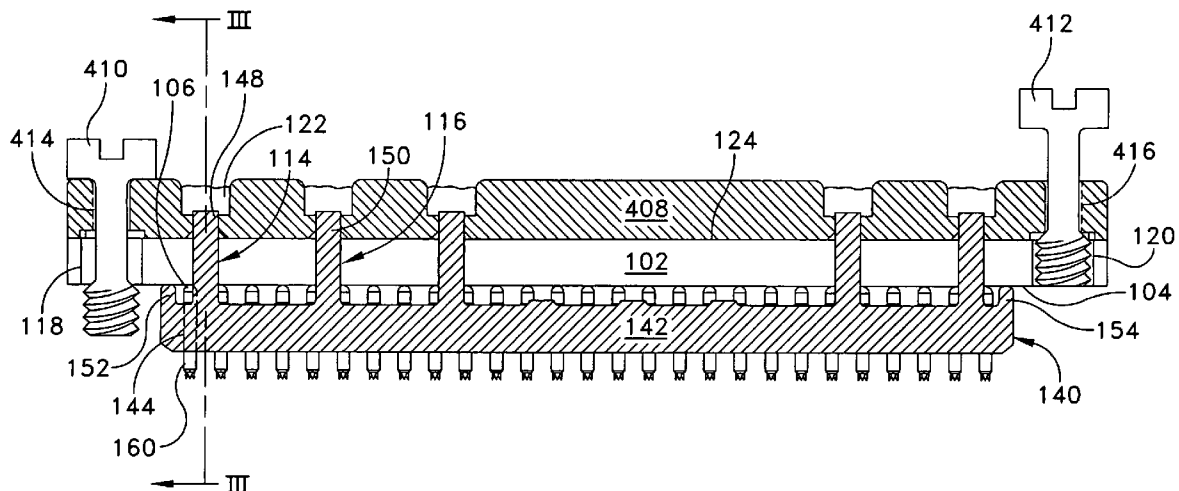


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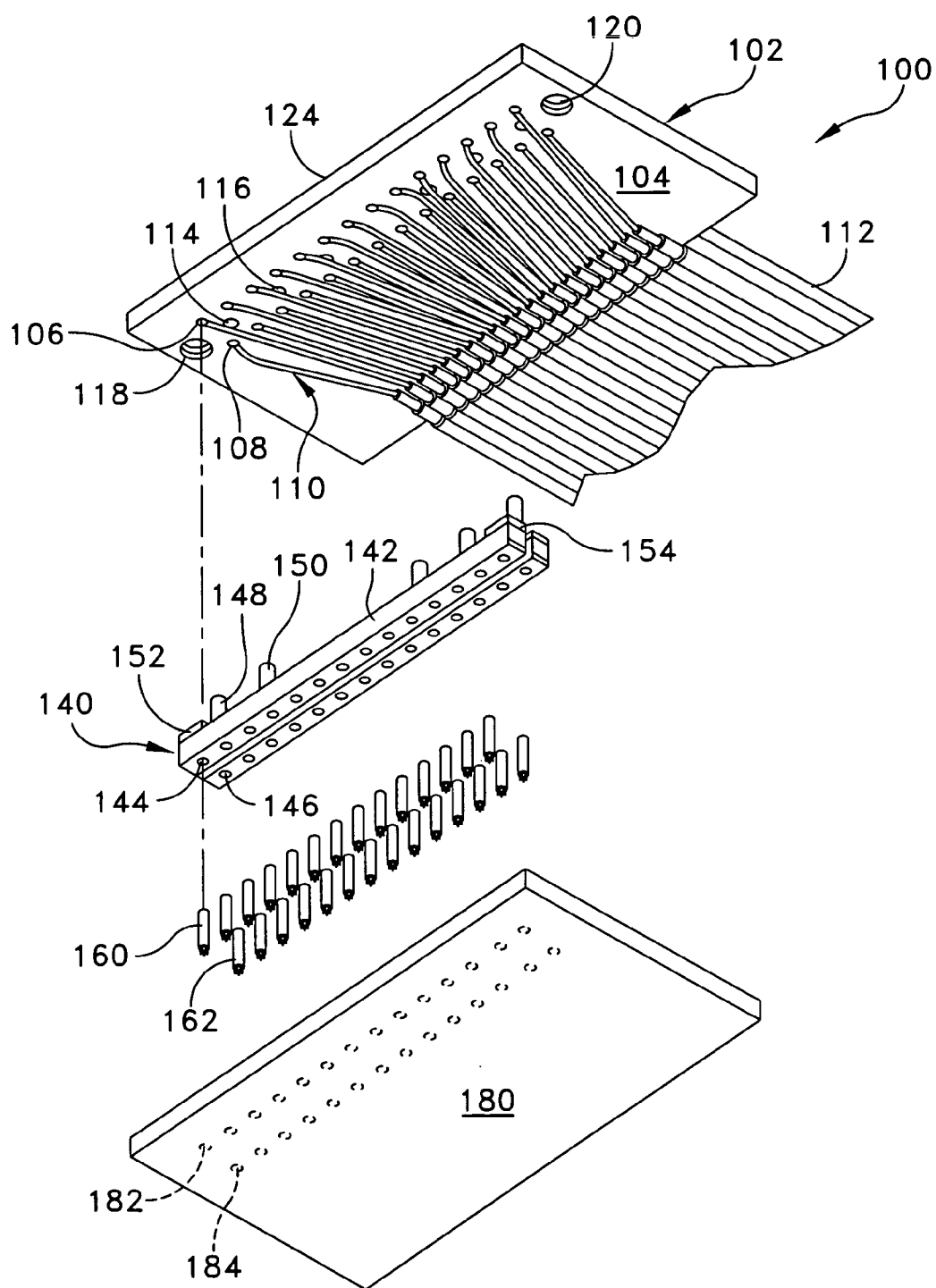


