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Vratny

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[54] **CONNECTING A FLAT-PACK-PACKAGED CHIP TO A PRINTED CIRCUIT BOARD**

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[52] **U.S. Cl.** ..... **339/17 CF**; 339/17 R

[58] **Field of Search** ..... 339/17 CF, 174, 176 M, 339/176 MP, 278 C; 174/52 FP

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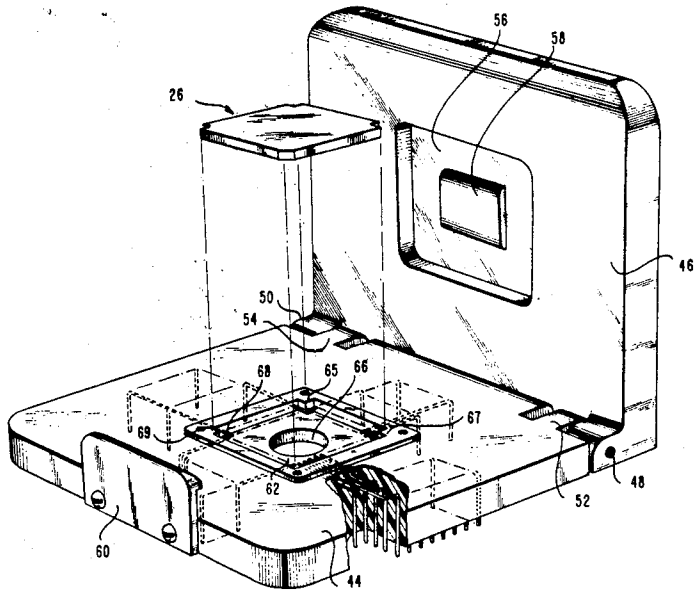
[57] **ABSTRACT**

A unique socket assembly is designed to interconnect a flat-pack-packaged integrated-circuit chip to a printed-circuit board in a manner that permits easy insertion and withdrawal of the packaged chip from the assembly. A base portion of the assembly includes a recess into which conductive cantilevered elements extend. When the packaged chip is positioned on these elements within the recess and a lid is placed on the base, secure but not permanent electrical contact is established between the elements and contact regions on the chip package.

