

NODE-BASED METHOD AND APPARATUS FOR CIRCUIT PROTOTYPING

Field of the Invention

5 This invention relates to a device for prototyping a circuit without using jumper wires. More particularly, this invention relates to a node-based method for prototyping a circuit rapidly, independent of the complexity of the circuit. Still more particularly, this invention relates to a system for prototyping a circuit comprises an automated means for facilitating conductive pins insertion to interconnect the electronic components of the circuit to be prototyped.

Background of the Invention

10 A breadboard is commonly used for prototyping an electronic circuit as it allows an electronic circuit to be temporarily built, tested, modified and evaluated before fabricating the final circuit on a printed circuit board. Through-holes are formed in the breadboard to allow leads of electronic components and jumper wires to be inserted therethrough, and metal strips are running underneath the breadboard to connect the through-holes. For such breadboards, electronic components are mounted onto the breadboard at random places and are interconnected together by jumper wires. This conventional prototyping method is called the "branch-based method". For this branch-based method, electronic components are mounted and connected one by one to the breadboard using jumper wires in various lengths which act as branches of the circuit to be prototyped. As the circuit complexity increases, more jumper wires would be required and hence the circuit connections will become more complicated and prone to errors due to many jumper wires crisscrossing on the breadboard. Furthermore, verification of the constructed circuit is difficult to be carried out as the circuit connections are not easy to be traced.

25 An apparatus that tried to address the above limitations is described in US Patent Application No. 10/715,750 entitled "Circuit Board" by Paul A. Swetland. This document describes a circuit board comprises a mounting board having various groupings of connection points for prototyping a circuit, including a distribution strip, a connection strip and a terminal strip. However, this apparatus is largely based on the conventional prototyping method as described above and requires the use of jumper wires to extend the electrical connections to interconnect the electronic components.

Therefore, those skilled in art are constantly striving to devise a device for prototyping a circuit more efficiently and allowing the prototyped circuit to be verified and modified easily in a relatively short time.

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Summary of the Invention

The above and the other problems are solved and an advance in the art is made by a circuit prototyping device in accordance with this invention. A first advantage of a device in accordance with this invention is no jumper wires are required to interconnect the electronic components, regardless of the complexity of the circuit to be prototyped. Instead, conductive pins (or any short thin piece of electrically conductive material) are used to interconnect the electronic components. Hence, the constructed circuit has a compact and neat layout, and more importantly free of spaghetti of jumper wires crisscrossing on the device.

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A second advantage of a device in accordance with this invention is a circuit can be prototyped rapidly using a simplified and efficient prototyping method (namely "node-based method"), independent of the complexity of the circuit to be prototyped. This method translates the circuit connections of the electronic components into nodes (i.e. connection numbers) which enable a circuit to be constructed easily and rapidly. In other words, this invention decouples the prototyping process from the complexity of the circuit to be prototyped.

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A third advantage of a device in accordance with this invention is the constructed circuit can be modified and verified in an organised and systematic manner with reference to a connection table having information of the nodes pre-assigned to all electronic components of the circuit to be prototyped. Hence, the time for troubleshooting the constructed circuit is relatively shorter.

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A fourth advantage of a system in accordance with this invention is the interconnections of electronic components via conductive pins can be performed automatically by an automated means, such as a robotic arm or any suitable automated machines. The automated means can be controlled from a far distance via computer network.

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A fifth advantage of a device in accordance with this invention is the reduction of ground loop noise of the constructed circuit due to elimination of the use of jumper wires. Otherwise, the unwanted ground loop noise may affect the circuit function and performance.