FIG. 1

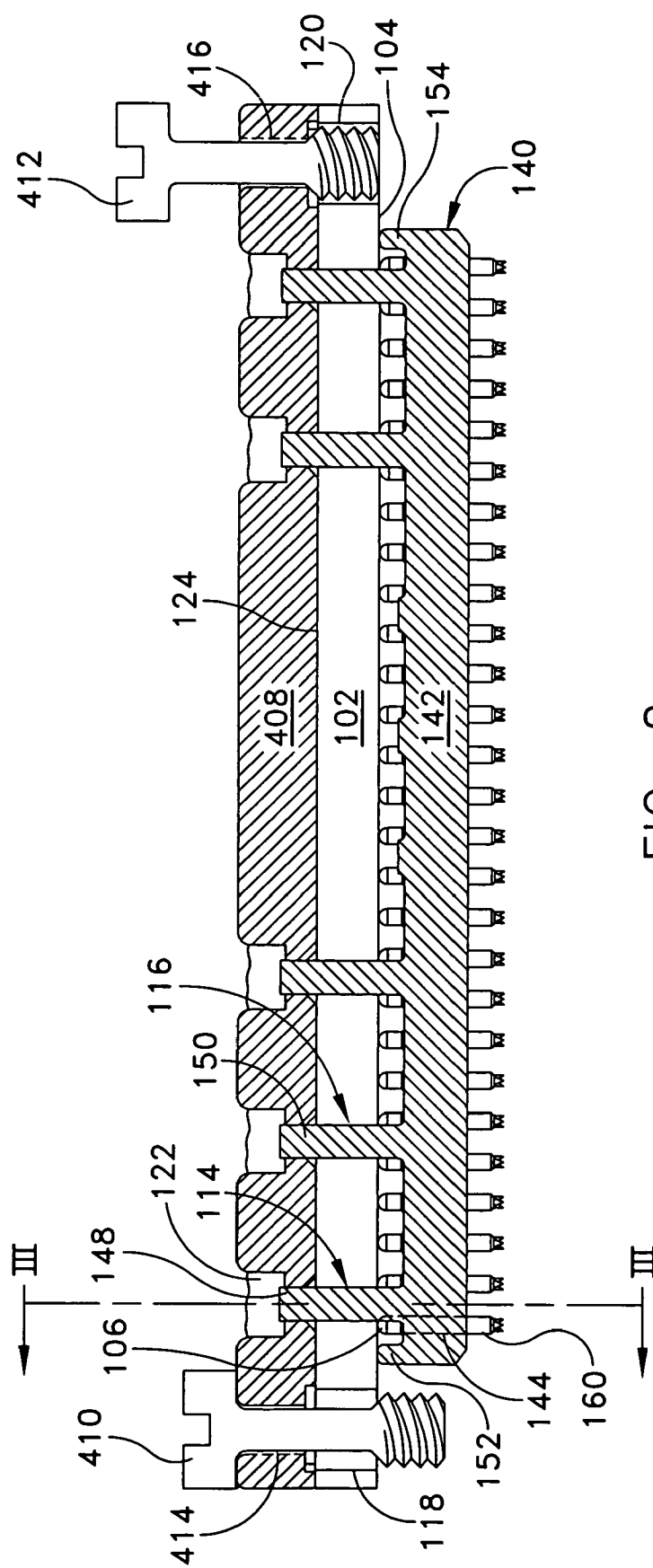


FIG. 2

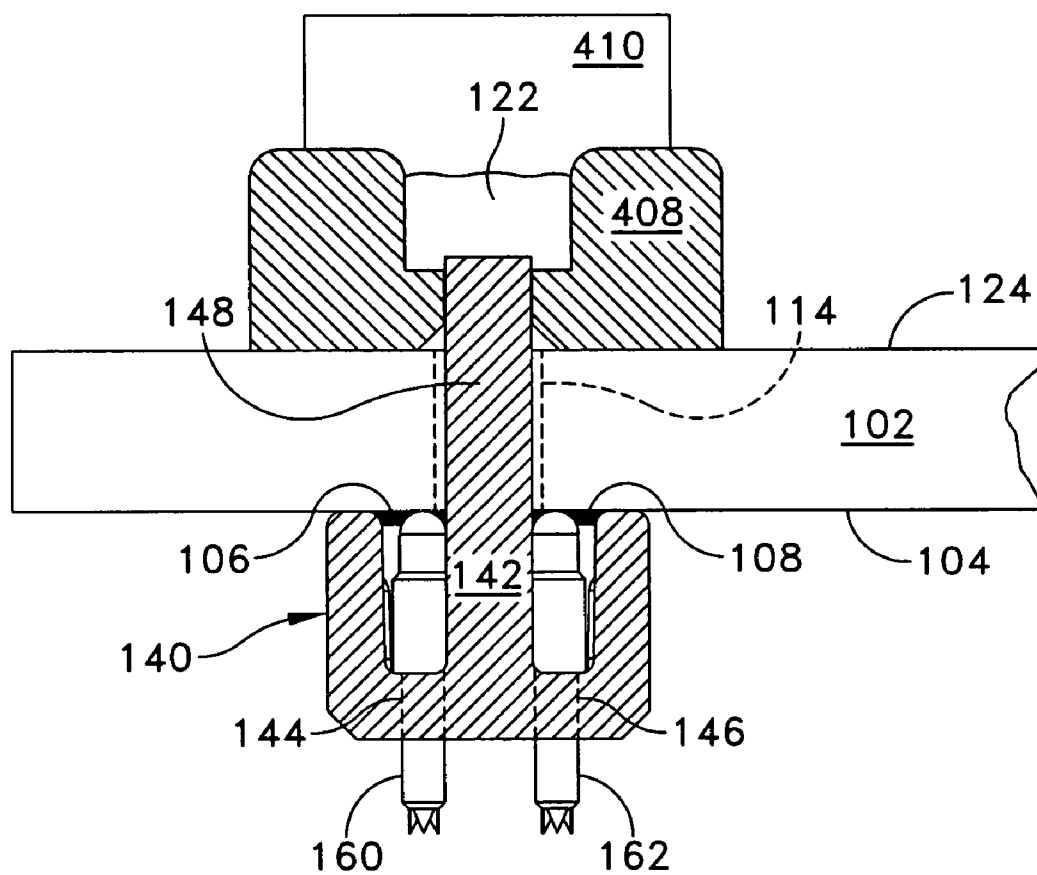


FIG. 3

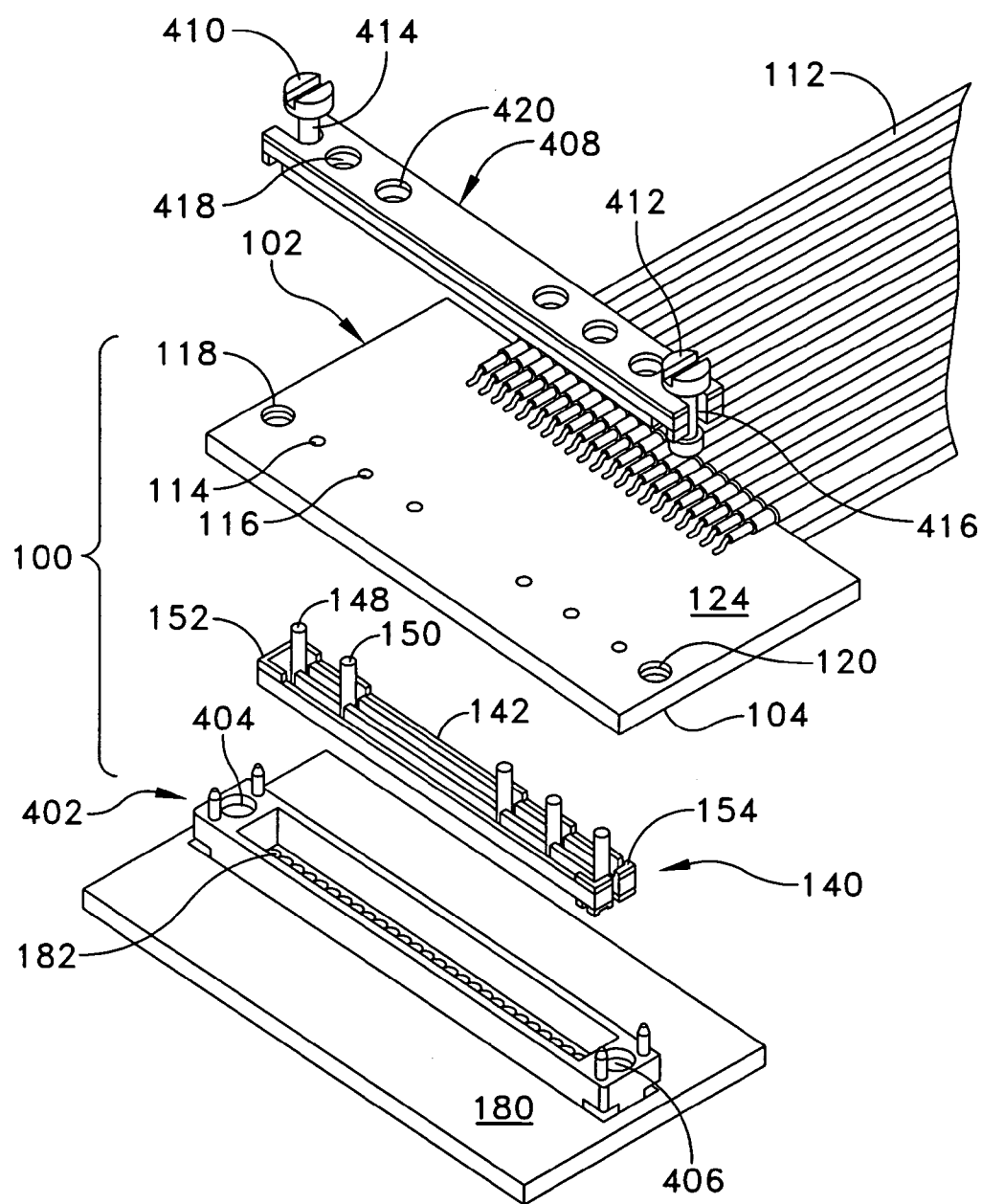


FIG. 4

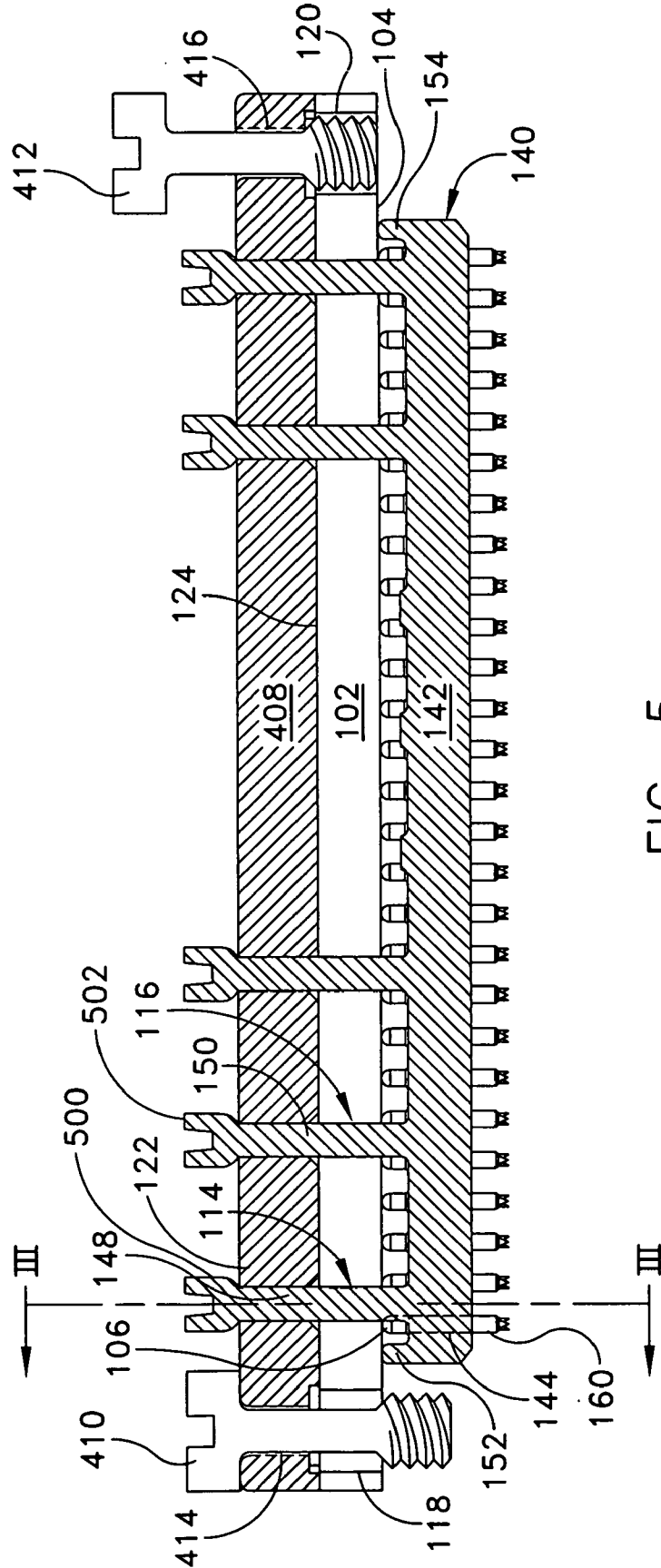


FIG. 5

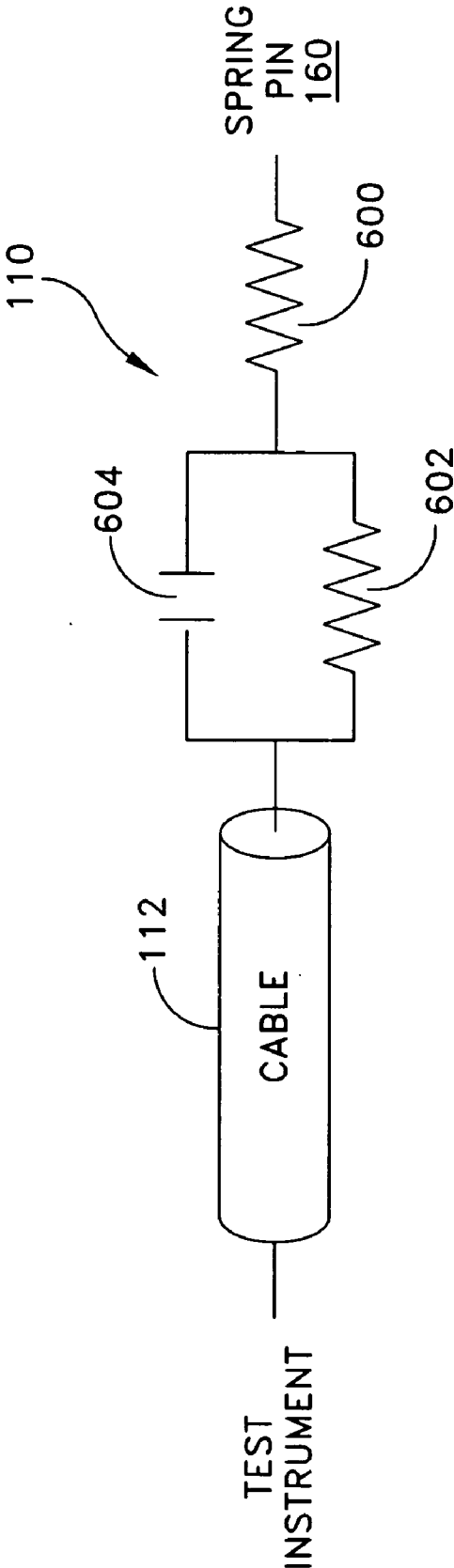


FIG. 6

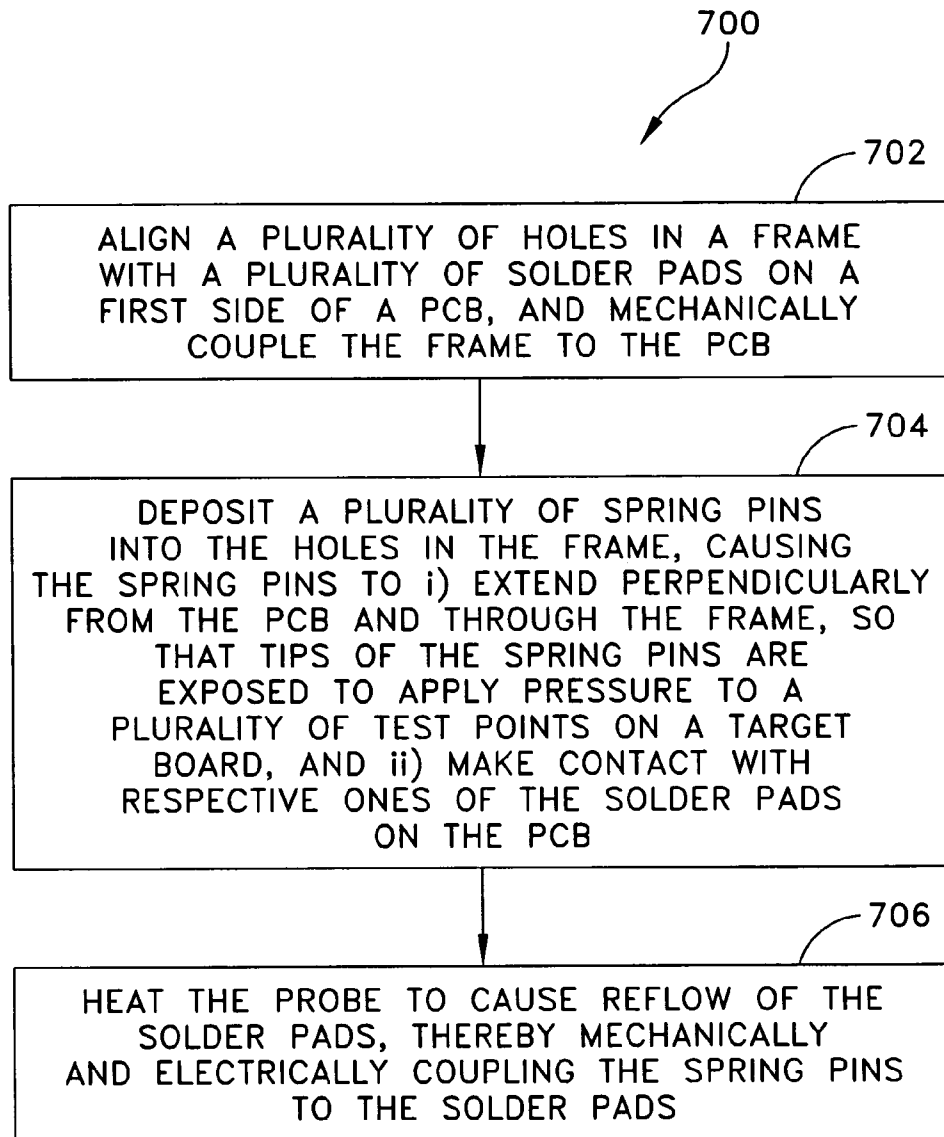


FIG. 7

PROBE HAVING A FRAME TO ALIGN SPRING PINS PERPENDICULARLY TO A PRINTED CIRCUIT BOARD, AND METHOD OF MAKING SAME

BACKGROUND

[0001] Connector-less probing has emerged as an attractive form of probing for logic analyzers and other test equipment. In connector-less probing, a customer designs their printed circuit board (PCB) to incorporate a “landing pattern” of test points. The customer then attaches a connector-less probe to their test equipment, and mounts the connector-less probe to their PCB so that a plurality of spring-pins on the probe engage the plurality of test points in their PCB’s landing pattern.