9 Claims, 6 Drawing Figures



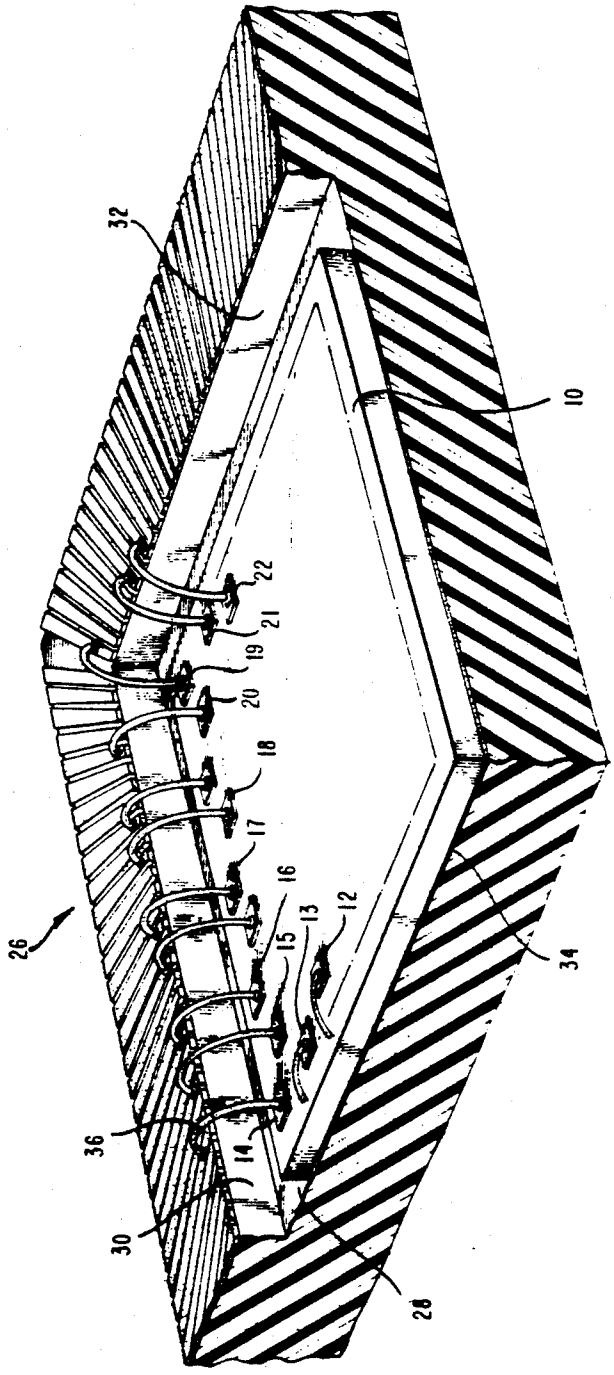


FIG. 1
(PRIOR ART)

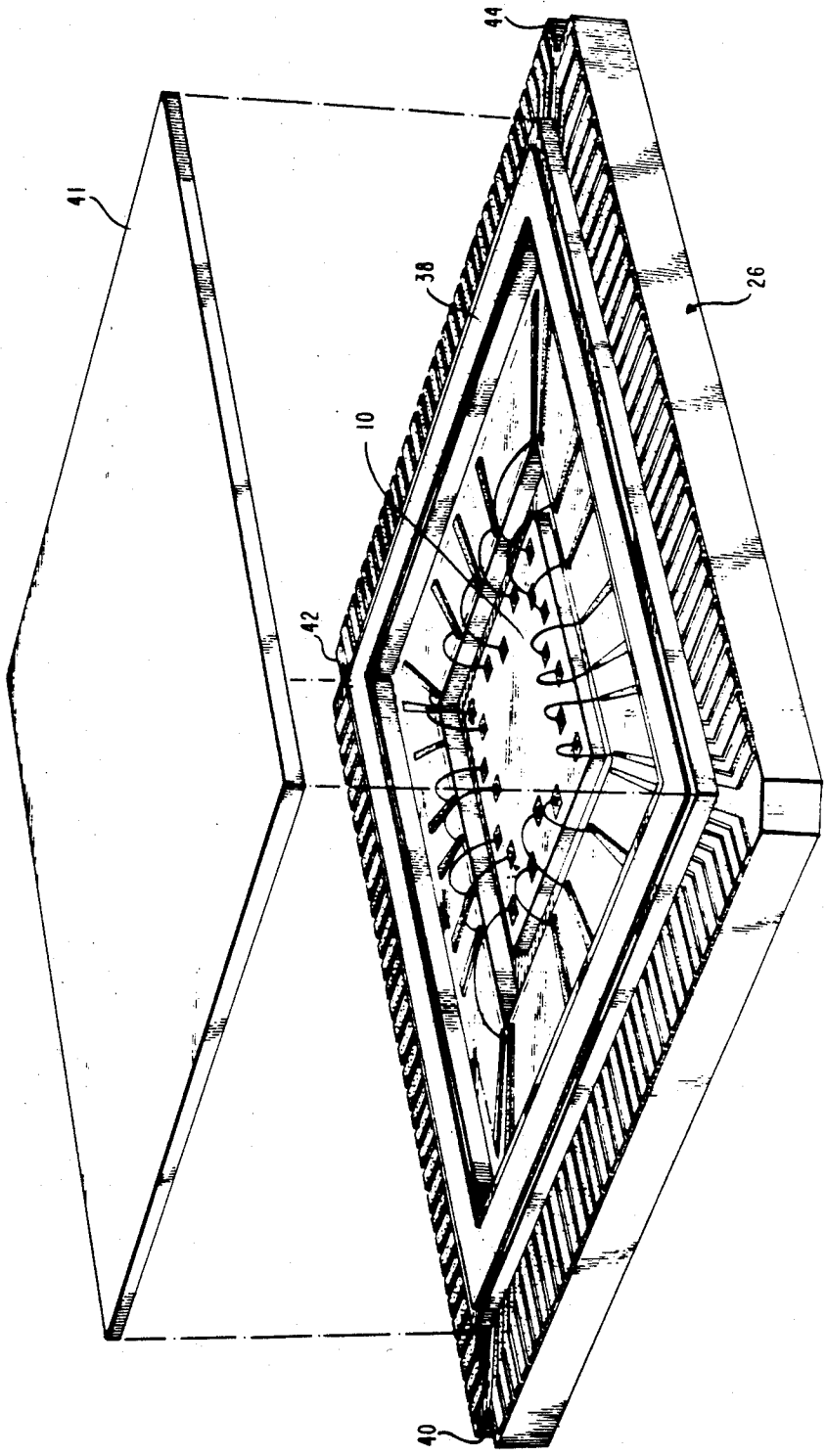


FIG. 2
(PRIOR ART)