5 In accordance with a first aspect of this invention, there is provided a device for prototyping a circuit without using jumper wires. The device comprises a body having a first layer and a second layer disposed below the first layer. The first layer has a component zone for placement of electronic components of the circuit to be prototyped. Each of the first and second layers has a first and a second connection zones for placement of conductive pins to interconnect
10 the electronic components placed in the component zone. The first and second connection zones of the second layer are aligned with the first and second connection zones of the first layer respectively. The first layer has a plurality of first conductive members extending from the component zone to the first and second connection zones of the first layer wherein the first conductive members are electrically isolated from one another. The second layer has a plurality
15 of second conductive members disposed in the first and second connection zones of the second layer. The second conductive members are arranged perpendicularly with respect to the first conductive members forming a rectangular matrix at each of the first and second connection zones of the first and second layers wherein points of the rectangular matrix define contact points for receiving conductive pins. Each of the second conductive members in the first
20 connection zone of the second layer is electrically connected to one of the second conductive members in the second connection zone of the second layer. A contact between one of the first conductive members and one of the second conductive members by a conductive pin at one of the contact points establishes an electrical connection between the one of the first conductive members and the one of the second conductive members.

25 In accordance with embodiments of this invention, the body further comprises a third layer disposed above the first layer. A plurality of holes are formed through the third layer and aligned with the first and second conductive members for receiving conductive pins and electronic components. The holes that are aligned with the first and second conductive members
30 in the first and second connection zones of the first and second layers are associated to the points of the rectangular matrix (i.e. contact points).

In accordance with embodiments of this invention, instead of having a third layer with holes formed through the third layer, a plurality of holes are formed through the first and second

layers along the length of the first and second conductive members for receiving conductive pins and electronic components. The holes in the first and second connection zones of the first and second layers are formed at the contact points (i.e. points of the rectangular matrix). Each array of holes formed along the length of a first or a second conductive member are electrically
5 connected by the said conductive member.

In accordance with embodiments of this invention, each of the first and second conductive members is a channel having two resiliently deformable locking portions to secure a conductive pin or the terminal of an electronic component. In accordance with some other
10 embodiments, the first and second conductive members are conductive strips.

In accordance with embodiments of this invention, the component zone is adapted to receive a daughter-board which allows electronic components to be mounted thereon. The component zone, the first connection zone, and the second connection zone of the first layer are
15 separable from each other. These three zones are attachable together by a connection means. Similarly, the first and second connection zones of the second layer are separable from each other.

In accordance with a second aspect of this invention, there is provided a method for
20 prototyping a circuit using a device which comprises:- a body having a first layer and a second layer disposed below the first layer, the first layer has a component zone for placement of electronic components of the circuit to be prototyped, each of the first and second layers has a first and a second connection zones for placement of conductive pins to interconnect the
25 electronic components placed in the component zone, the first and second connection zones of the second layer are aligned with the first and second connection zones of the first layer respectively; the first layer has a plurality of first conductive members extending from the component zone to the first and second connection zones of the first layer wherein the first conductive members are electrically isolated from one another; the second layer has a plurality
30 of second conductive members disposed in the first and second connection zones of the second layer, the second conductive members are arranged perpendicularly with respect to the first conductive members forming a rectangular matrix at each of the first and second connection zones of the first and second layers wherein points of the rectangular matrix define contact points for receiving conductive pins, each of the second conductive members in the first connection zone of the second layer is electrically connected to one of the second conductive

members in the second connection zone of the second layer; wherein a contact between one of the first conductive members and one of the second conductive members by a conductive pin at one of the contact points establishes an electrical connection between the one of the first conductive members and the one of the second conductive members. The method comprises:-
5 providing a circuit diagram to be prototyped; mounting electronic components of the circuit diagram in the component zone of the device; forming a connection table having connection numbers for the electronic components of the circuit diagram wherein the connection numbers are associated to the contact points of the device; and forming electrical connections in the first and second connection zones of the first and second layers based on the connection table to
10 interconnect the electronic components in the component zone.

In accordance with embodiments of this invention, the step of forming the connection table comprises assigning a connection number to each terminal of the electronic components of the circuit diagram wherein the terminals of two or more electronic components that meet at the
15 same point in the circuit diagram are assigned a same connection number.

In accordance with embodiments of this invention, the step of forming the electrical connections comprises inserting conductive pins at the contact points of the device which are associated to the connection numbers formed in the connection table.
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In accordance with embodiments of this invention, the step of forming the electrical connections comprises:- displaying an image of the contact points of the device on a user interface unit; selecting the contact points to be inserted by conductive pins from the displayed image; translating the selected contact points into X-Y coordinates; and inserting conductive pins
25 at the selected contact points by an automated means based on the X-Y coordinates. The automated means is a robotic arm.

