



US 20090079451A1

(19) **United States**  
(12) **Patent Application Publication**  
**Campbell et al.**

(10) **Pub. No.: US 2009/0079451 A1**  
(43) **Pub. Date: Mar. 26, 2009**

(54) **HIGH FREQUENCY PROBE**

**Related U.S. Application Data**

(75) Inventors: **Richard L. Campbell**, Portland, OR (US); **Michael Andrews**, Hillsboro, OR (US); **Lynh Bui**, Tigard, OR (US)

(63) Continuation of application No. 11/410,783, filed on Apr. 24, 2006, now Pat. No. 7,449,899.  
(60) Provisional application No. 60/688,821, filed on Jun. 8, 2005.

Correspondence Address:  
**CHERNOFF, VILHAUER, MCCLUNG & STENZEL**  
**1600 ODS TOWER, 601 SW SECOND AVENUE**  
**PORTLAND, OR 97204-3157 (US)**

**Publication Classification**

(51) **Int. Cl.**  
**G01R 1/067** (2006.01)  
(52) **U.S. Cl.** ..... **324/754**

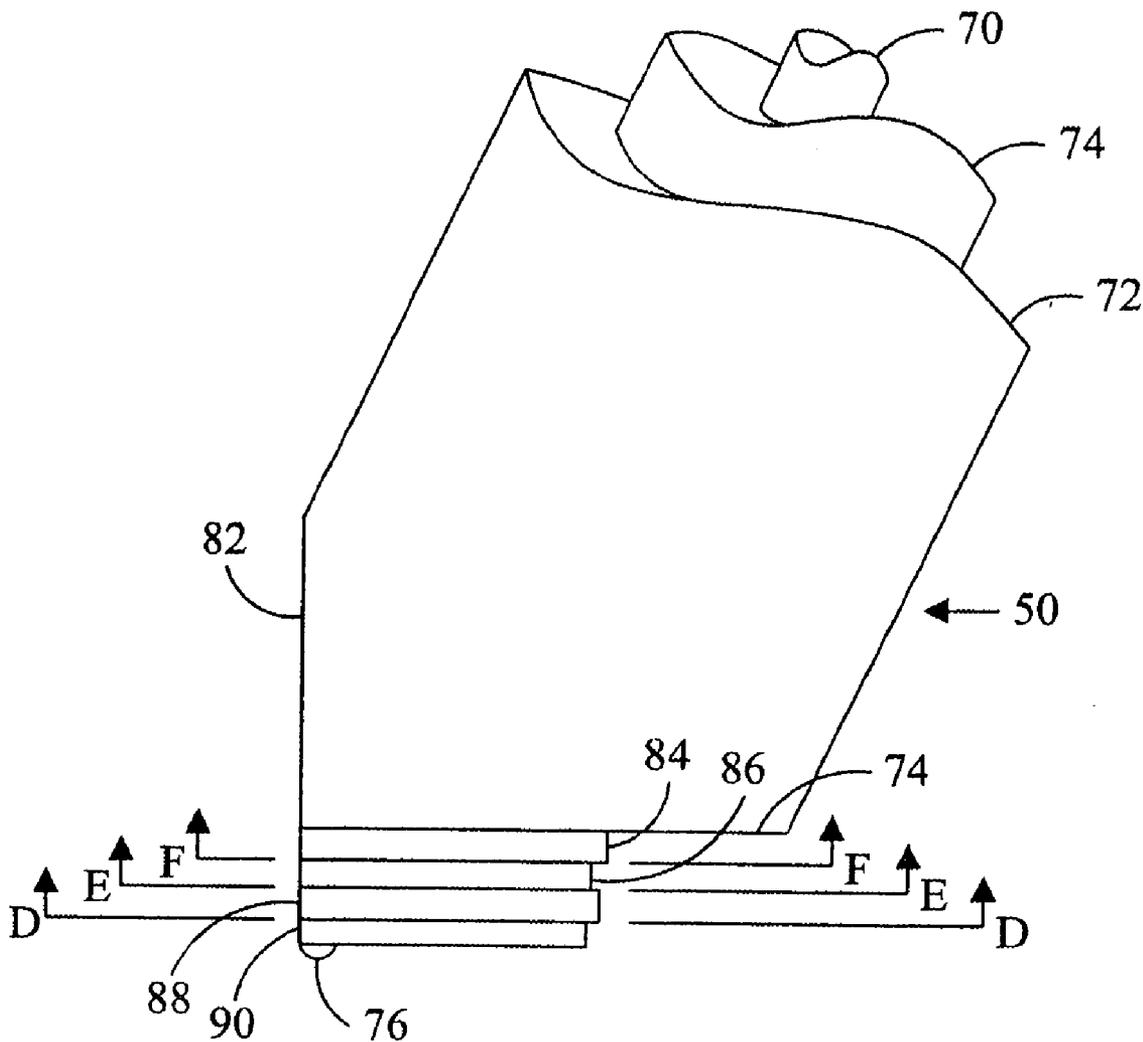
(73) Assignee: **Cascade Microtech, Inc.**

(57) **ABSTRACT**

(21) Appl. No.: **12/283,544**

A high frequency probe has contact tips located within the periphery of a terminal section of a coaxial cable and shielded by a ground conductor of the coaxial cable.

