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[Continued on next page]

(54) Title: PROBE TIP ASSEMBLY

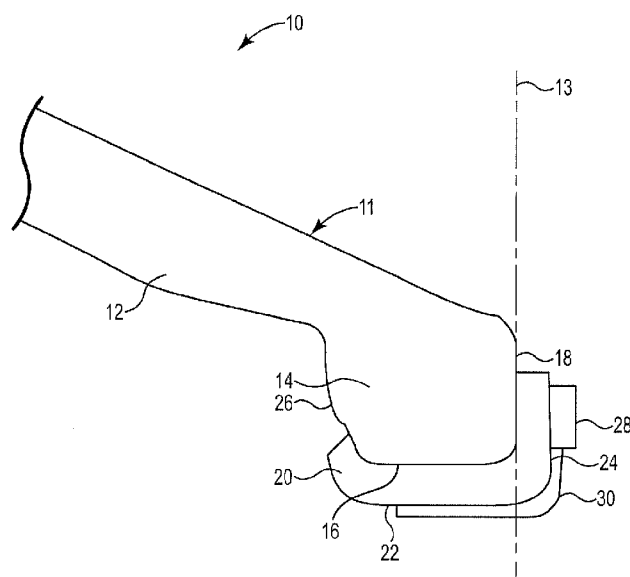


FIG. 1A

(57) Abstract: A probe tip assembly includes a probe tip, an insulating member, and a lead element. The probe tip includes glassy metal. The probe tip includes a head, a tail end, and a shaft extending between the head and the tail end. The head has a bottom surface and the head forwardly extends to a first vertical plane forward of the tail end. The insulating member is disposed on at least the bottom surface of the head. The lead element includes a lead wire disposed on the insulating member.

**Declarations under Rule 4.17:**

- *as to the identity of the inventor (Rule 4.17(i))*
- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

Published:

- *with international search report (Art. 21(3))*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

PROBE TIP ASSEMBLY

Background

[0001] Probes are used in sensing and testing of devices under test (DUT) such as semiconductors and other electronic devices. A probe for local measurement of an electrical signal, such as voltage, is used for analysis of failure such as short circuits and open interconnections. Probe tips electrically connect a probe and a DUT to transmit a signal between the probe and the DUT.

Brief Description of the Drawings

[0002] Figure 1A is a side view schematically illustrating a probe tip assembly according to an example of the present disclosure.

[0003] Figure 1B is a partial cross-section view schematically illustrating a probe tip according to an example of the present disclosure.

[0004] Figures 2A is a front view schematically illustrating a probe tip according to an example of the present disclosure.

[0005] Figure 2B is a side view schematically illustrating the probe tip according to the example of Figure 2A of the present disclosure.

[0006] Figure 2C is a series of cross-section views schematically illustrating the probe tip according to the example of Figures 2A and 2B of the present disclosure.

[0007] Figure 3 is a partial cross-section view schematically illustrating a probe with a probe tip assembly according to an example of the present disclosure.

[0008] Figures 4A-4B are partial top views of a probe with a probe tip assembly according to an example of the present disclosure.

Detailed Description

[0009] In the following detailed description, reference is made to the accompanying drawings which form a part hereof, and in which is shown by way of illustration specific examples in which the disclosure may be practiced. It is to be understood that other examples may be utilized and structural or logical changes may be made without departing from the scope of the present disclosure. The following detailed description, therefore, is not to be taken in a limiting sense, and the scope of the present disclosure is defined by the appended claims. It is to be understood that features of the various examples described herein may be combined, in part or whole, with each other, unless specifically noted otherwise.

[0010] With probes, especially probes with differential probe tips, test access to high-speed differential signals (or passive probing of traces) can be difficult and time consuming. Some methods and devices used in probing are bulky and clumsy and obscure the user's view of exactly where the probe tips are hitting the traces or vias that are being probed. Others, such as soldered in probes, are used when the target PCA is powered down, removed from the assembly, and taken to a solder rework station every time that the probe tip, or point, is moved.

[0011] A test point of a device under test (DUT) can be an area of trace, or via, that has been cleared of solder mask and sometimes thickened with solder to facilitate good test probe contact. Good electrical contact between a probe and a test, or contact, point is sometimes aided by applying solder to the test point on a DUT after removing solder mask from the test point. The solder thickened test point can also be roughened up to improve electrical contact.

