Electrical circuit test probe and connector.

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Description

The present invention relates to electrical circuit test probes and electrical connectors therefor and, more particularly, to an electrical circuit test probe with a spring loaded plunger in a socket tube having an offset wand extending therefrom to contact the interior of a member disposed within the socket tube and wherein the socket tube is provided with a releasable connector for a conductor comprising a plug housing formed in the end of the socket tube and a collet jawed plug for gripping the electrical conductor and slidably fitting within the plug housing to grip the conductor and hold it therein in electrical contact.

Of necessity, electrical circuit testing has made rapid strides in its technology in the past few years. Until the advent of miniaturization, circuit testing, took the form shown in Figure 1. To test whether a large fuse 10 was electrically conductive, a pair of large, hand-held probes 12 connected to a meter 14 were placed across the fuse 10.

Modern printed circuit (PC) boards have made such hand testing virtually impossible. Literally hundreds of connections at close-spaced proximity must be tested to verify proper circuit continuity. To do this in an automated way, apparatus such as that shown in Fig. 2 has come into common usage. The PC board 16 is positioned on a holding table 18 and a fixture 20 having a plurality of electrical test probes 22 is brought into contact with the surface thereof. The probes 22 are connected by cable 24 to testing logic 26. In this manner, the testing logic 26 can quickly and accurately test a multitude of circuit interconnections for proper continuity.

As can be readily understood, the functioning of the probes 22 relative to the fixture 20 and their electrical connection to the testing logic 26 are critical to the successful operation of the testing apparatus. Any failure of the probe 22 to make effective electrical contact with the PC board 16 or any failure of the electrical contact so made to be effectively passed back to the testing logic 26 will be interpreted, wrongly, by the testing logic 26 as a failure of the PC board 16.

Two aspects are critical in the overall operation of the probes 22. First, the probes 22 must have a degree of linear axial movement within the fixture 20 to accommodate variations in projection of contact points from the PC board, thereby to prevent undue pressure on the PC board 16 and/or breakage of the probe 22 while ensuring adequate electrical contact. Second, is the manner of electrically connecting a conductor from the cable 24 to the probe 22. Some of these aspects according to the prior art are shown in Figs. 3-8.

Turning first to Fig. 3, a probe is shown according to U.S. Patent No. 4,200,351. The probe, generally indicated as 26, comprises a spring-metal tube 30 press-fit within the bore 32 of fixture 20. Probe 26 has a first cylindrical portion 34 adapted to slidably fit within the tube 30 and having a head 36 on the outer end thereof for contacting the PC board 16. A smaller diameter cylindrical shaft 38 extends from the cylindrical portion 34 in axial alignment therewith to pass through the bore 32 and terminate in an end 40 having a square cross-section particularly adapted for attachment of an electrical conductor thereto by a so-called Wire Wrap process. An enlarged portion 42 on the shaft 38 contacts the outer ends of fingers 44 formed in the tube 30 to prevent longitudinal movement out of the tube 30 of the head 36 beyond a pre-established maximum point. A spring 46 is under compression between shoulder 48 and the inside of the fingers 44 to bias the assembly to its outer position. Since the electrical connection to the probe (not shown) is directly attached to the end 40, there is no danger of loss of electrical continuity as the probe 26 is moved in and out of bore 32. On the negative side, should it be desired to reconfigure the probe 26 or replace it, the task is not a simple one.

A test probe of the type shown in U.S. Patent No. 4,168,973 is shown in Fig. 4 and generally indicated at 50. Probe 50 comprises a socket tube 52 which is slid into a pair of aligned bores 32 in the fixture 20. Electrical connection is provided to the tube 52 by presssing the electrical conductor 54 into a pair of jaws 56 in connector member 58, which is cramped into the one end of the socket tube 52. A tubular sleeve 60 is fitted into the end of the socket tube 52 adjacent the connector member 58. The head 36 is mounted on a shaft 62 having a cylindrical portion 64 sized to slidably fit within the tube 52. Correspondingly, the inner end of the shaft 62 is sized to slidably fit within the tubular sleeve 60. Spring 46 is disposed between the tubular sleeve 60 and the cylindrical portion 64 to provide the outward biasing force on the head 36. Stop member 66 is provided to prevent the shaft 62 from moving outward past its previously selected maximum point. With this embodiment, the socket tube 52 can be easily removed from the bores 32 as necessary. To release the electrical conductor 54, however, it must be pried from between the jaws 56. Electrical contact between the moving shaft 62 and the electrical conductor 54 is hoped for by contact between the cylindrical portion 64 and the inside of the socket tube 52 in combination with contact between the inner end of the shaft 62 and the inside of the tubular sleeve 60.