(22) Filed: **Sep. 12, 2008**



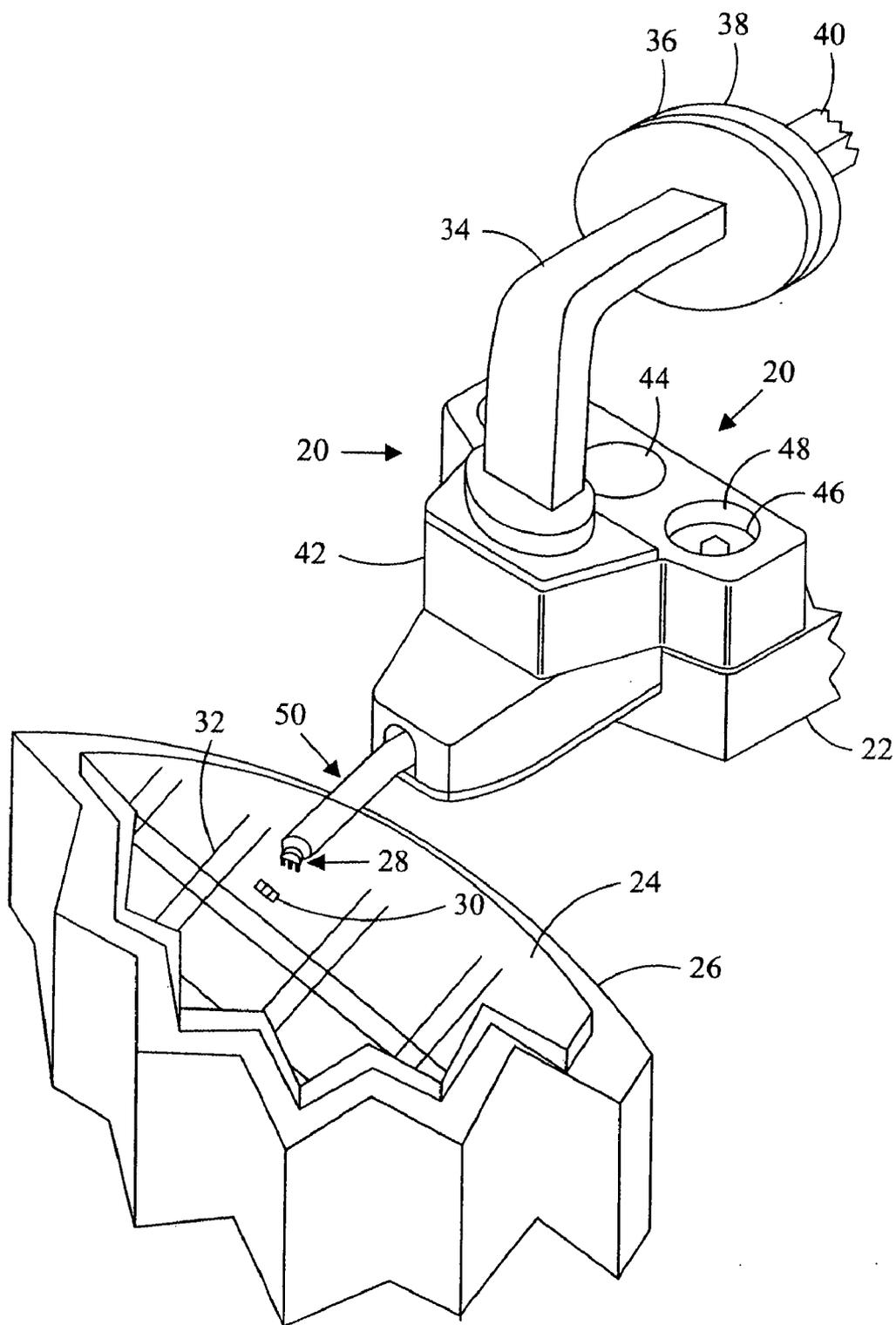


FIG. 1

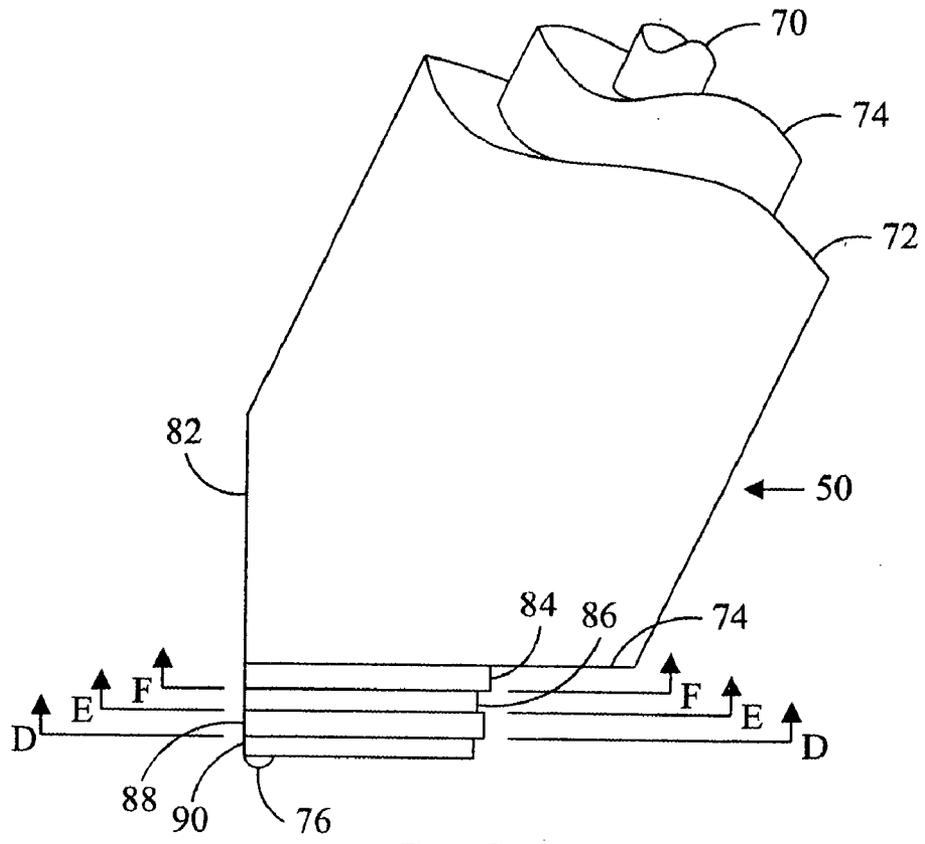


FIG. 2

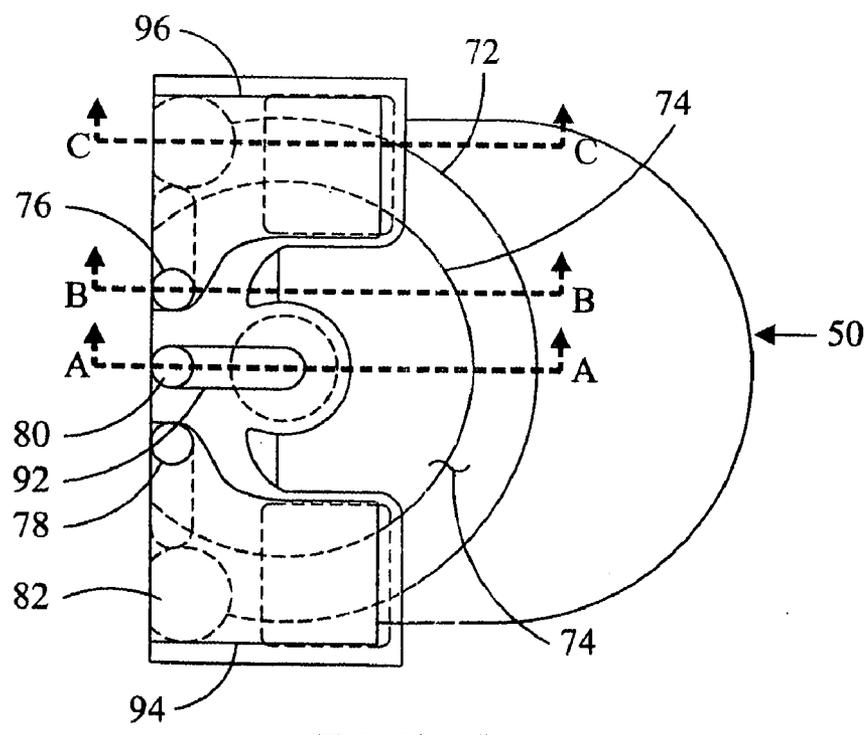


FIG. 3

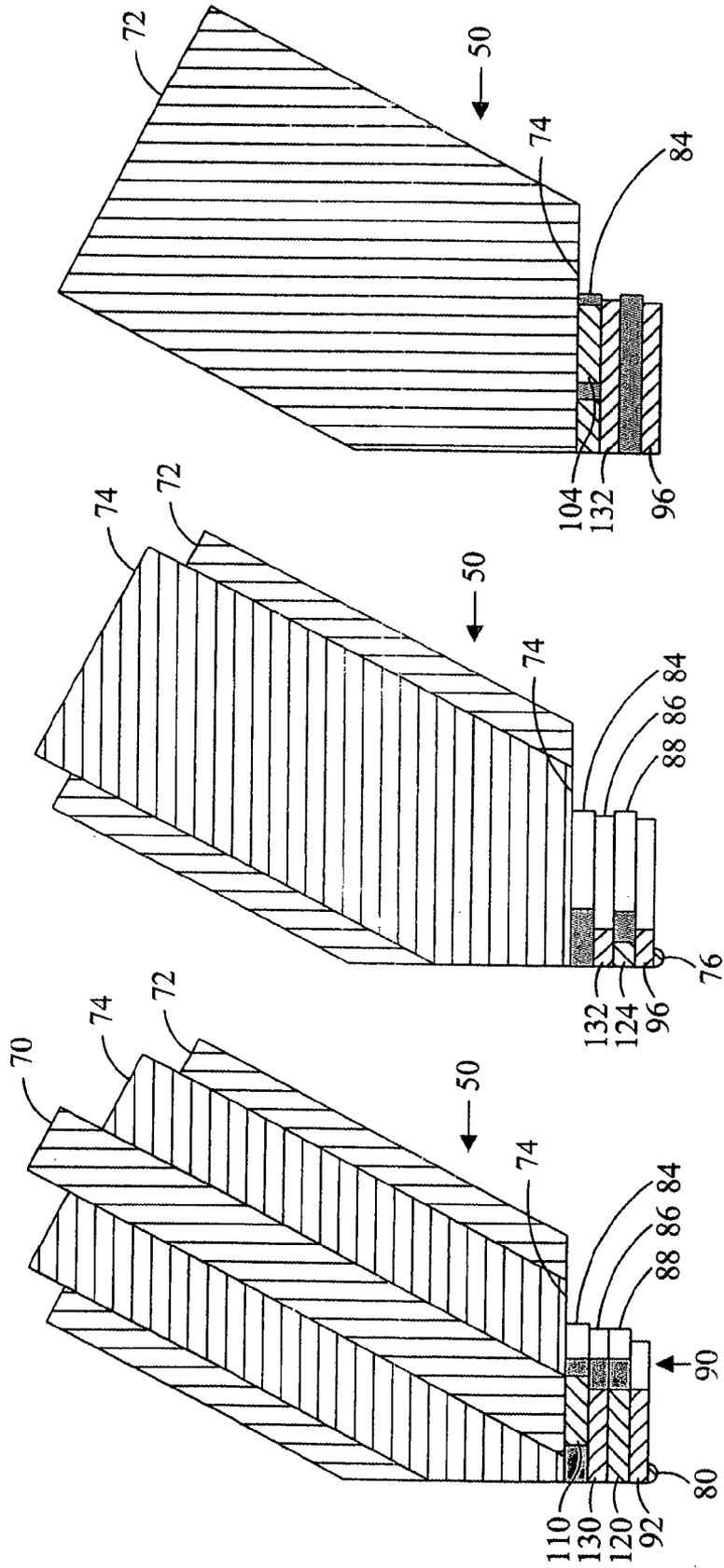


FIG. 4

FIG. 5

FIG. 6

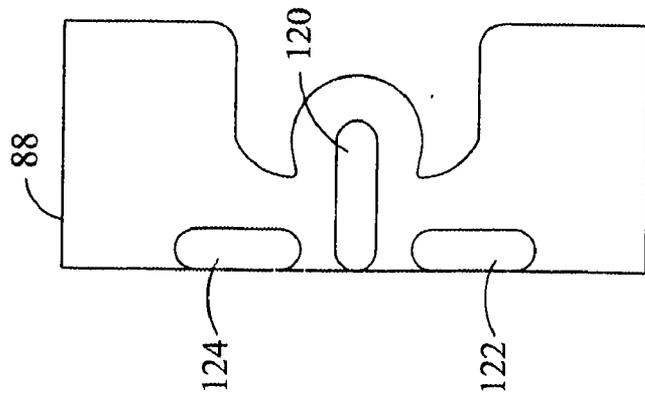


FIG. 7

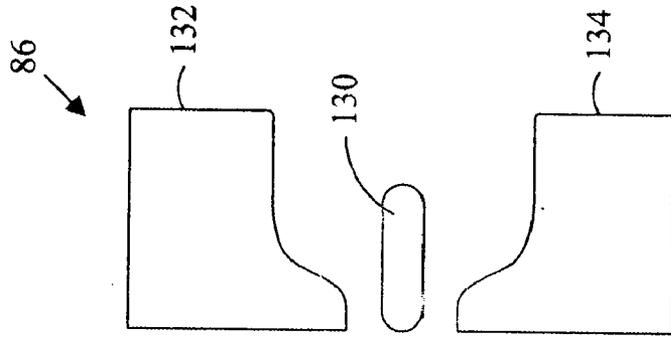


FIG. 8

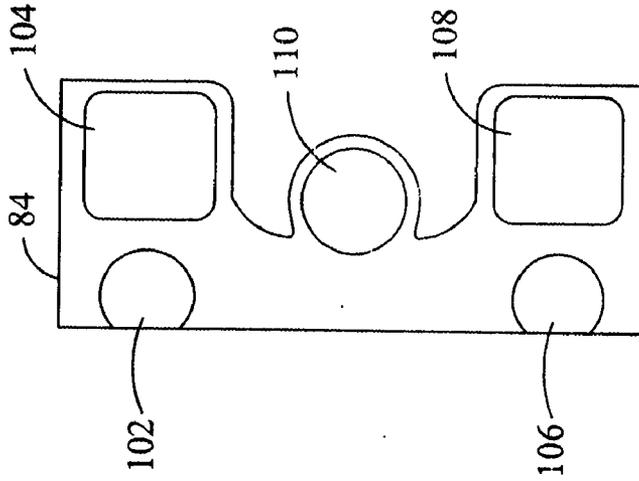


FIG. 9

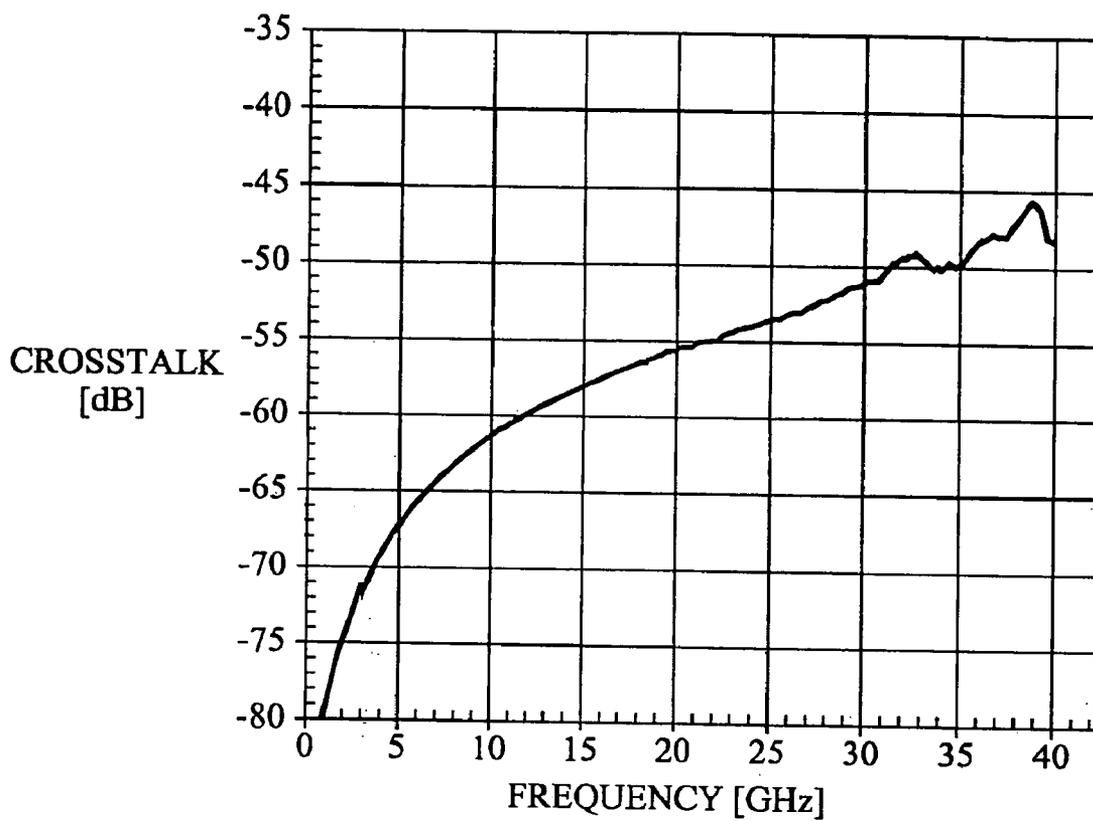


FIG. 10

**HIGH FREQUENCY PROBE**

**CROSS-REFERENCE TO RELATED APPLICATIONS**

[0001] This application is a continuation of U.S. patent application Ser. No. 11/410,783, filed Apr. 24, 2006, which application claims the benefit of U.S. Provisional App. No. 60/688,821, filed Jun. 8, 2005.

**BACKGROUND OF THE INVENTION**

[0002] The present invention relates to probe measurement systems for measuring the electrical characteristics of integrated circuits and other electronic devices operated at high frequencies.

[0003] There are many types of probing assemblies that have been developed for the measuring the characteristics of integrated circuits and other forms of microelectronic devices. One representative type of assembly uses a circuit card on the upper side of which are formed elongate conductive traces that serve as signal and ground lines. A central