[0012] According to aspects of the present disclosure, examples of probes with probe tip assemblies can be used in either side access or top-town vertical access. Probe tip assemblies can be used in the field of passively probing unpowered printed circuit boards (PCBs) or PCAs for signal integrity measurements, for example. Probe tip assemblies can be used for probing high-speed differential signals or for probing unpowered circuit boards for

characterizing the signal integrity aspects of differentials pairs (traces). Probe tip assemblies can be used with a “browser probe” in that the user can “browse” or move the probe from signal pair to signal pair while the circuitry remains operational. Example probe tip assemblies, according to aspects of this disclosure, can provide ease of adjustment, maintenance, or replacement of all or parts of the assembly and provide un-obscured user viewing when positioning and contacting the test points.

[0013] With reference to an example of a probe tip assembly 10 illustrated in FIG. 1A, probe tip assembly 10 includes a probe tip 11 having a shaft 12 that is slanted downwards from a top and a side to a head 14 at a first end of shaft 12 and a tail end (not shown) at a second end of shaft 12. Head 14 extends to a first vertical plane 13 forward of the tail end. Head 14 has a generally hemispherical shape, for example. Head 14 has a bottom surface 16 where contact is to be made to the DUT during testing and a front surface 18. Bottom surface 16 can be a substantially flat or planar surface. Additionally, front surface 18 can be a substantially flat or planar surface. Front surface 18 can be oriented at 90 degrees (a right angle) with respect to bottom surface 16, for example. Alternatively, front surface 18 can be at a different angle, such as 45 degrees, for example, that avoids obstructing a user’s view when positioning probe tip 10 for testing. Shaft 12 generally extends at an angle, such as a 45 degree angle, with respect to bottom surface 16 of head 14. Probe tip assembly 10 can be used in probing areas of the DUT where side access is available, for example.

[0014] In one example, an insulating member 20 is disposed on head 14 of probe tip 11. Insulating member 20 can be made of glass, hard plastic, or ceramic, for example, although other non-conductive materials are also suitable. Insulating member 20 can have a bottom portion 22 disposed on bottom surface 16 of head 14, for example, or have bottom portion 22 on bottom surface 16 and a front portion 24 on front surface 18 of head 14. Insulating member 20 can be roughly hemispherical and configured to cover bottom surface 16 and at least a portion of front surface 18 of head 14. In one example, insulating member 20 extends from bottom surface 16 to a rear surface 26 of head 14. With additional

reference to FIG. 1B, the surfaces of head 14 where insulating member 20 is attached can be roughened for increased surface bonding (e.g., glue adhesion). In one example, insulating member 20 has a substantially consistent thickness and follows the shape and contour of the combined surfaces of head 14 where insulating member 20 is disposed. The thickness and composition of insulating member 20 can be used to adjust a single-ended impedance between probe tip assembly 10 (which would be connected to a ground, see, e.g., FIG. 3) and the probed signal.

[0015] In accordance with the examples illustrated in FIGS. 1A and 1B, a lead element 28 can be disposed on insulating member 20. Lead element 28 can be a resistor, a simple wire, field-effect transistor (FET), a metal oxide semiconductor field effect transistor (MOSFET), or bi-polar transistor, for example. Front portion 24 of insulating member 20 facilitates placing lead element 28 closely to the test point.

[0016] A lead 30 extends in a first direction from lead element 28 along bottom portion 22 for electrical contact with a test point. In one example, insulating member 20 includes a slot, or groove 32, extending along at least bottom portion 22 of insulating member 20. Groove 32 is sized and shaped to accommodate at least a portion of lead 30 extending along bottom portion 22 of insulating member 20. Lead wire 30 protrudes from bottom portion 22 and groove 32 for electrical contact with the DUT to be tested or probed.

[0017] As illustrated in the example of FIG. 1B, lead 30 can be figure "8" shaped with a top lobe 34 and a bottom lobe 36 joined together to form the "8" shape of lead 30. Top lobe 34 is configured to be mounted (e.g., snap-in retention) into groove 32 of insulating member 20. Bottom lobe 36 is configured to contact the test point. In one example, bottom lobe 36 is larger than top lobe 34 and bottom lobe 36 extends out of groove 30. Alternatively, lead 30 can be a standard cylindrical lead (i.e., wire) that lacks the snap-in retention features of the figure "8" shaped lead.

[0018] In a situation where substantially vertical probing is desired, a probe tip 100 in accordance with the example illustrated in FIGS. 2A-2C can be employed for straight-down access. Probe tip 100 is suitable when side access to the test

point is not available and access between components of the DUT is tight. A shaft 112 generally extends at a 90 degree angle, with respect to a bottom surface 116 of a head 114 for straight-down access and visibility of the test point. Aspects of the probe tip 100 have many similarities to probe tip 11. For example, head 114 of probe tip 100 can include a substantially planar, or flat, bottom surface 116 and a shaft 112 extending between head 114 and a tail end 115.

