another.

[0023] In another aspect, the invention encompasses a termite sensing apparatus. Such apparatus comprises a first substrate having a conductive loop thereon. The loop has a pair of terminals extending therefrom, with the terminals defining first and second electrical nodes. A first dielectric material covers a predominate portion of the conductive loop and defines a fluid-type protective layer over such predominate portion of the conductive loop. The first dielectric material does not cover the first and second electrical nodes. The termite sensing apparatus further comprises a second substrate having a pair of conductive lines thereon. The conductive lines are a first line and a second line, and are spaced from one another. The first conductive line has a pair of opposing ends, and the second conductive line has a pair of opposing ends. One of the opposing ends of the first conductive line defines a third electrical node, and the other of the opposing ends of the first conductive line defines a fourth electrical node. One of the opposing ends of the second conductive line defines a fifth electrical node, and the other of the opposing ends of the second conductive line defines a sixth electrical node. The third and fifth electrical nodes are proximate one another. A portion of the second substrate is over a portion of the first substrate to define an overlap between the first and second substrates. The third electrical node overlaps the first electrical node in the overlap between the first and second substrates, and the fifth electrical node overlaps the second electrical node in such overlap between the first and second substrates. A conductive material is within the overlap between the first and second substrates. Such conductive material electrically bonds the first and third electrical nodes to one another, and electrically bonds the second and fifth electrical nodes to one another.

[0024] In yet other aspects, the invention encompasses methods of forming electrical apparatuses.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025] Preferred embodiments of the invention are described below with reference to the following accompanying drawings.

[0026] **FIG. 1** is a diagrammatic, cross-sectional view of an assembled prior art termite sensing device embedded in the ground.

[0027] **FIG. 2** is a perspective view of the prior art termite sensing device of **FIG. 1** in a disassembled configuration.

[0028] **FIG. 3** is a disassembled view of a prior art electronic sensor configured to detect termite infestation.

[0029] **FIG. 4** is a diagrammatic view of a person extracting information from the prior art electronic termite sensing device of **FIG. 3**.

[0030] **FIG. 5** is a diagrammatic view of a portion of a termite sensing device encompassed by the present invention at an initial step of a method of the present invention.

[0031] **FIG. 6** is a view of the **FIG. 5** portion shown at a processing step subsequent to that of **FIG. 5**.

[0032] **FIG. 7** is a diagrammatic view of a second portion of a termite sensing device of the present invention, and shown at an initial processing step.

[0033] **FIG. 8** is a view of the **FIG. 7** portion shown at a processing step subsequent to that of **FIG. 7**.

[0034] **FIG. 9** is a diagrammatic view of an assembly comprising the first portion of **FIG. 6**, and the second portion of **FIG. 8**.

[0035] **FIG. 10** is a partially disassembled, diagrammatic view of a third portion of a termite sensing device encompassed by the present invention.

[0036] **FIG. 11** is a partially disassembled, diagrammatic view of a device comprising the assembly of **FIG. 9**, joined with the third portion of **FIG. 10**.

[0037] **FIG. 12** is a diagrammatic side view of a termite sensing device encompassed by the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0038] This disclosure of the invention is submitted in furtherance of the constitutional purposes of the U.S. Patent Laws "to promote the progress of science and useful arts" (Article 1, Section 8).

[0039] A difficulty which can occur in forming the prior art termite sensing device of **FIG. 3** is in connecting circuit support **150** with prongs **134** and **136**. It is desired to have the circuitry associated with support **150** be planar along a surface of the ground so that it can be readily stimulated by an interrogator passed along the ground surface and over such circuitry, and it is further desirable to have the circuitry of loop **118** extending perpendicular with the surface of the ground so that such circuitry is likely to be intercepted by termites passing at various depths beneath a ground surface. An apparent solution for connecting loop **118** to circuitry associated with board **150**, without having to utilize prongs **134** and **136**, is simply to bend support **120** so that part of loop **118** will extend perpendicular to a ground surface, and another part (specifically, the ends of the loop) will extend substantially parallel with the surface of the ground. However, such will require a 90° bend in foam substrate **120**, which would likely break the substrate and accordingly break the circuit of loop **118**. The present invention provides a mechanism by which circuitry can be bent to enable a connection from the conductive loop extending perpendicular to a ground surface to a transponder circuit extending parallel with the ground surface.