In accordance with a third aspect of this invention, there is provided a system for prototyping a circuit without using jumper wires. The system comprises a processing unit, a
30 memory readable by the processing unit, an automated means in communication with the processing unit, and a device comprises:- a body having a first layer and a second layer disposed below the first layer, the first layer has a component zone for placement of electronic components of the circuit to be prototyped, each of the first and second layers has a first and a second connection zones for placement of conductive pins to interconnect the electronic

components placed in the component zone, the first and second connection zones of the second layer are aligned with the first and second connection zones of the first layer respectively; the first layer has a plurality of first conductive members extending from the component zone to the first and second connection zones of the first layer wherein the first conductive members are electrically isolated from one another; the second layer has a plurality of second conductive members disposed in the first and second connection zones of the second layer, the second conductive members are arranged perpendicularly with respect to the first conductive members forming a rectangular matrix at each of the first and second connection zones of the first and second layers wherein points of the rectangular matrix define contact points for receiving conductive pins, each of the second conductive members in the first connection zone of the second layer is electrically connected to one of the second conductive members in the second connection zone of the second layer; wherein a contact between one of the first conductive members and one of the second conductive members by a conductive pin at one of the contact points establishes an electrical connection between the one of the first conductive members and the one of the second conductive members. The system also comprises instructions stored by the memory for directing the processing unit to:- display an image of the contact points of the device on a user interface unit; receive information of the contact points to be inserted by conductive pins from the user interface unit; translate the selected contact points into X-Y coordinates; and insert conductive pins at the selected contact points by the automated means based on the X-Y coordinates. The automated means is a robotic arm.

Brief Description of the Drawings

The above and other aspects of this invention will now be described, by way of example only, with reference to the accompany drawings, in which:

Figure 1 is an exploded view of a device in accordance with an embodiment of this invention;

Figure 2 is a side view of the device shown in Figure 1;

Figure 3A is a partial side view (from X-direction) of the conductive member in the first layer of the device shown in Figure 1;

Figure 3B is a partial side view (from Y-direction) of the conductive member in the second layer of the device shown in Figure 1;

Figure 4 is a plan view of a device (first layer is shown) in accordance with an embodiment of this invention;

Figure 5 is a plan view of the second layer of the device shown in Figure 4;

Figure 6 is a side view of the device shown in Figure 4;

Figure 7 shows the first and second layers of the device (shown in Figure 1 or 4) are separable into three connectable sections;

Figure 8 is a flow chart showing the method for prototyping a circuit in accordance with an embodiment of this invention;

Figure 9 shows an example of a circuit diagram to be prototyped;

Figure 10 is a plan view of the device shown in Figure 1 with electronic components mounted in the component zone and conductive pins inserted in the connection zones based on the circuit diagram shown in Figure 9; and

Figure 11 shows an example of translating the selected contact points into X-Y coordinates.

Detailed Description of the Invention

This invention relates to a device for prototyping a circuit without using jumper wires. Instead of using jumper wires, conductive pins (or contact pins) are used to establish electrical connections to interconnect the electronic components of the circuit to be prototyped. More particularly, this invention allows a circuit to be prototyped easily and rapidly based on an efficient prototyping method, namely "node-based method", independent of the circuit complexity. This "node-based method" has significant advantages over the commonly used "branch-based method", as described in the summary section. In this invention, the prototyping

board is configured into various zones and layers to simplify and speed-up the circuit prototyping process.

For a commonly used breadboard, a circuit is prototyped in the following manner. A first
5 electronic component is mounted onto the breadboard and the circuit branches are expanded by
connecting a second electronic component to the first electronic component and connecting a
third electronic component to the first and second electronic components using jumper wires.
This process is continued until all electronic components are mounted and interconnected on the
breadboard. This circuit prototyping method is called the "branch-based method". On the other
10 hand, in the present invention, a circuit is prototyped by first mounting all electronic components
onto the prototyping board within a component zone. All electronic components can be
mounted in the component zone in any order without worrying about how they are being
interconnected later. Conductive pins are then inserted into the prototyping board within a
connection zone to interconnect the electronic components mounted in the component zone.
15 No jumper wires are required to interconnect the electronic components. This circuit
prototyping method is named the "node-based method".