[0019] Probe tip 100 can have a distorted-needle-shape. As illustrated in FIG. 2C, probe tip 100 can include multiple cross-sectional profiles along the elongated length of probe tip 100. Head 114 has bottom surface 116 where probe tip 100 contacts the DUT to be tested. In one example, the opposing end, tail end 115, is a sharp-tipped end. The cross-sections between head 114 and tail 115 are designed for structural strength and also to prevent spinning of probe tip 100 when assembled with a rod (see FIG. 3). In this manner, as illustrated in FIG. 2C, some cross-sections of the shaft 112 are "T" shaped. Additionally, as illustrated in FIG. 2B, probe tip 100 can be non-linear such that head 114 extends outward and is forwardly offset from tail end 115 when bottom surface 116 of head 114 contacts the DTU. In other words, head 114 forwardly extends to a first vertical plane 113 that is forward of tail end 115. This provides for visibility of head 114 during probing.

[0020] Probe tips 11, 100 are at least partially constructed of glassy metals. Glassy metals, also known as bulk metallic glasses or as amorphous metals, can be more durable and robust than tooled steel. Probe tips 11, 100 constructed of glassy metals are durable (i.e., wear resistant) and can be small and finely-pointed. According to aspects of the present disclosure, the amount of glassy metal used is minimized by force fitting glassy metal probe tip 11, 100 into a larger structural body (i.e., rod 124, outer tube 126). In one example, only head 14, 114 of probe tip 11, 100 is made of glassy metal and shaft 12, 112 transitions to less expensive structural materials and increases in size to provide structural support along the length of probe tip 11, 100.

[0021] Probe tips 11, 100 can be fabricated through molding or by a three dimensional (3D) printing method where sintered metals are fed onto the probe

and probe-tip. Lasers provide the heat to cause the sintered metals to bond to the probe. Less expensive sintered metal feedstock is used for the body of the probe and the 3D printer switches to the more expensive glassy metals (contained in a different hopper of feedstock) for the tip of the probe.

[0022] FIG. 3 illustrates a cross-section view of a probe 120 including probe tip assembly 110 according to an example of the present disclosure. As illustrated in FIG. 3, probe tip assembly 110, including probe tip 100, can be inserted into an opening 122 at a bottom of a rod 124 or an outer tube 126. Rod 124 and outer tube 126 can form the body or handle of probe 120. Tail end 115 can be inserted and force-fitted into opening 122. Opening 122 can be shaped and sized to accommodate the varied shape of shaft 112 and restrain probe tip 100 from spinning. Additionally, the corresponding shapes of opening 122 and shaft 112 can assist with correctly orienting head 114 of probe tip 100 within probe 120. Head 114 of probe tip 100 slants outwards, away from the bottom of rod 124, to provide easy visibility to the user when positioning probe tip 100 for contact with a test point.

[0023] Probe tip assembly 110 includes insulating member 20. Front portion 24 of insulating member 20 can include an indentation 26 appropriately sized and shaped to accommodate lead electrical element 28 (e.g., resistor, FET or bipolar transistor) that is electrically connected to an amplifier PCA 128. Indentation 26 provides mechanical stabilization of lead element 28 with respect to probe tip 100. The type of lead element 28 chosen is suitable for amplifier PCA 128 used. In one example, lead element 28 is an FET that is "gate" connected to the test point during probing and the "source" and "drain" wired to amplifier PCA 128.

[0024] In one example, lead element 28 is a bipolar transistor with a base of the bipolar transistor connected to the test point during probing, while the "emitter" and "collector" is connected, via wires 130, to amplifier PCA 128. Each probe tip 100 can have two wires 130 rather than one wire 130 (as used with a resistor) leading to the discrete component/amplifier PCA 128 from lead element 28. Lead element 28 is located near the test target DUT being tested for signal integrity. Lead element 28 picks up differential signals to be fed/connected to

amplifier PCA 128. A spring 132 can be included for attachment of amplifier PCA 128 to probe tip assembly 110.

[0025] In both active and passive probing, users have concerns of standardization, repeatability and alarm conditions. In other words, standardized conditions under which readings can be taken are in order to have the measurement be repeatable. The actual target parameters can be measured without side effects of higher or lower temperature or higher or lower mechanical strains on the test gear. Also, endangering the test equipment with “alarm” considerations to avoid breakage can be provided.

[0026] A strain gauge 134 can be provided to monitor the force exerted on the test point and to help prevent damage to probe tip 100. Monitoring the mechanical pressure on probe tip 100 as head 114 presses into the device under test is roughly equivalent to the mechanical strain on shaft 112 probe support structure. Strain gauge 134 can measure strain by the degree to which the underlying structural materials actually deform. Accordingly, strain gauge 134 can be positioned on probe tip 100 at the location where deformation is at a maximum such as on a narrow cross sectional location of shaft 112. The location of strain gauge 134 on probe tip 100 is suitable for attachment and support of strain gauge 134. Multiple strain gauges 134 can be provided along probe 120 and a monitoring system to collect and interpret the results can be provided. Strain gauge 134 is suitably small and robust for placement on probe tip 100 or sleeve 136. Examples of suitable strain gauges 134 are the Vishay® 015DJ or 015DV strain gages.