[0040] An assembly encompassed by the present invention is shown in **FIG. 12**, and a method of forming such assembly is described with reference to FIGS. **5-12**. In referring to FIGS. **5-12**, similar numbering will be utilized as was used in describing the prior art, with the suffix "a" used to differentiate structures of FIGS. **5-12** from the corresponding structures of the prior art FIGS. **1-4**.

[0041] Referring to **FIG. 5**, a first portion **190** of a termite sensing device of the present invention is shown. Portion **190** comprises a first substrate **120*a***. Substrate **120*a*** is similar to substrate **120** of the prior art (**FIG. 3**), and

preferably comprises a material which can be removed by termites, and can comprise, for example, polyethylene foam. Substrate **120***a* comprises notches **122***a* formed therein, and such notches can provide crevices within which termites can burrow.

[**0042**] Substrate **120***a* has an upper surface **119***a,* and a conductive material loop **118***a* is formed on such surface. Loop **118***a* can be formed utilizing methodology described above for forming loop **118** (**FIG. 3**), such as, for example, by screen printing one or both of a carbon-particle-containing ink and a metal-containing ink onto substrate **120**. Loop **118***a* has a pair of ends (or terminals) **130***a* and **132***a* extending therefrom. Terminals **130***a* and **132***a* define first and second electrical nodes, respectively. Terminals **130***a* and **132***a* comprise a thickened region of the conductive material relative to the rest of loop **118***a*. Such thickened region of conductive material can simplify connection of terminals **130***a* and **132***a* to other circuitry (described below).

[**0043**] Substrate **120***a* has a pair of opposing ends **141***a* and **143***a*. Terminals **130***a* and **132***a* are proximate end **143***a* of substrate **120***a,* but are spaced from such end by gaps **200**. Such spacing can enable terminals **130***a* and **132***a* to be completely protected from the environment by simply providing a protective covering over surface **119***a* and loop **118***a*. In contrast, if terminals **130***a* and **132***a* extended all the way to end **143***a,* the terminals would have a surface exposed over end **143***a,* and such surface could be difficult to protect from the environment. It is to be understood, however, that the shown embodiment is an exemplary embodiment, and that the invention encompasses other embodiments (not shown) having other configurations. Such other embodiments include, for example, embodiments in which terminals **130***a* and **132***a* extend to, and even beyond, end **143***a*.

[**0044**] Referring to **FIG. 6**, a dielectric material **202** is provided over a predominate portion of conductive loop **118***a* (shown in phantom view in **FIG. 6**). Specifically, dielectric material **202** covers an entirety of loop **118***a* except for the ends of terminals **130***a* and **132***a*. The uncovered ends **130***a* and **132***a* define first and second electrical nodes, respectively. Dielectric material **202** can comprise, for example, materials described above for prior art layer **127** (**FIG. 3**), and can form a fluid-tight protective layer over conductive loop **118***a*. Dielectric material **202** can have a termite attractant (such as, for example, a termite-attracting pheromone) mixed therein.

[**0045**] Referring to **FIG. 7**, a second portion **210** of a termite sensing device of the present invention is shown. Portion **210** comprises a second substrate **212** having an upper surface **215**, and pair of conductive lines **214** and **216** formed on surface **215**. Substrate **212** preferably comprises a flexible material, such as, for example, polyester or other plastics. Conductive lines **214** and **216** can comprise the same material utilized for conductive loop **118***a,* and can be printed onto substrate **212** by, for example, screen printing. In embodiments in which substrate **212** comprises an insulative material, conductive lines **214** and **216** can be printed directly onto the material. In other embodiments (not shown) substrate **212** can comprise a conductive material, and a dielectric material can be provided over such conductive material prior to the forming of conductive lines **214** and **216** over the substrate. Conductive lines **214** and **216** together comprise a circuit pattern formed over substrate **212**. Conductive line **214** can be referred to as a first conductive line, and conductive line **216** can be referred to as a second conductive line.

[**0046**] First conductive line **214** comprises a pair of ends (**218** and **220**), and second conductive line **216** comprises another pair of ends (**222** and **224**). End **222** of second conductive line **216** is proximate end **218** of first conductive line **214**, and end **224** of second conductive line **216** is proximate end **220** of first conductive line **214**. Ends **218**, **220**, **222** and **224** define electrical nodes. Electrical nodes **222** and **224** are referred to herein as a third electrical node and fourth electrical node, respectively, and electrical nodes **218** and **220** are referred to herein as a fifth and sixth electrical node, respectively.