[0002] One embodiment of a connector-less probe is disclosed in the United States Patent Application of Brent A. Holcombe, et al. entitled “Connector-Less Probe” (Ser. No. 10/373,820, filed Feb. 25, 2003). An alignment/retention device for mounting a connector-less probe to a PCB is disclosed in the United States Patent Application of Brent A. Holcombe, et al. entitled “Alignment/Retention Device For Connector-Less Probe” (Ser. No. 10/644,365, filed Aug. 20, 2003).

[0003] Connector-less probes for probing a plurality of breakout vias on the backside of a printed circuit board to which a grid array package is attached are disclosed in the United States Patent Application of Brock J. LaMeres, et al. entitled “Backside Attach Probe, Components Thereof, and Methods for Making and Using Same” (Ser. No. 10/902,405, filed Jul. 28, 2004). One embodiment of a probe with perpendicularly disposed spring pins is disclosed in the United States Patent Application of Brock J. LaMeres, et al. entitled “Probes With Perpendicularly Disposed Spring Pins, And Methods of Making and Using Same” (Ser. No. 10/781,086, filed Feb. 17, 2004).

[0004] Agilent Technologies, Inc. (headquartered in Palo Alto, Calif.) markets a number of connector-less probing solutions under the name “Soft Touch”.

SUMMARY OF THE INVENTION

[0005] In one embodiment, a probe for probing test points on a target board comprises a printed circuit board, a frame, and a plurality of spring pins. The printed circuit board (PCB) has a first side with a plurality of solder pads thereon, and a plurality of signal routes that are electrically coupled to the solder pads for routing signals to a test instrument. The frame is mechanically coupled to the PCB and has a main body portion with a plurality of holes therein. The holes in the frame are aligned with the plurality of solder pads on the first side of the PCB. The plurality of spring pins