Turning now to Fig. 5, a probe, generally indicated as 68, is shown according to the teachings of U.S. Patent No. 4,461,993. In this particular case, a tube 70 is mounted within the bore 32 of fixture 20. The head 36 comprises the end of a cylindrical shaft 72 slidably mounted within a tube 74 having its opposite end 76 of a reduced diameter adapted to snugly fit within the tube 70. The electrical conductor (not shown) is electrically connected to the tube 70 in any manner desired and electrical connection is made between the tubes 70, 74 by their snug fit together in electrical contact. Shaft 72 has a reduced diameter portion 78 and a bulbous end 80. The tube 74 is cramped as at 82 to prevent the shaft 72 from moving out of tube 74 beyond its desired extension limit. A spring 46 is positioned within the tube 74 between the portion 78 and the bulbous end 80 to urge the head 36 to its extended position. While tube 74 and its assembled components can be easily re-
moved from the tube 70 without disconnection of the electrical conductor (not shown), once again, electrical connection between the tube 74 and shaft 72 is hoped for by the sliding contact of the shaft 72 on the inside of tube 74, sliding contact of the bulbous end 80 within tube 74, and electrical contact by the spring 46 between the tube 74 and end 80.

The prior art configurations of Figs. 6-8 are variations that can be applied to the embodiments of Figs. 4 and 5 in an attempt to provide a greater probability that electrical contact will be provided between the outer tube and the shaft sliding therein containing the head 36. Fig. 6 corresponds to the teaching from U.S. Patent No. 4,050,762. In this case, a spring member 82 having fingers 84 is mounted to the end of the moving shaft 86 to press against the inside walls of the tube 88.

Fig. 7 shows the teachings of U.S. Patent 3 753 103, wherein a contact member 90 is connected to the end of sliding shaft 92 by a leaf spring 94 providing a biasing couple tending to urge the contact member 90 against the inside walls of the tube 98.

Finally, in Fig. 8, which corresponds to U.S. Patent No. 4 397 519, the inner end 98 of shaft 100 is angled at surface 102 and the biasing force of the spring 46 is applied through a ball 104 against angled surface 102 which results in a biasing force vector from spring 46 also being provided against end 98 towards the inner side wall of the tube 105.

All the above-described prior art probes, many of which remain mere paper proposals, and their manner of connection to the electrical conductor connected thereto have one or more problems relating to mechanical and electrical effectiveness and reliability, and cost, ease of manufacture and ease of use. Especially as the center-to-center spacing between probes in a multi-probe fixture of necessity becomes smaller and smaller as boards to be tested become correspondingly smaller, there is a requirement for a probe which is simple to manufacture because of few and simple parts, while, at the same time, being easily replaceable and completely reliable in its electrical conductivity.

Wherefore, it is the object of the present invention to provide an electrical circuit test probe and connector combining these features.

According to the invention, there is provided an electrical circuit test probe for mounting in a mounting hole in a test fixture board having a cylindrical socket tube of an electrically conductive material sized to snugly fit within the mounting hole of the fixture board, said socket tube including means for electrically connecting to an electrical conductor on one end, and being open on its opposite end; a longitudinal plunger member of an electrically conductive material having inner and outer ends and a first cylindrical portion slide fitted into said open opposite end and terminating on said outer end in an electrical contact for contacting circuits to be tested, said inner end of said first cylindrical portion being disposed within said socket tube and having a second cylindrical portion extending therefrom along a common longitudinal axis and being of a smaller diameter to form a shoulder where said two cylindrical portions join one another, a cylindrical plunger tube of an electrically conductive material disposed within said socket tube and in electrical contact therewith adjacent said electrical connecting means and a compression spring disposed between said shoulder and said plunger tube to create a bias force on said plunger member towards its extended position, characterized by said inner end of said second cylindrical portion having a resiliently flexible band extending therefrom at an angular offset to said common longitudinal axis, said wand terminating in a bulbous contact member, said contact member being disposed within said plunger tube and with said wand passing through an opening through which said contact member cannot pass; whereby said contact member is maintained in good electrical contact with the inner surface of said plunger tube by said biasing force from said offset of said wand as said plunger member is moved into and out of said socket tube.

The invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Fig. 1 is a simplified drawing of a prior art testing technique employing large size hand-held probes.

Fig. 2 is a simplified drawing of a prior art multi-probe test fixture as wherein the present invention is applicable.

Fig. 3-8 are drawings from prior art patents showing prior art probes.

Fig. 9 is an end view of the collet member of the present invention.

Fig. 10 is a sectional elevation along section line A-A of Fig. 8.

Fig. 11 is a plan view through the end of the collet member seen in the direction of arrow X in Fig. 9.

Fig. 12 is a cut-away view through the plug housing of the present invention.

Fig. 13 is a cut-away view of the electrical connector of the present invention being assembled, but prior to the conductor being gripped.

Fig. 14 is a cut-away view showing the connector of Fig. 13 in its fully inserted position.

Fig. 15 is a picture of the plunger of the present invention.

Fig. 16 is a cut-away view through the plunger tube of the present invention.

Fig. 17 is a picture of the socket tube of the present invention.

Fig. 18 is a cut-away view through the probe and connector of the present invention in its fully assembled state.

Fig. 19 is a cut-away view through the plunger tube portion of Fig. 18 with the plunger in its fully retracted position.

Turning first to Figs. 9-14, the novel electrical connector portion of the present invention will first be shown and described. Figs. 9-11 show a conductive metallic collet member, generally indicated as 106 adapted to fit over the end of an electrical conductor in a manner to be described shortly. Collet member 106 is generally cylindrical in shape and has an opening 108 into which the electrical conductor 110 can be inserted in the manner shown in Fig. 13. In
use, the insulation 112 is stripped from the end of the conductor 110 exposing a portion 114 of the conducting wire contained therein. The collet member 106 has a first cylindrical portion 116 having an internal diameter adapted to fit about the insulation 112 and a second cylindrical portion 118 of a smaller diameter adapted to fit about the conducting wire 114. The two portions 116, 118 form a shoulder 120 at their point of junction, which prevents insertion of the conductor 110 past its optimal point. The ends of the second cylindrical portion 118 are slit at 122 and curved inwardly to form two facing jaws at 124. Each jaw 124 has a neck portion 125 connecting it to the remainder of the cylindrical portion. The generally cylindrical collet member 106 has parallel diametrically opposite flat surfaces 126 formed in the region of and normal to slits 122 to reduce the thickness of material in the collet 106 laterally of the jaws 124. In the preferred embodiment as manufactured by the assignee of the present invention, the collet member 106 is of brass tubing per CDA 330, being three-quarter hard. A pair of raised ridges 127 are provided circumferentially about the exterior of the collet member 106 in spaced relationship to form a groove 128 adjacent the end with the opening 108. The purpose thereof will be discussed shortly.

It will be appreciated that while two jaws have been described in this preferred embodiment, three, four or more jaws might be formed and used in the collet member 106.

Turning now to Fig. 12, the plug housing of the present invention is shown generally indicated as 130. Plug housing 130 is of nickel silver per CDA 752 with its internal surface clad with gold alloy and is comprised of a first cylindrical portion 132 into which the collet member 106 can be inserted in a sliding fit as shown in Fig. 13. Plug housing 130 further comprises a second cylindrical portion 134 of a smaller diameter with the two portions 132, 134 being interconnected by a tapered portion 136 smoothly tapering as shown by the angle at 138 between the portions 132, 134. The plug housing 130 past the second cylindrical portion 134 constricts to a closed end 140 of yet a smaller diameter and forming a shoulder 142 on the exterior where end 140 meets cylindrical portion 134. The end 140 is provided to allow the plug housing 130 to be mounted in the outer end of an electrical circuit test probe of the present invention, to be described shortly. As will be recognized by those skilled in the art, all that is required is that the plug housing 130 be provided with some means for electrically connecting it to the circuit to which it is going to provide releasable electrical access.