[**0047**] Substrate **212** comprises a pair of opposing ends **230** and **232**. Conductive lines **214** and **216** are spaced from end **230** by gaps **234** and **236**, respectively, and are spaced from end **232** by gaps **238** and **240**, respectively.

[**0048**] A dielectric material **242** is formed over a predominate portion of circuitry **218**. Dielectric material **242** can comprise the same materials described above with reference to dielectric material **127** of the prior art (**FIG. 3**). Dielectric material **242** does not cover the ends of conductive lines **214** and **216**, and accordingly leaves the third, fourth, fifth and sixth electrical nodes exposed. Dielectric material **242** can form a fluid-tight protective coating over the predominate portion of **218** covered by such dielectric material.

[**0049**] Referring to **FIG. 8**, a conductive material **250** is provided over ends **218**, **220**, **222** and **224**. Conductive material **250** can comprise, for example, an adhesive having conductive particles dispersed therein. A suitable adhesive is 3M #9703™ electrically conductive adhesive transfer tape (Z-axis tape), available from 3M Corporation of St. Paul, Minn. The material is referred to as a Z-axis adhesive because such material conducts electricity only in a Z-axis direction. Accordingly, the material will not form a short between conductive lines **214** and **216**, but can form electrical connections from conductive lines **214** and **216** to other circuitry formed thereover. In the preferred embodiment, the conductive adhesive overlaps the edges of dielectric material **242**, and extends from the edges to ends **230** and **232** of substrate **212**. The Z-axis adhesive **250** and dielectric material **242** thus can together comprise a fluid-tight seal which extends entirely over conductive lines **214** and **216**, as well as entirely over the surface **215** of substrate **212** (**FIG. 7**).

[**0050**] In embodiments in which the conductive adhesive **250** comprises a Z-axis tape, the adhesive will be provided with a release liner adhered thereto. Such release liner can be left in place in forming the construction shown in **FIG. 8**.

[**0051**] Referring to **FIG. 9**, the assembly **210** of **FIG. 8** is adhered to the assembly **190** of **FIG. 6** utilizing the adhesive **250** proximate end **230**. (In embodiments in which conductive adhesive **250** comprises a Z-axis tape, the release liner over Z-axis tape **250** proximate end **230** will be removed prior to forming the construction of **FIG. 9**.) The assembly **210** is inverted relative to assembly **190** in the **FIG. 9** construction such that so-called upper surface **215** (**FIG. 7**)

of substrate **212** faces downwardly toward upper surface **119***a* of substrate **120***a*. Such enables electrical connection of nodes **218** and **222** with nodes **132***a* and **130***a*, respectively.

[**0052**] Substrate **212** overlaps with substrate **120***a* in an overlap region **260**. Also, third electrical node **222** overlaps with first electrical node **130***a* in overlap region **260**, and fifth electrical node **218** overlaps with second electrical node **132***a* in such overlap region. Conductive material **250** bonds third electrical node **222** to first electrical node **130***a*, and fifth electrical node **218** to second electrical node **132***a*. In embodiments in which material **250** comprises a Z-axis adhesive, such material can form a conductive bond between the first and third nodes, as well as between the second and fifth nodes, without causing a short between conductive lines **214** and **216**.

[**0053**] In the shown embodiment, dielectric material **202** and dielectric material **242** both extend into the overlap region **260**. Such can assist in forming a water-tight seal within overlap region **260**. A water-tight seal is desired to prevent water from leaking between lines **214** and **216**, and causing an electrical short between such lines.

[**0054**] Referring to **FIG. 10**, a transponder assembly **270** is shown in a partially disassembled view. Transponder assembly **270** comprises a circuit supporting substrate **150***a*, and circuitry **272** (shown in phantom due to its being beneath a layer **280**) formed over substrate **150***a*. Circuitry **272** is preferably configured to define at least a portion of a transponder device. An antenna **155***a* connects to circuitry **272** and extends over substrate **150***a*.

[**0055**] Circuitry **272** is connected with a pair of terminals **274** and **276** (shown in phantom due to their being beneath layers **280** and **300**). A substrate **278** is joined to board **150***a*, and supports terminals **274** and **276**. Substrate **278** is preferably a flexible material, such as, for example, polyethylene or other forms of plastic. Terminals **274** and **276** can comprise a printed conductive material, and can comprise, for example, the materials discussed above for forming conductive loop **118***a*. Alternatively, terminals **274** and **276** can comprise, for example, metal wires.