[0027] In one example illustrated in FIG.3, shaft 112 of probe tip 100 is inserted into a sleeve 136 and disposed in rod 124. Strain gauge 134 can be assembled onto sleeve 136. Sleeve 136 and probe tip 100 can then be inserted into rod 124. Sleeve 136 can provide additional surface area for the attachment of strain gauge 134 when not otherwise available on shaft 112. Sleeve 136 can be made of a material such as aluminum, for example. With reference to the example illustrated in FIGS. 4A-4B, a pair of probe tips 100a, 100b can be biased towards one side of sleeve 136 (not shown) so that a very small distance between two test probe tips 100a, 100b can still be obtained. The linear

distortion of the outermost surface of sleeve 136 housing probe tips 100a, 100b under the influence of bending forces being measured allows strain gauge 134 to be effective in measuring the forces.

[0028] Returning to FIG. 3, for example, a temperature monitoring device 138 can be positioned near head 114 of probe tip 100. The temperature can be monitored during the time that the readings are taken. Temperature monitoring device 138 can be positioned on rod 124, on an exposed surface of probe tip 100, or on sleeve 136. One example of a suitable temperature monitoring device 138 is Vishay® WTG-50A temperature sensor. In one example, strain gauge 134 could include temperature monitoring with the strain monitoring in a single device 134.

[0029] With reference to FIGS. 4A and 4B, the pair of probe tips 100a, 100b can be spaced apart from one another in a probe 120a. Probe tips 100a, 100b are inserted side by side at a fixed separation distance into with probe tip 100a inserted into outer tube 126 and probe tip 100b inserted into rod 124.

Alternatively, the user can select from a variety of support rods 124 having various distances between openings 122 for probe tips 100a, 100b to be inserted into. In one example, insulating members 20 on heads 114a, 114b are asymmetrical such that lead elements 28 and associated leads 30 can be positioned to be biased toward one another. Heads 114a, 114b, and in particular leads 30 on each of heads 114a, 114b, are independently movable with respect to one another. In one example, rod 124 is rotated within outer tube 126 by a user to increase or decrease the distance between heads 114a and 114b. A distance d_1 , d_2 can be adjusted by a user to suitably contact the test points on the DUT being probed and test for the differential impedance and trace geometry used. In other words, separation distance d_1 , d_2 can be adjusted for adjusting for trace separation, for adjusting the quality of the probe tips 100a, 100b mating contact to the pair of test points or traces, and quality and signal acquisition and for differential impedance.

[0030] Wire 130 extends from lead element 28 to amplifier PCA 128. Wire 130 is sized and connected to allow a flexible attachment with amplifier PCA 128 such that amplifier PCA 128 has a limited "free float" with respect to probe tips

100a, 100b. Amplifier PCA 128 can be positioned adjacent to probe tips 100a, 100b and picks up the signal in order to pass it to an oscilloscope (not shown). Amplifier PCA 128 is electrically insulated from probes 100a, 100b and any metallic or electrically conductive probe support behind or underneath amplifier PCA 128. With additional reference to FIG. 3, conductive circuits on the backside of amplifier PCA 128 can be insulated with an insulating layer 140 such as, for example, a rubber coating or plastic sheet. Insulating layer 140 can also act as a slidable barrier between amplifier PCA 128 and the mechanical mount of amplifier PCA 128 as probes 100a, 100b move closer or farther apart from one another.

[0031] Amplifier PCA 128 is mounted to accommodate probe tip 100a, 100b separation distance adjustments at heads 114a, 114b. In one example, hard-stops (not shown) are provided to probe tip 100a, 100b moving mechanism so that heads 114a, 114b cannot be separated more than 254 μm (0.010 inches) apart. The hard-stops would thereby prevent lead element 28 connections to amplifier PCA 128 from being dislodged. The minimum separation of heads 114a, 114b is approximately 6.35 μm (250 micrometers), for example.

[0032] Wires 130 extending from insulated member 20 to amplifier PCA 128 can allow for adjustment of trace separation distances and for differential impedance by allowing heads 114a, 114b of two probe tip 100a, 100b to be moved back and forth. The thickness and composition of insulating member 20 can be adjusted to attain different values of single-ended impedance.