Figures 1 and 2 illustrate a device for prototyping a circuit in accordance with an
embodiment of this invention. Device 100 comprises a prototyping board that comprises contact
20 point layer 101, first layer 102 positioned below contact point layer 101, and second layer 103
positioned below first layer 102. Contact point layer 101 has through-holes 105 for receiving
conductive pins and electronic components. First and second layers 102, 103 have electrically
conductive members 110, 120 aligned with through-holes 105. These three layers 101-103 are
aligned with each other in a stacked relationship as shown in Figure 2. These layers 101-103 are
25 made of a non-conductive material and assembled together to form a prototyping board with or
without a gap between any two layers.

Arrays of through-holes 105 are formed through contact point layer 101. Each through-
hole 105 serves as an electrical contact point and is configured to receive a conductive pin or the
30 lead/terminal of an electronic component. A conductive pin or the lead of an electronic
component is allowed to be inserted into through-hole 105. A plurality of arrays of through-holes
105 are arranged parallelly to form a rectangular matrix of through-holes 105 for receiving
electronic components (namely "component zone") or conductive pins (namely "connection
zone"). As shown in Figure 1, contact point layer 101 has one component zone 107 and two

connection zones 109a, 109b at two sides of component zone 107. Component zone 107 is divided into two segments 107a, 107b separated by a small gap. For an electronic component having two leads, the first lead of the electronic component can be inserted into a through-hole 105 at segment 107a, whereas the second lead of the electronic component being inserted into a through-hole 105 at segment 107b. For a single-in-line electronic component having more than two terminals (e.g. a transistor with three short terminals), the terminals of the electronic component can be inserted into different through-holes 105 along Y-direction at segment 107a or segment 107b.

First layer 102 has electrically conductive members 110 formed in first layer 102. Conductive members 110 are arranged parallel to each other and electrically isolated from each other. Each conductive member 110 is aligned with an array of through-holes 105 along the X-direction as shown by arrow X in Figure 1. Each conductive member 110 serves as an electrical path for connecting an array of through-holes 105. Hence, if two conductive pins are inserted into two through-holes 105 along a same conductive member 110, the pins will be in contact with the said conductive member 110 and the two through-holes 105 will be electrically connected through the said conductive member 110. This configuration gives a high contact density as many through-holes 105 can be connected by a conductive member 120 instead of a hole-to-hole contact. As shown in Figure 1, conductive members 110 in first layer 102 are grouped into two segments 110a, 110b. Conductive members 110 in segment 110a are aligned with through-holes 105 of connection zone 109a and component zone 107a, whereas conductive member 110 in segment 110b are aligned with through-holes 105 of connection zone 109b and component zone 107b. Conductive members 110 are made of an electrically conductive material and can be formed in any suitable configurations that are capable of securing/locking a conductive pin or the lead of an electronic component inserted into a through hole 105. A possible configuration of conductive members 110 is shown in Figure 3A. For this particular configuration, each conductive member 110 is a channel having two resiliently deformable portions 112 (act as clips) to hold and secure a conductive pin 114 firmly.

Second layer 103 has electrically conductive members 120 formed in second layer 103. Conductive members 120 are arranged parallel to each other and grouped into two segments 120a, 120b. Each conductive member 120 is aligned with an array of through-holes 105 of connection zones 109a, 109b along the Y-direction as shown by arrow Y in Figure 1. Hence, conductive members 120 of second layer 103 are arranged to be perpendicular with respect to

