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(54) **METHOD FOR PRODUCTION OF ELECTRICAL CONDUCTORS**

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H05K 3/00 (2006.01)

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USPC **29/842**; 29/843; 29/885; 164/97

(58) **Field of Classification Search**
USPC 29/842, 598, 606, 852, 843, 885; 164/97, 98; 361/678, 694, 730, 775, 361/784
See application file for complete search history.

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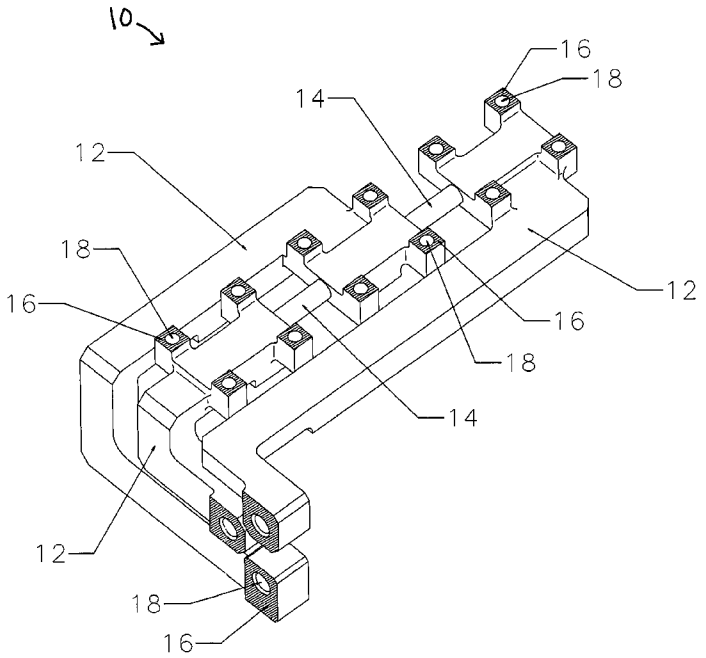
(57) **ABSTRACT**

Matrices of multiple cast conductors, and methods for making such matrices are disclosed. Methods according to the disclosure comprise: casting a conductor matrix including a plurality of conductors joined by at least one link; applying a surface treatment to at least a portion of the matrix; finishing a contact face on at least one of the conductors; and separating the conductors from each other at the at least one link.