[0033] In the some examples, probe 120a is used to passively probe unpowered PCBs or PCAs for signal integrity measurements such as near end crosstalk, far end crosstalk, time domain reflectometry (TDR) measurements, for example. In one example, one of wires 130 will be grounded and insulating member 20 on that side of the differential probe is eliminated.

[0034] Probe tips 100a, 100b can be a high-speed differential pair. Alternatively, probe tips can also apply to single-ended signals (e.g., just one probe tip used at a time, or two probe tips with one being "ground"). In another example, three probe tips are used at one time, two for a high-speed differential pair and the third being used at probe "ground", to fetch a differential reading and two single-

ended readings at the same time. The metal of the probe tip 100 can be grounded with a ground path between the structural backbone of the probe tip 100 and amplifier PCA 130. The wire of a ground path 142 is long enough to allow for movement of the amplifier with respect to probe tips 100a, 100b. Single-ended impedance to the two signals with respect to ground can be adjusted by providing the user with a variety of thickness and/or compositions of insulating members 20 between metallic probe tips 100a, 100b and lead elements 28.

[0035] It is envisioned that in some cases, optical magnification can be used to assist in viewing. For example, a fiber-optic scope can be included in or adjacent to the probe tip for viewing the probe tip in relation to the desired test point. A light (not shown) illuminating probe tip 100 can also be included to assist with probe point placement.

[0036] Elements of probe tip assemblies 10, 110 are modularly repairable with use of a microscope, suitable small tipped tools, and adhesive. For example, a damaged insulator member 20 can be removed (if necessary) and a new insulator member 20 can be adhered onto probe tip 11, 100. Similarly, lead elements 28 and leads 30, 130 can also be removed and replaced. If insulator member 20 or lead element 28 are dislodged from probe tip 11, 100 but not damaged, they may be re-adhered. Alternatively, probe tip assemblies 10, 110 are replaceable within probe 120.

[0037] Although specific examples have been illustrated and described herein, a variety of alternate and/or equivalent implementations may be substituted for the specific examples shown and described without departing from the scope of the present disclosure. This application is intended to cover any adaptations or variations of the specific examples discussed herein. Therefore, it is intended that this disclosure be limited only by the claims and the equivalents thereof.

CLAIMS

1. A probe tip assembly comprising:
a probe tip comprising glassy metal, the probe tip including a head, a tail end, and a shaft extending between the head and the tail end, wherein the head has a bottom surface, and wherein the head forwardly extends to a first vertical plane forward of the tail end;
an insulating member disposed on at least the bottom surface of the head; and
a lead element including a lead wire disposed on the insulating member.
2. The probe tip assembly of claim 1, wherein only the head is comprised of glassy metal.
3. The probe tip assembly of claim 1, wherein the insulating member includes a groove to removably retain at least a portion of the lead wire.
4. The probe tip assembly of claim 3, wherein the lead wire includes top and bottom lobes joined together to form a figure "8" cross-sectional shape and the top lobe is removably disposable in the groove.
5. The probe tip assembly of claim 1, wherein the insulating member has a front portion disposed on a front surface of the head, wherein the front portion includes an indentation to removably retain the lead element.
6. The probe tip assembly of claim 1, wherein the lead element is an axial-leaded resistor.
7. A probe comprising:
a rod;
an outer tube encircling the rod; and

a pair of probe tip assemblies spaced apart from one another, each probe tip assembly comprising:

a probe tip having a head, an opposing tail end, and a shaft extending between the head and the tail end, wherein the head has a bottom surface, wherein the head is disposed at an angle relative to the tail end, and wherein the tail end is removably insertable into the rod or the outer tube;

wherein a distance between the heads of the probe tips is adjustable.

8. The probe of claim 7, wherein one of the pair of probe tip assemblies is coupled to the rod and the other of the pair of probe tip assemblies is coupled to the outer tube.

9. The probe of claim 8, wherein one of the pair of probe tip assemblies is insertably force-fitted into an opening in the rod and the other of the pair of probe tip assemblies is insertably force-fitted into an opening in the outer tube.

10. The probe of claim 9, wherein the shaft of each of the probe tips has a cross-sectional shape that resists spinning with the openings.

11. The probe of claim 7, comprising:

an insulating member disposed on the head of at least one of the pair of probe tip assemblies, the insulating member extending along the bottom surface and a front surface; and

a lead element and lead disposed on the insulating member, wherein the insulating member electrically insulates the head from the lead element and the lead.

12. The probe of claim 11, comprising an amplifier printed circuit assembly, wherein the lead extends from the lead element to electrically connect with the amplifier printed circuit assembly.

13. The probe of claim 9, comprising a sleeve extending into one of the openings around the elongated probe tip and a strain gauge coupled to a sleeve outside of the opening.