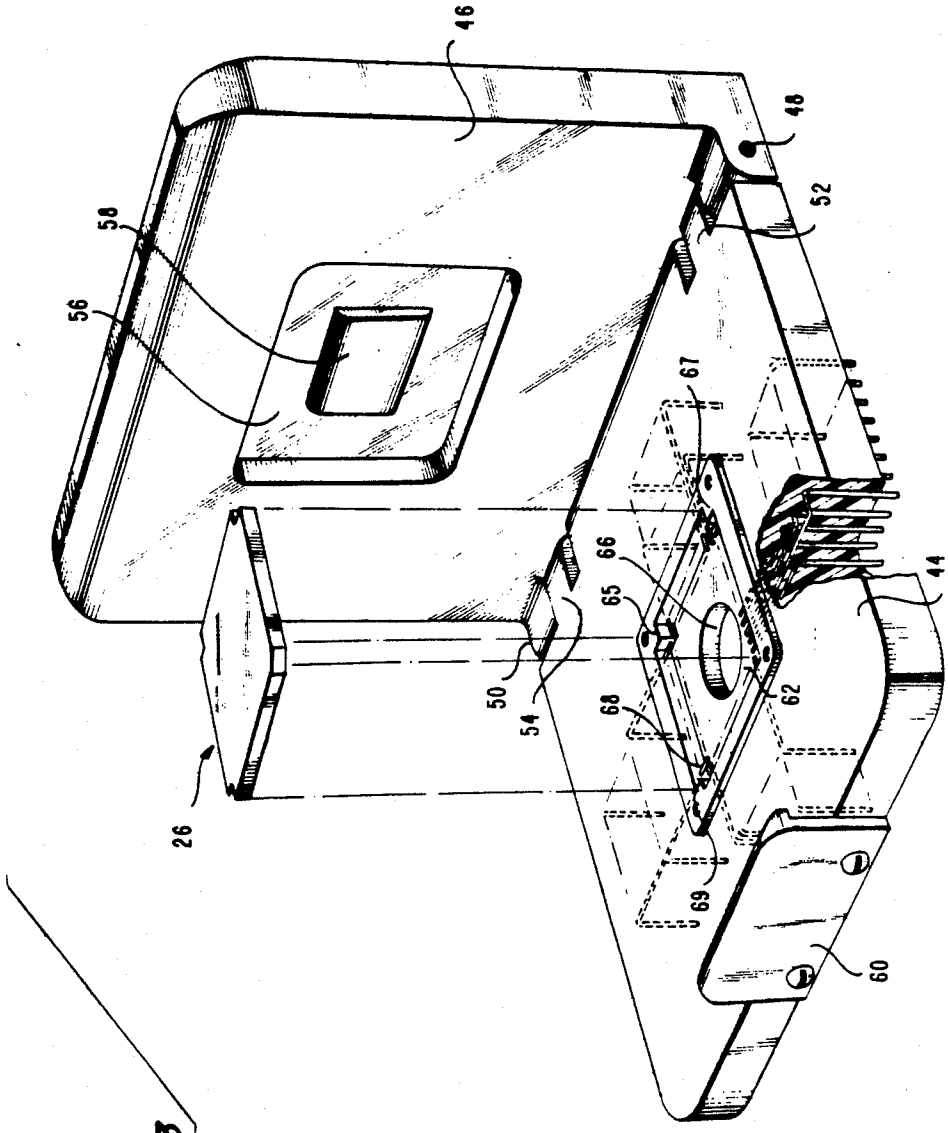


FIG. 3

FIG. 4

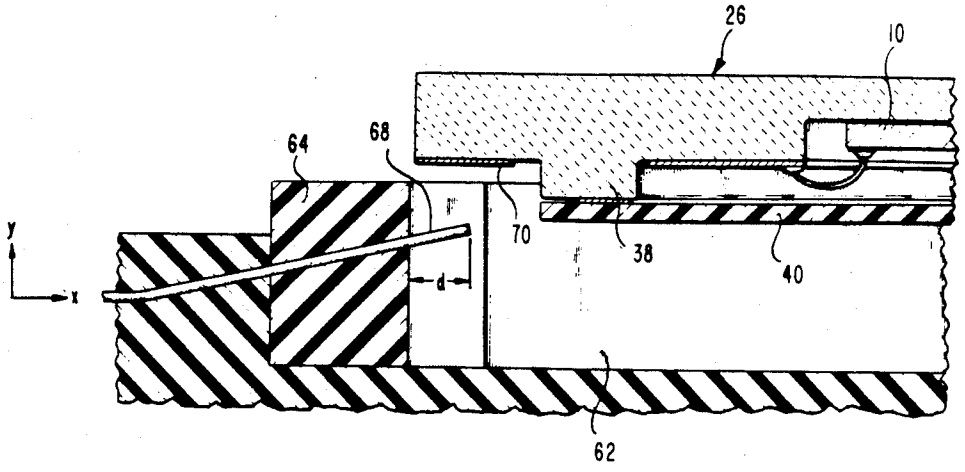