opening is formed in the card, and a needle-like probe tip is attached to the end of each signal trace adjacent the opening so that a radially extending array of downwardly converging needle-like tips is presented by the assembly for selective connection with the closely spaced pads of the microelectronic device being tested. A probe assembly of this type is shown, for example, in Harmon, U.S. Pat. No. 3,445,770. This type of probe does not exhibit resistive characteristics over a broad frequency range. At higher frequencies, including microwave frequencies in the gigahertz range, the needle-like tips act as inductive elements and the inductance is not counteracted by a capacitive effect from adjoining elements. Accordingly, a probing assembly of this type is unsuitable for use at microwave frequencies due to the high levels of signal reflection and substantial inductive losses that occur at the needle-like probe tips.

[0004] In order to obtain device measurements at somewhat higher frequencies than are possible with the basic probe card system described above, various related probing systems have been developed. Such systems are shown, for example, in Evans, U.S. Pat. No. 3,849,728; Kikuchi, Japanese Publication No. 1-209,380; Sang et al., U.S. Pat. No. 4,749,942; Lao et al., U.S. Pat. No. 4,593,243; and Shahriary, U.S. Pat. No. 4,727,319. Yet another related system is shown in Kawanabe, Japanese Publication No. 60-223,138 which describes a probe assembly having needle-like tips where the tips extend from a coaxial cable-like structure instead of a probe card. A common feature of each of these systems is that the length of the isolated portion of each needle-like probe tip is limited to the region immediately surrounding the device-under-test in order to minimize the region of discontinuity and the amount of inductive loss. However, this approach has resulted in only limited improvement in higher frequency performance due to various practical limitations in the construction of these types of probes. In Lao et al., for example, the length of each needle-like tip is minimized by using a wide conductive blade to span the distance between each tip and the supporting probe card, and these blades, in turn, are designed to be arranged relative to each other so as to form stripline type, transmission line structures. As a practical matter, however, it is difficult to join the thin vertical edge of each blade to the corresponding trace on the card while main-

taining the precise face-to-face spacing between the blades and the correct pitch between the ends of the needle-like probe tips.