14. A probe tip assembly, comprising:

an elongated probe tip comprised of a glassy metal, the elongated probe tip having a head, a tail end, and a shaft extending between the head and the tail end, wherein the head includes a flat bottom surface and a flat front surface extending at an angle from the bottom surface;

an insulating member disposed on the bottom surface and the front surface of the head, the insulating member including a groove on an outer bottom face; and

a lead element having leads extending from the lead element in a first direction within the groove.

15. The probe tip assembly of claim 14, wherein only the head of the elongated probe tip is comprised of a glassy metal.

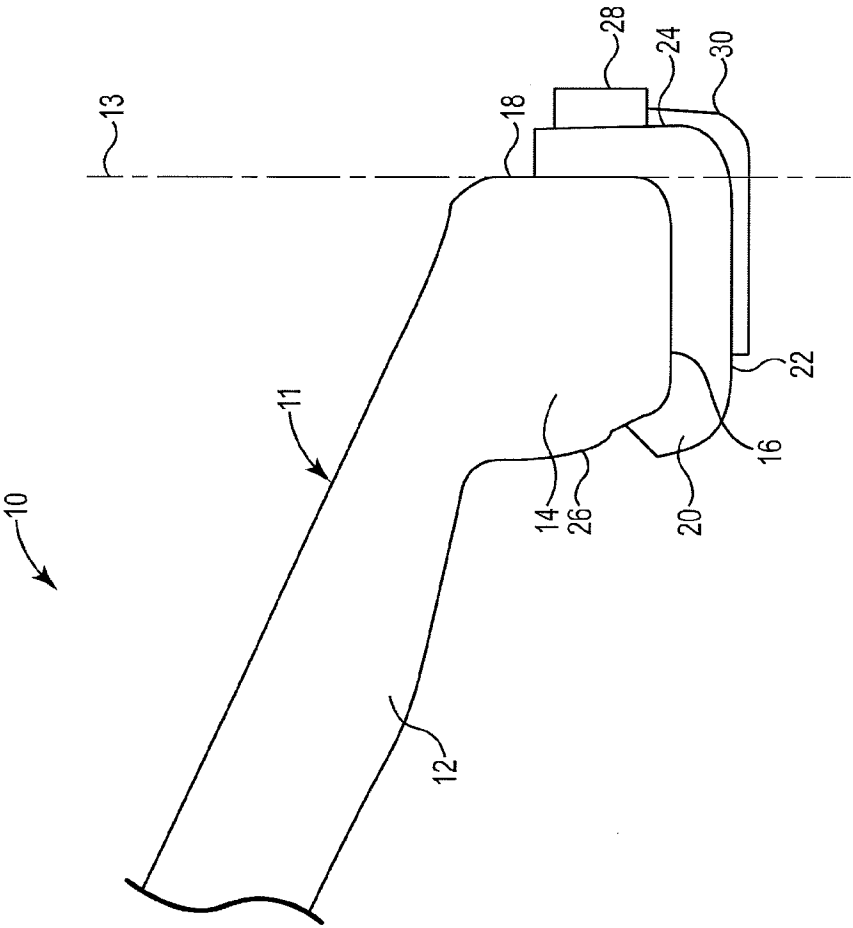


FIG. 1A

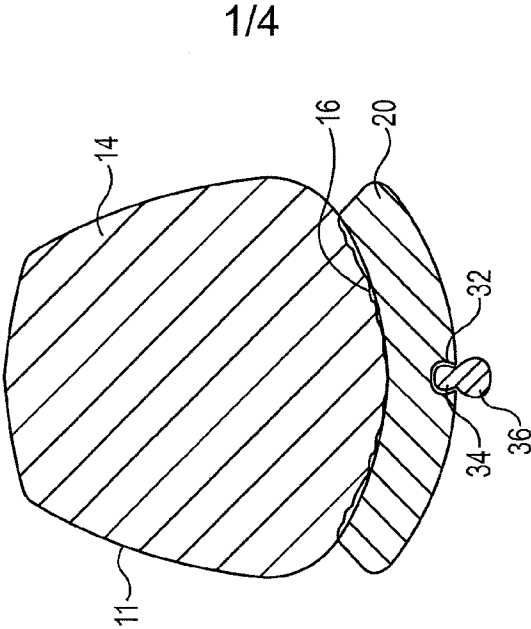


FIG. 1B

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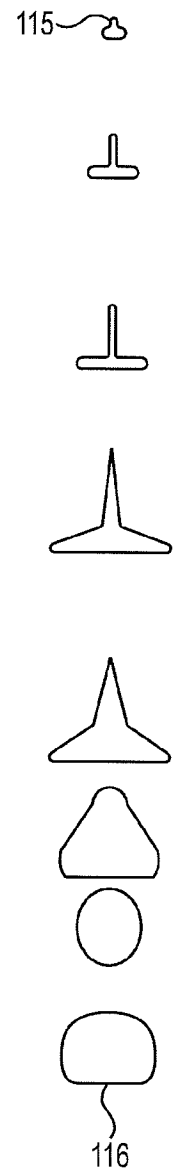