8 Claims, 3 Drawing Sheets



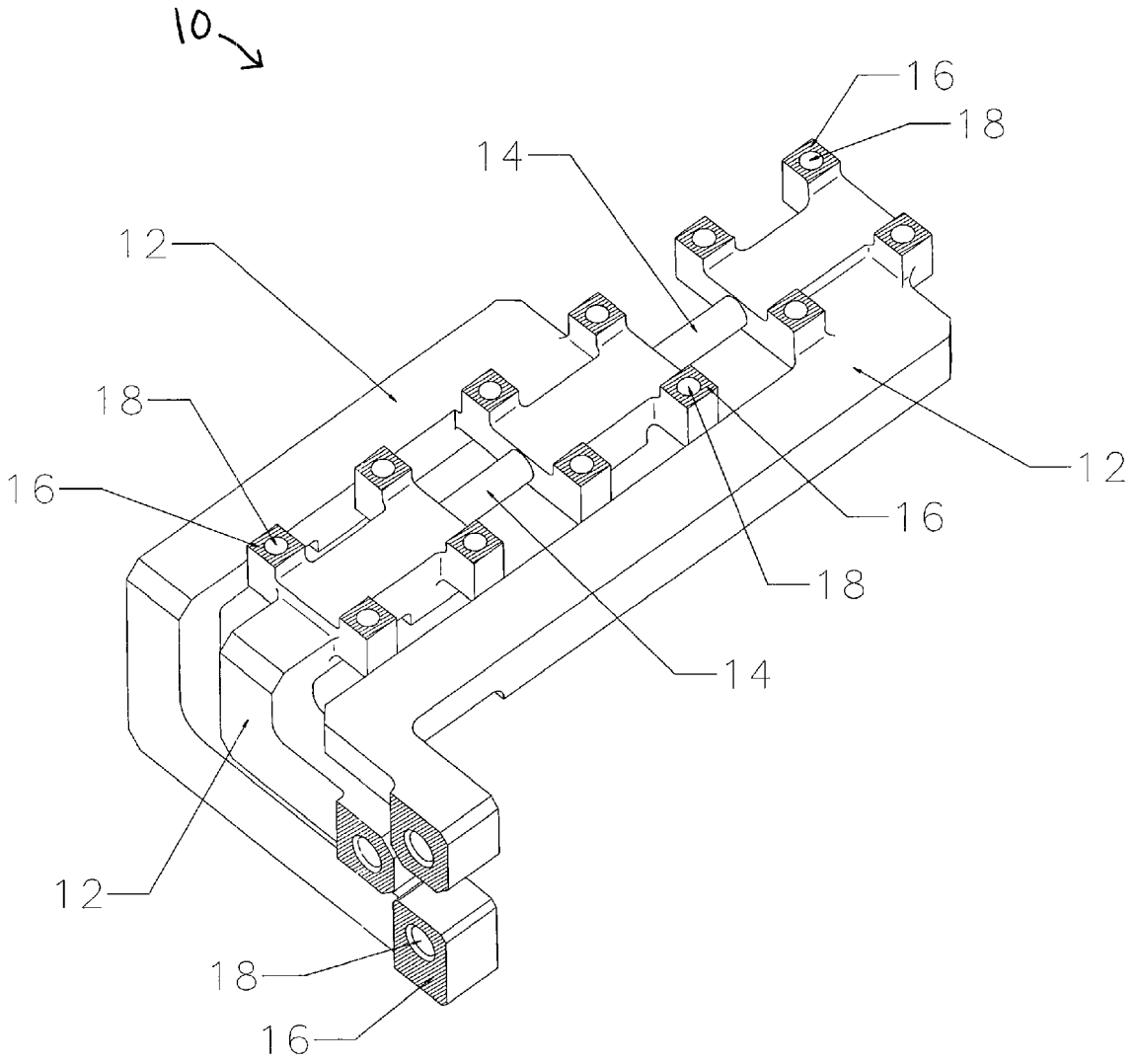


FIGURE 1

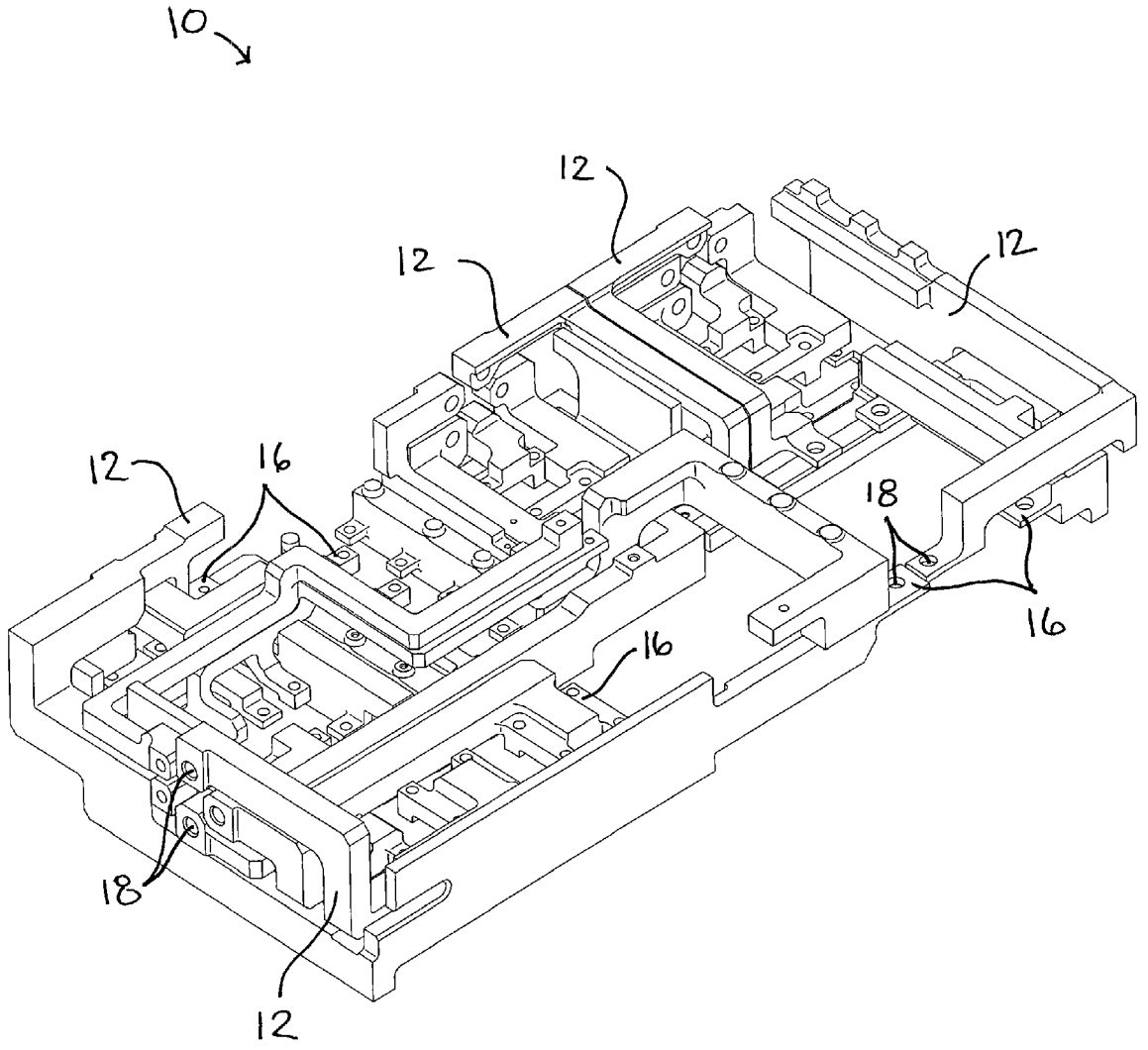


FIGURE 2

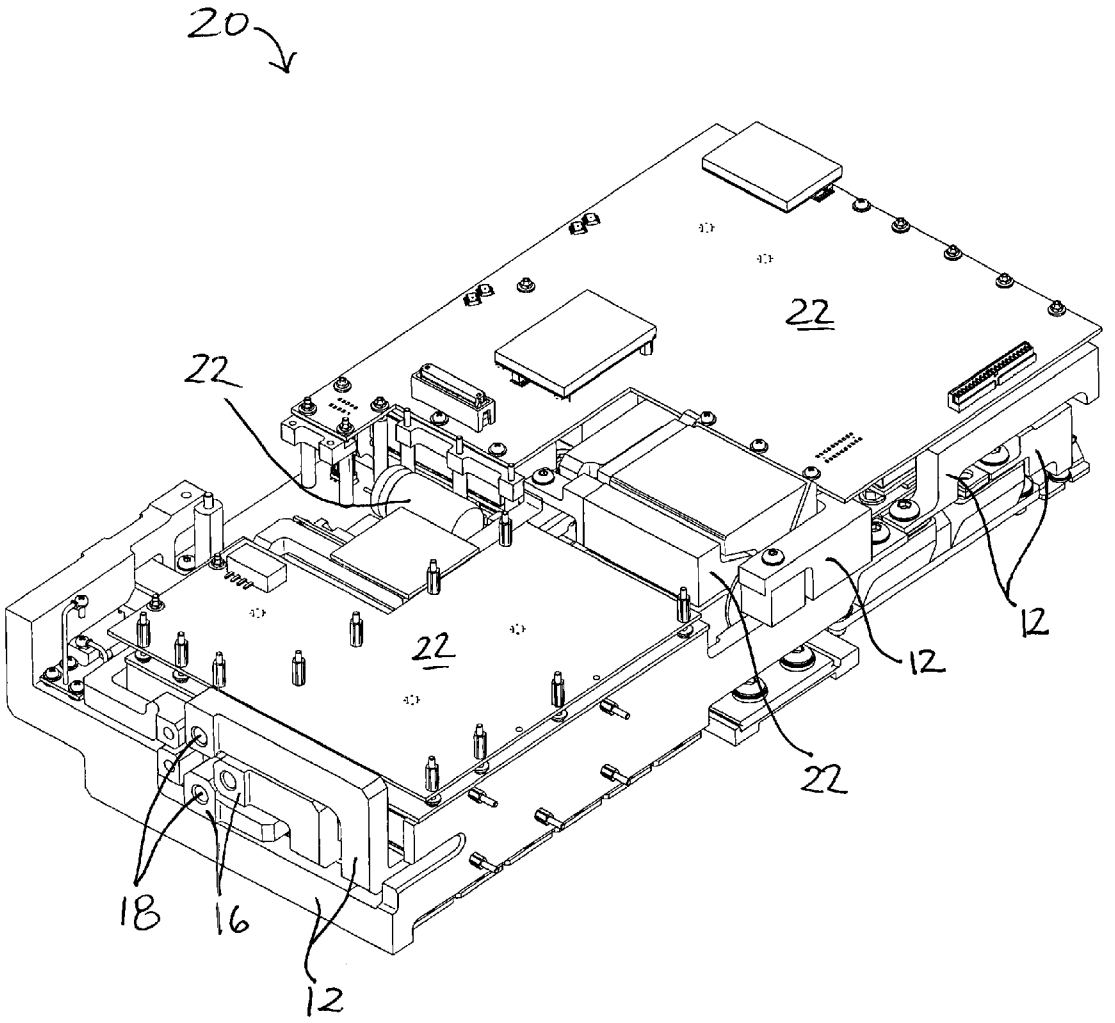


FIGURE 3

METHOD FOR PRODUCTION OF ELECTRICAL CONDUCTORS

TECHNICAL FIELD

The disclosure relates the manufacture of electrical conductors by casting.

BACKGROUND OF THE ART

Electrical power buses are used in a wide range of applications for the distribution of electrical power. Electrical conductors used as power buses have typically been manufactured individually, using conventional manufacturing processes including casting. When multiple electrical conductors are required, manufacturing the electrical conductors individually using conventional methods can be relatively time-consuming and therefore expensive.

There is a need for improved methods of manufacturing electrical conductors. In particular, there is a need for methods which improve the efficiency of casting pluralities of electrical conductors.

SUMMARY OF THE DISCLOSURE

In various aspect, the disclosure provides methods for producing pluralities of electrical conductors. Methods according to the disclosure can comprise: casting a conductor matrix including a plurality of conductors joined by at least one link; applying a surface treatment to at least a portion of the matrix; finishing a contact face on at least one of the conductors; and separating the conductors from each other at the at least one link.