[0005] One type of probing assembly that is capable of providing a controlled-impedance low-loss path between its input terminal and the probe tips is shown in Lockwood et al., U.S. Pat. No. 4,697,143. In Lockwood et al., a ground-signal-ground arrangement of strip-like conductive traces is formed on the underside of an alumina substrate so as to form a coplanar transmission line on the substrate. At one end, each associated pair of ground traces and the corresponding interposed signal trace are connected to the outer conductor and the center conductor, respectively, of a coaxial cable connector. At the other end of these traces, areas of wear-resistant conductive material are provided in order to reliably establish electrical connection with the respective pads of the device to be tested. Layers of microwave absorbing material, typically containing ferrite, are mounted about the substrate to absorb spurious microwave energy over a major portion of the length of each ground-signal-ground trace pattern. In accordance with this type of construction, a controlled high-frequency impedance (e.g., 50 ohms) can be presented at the probe tips to the device under test. Broadband signals that are within the range, for example, of DC to 18 gigahertz (GHz) can travel with little loss from one end of the probe assembly to another along the coplanar transmission line formed by each ground-signal-ground trace pattern. The probing assembly shown in Lockwood et al. fails to provide satisfactory electrical performance at higher microwave frequencies and there is a need in microwave probing technology for compliance to adjust for uneven probing pads.

[0006] Several high-frequency probing assemblies have been developed for improved spatial conformance between the tip conductors of the probe and an array of non-planar probe pads or surfaces. Such assemblies are described, for example, in Drake et al., U.S. Pat. No. 4,894,612; Coberly et al., U.S. Pat. No. 4,116,523; and Boll et al., U.S. Pat. No. 4,871,964. The Drake et al. probing assembly includes a substrate on the underside of which are formed a plurality of conductive traces which collectively form a coplanar transmission line. However, in one embodiment shown in Drake et al., the tip end of the substrate is notched so that each trace extends to the end of a separate tooth and the substrate is made of moderately flexible non-ceramic material. The moderately flexible substrate permits limited independent flexure of each tooth relative to the other teeth so as to enable spatial conformance of the trace ends to slightly non-planar contact surfaces on a device-under-test. However, the Drake et al. probing assembly has insufficient performance at high frequencies.

[0007] With respect to the probing assembly shown in Boll et al., as cited above, the ground conductors comprise a pair of leaf-spring members the rear portions of which are received into diametrically opposite slots formed on the end of a miniature coaxial cable and which are electrically connected with the cylindrical outer conductor of that cable. The center conductor of the cable is extended beyond the end of the cable (i.e., as defined by the ends of the outer conductor and the inner dielectric) and is gradually tapered to form a pin-like member having a rounded point. In accordance with this construction, the pin-like extension of the center conductor is disposed in a spaced apart, generally centered position between the respective forward portions of the leaf-spring members and thereby forms, in combination with these leaf-

spring members, a rough approximation to a ground-signal-ground coplanar transmission line structure. The advantage of this particular construction is that the pin-like extension of the cable's center conductor and the respective forward portions of the leaf-spring members are each movable independently of each other so that the ends of these respective members are able to establish spatially conforming contact with any non-planar contact areas on a device being tested. On the other hand, the transverse-spacing between the pin-like member and the respective leaf-spring members will vary depending on how forcefully the ends of these members are urged against the contact pads of the device-under-test. In other words, the transmission characteristic of this probing structure, which is dependent on the spacing between the respective tip members, will vary in an ill-defined manner during each probing cycle, especially at high microwave frequencies.

**[0008]** Burr et al., U.S. Pat. No. 5,565,788, disclose a microwave probe that includes a supporting section of a coaxial cable including an inner conductor coaxially surrounded by an outer conductor. A tip section of the microwave probe includes a central signal conductor and one or more ground conductors, generally arranged in parallel relationship to each other along a common plane with the central signal conductor, to form a controlled impedance structure. The signal conductor is electrically connected to the inner conductor and the ground conductors are electrically connected to the outer conductor of the coaxial cable. A shield member is interconnected to the ground conductors and covers at least a portion of the signal conductor on the bottom side of the tip section. The shield member is tapered toward the tips with an opening for the tips of the conductive fingers. The signal conductor and the ground conductors each have an end portion extending beyond the shield member and, despite the presence of the shielding member, the end portions are able to resiliently flex relative to each other and away from their common plane so as to permit probing of devices having non-planar surfaces.

**[0009]** In another embodiment, Burr et al. disclose a microwave probe that includes a supporting section of a coaxial cable including an inner conductor coaxially surrounded by an outer conductor. A tip section of the microwave probe includes a signal line extending along the top side of a dielectric substrate connecting a probe finger with the inner conductor. A metallic shield may be affixed to the underside of the dielectric substrate and is electrically coupled to the outer metallic conductor. Ground-connected fingers are placed adjacent the signal line conductors and are connected to the metallic shield by way of vias through the dielectric substrate. The signal conductor is electrically connected to the inner conductor and the ground plane is electrically connected to the outer conductor. The signal conductor and the ground conductor fingers (connected to the shield by vias) each have an end portion extending beyond the shield member and, despite the presence of the shielding member, the end portions are able to resiliently flex relative to each other and away from their common plane so as to permit devices having non-planar surfaces to be probed. While the structures disclosed by Burr et al. are intended to provide uniform results over a wide frequency range, they unfortunately tend to have non-uniform response characteristics at high microwave frequencies.