FIG. 2A

FIG. 2B

FIG. 2C

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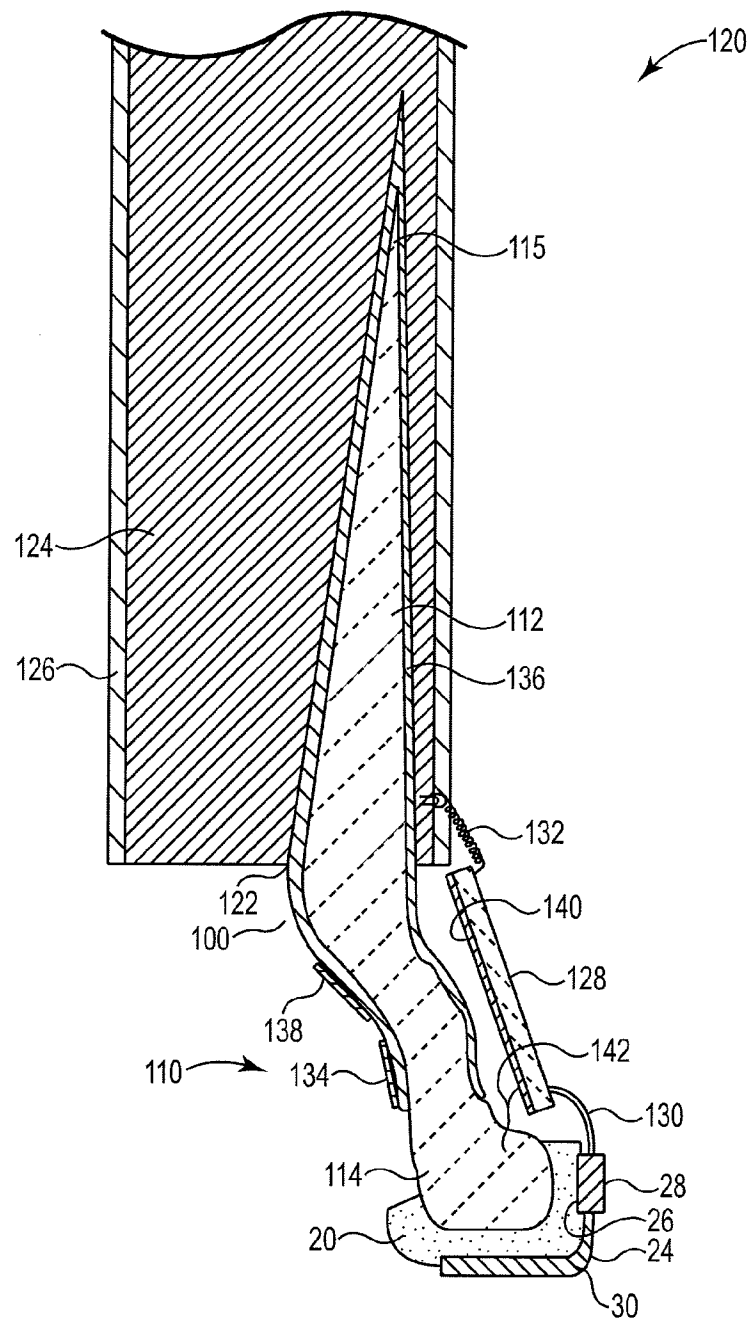