[**0056**] A dielectric material **280** is shown formed over substrates **150***a* and **278**. Dielectric material **280** encapsulates circuitry **272** and predominate portions of conductive lines **274** and **276**. Dielectric material **280** can comprise, for example, the materials described above for utilization in dielectric material **202**.

[**0057**] Terminals **274** and **276** comprise ends **290** and **292**, respectively. Ends **290** and **292** define seventh and eighth electrical nodes, respectively. Dielectric material **280** does not cover such electrical nodes. A conductive adhesive **300** is provided over the electrical nodes defined by ends **290** and **292**, as well as over a portion of substrate **278** proximate ends **290** and **292** (i.e., a terminal, or end, portion of substrate **278**). Conductive adhesive **300** can comprise, for example, a Z-axis adhesive of the type described above for material **250**.

[**0058**] Referring to **FIG. 11**, assembly **270** is combined with assemblies **190** and **210** to form a termite sensing device **310**. Preferably, the transponder encompassed by circuitry **272** is configured to emit a first signal when conductive loop **118***a* is intact, and a second signal if conductive loop **118***a* is broken, with the second signal being different than the first signal.

[**0059**] It is noted that one or the other of conductive adhesive **300** on assembly **270** and conductive adhesive **250** proximate end **232** of assembly **210** is optional, in that conductive adhesive applied to either of assemblies **270** or **210** can be utilized to bind the assemblies **270** and **210** together. It is further noted that substrate **278** and terminals **274** and **276** are optional, and that circuitry **272** can be directly bonded to ends **220** and **224** of lines **214** and **216**.

[**0060**] Referring to **FIG. 12**, sensing device **310** is shown incorporated into a termite detecting device **400**. The relative scales of portions **190**, **210** and **270** are changed in the view of **FIG. 12** relative to FIGS. **5-11**, with the relative scales in **FIG. 12** being a more preferred application of the invention, and the relative scales of FIGS. **5-11** being utilized for illustration purposes.

[**0061**] **FIG. 12** shows sensing device **310** provided between a pair of wooden blocks **20***a* and **22***a*, and adjacent a holder **24***a* that is also provided between the wooden blocks. Substrate **190** is between blocks **20***a* and **22***a*, whereas flexible substrate **210** extends from between blocks **20***a* and **22***a* to over block **20***a*. Flexible substrate **210** is bent around a corner of block **20***a*. The overlap of substrate **212** relative to substrates **120***a* and **278** can be seen in the view of **FIG. 12**.

[**0062**] It is noted that antenna **155** is shown overlapping substrate **212**, and received over both of blocks **20***a* and **22***a*. Such can be accomplished by sliding the loop antenna over an upper portion of holder **24***a*. Antenna **155** can be joined to circuitry **272** (**FIG. 10**) before joining substrate **278** with substrate **212**, after joining substrate **278** with substrate **212**, and/or after providing the rest of assembly **310** between blocks **20***a* and **22***a*.

[**0063**] In preferred embodiments, substrate **212** is formed of a more flexible material than substrate **190**. Specifically, substrate **190** is preferably formed of a relatively firm foam, which can be removed by termites, whereas substrate **212** is preferably formed of a relatively flexible plastic material, such as, for example, polyethylene. Substrate **212** can then be bent around within receptacle **14***a* without breaking the substrate, and accordingly without breaking circuitry formed over the substrate.

[**0064**] In compliance with the statute, the invention has been described in language more or less specific as to structural and methodical features. It is to be understood, however, that the invention is not limited to the specific features shown and described, since the means herein disclosed comprise preferred forms of putting the invention into effect. The invention is, therefore, claimed in any of its forms or modifications within the proper scope of the appended claims appropriately interpreted in accordance with the doctrine of equivalents.

CLAIMS:

1. An electrical apparatus comprising:

a first substrate having first circuitry thereon, the first circuitry having a terminal extending therefrom, said terminal of the first circuitry defining a first electrical node;

a second substrate having second circuitry thereon, the second circuitry having a terminal extending therefrom, said terminal of the second circuitry defining a second electrical node, the second substrate comprising a different material than the first substrate, a portion of the second substrate being over a portion of the first substrate to define an overlap between the first and second substrates, the second substrate being more flexible than the first substrate; and

a conductive material being within the overlap between the first and second substrates and electrically bonding the first and second electrical nodes to one another.