**[0010]** Gleason et al., U.S. Pat. No. 6,815,963 B2, disclose a probe comprising a dielectric substrate that is attached to a

shelf cut in the underside of a coaxial cable. The substrate projects beyond the end of the cable in the direction of the longitudinal axis of the cable. A signal trace for conducting a test signal between the center conductor of the coaxial cable and a probing or contact pad on the device under test (DUT) is formed on the upper side of the substrate. At the distal end of the signal trace, near the distal edge of the substrate, a via, passing through the substrate, conductively connects the signal trace to a contact bump or tip that will be brought into contact with the contact pad of the DUT during probing. A conductive shield which is preferably planar in nature is fixed to the bottom surface of the substrate and electrically connected to the outer conductor of the coaxial cable. The conductive shield is typically coextensive with the lower surface of the substrate with the exception of an aperture encircling the contact tip for the signal trace. Contact tips may also be provided for contacting ground contact pads spaced to either side of the signal probe pad on the DUT. Compared to coplanar type probes, this probe tip provides superior electromagnetic field confinement and reduces unwanted coupling or cross talk between the probe's tips and with adjacent devices. However, at high frequencies, approximately 220 GHz and greater, the length of the conductive interconnection between the probe tip and the coaxial cable connection becomes a significant fraction of the wavelength of the signal and the interconnection acts increasingly as an antenna, emitting increasingly stronger electromagnetic fields that produce undesirable coupling paths to adjacent devices. In addition, the conductive interconnection comprises a single metal layer deposited on the dielectric substrate and the relatively small section of the conductive interconnection limits the current carrying capacity of the probe.

**[0011]** What is desired, therefore, is a probe tip for an on-wafer probe enabling probing at higher frequencies, reducing stray electromagnetic fields in the vicinity of the probe tip to reduce cross talk with adjacent devices and capable of conducting a substantial current.

#### BRIEF DESCRIPTION OF THE DRAWINGS

**[0012]** FIG. 1 is a partial perspective view of a probe station including a high frequency probe and a wafer to be tested.

**[0013]** FIG. 2 is an elevation view of an exemplary probe tip portion of a high frequency probe.

**[0014]** FIG. 3 is a bottom view of the probe tip of FIG. 2.

**[0015]** FIG. 4 is a section view of the probe tip of FIG. 3 along A-A.

**[0016]** FIG. 5 is a section view of the probe tip of FIG. 3 along B-B.

**[0017]** FIG. 6 is a section view of the probe tip of FIG. 3 along C-C.

**[0018]** FIG. 7 is a section view of the probe tip of FIG. 2 along D-D.

**[0019]** FIG. 8 is a section view of the probe tip of FIG. 2 along E-E.

**[0020]** FIG. 9 is a section view of the probe tip of FIG. 2 along F-F.

**[0021]** FIG. 10 is a graphical illustration of crosstalk between a pair of high frequency probes having tips shorted on a test structure.

#### DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

**[0022]** The present inventors considered the probe disclosed by Gleason et al.; U.S. Pat. No. 6,815,963 B2; incor-

porated herein by reference, and concluded that while the probe provides superior performance, the high frequency performance of the probes are constrained by the length of the conductors that interconnect the probe tips and the coaxial cable of the probe. In a time-varying electromagnetic field, a conductor acts as an antenna radiating electromagnetic energy. For an antenna shorter than one wavelength of a signal, the radiated power is roughly proportional to the length of the antenna. The energy radiated by the conductive interconnection increases as the frequency of the signal increases and as the fixed length of the interconnecting conductor represents an increasingly larger fraction of the decreasing wavelength of the signals. The in-air wavelength of a 220 gigahertz (GHz) signal is 1.3 millimeters (mm). The length of the conductive interconnection of the probe disclosed by Gleason et al. is a significant fraction of this distance and substantial electromagnetic fields have been confirmed along the edges of the dielectric membrane in the vicinity of the contact tips.

**[0023]** When multiple probes are used for probing in a confined area, such as the contact pads of an individual device on a wafer, the probe tips come into close proximity with one another and energy radiated by the probes produces capacitive coupling of the probes, normally referred to as cross-talk. Crosstalk increases as the frequency of the signal increases because the energy radiated by the probe increases. The inventors concluded that reducing the length of the conductive elements in the probe tip would reduce the electromagnetic fields emanating from the contact tip area of the probe, reducing cross-talk with adjacent devices, and increasing the frequency at which the probe would be useful.

**[0024]** Referring in detail to the drawings where similar parts of the probe are identified by like reference numerals and, more particularly to FIGS. 1, 2 and 3, a high frequency probe 20 is designed to be mounted on a probe-supporting member 22 of a probe station so as to be movable to a suitable position for probing a device-under-test (DUT), such as an individual component on a wafer 24. In this type of application, the wafer is typically restrained on the upper surface of a chuck 26 which is part of the same probe station. The upper surface of the chuck commonly includes a plurality of apertures that are selectively connectible to a source of vacuum. When vacuum is connected to the apertures, air pressure on a wafer, resting on the upper surface of the chuck, secures the wafer to the chuck's surface. Ordinarily an X-Y-Z positioning mechanism, such as a micrometer knob assembly, is provided to effect movement between the supporting member 22 and the chuck 26 so that the contact tips 28 of the probe can be brought into pressing engagement with contact or probing pads 30 on the wafer. The contact pads typically comprise a signal contact pad and at least one ground contact pad for a particular component 32 requiring measurement. A common contact pad arrangement comprises a centrally located signal contact pad flanked by a pair of ground contact pads, also referred as a GSG (ground-signal-ground) probing configuration.

**[0025]** The exemplary high frequency probe 20 has a port which, in the preferred embodiment depicted, comprises a waveguide 34 having a flanged connector 36. The flanged connector enables selective connection, through a mating flanged connector 38, to an external waveguide 40 connecting the probe to the measuring instrumentation. The waveguide is connected to a primary support block 42 of the probe which, in the preferred embodiment shown, is made of brass and is

suitably constructed for connection to the probe-supporting member 22. To effect connection to the probe-supporting member, a round opening 44 that is formed on the block is snugly and slidably fitted onto an alignment pin (not shown) that projects upward from the probe-supporting member. A screw 46 is inserted into each of a pair of countersunk openings 48 provided in the block. The screws engage corresponding threaded apertures in the probe-supporting member to secure the probe to the supporting member.

**[0026]** A semi-rigid coaxial cable 50 is retained in the primary support block 42 and is connected, within the block, to the waveguide 34 by a coaxial cable-to-waveguide transition; such the adjustable backshort disclosed by Martin, U.S. Pat. No. 6,549,106 B2, incorporated herein by reference. In the preferred embodiment, the semi-rigid coaxial cable 50 has a nominal outer diameter of 0.584 mm (0.023 inches) and comprises an axially extending silver plated copper center conductor 70 and a coaxial copper outer conductor 72 separated from the center conductor by an air-expanded Teflon™ dielectric 74. One suitable type of cable, for example, is available from Micro-coax Components Inc. of Pottstown, Pa. under model number UT-020.