FIG. 3

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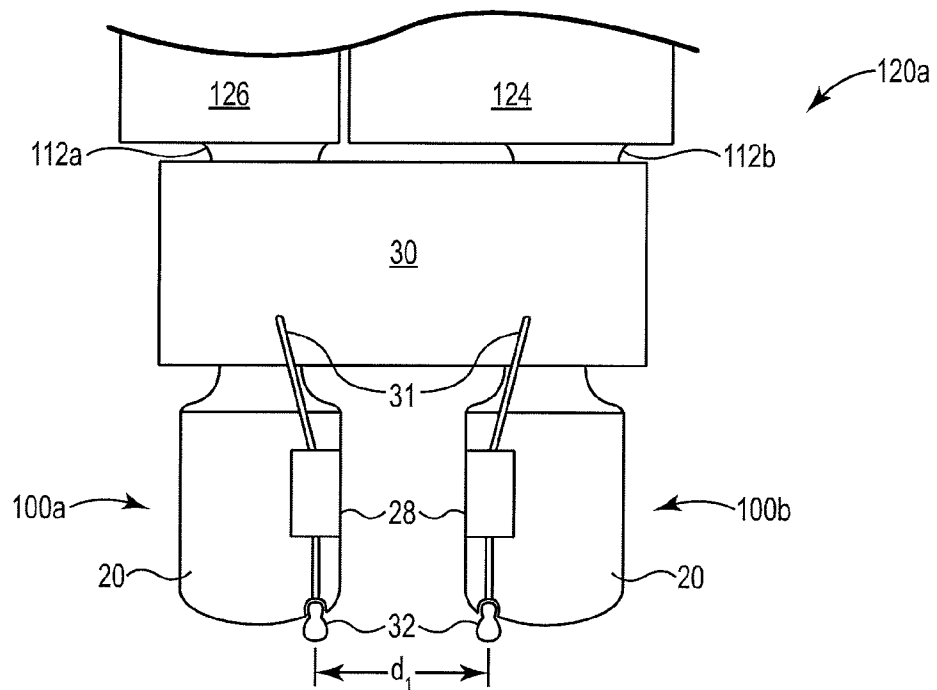


FIG. 4A

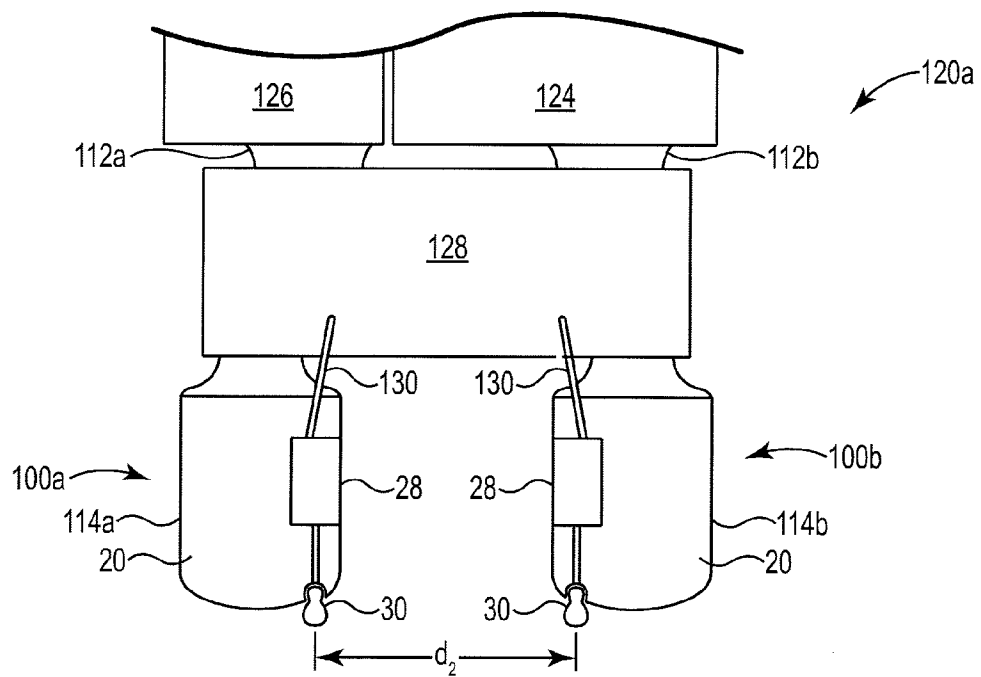


FIG. 4B

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2014/014295**A. CLASSIFICATION OF SUBJECT MATTER****G01R 1/067(2006.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

G01R 1/067; G01R 3/00; H01L 21/66; G01R 31/02; G01R 27/08

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & keywords: probe tip, lead, insulting, shaft

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2002-0072136 A1 (KANAMARU et al.) 13 June 2002	1-2,5-6
A	See abstract, paragraphs [0056]-[0059] and figures 2-3.	3-4,7-15
Y	US 2005-0162177 A1 (CHOU) 28 July 2005	1-2,5-6
A	See abstract, paragraphs [0028]-[0029] and figure 2A.	
A	US 2009-0206855 A1 (YASUTAKE) 20 August 2009	1-15
A	See abstract, claim 1 and figures 1-6.	
A	US 6727716 B1 (SHARIF) 27 April 2004	1-15
A	See column 6, lines 41-58 and figure 6.	
A	US 2009-0160473 A1 (FUKAMI et al.) 25 June 2009	1-15
A	See abstract, claims 1-9 and figures 1-6.	



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

25 June 2015 (25.06.2015)

Date of mailing of the international search report

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Name and mailing address of the ISA/KR

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