FIG. 5

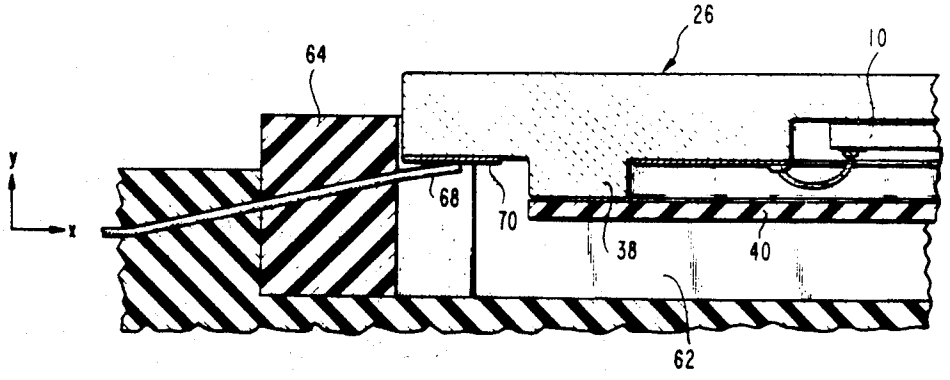
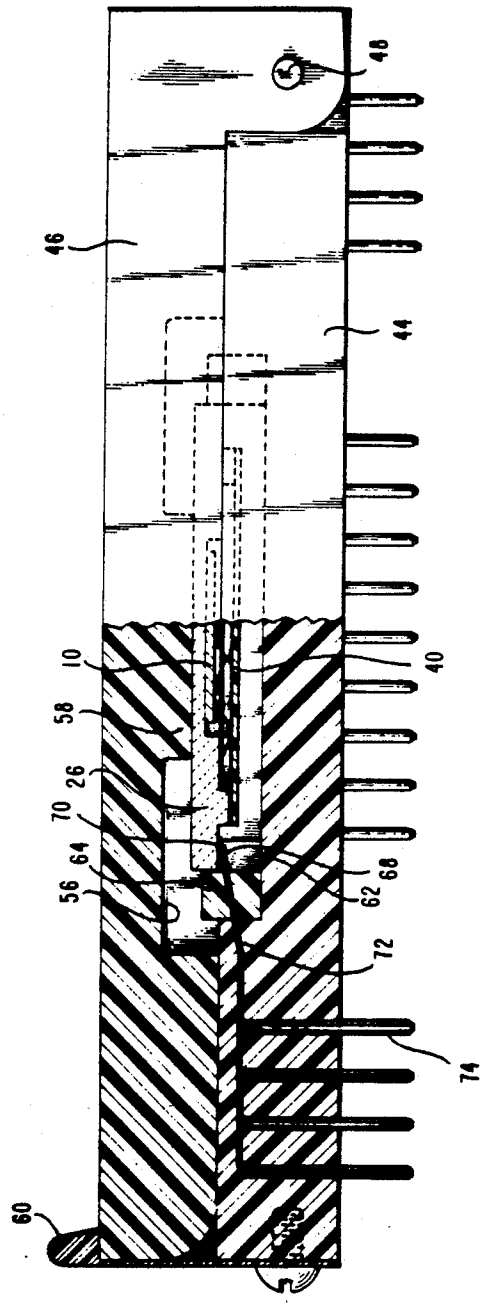