**[0027]** The end portion of the cable 50 projecting from the support block remains freely suspended and, in this condition, serves as a movable support for the contact tips 28 of the probe. A portion of the cable protruding from the primary support block is bent downwardly and is terminated in an oblique terminal section 74 formed by cutting the coaxial cable at an oblique angle. While the oblique angle could be any convenient angle, the angle is typically the complement of angle of the downward sloping portion of the coaxial cable so that when the probe is installed in a probe station the substantially planar oblique terminal section 74 will be aligned substantially parallel to the top surface of the chuck 26.

**[0028]** The inventors concluded that to reduce the stray electric fields ("E-fields") and magnetic fields ("H-fields") in the vicinity of the probe tip the distance between the ends of the contact tips and the conductors of the coaxial cable should be minimized and the contact tips should be located in an area shielded by the outer conductor of the coaxial cable. The contact pads of devices commonly tested in probe stations are commonly arranged in rows with a centrally located signal contact pad flanked by a pair of ground contact pads, a GSG (ground-signal-ground) arrangement. The three contact tips 76, 78, 80 of the exemplary probe 20 correspond to a GSG arrangement for contact pads with the central contact tip 80 of the exemplary probe, the signal tip of the GSG arrangement, conductively connected to the center conductor 70 of the coaxial cable 50 and the flanking contact tips 76, 78, on either side of the central contact tip, conductively connected to the outer conductor 72 of the coaxial cable which is connected to a ground. However, other arrangements of contact tips corresponding to other arrangements of contact pads, for examples a GSSG (ground-signal-signal-ground) arrangement, an SGS (signal-ground-signal) arrangement or an SGGS (signal-ground-ground-signal) arrangement, may be used. To improve shielding and reduce the lengths of conductive connections to the coaxial cable, the contact tips of the high frequency probe 20 are located within the periphery of the coaxial cable and, more specifically, within the periphery of the oblique terminal section 74 of the coaxial cable.

**[0029]** When positioning the contact tips of a probe in a probe station, the operator typically observes the contact tips

of the probe and the contact pads of the DUT through a microscope that is positioned above the DUT. To minimize the conductor length while enabling visual observation of the contact tips, the end portion of the coaxial cable further comprises a second oblique section **82** produced by cutting the coaxial cable at a second oblique angle, typically normal to the oblique terminal section **74**. The second oblique section **82** intersects the oblique terminal section **74** adjacent to the edge of the contact tips **76, 78, 80** enabling the operator to view the edges of the contact tips from above.

[0030] Referring to FIGS. **4, 5, 6, 7, 8** and **9**, the tip portion of the probe **20** further comprises a planar upper dielectric substrate **84** affixed to the coaxial cable **50** and having an upper surface abutted to the oblique terminal section **74** of the cable. The upper dielectric substrate may be affixed to the coaxial cable by, for example, an epoxy adhesive applied to the upper surface of the substrate along the periphery of the cable and solder joining metallic vias **102, 104, 106, 108** in the substrate to the metallic outer conductor **72** of the cable. The upper dielectric substrate **84** has a lower surface which is bonded to, by plating or otherwise, an upper surface of an upper conductive layer **86**, comprising three typically metallic, conductively disconnected regions **130, 132, 134**. The lower surface of the upper conductive layer **86** is, in turn, bonded to an upper surface of a lower dielectric layer **88** and a lower conductive layer **90** is bonded to the lower surface of the lower dielectric layer. The contact tips **76, 78, 80**, which may comprise metallic bumps or buttons, are formed on or conductively affixed to the lower surfaces of respective portions of the lower conductive layer **90**.

[0031] The lower conductive layer **90** comprises three conductive, typically metallic, regions **92, 94, 96** that are not conductively connected to each other. A first region **92** includes a portion, at least partially, spatially coinciding with and conductively connected to the central contact tip **80**, the signal contact tip of the GSG probe arrangement. The second **94** and third **96** regions of the lower metallic layer are respectively conductively connected to a contact tip **76, 78** located on either side of the central tip. The second **94** and third **96** regions of the lower conductive layer **90** are conductively connected to the outer conductor **72** of the coaxial cable **50** which is connected to a ground in the typical GSG probing arrangement. The second **92** and third **94** regions of the lower conductive layer effectively extend the outer conductor of the coaxial cable to the immediate vicinity of the signal contact tip forming a conductive shield that extends over an area of the cable's terminal section that is substantially larger than the area of the ground contact tips and proximate to the signal contact tip **80**. The conductive shield confines electromagnetic radiation in the immediate area of the contact tips.

[0032] The central contact tip **80** is conductively connected to the center conductor **70** of the coaxial cable by conductors that are arranged within the periphery of the terminal section of the coaxial cable and extend through the upper and lower dielectric layers and the upper conductive layer. A conductive via **120** in the lower dielectric layer **88** that is at least partially spatially coincident with and conductively connected to the first region **92** of the lower conductive layer **90** connects the first region of the lower conductive layer to a first region **130** of the upper conductive layer **86**. A conductive via **110** in the upper dielectric substrate **84** that is, at least partially, spatially coincident with and conductively connected to the first region **130** of upper conductive layer **86** conductively connects the first region of the upper conductive layer and the central

contact tip **80** to the center conductor **70** of the coaxial cable **80**. The cross-sections of the conductive interconnection of the central contact tip **80** and the coaxial cable are substantially greater than that of a conductor comprising a single metal layer deposited on a substrate permitting higher current to be transmitted by the contact tips.

[0033] Similarly, the flanking contact tips **76, 78** are conductively connected to the outer conductor of the coaxial cable **50** by respective conductive vias **124, 122** in the lower dielectric layer **88** that are, conductively connected to, respective, second **96** and third **94** regions of the lower conductive layer **90** and with the corresponding second **132** and third **134** regions of the upper conductive layer **86**. Conductive vias **102, 104** and **106, 108** in the upper dielectric layer **84** provide a conductive connection between the second **132** and third **134** regions of the upper conductive layer **84** and the outer conductor **72** of the coaxial cable **50**. The conductive connections from the flanking contact tips to the outer conductor of the coaxial cable are arranged substantially with the periphery of the terminal section of the cable enabling pluralities of probes to be used to probe of areas.