Turning now to Fig. 13, it can be seen that in use, the stripped electrical conductor 110 is inserted into the open end 108 of the collet member 106 with the insulation 112 abutting against shoulder 120 and the conducting wire 114 passing between the facing jaws 124. A heat shrinkable cylindrical member 144 of electrically insulating material is disposed around the member 106 between the raised ridges 127 and shrunk into the groove 128 to thereby grip the groove. Member 144 has an outer diameter greater than the outer diameter of the probe and connector thereby to provide electrical separation between adjacent probes in a test fixture. The jaws 124 of the collet member 106 are inserted into the plug housing 130 as shown in Fig. 13 and then the entire member 106 is forced into the plug housing 130 until the innermost raised ridge 127 abuts the outer end of the plug housing 130. In that movement, the jaws 124 are slid along the tapering portion 136 and into the reduced diameter second cylindrical portion 134. In so doing the jaws are forced to bite into wire 114 to produce electrically conductive gripping communication therewith with further insertion causing the necked portions 125 to be stressed sufficiently for them to plastically deform to maintain the facing jaws 124 in intimate (biting) electrical contact with the conducting wire 114 while permitting complete insertion of the collet member 106 into plug housing 130. Moreover, the jaws 124 are moved away from the tapering portion 136 and well into the second cylindrical portion 134 such that their outward force tends to hold the collet member 106 within the plug housing 130.

Turning now to Figs. 15-19, the electrical circuit test probe portion of the present invention will be shown and described with particularity.

Turning first to Fig. 15, the plunger thereof is generally indicated as 146. Plunger 146 comprises a first cylindrical portion 148 (in some embodiments may have a portion thereof, intermediate its ends, relieved to form two spaced cylindrical surfaces which together correspond to portion 148) having an electrical contact 36 at one end. Extending from the opposite end is a second cylindrical portion 152 of a smaller diameter and in alignment with a common longitudinal axis 154. Extending from the other end of the portion 152 is a wand portion 156 of yet a smaller diameter and terminating in a bulbous contact portion 158 of a diameter substantially identical to that of the second cylindrical portion 152. The plunger is of heat treated beryllium copper 33-25 or M25, being one-half hard per CDA 173 and plated with 0.00127 millimetres of gold over 0.00254 millimetres of nickel. The wand portion 156 in the tested embodiment is 0.234 millimetres in diameter and is offset from the common longitudinal axis 154 a distance of 0.254 millimetres in a length of 4.57 millimetres. As thus sized and constructed, it can be realized that the wand portion 156 acts as a flexible finger with the contact portion 158 at the end thereof.

Turning now to Fig. 16, the plunger tube is indicated as 160. Plunger tube 160 has an internal diameter sized to be a loose slide fit for the contact portion 158 of plunger 146. The plunger tube in the tested embodiment is CDA #725 clad on both sides with gold alloy.

Turning now to Fig. 17, the socket tube of the present invention is generally indicated as 162. The socket tube 162 in the tested embodiment is of beryllium copper alloy clad with a silver alloy on the internal surfaces. The sizing and interaction of the various parts will be understood from the description which follows with respect to Fig. 18. First, end 164 of tube 162 is sized to receive end 140 of plug housing 130. When end 140 is inserted into end 164 and the tube cramped together, a secure point of mechanical and electrical contact to socket tube 162 is provided. Socket tube 162 is indented at 166. The
outer diameter of plunger tube 160 is sized such that it can be slid into socket tube 162 and be held in place adjacent the ends 140, 164 by the interference fit pressure of the indentation 146. Prior to such insertion, however, bulbous end 158 is inserted into the plunger tube 160 and the end at 168 crimped about the wand 156 to a size that allows the wand 156 to easily slide therethrough, but being of an opening size insufficient to allow the bulbous end portion 158 to pass back therethrough. Accordingly, contact portion 158 is trapped within the plunger tube 160. Again, prior to such insertion and crimping however, compression spring 170 is slid over the wand 156 and second cylindrical portion 152 into abutment with the shoulder 172 where the second cylindrical portion 152 joins the first cylindrical portion 148. Then, as the plunger tube is positioned and cramped, the spring 170 is trapped between the shoulder 172 and the end 168 of the plunger tube 160. Thereafter, the plunger tube 160 is positioned within the socket tube 162 as shown in Fig. 18, which holds the entire probe assembly, generally indicated as 174, in assembled condition. The probe assembly 174 can be disposed within a bore 32 on a fixture 20 and is held in place by the snug gripping action of one or more raised areas 176 on the outer periphery of the tube 162. These raised areas 176 are preferably disposed in a portion of the socket tube 162 remote from the inner most projection, in use, of the first cylindrical portion 148 into the socket tube.