In another aspect, methods according to the disclosure can comprise: casting a conductor matrix including a plurality of conjoined conductors; applying a surface treatment to at least a portion of the matrix; producing a plurality of electrical contact faces on the matrix; and separating the conductors from each other.

In further aspects, the disclosure provides matrices of commonly-cast conductors joined by links, the plurality of commonly-cast conductors comprising a plurality of electrical contact faces; and a surface treatment applied to at least a portion of the commonly-cast conductors other than the electrical contact faces.

Further details of these and other aspects of the present invention will be apparent from the detailed description and figures included below.

DESCRIPTION OF THE DRAWINGS

Reference is now made to the accompanying figures depicting aspects of the present invention, in which:

FIGS. **1** and **2** are isometric views of conductor matrices comprising pluralities of conjoined conductors according to the disclosure.

FIG. **3** is an isometric view of an electrical component comprising installed conductors manufactured in accordance with the disclosure.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIGS. **1** and **2** illustrate cast conductor matrices, generally shown at **10**, according to the disclosure. Conductor matrices **10** each comprise a plurality of commonly-cast electrical conductors **12** conjoined by at least one temporary link, or frangible portion, **14**. Conductors **12** comprise a plurality of contact faces **16**. Mounting holes **18** may be disposed in or through one or more of contact faces **16**.

Contact faces **16** may be intended to provide sure and efficient electrical contact between conductors **12** and other conductors **12** and/or other electrical contacts, including contacts for, for example, electrical devices such as MOSFET transitors. At least some or all of contact faces **16** may be commonly-oriented. To say that contact faces **16** are commonly oriented means that, to the extent such faces are planar, they lie in substantially parallel planes (that is, they are substantially co-planar); or, to the extent that they are not planar, axes drawn normal from their most prominent points are substantially parallel. As will be understood by those skilled in the relevant arts, terms such as 'substantially parallel' or 'substantially co-planar' mean parallel or co-planar within normal manufacturing tolerances or expectations.