FIG. 6



CONNECTING A FLAT-PACK-PACKAGED CHIP TO A PRINTED CIRCUIT BOARD

BACKGROUND OF THE INVENTION

This invention relates to the packaging of integrated-circuit chips and, more particularly, to an assembly for mounting a chip on a printed-circuit board.

Various solutions have been proposed to the problem of connecting a microminiature integrated-circuit chip to a standard printed-circuit board. In accordance with one approach, the chip is mounted in the recessed portion of the top side of a so-called flat-pack carrier that contains a radially extending conductive pattern. Wire bonds extend between pads on the chip and inner terminal portions of the conductive pattern. A protective material and/or a cover are typically added to the carrier to seal the mounted chip in place. After sealing, outer terminal portions of the conductive pattern on the carrier remain accessible for interconnection to an associated electrical component such as a printed-circuit board.

Several known approaches are then available for mounting the flat-pack-packaged chip on a printed-circuit board. In one approach, the carrier is placed top-side down on a board that includes a conductive pattern with solder bumps. The bumps are located to establish respective electrical contact with the outer terminal portions of the conductive pattern on the carrier. In another approach, the carrier is bonded top-side up to a printed-circuit board that includes conductive terminal portions formed on the board in the immediate vicinity of the bonded carrier. Wire bonds are then made between these terminal portions on the board and the outer terminal portions of the conductive pattern on the carrier.

For some applications, the aforementioned approaches are adequate for mounting a chip-containing carrier on a printed-circuit board. But soldered or bonded carriers on a printed-circuit board cannot easily be replaced during development and testing of the board. Additionally, the final-design version of such a board cannot easily be repaired in the field.

Accordingly, workers in the art have directed considerable efforts at trying to devise other approaches for mounting flat-pack-packaged chips on a printed-circuit board. It was recognized that such efforts, if successful, had the potential for providing an improved mounting assembly capable of lowering the cost of developing, testing and repairing equipment that includes chip carriers on a printed-circuit board.

SUMMARY OF THE INVENTION

Hence, an object of the present invention is an improved assembly for mounting a chip on a printed-circuit board. More specifically, an object of this invention is a compact assembly for mounting a flat-pack-packaged chip on a printed-circuit board in an easily replaceable manner.

Briefly, these and other objects of the present invention are realized in a specific illustrative socket assembly that is adapted to be plugged into a printed-circuit board. A multiple-pad flat pack containing a chip is mounted in the assembly in an easily removable manner that is mechanically secure and electrically stable.

The specific illustrative socket assembly made in accordance with this invention includes a frame portion defining a cavity. Multiple cantilevered terminal members extend into the cavity around the periphery thereof. The terminal members are each upwardly inclined and include a terminal edge portion designed to make sliding and slightly penetrating contact with an associated one of the pads of the flat pack when the pack is positioned face-down on the pins within the cavity. A lid portion of the assembly is designed to contact the back side of the flat pack and thereby maintain the terminal members in resilient contact with their respective pads.

The terminal members constitute the ends of conductors embedded in the frame portion of the assembly. The other ends of these conductors extend from the bottom of the frame and constitute terminals designed to be inserted into a standard socket on a conventional printed circuit board.

BRIEF DESCRIPTION OF THE DRAWING

A complete understanding of the present invention and of the above and other features thereof may be gained from a consideration of the following detailed description presented hereinbelow in connection with the accompanying drawing, not drawn to scale, in which:

FIGS. **1** and **2** show an integrated-circuit chip mounted on and interconnected to a standard flat-pack carrier;

FIG. **3** depicts a specific illustrative socket assembly made in accordance with the principles of the present invention, which assembly is adapted to have the carrier of FIGS. **1** and **2** mounted therein;

FIGS. **4** and **5** are side views of a portion of the FIG. **3** assembly; and

FIG. **6** is a side view, partially broken away, of the FIG. **3** assembly with the chip-containing carrier mounted therein.