As the plunger tube 160 is slid into the socket tube 162 followed by the cylindrical portion 148 of the plunger 146, the wand 156, of necessity, is straightened out from its offset position, thus creating a biasing force by the contact portion 158 against the interior precious metal clad surface of the plunger tube 160. Thus, as shown in Fig. 19, the contact portion 158 is held firmly against the inside of the plunger tube 160 throughout its entire length of travel, whereby continuous electrical contact is assured.

Thus, it can be seen from the foregoing description that the present invention has truly met its desired objectives. Construction is simple and of a minimum of parts, which are all of easily fabricated design. The plunger 146, for example, is of unitary construction. The electrical connector is easily removable, while, at the same time, being of small size and affording a firm electrical grip. In the tested embodiment by the assignee of the present invention, center-to-center dimensions of as little as 1.27 millimetres have been easily obtained with reliable results and ease of use in a probe capable of a longer stroke than prior art probes coupled with higher spring generated contact pressures to ensure reliable electrical contact with PCB's being tested.

Claims

1. An electrical circuit test probe (174) for mounting in a mounting hole (32) in a test fixture board (20) having a cylindrical socket tube (162) of an electrically conductive material sized to snugly fit within the mounting hole of the fixture board, said socket tube (162) including means for electrically connect-

ing to an electrical conductor on one end, and being open on its opposite end; a longitudinal plunger member (146) of an electrically conductive material having inner and outer ends and a first cylindrical portion (148) slide fitted into said open opposite end and terminating on said outer end in an electrical contact for contacting circuits to be tested, said inner end of said first cylindrical portion (148) being disposed within said socket tube (162) and having a second cylindrical portion (152) extending therefrom along a common longitudinal axis and being of a smaller diameter to form a shoulder (172) where said two cylindrical portions (148, 152) join one another, a cylindrical plunger tube (160) of an electrically conductive material disposed within said socket tube (162) and in electrical contact therewith adjacent said electrical connecting means and a compression spring (170) disposed between said shoulder (172) and said plunger tube (160) to create a bias force on said plunger member (146) towards its extended position, characterized by said inner end of said second cylindrical portion (152) having a resiliently flexible wand (156) extending therefrom at an angular offset to said common longitudinal axis, said wand terminating in a bulbous contact member (158), said contact member (158) being disposed within said plunger tube (160) and with said wand (156) passing through an opening (168) through which said contact member (158) cannot pass; whereby said contact member (158) is maintained in good electrical contact with the inner surface of said plunger tube (160) by said biasing force from said offset of said wand (156) as said plunger member is moved into and out of said socket tube (162).

2. A test probe according to claim 1 characterized in that: said means for electrically connecting said probe is a releasable connector (106, 130) which plugs into said end of said socket tube (162).

3. A test probe according to claim 1 or 2 characterized in that said releasable connector means comprises: a socket (164) formed into the end of the socket tube (162); and, plug means (106, 130) for electrically gripping the end of an electrical conductor (114) and for releasably fitting into said socket (164) in electrical contact therewith.