2. The apparatus of claim 1 wherein the first substrate is foam and the second substrate is polyester.

3. The apparatus of claim 1 further comprising third circuitry joined to the second substrate, the third circuitry comprising a radio frequency identification device transponder and being electrically connected to the first circuitry through the second circuitry.

4. The apparatus of claim 1 wherein the first substrate is foam and the second substrate is polyester, and further comprising third circuitry joined to the second substrate, the third circuitry comprising a radio frequency identification device transponder and being electrically connected to the first circuitry through the second circuitry.

5. An electrical apparatus comprising:

a first substrate having first circuitry thereon, the first circuitry having a terminal extending therefrom, said terminal of the first circuitry defining a first electrical node;

a first dielectric material covering a predominate portion of the first circuitry and not covering the first electrical node;

a second substrate having second circuitry thereon, the second circuitry having a terminal extending therefrom, said terminal of the second circuitry defining a second electrical node, the second substrate comprising a different material than the first substrate, a portion of the second substrate being over a portion of the first substrate to define an overlap between the first and second substrates;

a second dielectric material covering a predominate portion of the second circuitry and not covering the second electrical node, the second electrical node overlapping the first electrical node in the overlap between the first and second substrates; and

a conductive material being within the overlap between the first and second substrates and electrically bonding the first and second electrical nodes to one another.

6. The apparatus of claim 5 wherein:

the first circuitry comprises a conductive loop;

the second circuitry comprises a pair of spaced conductive lines;

the conductive loop comprises a pair of ends, one of the ends being the first terminal and an other of the ends being a third terminal;

one of the pair lines comprises an end that is the second terminal;

an other of the pair of lines comprises an end that is a fourth terminal; and

the third terminal overlaps the fourth terminal in the overlap between the first and second substrates and is bonded to the fourth terminal by the conductive material.

7. The apparatus of claim 5 wherein the conductive material comprises a conductive adhesive.

8. The apparatus of claim 5 wherein the conductive material comprises a Z-axis adhesive.

9. The apparatus of claim 5 wherein the first and second dielectric materials are the same as one another.

10. The apparatus of claim 5 wherein the first and second dielectric materials extend into the overlap between the first and second substrates, and wherein the conductive material overlaps the first and second dielectric materials.

11. The apparatus of claim 5 wherein the first substrate is more rigid than the second substrate.

12. The apparatus of claim 11 wherein the first substrate comprises foam and the second substrate comprises plastic.

13. The apparatus of claim 11 wherein the first substrate comprises foam and the second substrate comprises polyester.

14. A termite sensing apparatus comprising:

a first substrate having a conductive loop thereon, the loop having a pair of terminals extending therefrom, said terminals defining first and second electrical nodes;

a first dielectric material covering a predominate portion of the conductive loop and defining a fluid-tight protective layer over said predominate portion of the conductive loop, the first dielectric material not covering the first and second electrical nodes;

a second substrate having a pair of conductive lines thereon, the conductive lines being a first line and a second line, and being spaced from one another, the first conductive line having a pair of opposing ends and the second conductive line having a pair of opposing ends; one of the opposing ends of the first conductive line defining a third electrical node and the other of the opposing ends of the first conductive line defining a fourth electrical node; one of the opposing ends of the second conductive line defining a fifth electrical node and the other of the opposing ends of the second conductive line defining a sixth electrical node; the third and fifth electrical nodes being proximate one another; a portion of the second substrate being over a portion of the first substrate to define an overlap between the first and second substrates;

a second dielectric material covering predominate portions of the first and second conductive lines and defining a fluid-tight protective layer over said predominate portions of the first and second conductive lines, the second dielectric material not covering the third, fourth, fifth and sixth electrical nodes; the third electrical node overlapping the first electrical node in the overlap between the first and second substrates, and the fifth electrical node overlapping the second electrical node in the overlap between the first and second substrates; and

a conductive material being within the overlap between the first and second substrates; the conductive material

electrically bonding the first and third electrical nodes to one another, and electrically bonding the second and fifth electrical nodes to one another.