conductive members 110 of first layer 102 defining a rectangular matrix of contact points for receiving conductive pins. Each conductive member 120 serves as an electrical path for connecting an array of through-holes 105. When a conductive pin is inserted at a contact point, the pin will be in contact with a conductive member 110 of first layer 102 (arranged in X-direction) and a conductive member 120 of second layer 103 (arranged in Y-direction), thereby electrically connect the said two conductive members together. Conductive members 120 in segment 120a are aligned with through-holes 105 of connection zone 109a, whereas conductive members 120 in segment 120b are aligned with through-holes 105 of connection zone 109b. Each one of conductive members 120 in segment 120a is electrically connected to one of conductive members 120 in segment 120b as shown in Figure 1. Any two or more conductive members 120 in segment 120a connected to a same conductive member 120 in segment 120b is not allowed. Conductive members 120 are made of an electrically conductive material and can be formed in any suitable configurations that are capable of securing/locking a conductive pin inserted into a contact point. A possible configuration of conductive members 120 is shown in Figure 3B. For this particular configuration, each conductive member 120 is a channel having two resiliently deformable portions 116 (act as clips) to hold and secure a conductive pin 118 firmly.

A device for prototyping a circuit in accordance with an alternative embodiment of this invention is shown in Figures 4 to 6. Device 400 comprises a prototyping board having first layer 402 (see Figure 4) and second layer 403 (see Figure 5), which are similar to first and second layers 102, 103 of device 100. Second layer 403 is positioned below and aligned to first layer 402 (see Figure 6). Unlike device 100, device 400 does not have a contact point layer 101. Instead, through-holes 405, 406 are formed directly through first and second layers 402, 403 to serve as electrical contact points for receiving conductive pins or leads of electronic components. First and second layers 402, 403 are made of a non-conductive material and may be built from prototyping printed circuit boards. First and second layers 402, 403 may be separated by a small gap 602 or attached together without a gap between the two layers.

The arrangement of through-holes 405, 406 for device 400 is same as through-holes 105 of contact point layer 101 for device 100. First layer 402 has component zone 407 and connection zones 409a, 409b, and second layer 403 has component zone 408 and connection zones 410a, 410b. Through-holes 405 of first layer 402 are in alignment (in register) with through-holes 406 of second layer 403 so that a conductive pin can be inserted through any two aligned through-holes 405, 406. For example, through-hole 405 at location A9 of first layer 402

and through-hole 406 at location A9 of second layer 403 are aligned with each other for receiving a conductive pin to be inserted therethrough. Electronic components can be removably mounted or soldered in component zone 407.

5 Arrays of through-holes 405 in component zone 407 and connection zones 409a, 409b of first layer 402 are arranged parallelly in X-direction, shown by arrow X in Figure 4. Through-holes 405 arranged in an array are electrically connected by conductive member 420. This also means through-holes 405 are formed along the length of conductive member 420 in X-direction. Preferably, conductive member 420 is a conductive strip configured to connect an array of
10 through-holes 405. Component zone 407 is divided into two segments 407a, 407b of arrays of through holes 405. Each array of through-holes 405 in connection zone 409a is electrically connected to an array of through-holes 405 in component zone 407a by conductive member 420, whereas each array of through-holes 405 in connection zone 409b is electrically connected to an array of through-holes 405 in component zone 407b by conductive member 420. The arrays of
15 through-holes 405 in connection zone 409a are not electrically connected to the arrays of through-holes 405 in connection zone 109b. This also means conductive members 420 in connection zone 409s are electrically isolated to conductive members 420 in connection zone 409b.

20 Arrays of through-holes 406 in connection zones 410a, 410b of second layer 403 are arranged parallelly in Y-direction (perpendicular to X-direction), shown by arrow Y in Figure 5. Through-holes 406 arranged in an array are electrically connected by conductive member 430. This also means through-holes 406 are formed along the length of conductive member 430 in Y-direction. Preferably, conductive member 430 is a conductive strip configured to connect an
25 array of through-holes 406. Each array of through-holes 406 in connection zone 410a is electrically connected to an array of through-holes 406 in connection zone 410b by conductive member 430. This also means each conductive member 430 connecting an array of through-holes 406 in connection zone 410a is electrically connected to one conductive member 430 connecting an array of through-holes 406 in connection zone 410b. Conductive members 430 in
30 connection zone 410a (or 410b) of second layer 403 (in Y-direction) are arranged perpendicular to conductive members 420 in connection zone 409a (or 409b) of first layer 402 (in X-direction) defining a rectangular matrix of contact points for receiving conductive pins. Hence, for example, if a conductive pin is inserted at contact point A9 of first and second layers 402, 403, an electrical

connection will be established between conductive member 420 connecting A9 to A1 in X-direction and conductive member 430 connecting A9 to L9 in Y-direction.