[0034] Stray E-fields in the area of the probe tip produce capacitive coupling to or crosstalk with adjacent devices at frequencies well below the resonant frequency of the probe tip. The crosstalk worsens as the frequency of the signal increases and the stray fields strengthen. At any particular frequency, the worst case crosstalk occurs when adjacent probes are terminated with short circuits on a test substrate. FIG. **10** graphically illustrates tip-to-tip crosstalk between a pair high frequency probes, exemplified by the high frequency probe **20**, at signal frequencies up to 40 GHz. FIG. **10** records tip-to-tip crosstalk for two high frequency probes with probe tips separated by 150 micrometers ( $\mu\text{m}$ ) on a continuous ground structure. Exemplary values of tip-to-tip crosstalk for the high frequency probes are  $-58$  dB at 15 GHz and approximately  $-51$  dB at 30 GHz. Over the frequency range of 5 to 40 GHz, the tip-to-tip crosstalk of the high frequency probes is approximately 10 dB less than probe tips of the type disclosed by Gleason et al.

[0035] The conductive connections between the contact tips and the conductors of the coaxial cable of the high frequency probe are substantially shorter than the conductive interconnections of prior probes reducing the conductor length-to-wavelength ratio and the power radiated by the probe's conductors when high frequency signals are applied. In addition, the high frequency probe incorporates shielding for the contact tips to confine energy radiated from the area of the probe tip. The useable frequency range of the probe is extended and crosstalk to adjacent probes is substantially reduced by the reduction in and confinement of energy radiated from the vicinity of the probe tip. Moreover, the cross-sections of the conductive interconnections from the contact tips to the coaxial cable are substantially greater than the cross-sections of the single layer conductive interconnections of prior probes substantially increasing the current carrying capacity of the probe.

[0036] The detailed description, above, sets forth numerous specific details to provide a thorough understanding of the present invention. However, those skilled in the art will appreciate that the present invention may be practiced without these specific details. In other instances, well known methods, procedures, components, and circuitry have not been described in detail to avoid obscuring the present invention.

[0037] All the references cited herein are incorporated by reference.

[0038] The terms and expressions that have been employed in the foregoing specification are used as terms of description and not of limitation, and there is no intention, in the use of such terms and expressions, of excluding equivalents of the features shown and described or portions thereof, it being recognized that the scope of the invention is defined and limited only by the claims that follow.

- 1. A probe comprising:
  - (a) a coaxial cable including an axially extending first conductor, a coaxial second conductor and a dielectric, said coaxial cable terminating in an oblique terminal section;
  - (b) a dielectric substrate affixed to said coaxial cable with a first side proximate said terminal section and a second side remote from said terminal section;
  - (c) a first conductive member conductively connecting said first conductor to a first contact located on said second side of said dielectric substrate and substantially within a periphery of said terminal section, said first contact engageable with a device to be tested; and
  - (d) a second conductive member conductively connecting said second conductor to a second contact located on said second side of said dielectric substrate and substantially within said periphery of said terminal section.
- 2. The probe of claim 1 wherein said first conductive member is located substantially within said periphery of said terminal section.
- 3. The probe of claim 2 wherein said second conductive member is located substantially within said periphery of said terminal section.
- 4. The probe of claim 1 further comprising a third contact conductively connected to said second conductor and located substantially within said periphery of said terminal section on said second side of said dielectric substrate.
- 5. The probe of claim 4 wherein said conductive connection of said third contact to said second conductor is located substantially within said periphery of said terminal section.
- 6. The probe of claim 1 wherein said oblique terminal section comprises: (a) a first oblique substantially planar section of said coaxial cable; and (b) an intersecting second oblique section of said coaxial cable.
- 7. The probe of claim 6 wherein said second oblique section intersects said first oblique planar section proximate said first contact.
- 8. The probe of claim 6 wherein said second oblique section is substantially normal to said first oblique planar section.
- 9. The probe of claim 1 wherein said second conductive member further comprises a planar portion adjacent to but free of conductive connection with said first contact.
- 10. The probe of claim 9 wherein said second conductive member is conductively connected to a ground.
- 11. The probe of claim 1 wherein said dielectric substrate comprises:
  - (a) a first dielectric layer having a first side and a second side;
  - (b) a conductive layer having a first side in contact with said second side of said first dielectric layer and a second side; and

- (c) a second dielectric layer having a first side in contact with said second side of conductive layer and a second side.
- 12. The probe of claim 1 wherein one of said first and said second conductive members comprises:
  - (a) a contact tip; and
  - (b) a substantially planar conductive shield conductively connected to said contact tip and electrically isolated from the other of said first and said second conductive members, said conductive shield coextensive with a greater area of said terminal section than an area of said contact tip.
- 13. A probe comprising:
  - (a) a coaxial cable including an axially extending first conductor and a coaxial second conductor
  - (b) a first contact tip conductively connected to said first conductor; and
  - (c) a second contact tip conductively connected to said second conductor, crosstalk between said second contact tip of said probe and a contact tip of a substantially similar probe, spaced 150 micrometers apart on a ground structure from said second contact, being less than -42 dB for an applied signal frequency of 30 gigahertz.
- 14. The probe of claim 11 wherein said crosstalk is less than -47 dB for said applied signal frequency of 30 gigahertz.
- 15. The probe of claim 11 wherein said crosstalk is less than -50 dB for said applied signal frequency of 30 gigahertz.
- 16. A probe comprising:
  - (a) a coaxial cable including an axially extending first conductor, a coaxial second conductor conductively connected to a ground, and a dielectric, said coaxial cable terminating in an oblique terminal section;
  - (b) a first contact located substantially within a periphery of said terminal section and conductively connected said first conductor, said first contact engageable with a device to be tested; and
  - (c) a conductive member conductively connecting said second conductor to a second contact located substantially within said periphery of said terminal section, said conductive member including a substantially planar conductor located proximate to but conductively disconnected from said first contact.
- 17. The probe of claim 16 wherein said conductive member is located substantially within said periphery of said terminal section.
- 18. The probe of claim 16 further comprising a second conductive member conductively connecting said second conductor to a third contact located substantially within said periphery of said terminal section, said second conductive member including a substantially planar conductor located proximate to but conductively disconnected from said first contact.
- 19. The probe of claim 16 wherein said oblique terminal section comprises an oblique substantially planar first section of said coaxial cable intersected by a second oblique section of said coaxial cable.
- 20. The probe of claim 19 wherein said second oblique section intersects said first section proximate said first contact.

\* \* \* \* \*