are provided for probing the test points on the target board, with each spring pin being i) disposed in one of the holes in the frame, perpendicularly abutting the first side of the PCB, and ii) electrically coupled to one of the solder pads.

[0006] In another embodiment, a method of forming a test probe comprises 1) aligning a plurality of holes in a frame with a plurality of solder pads on a first side of a PCB, and mechanically coupling the frame to the PCB; 2) depositing a plurality of spring pins into the holes in the frame, causing the spring pins to i) extend perpendicularly from the PCB and through the frame, so that tips of the spring pins are exposed to make contact with, and apply pressure to, a

plurality of test points on a target board, and ii) make contact with respective ones of the solder pads on the PCB; and 3) heating the probe to cause reflow of the solder pads, thereby mechanically and electrically coupling the spring pins to the solder pads.

[0007] Other embodiments are also disclosed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Illustrative embodiments of the invention are illustrated in the drawings, in which:

[0009] FIG. 1 shows a first exploded perspective view of the components of a first exemplary test probe;

[0010] FIG. 2 illustrates a first assembled cross-section of the probe shown in FIG. 1;

[0011] FIG. 3 illustrates a second assembled cross-section of the probe shown in FIG. 1;

[0012] FIG. 4 illustrates a second exploded perspective view of the components of the probe shown in FIG. 1;

[0013] FIG. 5 illustrates an alternate way to couple the frame and PCB of the probe shown in FIG. 1;

[0014] FIG. 6 illustrates exemplary tip-network components that may be included in the signal traces of the probe shown in FIG. 1; and

[0015] FIG. 7 illustrates an exemplary method of forming a test probe such as the one shown in FIGS. 1-4.