5 Instead of mounting electronic components directly onto component zone 107 (or 407), electronic components may be pre-mounted onto a daughter-board and then attach it to component zone 107 (or 407) by a connection means. The daughter-board is removably detachable to component zone 107 (or 407). The connection means may be in any suitable forms that are capable of connecting the daughter-board to component zone 107 (or 407) electrically. For example, the daughter-board has terminals insertable into through-holes 105 (or 405) of
10 component zone 107 (or 407).

The size of device 100 (or 400) is adjustable in X and/or Y directions. For example, first layer 102 (or 402) is separable into three connectable sections 701-703 associated to component zone 107 (or 407), connection zone 109a (or 409a) and connection zone 109b (or 409b)
15 respectively. Second layer 103 (or 403) is also separable into three connectable sections 701-703 similar to first layer 102 (or 402). See Figure 7. The three sections 701-703 are connectable together by a connection means 709, e.g. matching connector. This expandable configuration is useful if a larger component zone 107 (or 407) is required for accommodating more or large electronic components or a larger connection zone 109a, 109b (or 409a, 409b) is required for
20 accommodating more conductive pins.

A method for prototyping a circuit using device 100 (or 400) is described in the following manner as illustrated by a flow chart 800 in Figure 8, in accordance with an embodiment of this invention. A circuit diagram to be prototyped is provided in step 802. All electronic components
25 of the circuit diagram to be prototyped are mounted onto component zone 107 (or 407) in step 804. If a daughter-board is used instead, the daughter-board with the mounted electronic components is attached to component zone 107 (or 407). In step 806, a connection table is formed based on how the electronic components are being interconnected in the circuit diagram. Each terminal of an electronic component will be assigned a specific connection number (namely
30 "node"). If the terminals of two of more electronic components meet at the same point in the circuit diagram, these terminals will be assigned a same node. The connection table includes information of the nodes assigned to all terminals of the electronic components in the circuit diagram. The nodes are associated with the contact points in connection zones 109a, 109b (or 409a, 409b) to be inserted by conductive pins. The relationship between the nodes and the

contact points will be elaborated further by an example below. In step 808, electrical connections between the electronic components mounted in component zone 107 (or 407) are established by inserting conductive pins at the appropriate contact points in connection zones 109a, 109b (or 409a, 409b) based on the connection table formed in step 806.

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The method for prototyping a circuit using device 100 (or 400) is now illustrated by an example shown in Figures 9 and 10. Figure 9 shows a circuit diagram 900 to be prototyped which comprises a diode (D1), two resistors (R1 and R2), a transistor (Q1), and a battery (V1). Circuit diagram 900 has five nodes labelled as 1 to 5. As shown in the circuit, a terminal of D1 and a terminal of R1 are connected together at the same point and hence these terminals are assigned a same node, i.e. node 3. A similar analysis is carried out for all other electronic components. A connection table for circuit diagram 900 which includes information of the electronic components and their assigned nodes is formed in Table 1 below:

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Electronic Components	Connection Numbers / nodes
R1	3, 4
R2	2, 5
D1	2, 3
Q1	1, 4, 5
V1	1, 2

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Table 1: A connection table for circuit diagram 600

Electronic components R1, R2, D1, Q1, V1 are mounted in component zone 107 (or 407). Figure 10 shows a device 100 with electronic components R1, R2, D1, Q1, V1 mounted thereon. Conductive pins are inserted in connection zones 109a, 109b based on the nodes listed in Table 1. In this method, the number of nodes does not increase linearly with the number of electronic components to be prototyped.