FIG. **3** illustrates an electrical component such as a bus structure or other assembly, generally shown at **20**, that may be produced using, for example, conductors **12** of the conductor matrix **10** of FIG. **2**. Electrical bus structure **20** comprises the conductors **12** that are connected between respective electrical components **22**. In addition to providing electrical connections between their respective electrical components **22**, conductors **12** may also serve as part of or the entirety of the structural framework for the electrical bus structure **20**, so that conductors **12** may provide desired spatial orientation and structural support for components **22** subject to gravity, magnetic forces, buffets, accelerations, or other potentially displacing loads. Electrical components **22** may include any suitable or otherwise desired electrical components, including for example MOSFET transistors; capacitors; controllers; pressure, temperature, or other transducers; data processing or communicatons components; transformers, thermostats, rheostats, etc.

Among the advantages offered by methods and devices disclosed herein are improved efficiencies and cost savings provided by common casting, machining, and finishing processes, which can be applied to multiple conductors simultaneously, particularly where relevant portions of conductors **12**, including for example contact faces **16**, are co-planar and/or otherwise commonly oriented.

Methods for producing pluralities of conductors **12** according to the disclosure may include, for example: casting a conductor matrix **10** of conjoined conductors **12**; finishing at least a portion of the conductor matrix **10** corresponding to the contact face **16** of at least one of the conductors **12**; and separating the conductors **12** from each other by, for example, severing, flexing, or otherwise breaking one or more frangible portions **14**. A suitable surface treatment may be applied to at least a portion of the conductor matrix **10**.

Conductor matrices **10** may be cast in accordance with the disclosure by any known or otherwise suitable processes, including for example hereafter-developed processes and the process of investment casting (such as lost-wax) where a ceramic or other suitable mold (not shown) is produced from a disposable pattern (not shown) and the conductor matrix **10** is subsequently cast in the mold. Such a pattern may represent a 3-dimensional model of the conductor matrix **10**. The pattern may be designed using any suitable process, including for example suitably-implemented conventional computer aided design (CAD) systems. The pattern may be then be produced from wax using conventional methods or from a resin using a rapid prototyping system. For example, the pattern may be produced using stereolithography (SLA) and removed from the mold by burning. The conductor matrix **10** may be cast using materials suitable for use as electrical

conductors such as, for example, copper, aluminum, copper alloys and aluminum alloys. Casting of the conductors **12** provides the designer with the freedom to design the shape and configuration of the conductors **12**, including the orientation of contact surfaces **16**, based on factors such as desired current flow, heat dissipation and assembly/packaging requirements of the electrical assembly **20**. For example, as will be understood by those skilled in the relevant arts, it may be desirable to produce conductors have a varying cross-section and/or sharp or gradual corners.

Molds for conductor matrices **10** may be designed so as to facilitate casting processes and subsequent operations required to manufacture conductors **12**. In order to facilitate assembly and reduce assembly times, a conductor matrix **10** may optionally be cast in the same (exact or modified) configuration and relative positioning of the conductors as they are intended to be assembled into the bus or other electrical assembly **20** (see FIGS. **2** and **3**).

Links or frangible portions **14** may be provided in order to allow for several conductors to be cast together in a single step by permitting the molten material to flow in the mold and form both all of the conductors **12** in the conductor matrix **10** and optionally the frangible portions **14** as well. The number of links **14** and the configuration (size, shape, positioning) of the links **14** may be determined using conventional, new, modified, or otherwise desired mold design techniques. In some circumstances, as will be understood by those skilled in the relevant arts, conductor matrix **10** may advantageously be cast to as close to the final dimensions as possible. In the same or other circumstanes it may also be advantageous (e.g., practical and economical) to add features to the conductor matrix **10** using one or more subsequent finishing operations.

For example, finishing of one or more contact faces **16** may be required or desired to produce suitable surface properties for electrically and/or structurally connecting the conductors **12** to respective components. Finishing operations used to produce contact faces **16** may include suitable material removal processes such as machining and/or grinding. Subsequent drilling or finishing of the mounting holes **18** may also be required or desired.