15. The apparatus of claim 14 wherein the conductive material comprises a conductive adhesive.

16. The apparatus of claim 14 wherein the conductive material comprises a Z-axis adhesive.

17. The apparatus of claim 14 wherein the first and second dielectric materials are the same as one another.

18. The apparatus of claim 14 further comprising a termite attractant proximate the conductive loop.

19. The apparatus of claim 18 wherein the termite attractant comprises a pheromone.

20. The apparatus of claim 14 wherein the first and second dielectric materials extend into the overlap between the first and second substrates, and wherein the conductive material overlaps the first and second dielectric materials.

21. The apparatus of claim 14 wherein the first substrate is more rigid than the second substrate.

22. The apparatus of claim 21 wherein the first substrate comprises foam and the second substrate comprises plastic.

23. The apparatus of claim 21 wherein the first substrate comprises foam and the second substrate comprises polyester.

24. The apparatus of claim 14 further comprising a pair of wooden blocks having a gap therebetween, at least a portion of the conductive loop and first substrate being within the gap.

25. The apparatus of claim 14 further comprising a pair of wooden blocks having a gap therebetween, at least a portion of the conductive loop and first substrate being within the gap, and at least a portion of the second substrate being out of the gap and bending around at least a portion of at least one of the blocks.

26. The apparatus of claim 14 further comprising a transponder, the transponder having a pair of leads extending therefrom, the leads being connected with the fourth and sixth electrical nodes, respectively.

27. The apparatus of claim 26 wherein:

the leads extending from the transponder are on a third substrate;

a portion of the third substrate comprising the leads overlaps the fourth and sixth nodes and a region of the second substrate proximate the fourth and sixth nodes; and

the leads are bonded to the fourth and sixth nodes with a conductive material that is within an overlap of the second and third substrates.

28. The apparatus of claim 27 wherein the conductive material within the overlap of the second and third substrates is the same as the conductive material within the overlap of the first and second substrates.

29. A method of forming an electrical apparatus, comprising:

providing a first substrate having first circuitry thereon;

forming a first dielectric material over a predominate portion of the first circuitry, the first dielectric material not covering a portion of the first circuitry;

providing a second substrate having second circuitry thereon, the second substrate comprising a different material than the first substrate;

forming a second dielectric material over a predominate portion of the second circuitry, the second dielectric material not covering a portion of the second circuitry;

placing the first and second substrates relative to one another with a portion of the second substrate being over a portion of the first substrate to define an overlap between the first and second substrates, the uncovered portion of the second circuitry overlapping the uncovered portion of the first circuitry in the overlap between the first and second substrates; and

providing a conductive material within the overlap between the first and second substrates to electrically bond the uncovered portions of the first and second circuitries to one another.

30. The method of claim 29 wherein the conductive material comprises a conductive adhesive.

31. The method of claim 29 wherein the conductive material comprises a Z-axis adhesive.

32. The method of claim 29 wherein the first and second dielectric materials are the same as one another.

33. The method of claim 29 wherein the first and second dielectric materials extend into the overlap between the first and second substrates, and wherein the conductive material overlaps the first and second dielectric materials.

34. The method of claim 29 wherein the first substrate is more rigid than the second substrate.

35. The method of claim 34 wherein the first substrate comprises foam and the second substrate comprises plastic.

36. The method of claim 34 wherein the first substrate comprises foam and the second substrate comprises polyester.

37. A method of forming an electrical apparatus, comprising:

providing a first substrate;

printing first circuitry on the first substrate, the first circuitry having a terminal extending therefrom, said terminal of the first circuitry defining a first electrical node;

forming a first dielectric material over a predominate portion of the first circuitry, the first dielectric material not covering the first electrical node;

providing a second substrate;

forming second circuitry on the second substrate, the second circuitry having a terminal extending therefrom, said terminal of the second circuitry defining a second electrical node, the second substrate comprising a different material than the first substrate;

forming a second dielectric material over a predominate portion of the second circuitry, the second dielectric material not being over the second electrical node;

placing the first and second substrates relative to one another with a portion of the second substrate being over a portion of the first substrate to define an overlap between the first and second substrates, the second electrical node overlapping the first electrical node in the overlap between the first and second substrates; and

providing a conductive material within the overlap between the first and second substrates to electrically bond the first and second electrical nodes to one another.