DETAILED DESCRIPTION

A conventional integrated-circuit chip **10** is schematically represented in FIG. **1**. By way of example, the chip **10** comprises a very-large-scale-integrated (VLSI) semiconductor chip measuring approximately 4.6 millimeters (mm) by 4.8 mm. A number of conductive bonding pads are included on the chip **10** around the periphery thereof, in a manner well known in the art. In one specific chip design, **132** such pads each measuring about 75 micrometers (μm) by 75 μm are formed thereon. So as not to unduly clutter the drawing, FIG. **1** explicitly shows only eleven bonding pads **12** through **22** on the chip **10**.

FIG. **1** also shows a portion of a standard flat-pack chip carrier **26** made, for example, of ceramic. The carrier **26** comprises a recessed portion **28** partially defined by side walls **30** and **32**. Illustratively, the bottom of the recessed portion **28** is coated with a layer of gold. The bottom of the chip **10** is bonded and established in electrical contact with the gold layer by, for example, eutectic bonding or by means of a layer **34** comprising a standard silver epoxy cement.

A portion of a conductive pattern formed on the main planar top side of the carrier **26** is shown in FIG. **1**. This pattern is made, for example, of gold. Inner terminal portions of this conductive pattern extend to the edge of the previously specified recessed portion **28**. Standard wire bonds interconnect the pads on the chip **10** with respective ones of these inner terminal portions. Thus, for example, wire bond **36** shown in FIG. **1** serves to

connect the chip pad **14** to an associated one of the inner terminal portions of the carrier **26**.

FIG. 2 shows the entire top side of the carrier **26** including the chip **10** mounted on and interconnected thereto. The conductive pattern on the main planar top side of the carrier **26** includes multiple flat conductors each of which extends from the recessed portion **28** to the outside perimeter of the carrier. The outer terminal portions of the conductive pattern along the perimeter are adapted to be contacted by terminal members included in applicant's novel socket, as will be described in detail later below.

The carrier shown in FIG. **2** also includes a ledge portion **38**. Illustratively, the portion **38** is also made of ceramic and is, for example, bonded to the main planar top side of the carrier **26** overlying portions of the aforespecified multiple flat conductors. A standard flat cover **40** is designed to be positioned on the ledge portion **38** and to be bonded thereto. In conjunction with a conventional sealing or potting material applied to the carrier **26** within the ledge portion **38**, the cover **41** serves to protect the chip **10** and its associated connections from dust, moisture, etc.

As depicted in FIG. **2**, three corners of the carrier **26** include cut-out regions **40**, **42** and **44**, respectively. As will be evident later below, these regions serve as keys to insure proper registration of the carrier **26** in applicant's novel socket assembly.

A specific illustrative socket assembly made in accordance with applicant's inventive principles is depicted in FIG. **3**. As shown, the socket is in its so-called open position. A chip carrier **26** of the type represented in FIGS. **1** and **2** is shown, bottom side up, lifted from its intended mounting position in contact with the base **44** of the depicted assembly.

A lid **46** (FIG. **3**) is hingedly secured by pins **48** and **50** to tabs **52** and **54**, respectively, that constitute integral parts of the base **44**. The lid is adapted, when rotated to contact the top surface of the base **44**, to maintain a mounted chip carrier firmly in place in the illustrated socket assembly. For that purpose, the lid **46** comprises a recess **56** that includes a pedestal **58**. When the lid is closed and retained in place by clip **60**, the pedestal **58** presses down on the back side of the mounted carrier **26**. This serves to maintain the aforespecified outer terminal portions on the top side of the carrier **26** in secure electrical engagement with cantilevered terminal members included in the base **44** of the depicted socket.

Illustratively, the lid **46** and the base **44** of the herein-considered socket assembly are made of a rigid plastic material. Numerous such materials exhibiting good mechanical and electrical insulating properties are well known in the art.

The base **44** of the socket assembly shown in FIG. **3** includes a recess **62** whose dimensions are slightly larger than the corresponding dimensions of a chip carrier to be mounted therein. In one specific illustrative embodiment, the recess **62** is framed by a ledge portion **64**.