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The insertion of conductive pins into connection zones 109a, 109b (or 409a, 409b) in step 808 may be performed manually or by an automated means (e.g. a robotic arm or any suitable automated machines) which is controllable from a far distance via computer network. If the insertion is performed by an automated means, the step 808 comprises:- display an image of the contact points of device 100 (or 400) on a user interface unit, e.g. a touch screen; select the contact points (in connection zones 109a, 109b or 409a, 409b) to be inserted by conductive pins

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based on the connection table - this step can be done by activating the contact points from the displayed image; translate the selected contact points into X-Y coordinates; and insert conductive pins at the selected contact points by an automated means based on the X-Y coordinates associated to the selected contact points. Figure 11 shows an example of how the selected contact points are translated into X-Y coordinates of the automated means. For example, the selected contact points at locations A3, C2, E2 and F1 in connection zone 109a are translated into X-Y coordinates of {7, 12}, {8, 10}, {8, 8} and {9, 7} respectively. Hence, conductive pins can be accurately inserted at the selected contact points by the automated means (e.g. a robotic arm) based on the locations denoted by the X-Y coordinates.

In according with an embodiment of this invention, a system for prototyping a circuit comprises device 100 (or 400) as described above, a processing unit, a memory readable by the processing unit, an automated means (e.g. a robotic arm or any suitable automated machines) in communication with the processing unit, and instructions stored by the memory for directing the processing unit to: display an image of the contact points of device 100 (or 400) on a user interface unit (e.g. a touch screen); receive from the user interface unit the information of the contact points to be inserted by conductive pins (selected by a user); translate the selected contact points into X-Y coordinates; and insert conductive pins at the selected contact points by the automated means based on the X-Y coordinates associated to the selected contact points.

While preferred embodiments of the present invention have been described and illustrated above, it is to be understood that they are exemplary of the invention and are not to be considered to be limiting. It is expected that those skilled in the art can and will design alternative embodiments that infringe this invention as set forth in the following claims.

What is claimed is:

1. A device for prototyping a circuit without using jumper wires, the device comprising:

5 a body having a first layer and a second layer disposed below the first layer, the first layer having a component zone for placement of electronic components of the circuit to be prototyped, each of the first and second layers having a first and a second connection zones for placement of conductive pins to interconnect the electronic components placed in the component zone, the first and second connection zones of the second layer are aligned with the first and second
10 connection zones of the first layer respectively;

the first layer having a plurality of first conductive members extending from the component zone to the first and second connection zones of the first layer wherein the first conductive members are electrically isolated from one another;

15 the second layer having a plurality of second conductive members disposed in the first and second connection zones of the second layer, the second conductive members are arranged perpendicularly with respect to the first conductive members forming a rectangular matrix at each of the first and second connection zones of the first and second layers wherein points of the rectangular matrix define contact points for receiving conductive pins, each of the second conductive members in the first connection zone of the second layer is electrically connected to
20 one of the second conductive members in the second connection zone of the second layer;

wherein a contact between one of the first conductive members and one of the second conductive members by a conductive pin at one of the contact points establishes an electrical connection between the one of the first conductive members and the one of the second conductive members.

25 2. The device of claim 1, wherein the body further comprises a third layer disposed above the first layer, a plurality of holes formed through the third layer and aligned with the first and second conductive members for receiving conductive pins and electronic components.

30 3. The device of claim 1, a plurality of holes formed through the first and second layers along the length of the first and second conductive members for receiving conductive pins and electronic components wherein the holes in the first and second connection zones of the first and second layers are formed at the contact points.

4. The device of claim 1, each of the first conductive members is a channel having two resiliently deformable locking portions to secure a conductive pin or the terminal of an electronic component.
- 5 5. The device of claim 1, each of the second conductive members is a channel having two resiliently deformable locking portions to secure a conductive pin.
6. The device of claim 1, wherein the first conductive members are conductive strips.
- 10 7. The device of claim 1, wherein the second conductive members are conductive strips.
8. The device of claim 1, wherein the component zone is adapted to receive a daughter-board which allows electronic components to be mounted thereon.
- 15 9. The device of claim 1, wherein the component zone, the first connection zone, and the second connection zone of the first layer are separable from each other.
10. The device of claim 1, wherein the first and second connection zones of the second layer are separable from each other.
- 20 11. A method for prototyping a circuit using a device comprising:
a body having a first layer and a second layer disposed below the first layer, the first layer having a component zone for placement of electronic components of the circuit to be prototyped, each of the first and second layers having a first and a second connection zones for placement of
25 conductive pins to interconnect the electronic components placed in the component zone, the first and second connection zones of the second layer are aligned with the first and second connection zones of the first layer respectively;
the first layer having a plurality of first conductive members extending from the component zone to the first and second connection zones of the first layer wherein the first
30 conductive members are electrically isolated from one another;
the second layer having a plurality of second conductive members disposed in the first and second connection zones of the second layer, the second conductive members are arranged perpendicularly with respect to the first conductive members forming a rectangular matrix at each of the first and second connection zones of the first and second layers wherein points of the