DETAILED DESCRIPTION

[0016] Connector-less probing provides both electrical and mechanical advantages over traditional probing. Electrically, connector-less probing provides for the placement of tip-network components closer to where signals are being sampled. This can reduce electrical loading on a target board and provide higher signal fidelity to a test instrument. Mechanically, connector-less probing eliminates a customer’s need to provide test connectors on each of their PCBs. Rather, test access is merely provided by designing a board to include a landing pattern of test points. Also, unlike the larger and more intrusive footprints that are needed for connector mounting, the footprints needed for connector-less probing are smaller and less intrusive. This makes it easier to incorporate connector-less probe landing patterns on both prototype and production boards (while only minimally or not at all impacting the functionality of the production boards).

[0017] A disadvantage of currently available connector-less probes is their vertical space requirement. That is, the bodies of currently available connector-less probes extend substantially perpendicular from a target board’s landing pattern. However, at times, a customer needs to test a board in an environment with little Z-axis access to the board’s landing pattern (e.g., a landing pattern on a motherboard mounted inside of a chassis). Under such circumstances, it is difficult if not impossible to mount a connector-less probe to the landing pattern. Connector-less probes that can be maneuvered in environments with little Z-axis would therefore be desirable.

[0018] FIGS. 1-4 illustrate one exemplary embodiment of a connector-less probe **100** for probing test points **182, 184** on a target board **180**. As best shown in the FIG. 1 “exploded view”, the probe **100** comprises a printed circuit board (PCB) **102** having a first side **104** with a plurality of exposed solder pads **106, 108** thereon. A plurality of signal routes **110** (thereon or therein) are electrically coupled to the solder

pads **106, 108**, as shown in FIG. 1. The signal routes **110** are provided for routing signals to a test instrument (e.g., via one or more ribbon cables **112**). As used herein, the term “signal route” encompasses both PCB traces, as well as components that may be coupled to or formed within signal traces.

[0019] The probe **100** also comprises a frame **140** that is mechanically coupled to the PCB **102**. The frame **140** has a main body portion **142** having a plurality of holes **144, 146** disposed therein. The plurality of holes **144, 146** are spaced for alignment with the plurality of exposed solder pads **106, 108** on the first side **104** of the PCB **102**, as shown in FIG. 1. The frame **140** may be formed using various materials, but is preferably formed from a rigid, non-conductive plastic.

[0020] As shown in FIGS. 2 & 3, the PCB **102** may have a plurality of holes **114, 116** formed therein for receiving corresponding posts **148, 150** of the frame **140**. The posts **148, 150** extend perpendicularly from the main body portion **142** of the frame **140**. In some embodiments the main body portion **142** and posts **148, 150** may be formed using the same material. In other embodiments, the main body portion **142** and posts **148, 150** may be formed from different materials.

[0021] In one embodiment, the posts **148, 150** of the frame **140** pass through the PCB **102** and mate with holes **418, 420** in a plate **408** that is positioned adjacent a second side **124** of the PCB **102** (opposite the first side **104**). An adhesive **122** deposited on top of the posts **148, 150** and plate **408** (or deposited within the holes **418, 420** of the plate **408**) then secures the frame **140** to the plate **408**, clamping the PCB **102** therebetween. The adhesive **122** may comprise any suitable adhesive material, such as an epoxy resin, for example. Although the frame **140** or plate **408** could alternately, and each, be directly attached to the PCB **102**, joinder of the frame **140** and plate **408** dispenses with any need to apply an adhesive or other attachment mechanism to the PCB **102** that supports the somewhat sensitive signal traces **110**. As shown in FIG. 5, the frame **140** could alternately be secured to the PCB **102**, or to the plate **408**, via a snap-type or compression mechanism, such as enlarged and slightly deformable ends **500, 502** of the posts **148, 150** of the frame **140**.

[0022] The probe **100** may also comprise a plurality of spring pins **160, 162** for probing the test points **182, 184** on the target board **180**. The spring pins **160, 162** are disposed within the holes **144, 146** in the frame **140**, after the frame **140** is attached to the PCB **102**, so that the spring pins **160, 162** perpendicularly abut the first side **104** of the PCB **102**. Preferably, the holes **144, 146** do not frictionally engage the spring pins **160, 162**, thereby enabling unrestricted movement of the spring pins **160, 162** within the holes. However, it is also preferable that the unrestricted movement of the spring pins **160, 162** be limited so that the spring pins **160, 162** are maintained 1) in substantially parallel positions with respect to one another, and 2) in alignment with their respective solder pads **106, 108**.

[0023] Once the spring pins **160, 162** are inserted or deposited into the holes **144, 146** of the frame **140**, the probe **100** may be heated in a reflow oven to cause the solder of the solder pads **106, 108** to wet and bond to the spring pins **160, 162**. In this manner, each of the spring pins **160, 162** is mechanically and electrically coupled to one of the solder pads **106, 108**, as shown in FIGS. 2 & 3.