Patentansprüche

1. Elektrische Prüfspitze (74) zum Einbauen in ein Befestigungloch (32) einer Prüfpultvorrichtung (20) mit einer zylinderförmigen Steckerhülse (162) aus elektrisch leitendem Material, welche so groß ist, daß sie innerhalb des Befestigungslöchers der Prüfpultvorrichtung satt anliegt, wobei die Steckerhülse (162) eine Einrichtung zum elektrischen Verbinden mit einem Stromleiter an einem Ende aufweist und an ihrem anderen Ende offen ist, mit einem Längskolbenteil (148) aus elektrisch leitendem Material mit innern und äußeren Enden und einem ersten zylindrischen Abschnitt (148), der mit Gleitsitz in das offene andere Ende eingepaßt ist und der an dem äußeren Ende in einem elektrischen Kontakt zum Berühren der zu prüfenden Stromkreise be- grenzt ist, wobei das innere Ende des ersten zylindrischen Abschnittes (148) innerhalb der Stecker-
hülse (162) angeordnet ist und einen zweiten zylindrischen Abschnitt (152) aufweist, der sich von da entlang einer gemeinsamen Längsachse erstreckt und von einem kleineren Durchmesser ist, um eine Schulter (172) zu bilden, wo die zwei zylindrischen Abschnitte (148, 152) sich aneinandersetzen, mit einer zylindrischen Kolbenhülse (160) aus elektrisch leitendem Material, die innerhalb der Steckerhülse (162) angeordnet ist und die in elektrischem Kontakt damit ist nahe der elektrischen Verbindungseinrichtung, und mit einer Druckfeder (170), die zwischen der Schulter (172) und der Kolbenhülse (160) angeordnet ist, um eine Vorspannung auf das Kolbenteil (146) gegen seine ausgestreckte Position zu bilden, dadurch gekennzeichnet, daß das innere Ende des zweiten zylindrischen Abschnittes (152) einen nachgiebigen flexiblen Stab (156) aufweist, der sich davon in einem der gemeinsamen Längsachse winkelförmigen Versatz erstreckt, wobei dieser Stab in einem wulstigen Kontaktteil (158) endet, und das Kontaktteil (158) innerhalb der Kolbenhülse (160) angeordnet ist, und wobei der Stab (156) durch eine Öffnung (158) durchschubbbar ist, durch die das Kontaktteil (158) nicht durchgehen kann; wobei das Kontaktteil (158) durch die Vorspannkraft der Ver- setzung des Stabes (156) mit der Innenseitefläche der Kolbenhülse (160) in gutem elektrischem Kontakt gehalten wird, wenn das Kolbenteil in und aus der Steckerhülse (162) bewegt wird.

2. Prüfspitze nach Anspruch 1, dadurch gekennzeichnet, daß die Einrichtung zum elektrischen Verbinden der Prüfspitze ein lösbare Verbinde (106, 130) ist, der in das Ende der Steckerhülse (162) einsteckbar ist.

3. Prüfspitze nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß die lösbare Verbindungsein- richtung eine Muffe (164), die in das Ende der Steckerhülse (162) eingefügt ist und eine SteckEinrichtung (106, 130) zum elektrischen Greifen des Endes eines elektrischen Leiters (114) und zum lösbaren Einsetzen in die Muffe (164) in elektrischem Kontakt damit aufweist.

Revendications

1. Sonde (174) de tests de circuits électriques, destinée à être montée dans un trou de montage (32) dans une carte de montage de test (20), comportant: un tube cylindrique de raccord (162) en matière élect- triquement conductrice, dimensiné de façon à s’ajuster dans le trou de montage de ladite carte, le- dit tube de raccord (162) comportant des moyens de connexion électrique à un conducteur électrique à l’une de ses extrémités et étant ouvert à son extrémité opposée; un élément longitudinal mobile (148) en matière électriquement conductrice, ayant une extrémité intérieure, une extrémité extérieure et une première partie cylindrique (148) montée de manière coulissante dans ladite extrémité opposée ouverte et se terminant à ladite extrémité extérieure par un contact électrique à contrôler, ladite extrémité intérieure de la première partie cylindrique (148) étant disposée à l’intérieur du tube de raccord (162) et ayant une seconde partie cylindrique (152) s’étend- dant à partir de la première suivant un axe longitudi-