Illustratively, the recess **62** in the base **44** of FIG. **3** includes an opening **66**. This opening serves as an air passage for facilitating cooling of a mounted chip carrier. When the depicted socket assembly is mounted in place on a printed-circuit board, the bottom of the base **44**, and thus also the bottom of the opening **66**, are designed to be spaced apart from the surface of the printed-circuit board. In that way, space for air circulation to cool the chip carrier is provided.

The ledge portion **64** shoen in FIG. **3** includes protuberances **65**, **67** and **69** at three of its four inner corners. These protuberances are designed to mate with the aforementioned cut-out regions formed on three of the four corners of the chip carrier **26**. Accordingly, the carrier **26** is adapted to be properly registered and mounted on the cantilevered terminal members in only one specified orientation.

The aforementioned cantilevered terminal members shown in FIG. **3** extend into the recess **62** from the inner four vertical walls of the ledge portion **64**. (Reference numeral **68** in FIG. **3** designates one such terminal member.) In the specific illustrative case in which the chip carrier **26** includes thirty-three spaced-apart outer terminal portions along each top-side edge, thirty-three spaced-apart terminal members extend from each inner vertical wall of the ledge portion **64**. Each such terminal member is designed to contact a respective one of the outer terminal portions on the top-side of the chip carrier **26** when the carrier is mounted in the depicted socket assembly. These terminal members constitute the sole support for a mounted carrier.

Advantageously, each of the cantilevered terminal members included in the socket assembly of FIG. **3** constitutes one free end of a length of gold-plated stainless steel wire. In one specific illustrative embodiment, the wire has a circular cross-section approximately 0.23 mm in diameter.

FIG. **4** is a cross-sectional depiction that shows one such cantilevered terminal member **68** extending into the recess **62** from one vertical side wall of the ledge portion **64**. Before being contacted by the chip carrier **26**, the terminal member **68** is upwardly inclined at an angle of, for example, approximately 12.5 degrees with respect to a line parallel to the X axis. Illustratively, the terminal member **68** extends into the recess **62** from the indicated side wall of the portion **64** by a distance $\underline{d}$ that in one specific enbodiment was about 5.75 mm.

Advantageously, the right-hand end of the terminal member **68** shown in FIG. **4** is cut off square. In other words, the planar end surface of the terminal member **68** is perpendicular to the main longitudinal axis of the member **68**. In that way, the upper right-hand portion of the end of the member **68** provides a sharp edge for intimate scraping and even slightly penetrating contact with an associated one of the outer terminal portions of the chip carrier **26**. In FIG. **4**, the conductive terminal portion of the carrier **26** intended to be contacted by the terminal member **68** is designated by reference numeral **70**.

FIG. **5** shows a portion of the chip carrier **26** in its final mounted position in applicant's unique socket assembly. As depicted, the terminal member **68** is in intimate electrical contact with the terminal portion **70** of the carrier **26**. In the indicated position, all the other cantilevered terminal members extending from the ledge portion **64** are similarly established in intimate electrical contact with respective ones of the outer terminal portions included on the chip carrier **26**. The chip **10** is thereby securely mechanically mounted and electrically connected in an effective manner to the socket assembly described herein.

With the chip carrier **26** in its final mounted position in the socket assembly, as indicated in FIG. **5**, the cantilevered terminal member **68** is still upwardly inclined. But the angle between the main longitudinal axis of the

member **68** and a line parallel to the X axis is, for example, about 8 degrees less than the 12.5-degree angle specified above for the quiescent case (FIG. **4**) in which the carrier **26** is not yet in contact with the terminal member **68**. In the contacting position represented in FIG. **5**, the end of the member **68** exerts a resilient upward force on the terminal portion **70**.

The terminal member **68** depicted in FIG. **5** is also shown in the more complete view designated FIG. **6**. The member **68** and each of the other cantilevered members specified herein constitute the free movable ends of conductors that are rigidly retained in the base **44** of the FIG. **6** socket assembly. Thus, as shown in FIG. **6**, the terminal member **68** constitutes one end of a conductor **72** whose other end extends through and beyond the bottom surface of the base **44**.