[0024] In some cases, it may be undesirable for the main body portion **142** of the frame **140** to fully contact the first

side **104** of the PCB **102**. For example, it may be desirable to provide some space for the solder of the solder pads **106, 108** to reflow. The frame **140** may therefore comprise a plurality of feet **152, 154** that extend from the main body portion **142** of the frame **140**, toward the first side **104** of the PCB **102**, to provide a predetermined spacing between the PCB **102** and the main body portion **142** of the frame **140** (see FIG. 2). Alternately, the PCB-facing openings of the holes **144, 146** could be beveled or otherwise enlarged to provide adequate space for solder reflow.

[0025] As shown in FIG. 4, a retention device **402** may be used to secure the probe **100** to a target board **180**. In one embodiment, the retention device **402** and frame **140** comprise corresponding relief patterns that allow the frame **140** to press into, or clip to, the retention device **402**. In the same or a different embodiment, the retention device **402** may also comprise features that are designed to mate with features of the plate **408**. For example, the plate **408** may comprise holes or notches **414, 416** for receiving fasteners such as screws or bolts **410, 412** that pass through the plate **408** and into corresponding holes **404, 406** in the retention device **402**. The screws or bolts **410, 412** may also pass through holes **118, 120** in the PCB **102**. Clips or other mechanisms could also be used for this purpose, so long as they can provide a suitable force to hold the probe **100** in position (i.e., in contact with a plurality of test points **182, 184**).

[0026] As already alluded to, each of the signal routes **110** of the PCB **102** may comprise one or more tip-network components **600, 602, 604** that are preferably positioned adjacent the probe's spring pins **160, 162**. By way of example, and as shown in FIG. 6, the tip-network components **600, 602, 604** of each signal route **110** may comprise an isolation resistor **600**, as well as a tip resistor **602** connected in parallel with a tip capacitor **604**. The combination of the tip resistor **602** and tip capacitor **604** may be coupled in series with the isolation resistor **600**.

[0027] FIG. 7 illustrates one exemplary method **700** for forming a probe such as the probe **100**. The method **700** commences with the alignment of i) a plurality of holes in a frame, with ii) a plurality of solder pads on a first side of a PCB (at block **702**). The frame is then mechanically coupled to the PCB by, for example, one of the means already disclosed in this description (at block **702**). Thereafter, a plurality of spring pins are deposited into the holes in the frame such that the spring pins extend perpendicularly from the PCB and through the frame, with their tips being exposed for the purpose of making contact with, and applying pressure to, a plurality of test points on a target board. Ends of the spring pins opposite their tips make contact with respective ones of the solder pads on the PCB. See, block **704**. After fitting the pieces of the probe together, the probe is heated (at block **706**) to cause reflow of the solder pads, thereby mechanically and electrically coupling the spring pins to the solder pads. In one embodiment, the probe may be heated in a reflow oven using conventional techniques.

1. A probe for probing test points on a target board, comprising:

- a printed circuit board (PCB) having i) a first side with a plurality of solder pads thereon, ii) a second side, opposite the first side, iii) a plurality of signal routes that are electrically coupled to the solder pads for routing signals to a test instrument, and iv) a plurality of holes therein;

- a frame, mechanically coupled to the PCB, having i) a main body portion with a plurality of holes therein, the holes in the frame being aligned with the plurality of solder pads on the first side of the PCB, and ii) a plurality of posts that extend from the main body portion of the frame into the plurality of holes in the PCB;
 - a plurality of spring pins for probing the test points on the target board, each spring pin of which is i) disposed in one of the holes in the frame, perpendicularly abutting the first side of the PCB, and ii) electrically coupled to one of the solder pads; and
 - a plate adjacent the second side of the PCB, the plate having a plurality of holes therein to receive the plurality of posts extending from the main body portion of the frame, and the plate being mechanically coupled to the frame via the plurality of posts.
- 2-4.** (canceled)
- 5.** The probe of claim 1, wherein the probe further comprises an adhesive, in contact with the posts and the plate, to mechanically couple the frame to the plate, and thus to the PCB.
- 6.** The probe of claim 5, further comprising a plurality of fasteners that extend through the plate toward the second side of the PCB; the fasteners being configured and positioned to mate with a retention device on the target board.
- 7.** The probe of claim 1, wherein the frame further comprises a plurality of feet, extending perpendicularly

from the main body portion of the frame and abutting the first side of the PCB, to provide a predetermined spacing between the main body portion of the frame and the first side of the PCB.

8. The probe of claim 1, wherein the signal routes comprise tip-network components positioned adjacent the spring pins.

9. The probe of claim 8, wherein the tip-network components comprise isolation resistors.

10. The probe of claim 1, wherein the frame further comprises a relief pattern corresponding to a retention device on the target board, for mechanically coupling the frame to the retention device.

11. The probe of claim 1, wherein the frame is formed from a rigid, non-conductive plastic.

12-17. (canceled)

18. The probe of claim 1, wherein the probe further comprises a snap-type mechanism that mechanically couples the frame to the plate.

19. The probe of claim 1, wherein the probe further comprises a compression mechanism that mechanically couples the frame to the plate.

20. The probe of claim 1, wherein the posts comprise enlarged and slightly deformable ends that mechanically couple the frame to the plate.

* * * * *