38. The method of claim 37 wherein:

the first circuitry comprises a conductive loop and is formed by printing a conductive ink on the first substrate;

the second circuitry comprises a pair of spaced conductive lines and is formed by printing a conductive ink on the second substrate;

the conductive loop comprises a pair of ends, one of the ends being the first terminal and an other of the ends being a third terminal;

one of the pair lines comprises an end that is the second terminal;

an other of the pair of lines comprises an end that is a fourth terminal; and

the third terminal overlaps the fourth terminal in the overlap between the first and second substrates and is bonded to the fourth terminal by the conductive material.

39. The method of claim 37 wherein the conductive material comprises a conductive adhesive.

40. The method of claim 37 wherein the conductive material comprises a Z-axis adhesive.

41. The method of claim 37 wherein the first and second dielectric materials are the same as one another and are printed on the first and second substrates, respectively.

42. The method of claim 37 wherein the first and second dielectric materials extend into the overlap between the first and second substrates, and wherein the conductive material overlaps the first and second dielectric materials.

43. The method of claim 37 wherein the first substrate is more rigid than the second substrate.

44. The method of claim 43 wherein the first substrate comprises foam and the second substrate comprises plastic.

45. The method of claim 43 wherein the first substrate comprises foam and the second substrate comprises polyester.

46. A method of forming a termite sensing apparatus, comprising:

providing a first substrate having a conductive loop thereon, the loop having a pair of terminals extending therefrom, said terminals defining first and second electrical nodes;

forming a first dielectric material over a predominate portion of the conductive loop, the first dielectric material not covering the first and second electrical nodes;

providing a second substrate having a pair of conductive lines thereon, the conductive lines being a first line and a second line, and being spaced from one another; the first conductive line having a pair of opposing ends and the second conductive line having a pair of opposing ends; one of the opposing ends of the first conductive line defining a third electrical node and the other of the opposing ends of the first conductive line defining a fourth electrical node; one of the opposing ends of the second conductive line defining a fifth electrical node and the other of the opposing ends of the second conductive line defining a sixth electrical node; the third and fifth electrical nodes being proximate one another;

forming a second dielectric material over predominate portions of the first and second conductive lines, the second dielectric material not covering the third, fourth, fifth and sixth electrical nodes;

placing the first and second substrates relative to one another with a portion of the second substrate being over a portion of the first substrate to define an overlap between the first and second substrates; the third electrical node overlapping the first electrical node in the overlap between the first and second substrates, and the fifth electrical node overlapping the second electrical node in the overlap between the first and second substrates; and

providing a conductive material within the overlap between the first and second substrates; the conductive material electrically bonding the first and third electrical nodes to one another, and electrically bonding the second and fifth electrical nodes to one another.

47. The method of claim 46 wherein the conductive material comprises a conductive adhesive.

48. The method of claim 46 wherein the conductive material comprises a Z-axis adhesive.

49. The method of claim 46 wherein the first and second dielectric materials are the same as one another.

50. The method of claim 46 further comprising providing a termite attractant proximate the conductive loop.

51. The method of claim 50 wherein the termite attractant comprises a pheromone.

52. The method of claim 46 wherein the first and second dielectric materials extend into the overlap between the first and second substrates, and wherein the conductive material overlaps the first and second dielectric materials.

53. The method of claim 46 wherein the first substrate is more rigid than the second substrate.

54. The method of claim 53 wherein the first substrate comprises foam and the second substrate comprises plastic.

55. The method of claim 53 wherein the first substrate comprises foam and the second substrate comprises polyester.

56. The method of claim 46 further comprising:

providing a pair of wooden blocks; and

placing at least a portion of the conductive loop and first substrate between the wooden blocks.

57. The method of claim 46 further comprising:

providing a pair of wooden blocks;

placing at least a portion of the conductive loop and first substrate between the wooden blocks; and

bending at least a portion of the second substrate around at least a portion of at least one of the wooden blocks.

58. The method of claim 46 further comprising:

providing a transponder, the transponder having a pair of leads extending therefrom; and

connecting the leads with the fourth and sixth electrical nodes, respectively.

59. The method of claim 58 further comprising:

providing the leads extending from the transponder on a third substrate;

placing the third substrate relative to the second substrate with a portion of the third substrate overlapping a region of the second substrate proximate the fourth and sixth nodes, the leads overlapping the fourth and sixth nodes within the overlap of the second and third substrates; and

bonding the leads to the fourth and sixth nodes with a conductive material that is within an overlap of the second and third substrates.

60. The method of claim 59 wherein the conductive material within the overlap of the second and third substrates is the same as the conductive material within the overlap of the first and second substrates.

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