The conductor ends that extend from the bottom surface of the base **44** are designed to be inserted into a standard female receptacle on a printed-circuit board. In some cases of practical importance, it is advantageous to impart additional size and rigidity to these conductor ends. In such cases, lengths of gold-plated stainless-steel tubing, for example, can be bonded to these conductor ends with a suitable adhesive such as silver epoxy cement. Such lengths of tubing, including tubing **74** around the lower end of the conductor **72**, are shown in FIG. **6**.

The novel socket assembly described herein is adapted for mounting a flat-pack-packaged chip on a printed-circuit board. The assembly provides a reliable mechanical and electrical interface between the packaged chip and the board. The assembly can be disengaged from the board and, significantly, the packaged chip can be quickly and easily removed from the socket assembly. As a consequence, development, testing and repair of such an assemblage of components are greatly facilitated.

Finally, it is to be understood that the above-described arrangements are only illustrative of the principles of the present invention. In accordance with these principles, numerous modifications and alternatives may be devised by those skilled in the art without departing from the spirit and scope of the invention. For example, although emphasis herein has been directed to mounting only a single chip on the bottom of the recessed portion **28** of the carrier **26** (FIG. **1**), it is feasible to mount and interconnect plural chips directly on the bottom of the portion **28**. Further, in some cases of practical importance it is advantageous to mount one or more chips on a subcarrier which in turn is mounted on the bottom of the recessed portion **28**.

What is claimed is:

1. Apparatus for electrically interconnecting an integrated-circuit chip to a printed-circuit board, said apparatus comprising

a flat-pack board having a multiple-pad integrated-circuit chip mounted on the topside of said flat-pack board,

first electrical conductors on the topside of said flat-pack board, said conductors including inner terminal portions adjacent said mounted chip and outer terminal portions disposed along the perimeter of said flat-pack board,

means electrically connecting the pads on said chip to respective ones of said inner terminal portions,

a socket assembly comprising a base having a recess formed in the topside thereof,

second electrical conductors mounted in said base and having inner terminal elements extending into the recess in said base around the perimeter of said recess and outer terminal elements extending from said base and adapted to be inserted into a female connector on a printed-circuit board, said inner terminal elements constituting topside-inclined cantilevered elements extending from the side walls defining the recess in said base, said cantilevered elements being adapted to respectively contact the outer terminal portions of said flat-pack board when the topside of said flat-pack board is positioned on said cantilevered elements,

and a lid member, constituting a part of said socket assembly, adapted to be positioned in contact with said base for exerting force on the bottomside of said flat-pack and thereby causing the still inclined but slightly depressed cantilevered elements to establish stable electrical connections with said outer terminal portions.

2. Apparatus as in claim **1** wherein each inclined cantilevered element comprises a planar end surface perpendicular to the main longitudinal axis of the element thereby providing a sharp upper edge on said element for engagement with its respective outer terminal portion.

3. Apparatus as in claim **2** wherein said cantilevered elements comprise gold-plated stainless-steel wires.

4. Apparatus as in claim **3** further including means for retaining said lid on said base in a secure mechanical manner.

5. A socket assembly comprising

a base having a recessed portion formed in the top surface thereof, said recessed portion being bounded by a sidewall, the cross-sectional dimensions of said recessed portion being slightly larger than the corresponding dimensions of a chip package to be placed in said recessed portion,

conductors in said base including cantilevered elements extending from said sidewall into said recessed portion and quiescently inclined upwards towards said top surface, said conductors also including terminal elements extending from said base and adapted for insertion into a socket on a printed-circuit board,

and lid means adapted to mate with the top surface of said base and to exert a force on a chip package placed in said recessed portion on said cantilevered elements to establish respective electrical contact between said cantilevered elements and contact regions on said chip package.

6. An assembly as in claim **5** wherein each of said cantilevered elements comprises a planar end surface perpendicular to the main longitudinal axis of the element thereby providing a sharp upper edge on said element for engagement with its respective contact region on said chip package.

7. An assembly as in claim **6** wherein said cantilevered elements are still inclined upwards towards said top surface but slightly depressed relative to their quiescent inclinations when the lid means mates with said base and exerts a force on the chip package placed in said recessed portion.

8. An assembly as in claim **7** wherein said lid means is hingedly mounted on said base and adapted to be mechanically retained in place on said base when said lid means mates with the top surface of said base.

9. An assembly as in claim **8** wherein said cantilevered elements comprise gold-plated stainless-steel wires.

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