rectangular matrix define contact points for receiving conductive pins, each of the second conductive members in the first connection zone of the second layer is electrically connected to one of the second conductive members in the second connection zone of the second layer;

5 wherein a contact between one of the first conductive members and one of the second conductive members by a conductive pin at one of the contact points establishes an electrical connection between the one of the first conductive members and the one of the second conductive members; the method comprising:

providing a circuit diagram to be prototyped;

10 mounting electronic components of the circuit diagram in the component zone of the device;

forming a connection table having connection numbers for the electronic components of the circuit diagram wherein the connection numbers are associated to the contact points of the device; and

15 forming electrical connections in the first and second connection zones of the first and second layers based on the connection table to interconnect the electronic components in the component zone.

12. The method of claim 11, wherein the step of forming the connection table comprising:

20 assigning a connection number to each terminal of the electronic components of the circuit diagram wherein the terminals of two or more electronic components that meet at the same point in the circuit diagram are assigned a same connection number.

13. The method of claim 11, wherein the step of forming the electrical connections comprising:

25 inserting conductive pins at the contact points of the device which are associated to the connection numbers formed in the connection table.

14. The method of claim 11, wherein the step of forming the electrical connections comprising:

30 displaying an image of the contact points of the device on a user interface unit;

selecting the contact points to be inserted by conductive pins from the displayed image;

translating the selected contact points into X-Y coordinates; and

inserting conductive pins at the selected contact points by an automated means based on the X-Y coordinates.

15. The method of claim 14, wherein the automated means is a robotic arm.

16. A system for prototyping a circuit without using jumper wires, the system comprising:

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a processing unit;

a memory readable by the processing unit;

an automated means in communication with the processing unit;

a device comprising:

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a body having a first layer and a second layer disposed below the first layer, the first layer having a component zone for placement of electronic components of the circuit to be prototyped, each of the first and second layers having a first and a second connection zones for placement of conductive pins to interconnect the electronic components placed in the component zone, the first and second connection zones of the second layer are aligned with the first and second connection zones of the first layer respectively,

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the first layer having a plurality of first conductive members extending from the component zone to the first and second connection zones of the first layer wherein the first conductive members are electrically isolated from one another,

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the second layer having a plurality of second conductive members disposed in the first and second connection zones of the second layer, the second conductive members are arranged perpendicularly with respect to the first conductive members forming a rectangular matrix at each of the first and second connection zones of the first and second layers wherein points of the rectangular matrix define contact points for receiving conductive pins, each of the second conductive members in the first connection zone of the second layer is electrically connected to one of the second conductive members in the second connection zone of the second layer,

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wherein a contact between one of the first conductive members and one of the second conductive members by a conductive pin at one of the contact points establishes an electrical connection between the one of the first conductive members and the one of the second conductive members; and

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instructions stored by the memory for directing the processing unit to:

display an image of the contact points of the device on a user interface unit;

receive information of the contact points to be inserted by conductive pins from the user interface unit;

translate the selected contact points into X-Y coordinates; and
insert conductive pins at the selected contact points by the automated means
based on the X-Y coordinates.

5 17. The system of claim 16, wherein the automated means is a robotic arm.

18. The system of claim 16, wherein the body further comprises a third layer disposed above
the first layer, a plurality of holes formed through the third layer and aligned with the first and
second conductive members for receiving conductive pins and electronic components.

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19. The system of claim 16, a plurality of holes formed through the first and second layers
along the length of the first and second conductive members for receiving conductive pins and
electronic components wherein the holes in the first and second connection zones of the first and
second layers are formed at the contact points.