Conductors **12** may be positioned in the conductor matrix **10** so as to facilitate any subsequent finishing operations. For example, the conductors **12** may be positioned to orient the contact faces **16** in a common orientation if possible, or at least in a reduced number of orientations. As previously noted, commonly-oriented faces may, for example, have normals that are substantially parallel or may include cyclindrical surfaces having central axes that are substantially parallel. The term "commonly oriented" may be used to describe surfaces that are oriented so that they can be be finished in a single setup on a finishing machine. For example, the commonly-oriented contact faces **16** in FIG. **1** may be machined in a single setup while the conductor matrix **10** is positioned and clamped on a bed of a machine tool, without requiring re-positioning and re-clamping of the conductor matrix **10** on the machine tool bed. Accordingly, the conductor matrix **10**, including contact faces **16**, may be configured so as to reduce the number of setups in a finishing machine. Contrary to conventional methods where conductors are manufactured individually, the above method allows for multiple conductors **12** to be cast together and also finished together in a reduced number of operations and at a reduced cost.

Conjoined conductors **12** may be separated from each other at any convenient time. For example, conjoined conductors **12** may be separated from each other during finishing processes or during assembly of the electrical bus structure or other electrical assembly **20**. If the electrical components **22** can be assembled directly to the cast conductor matrix **10**, the conjoined conductors **12** may alternatively be separated after assembly by cutting the links **14** using a suitable tool. Advantageously, the conductors **12** may be separated once any finishing operation has been fully or partially completed. The conductors **12** may then be connected to their corresponding electrical components **22** in order to form, for example, the electrical bus structure **20** shown in FIG. **3**. The conductors **12** may be separated from each other by breaking the links **14**. Depending on the configuration and properties of the links **14**, the links **14** may be broken or cut using a suitable tool such as a saw or grinder.

One or more surface treatments to enhance the properties such as the corrosion resistance, surface hardness, or conductivity of conductors **12** may optionally be applied to at least a portion of the conductor matrix **10**. Suitable surface treatments may include, for example, anodidization, powder or other coating or plating processes. The surface treatment may optionally be applied to the entire conductor matrix **10** prior to the finishing of the contact faces **16**. Alternatively, the surface treatment may be applied to regions of the conductor matrix **10** other than the contact faces **16**.

Conductors **12** may be made of any suitable material that may be cast and also be used as an electrical conductor. Conductors **12** may have any desired or required configuration(s), including for example complex geometric configurations of varying cross-section, so as to optimize their electrical and/or their structural properties. Accordingly, for example, inductive components or coils (not shown) may be formed as part of the electrical and/or structural framework of an electrical bus structure.

While the invention has been described and illustrated in connection with specific, presently-preferred embodiments, many variations and modifications may be made without departing from the spirit and scope of the invention. The invention is therefore not to be limited to the exact components or details of methodology or construction set forth above. Except to the extent necessary or inherent in the processes themselves, no particular order to steps or stages of methods or processes described in this disclosure, including the Figures, is intended or implied. In many cases the order of process steps may be varied without changing the purpose, effect, or import of the methods described. The scope of the claims is to be defined solely by the appended claims, giving due consideration to the doctrine of equivalents and related doctrines.

The invention claimed is:

1. A method for producing a plurality of electrical conductors, the method comprising:

casting a plurality of conductors together as a conductor matrix, the plurality of conductors in the matrix being joined by at least one temporary link;

applying a surface treatment to at least a portion of the matrix;

finishing a contact face on at least one of the conductors; and

separating the conductors from each other at the at least one link.

2. The method as defined in claim **1**, comprising finishing a plurality of commonly-oriented contact faces on the conductor matrix.

3. The method as defined in claim **1**, wherein separating the conductors comprises severing the at least one link.

4. The method as defined in claim **1**, wherein the surface treatment comprises anodization.

5. The method as defined in claim **1**, wherein the surface treatment comprises plating.

6. The method as defined in claim 1, wherein the finishing comprises machining.

7. The method as defined in claim 1, wherein the finishing comprises grinding.

8. The method as defined in claim 1, wherein the finishing comprises removing material from the at least one of the conductors.

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