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(54) Insert-molded electrical connector and method of manufacture

(57) An electrical connector (10) is provided having a plurality of conductive terminals(15) insert-molded with a housing (30). Each of the terminals (14) has a reduced-thickness tip portion (40) having a stepped profile (42). The stepped profile (42) has a non-curved corner that meets an exposed contact surface (38) of the terminal (14). The corner of the terminal remains positioned against a wall of a mold cavity during the insert-molding process but permits the tip portion (40) to be embedded in the housing material for secure mounting. The terminal advantageously avoids the formation of a burr or resin film on the exposed contact surface (38) during insert-molding. Such a connector is useful, for example, in miniature size connector applications wherein the terminals are small and lack significant rigidity needed to permit easy assembly with a preformed housing.

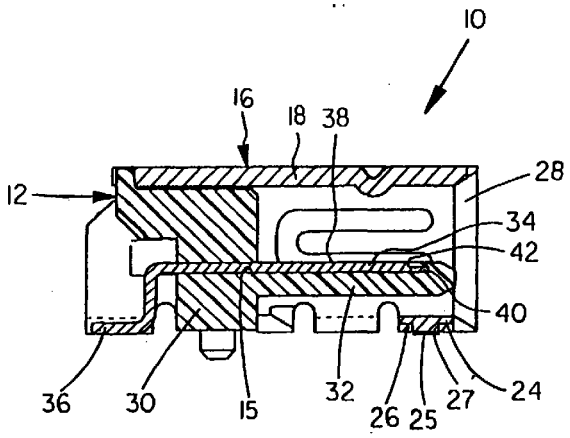

FIG. 4

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Description

Background of the Invention

[0001] The present invention generally relates to the art of electrical connectors and particularly to small electrical connectors having one or more conductive terminals embedded within an insulative housing by an insert-molding manufacturing process.

[0002] Conventionally, electrical connectors have been manufactured by providing a rigid insulative housing which is then assembled with a plurality of metal terminals. The terminals are inserted into terminal cavities formed in the housing. Advances in electronics devices have required reduced-size electrical connectors. Such miniaturization has resulted in terminals that are made of very thin strips of metal. Accordingly, such terminals have very little structural rigidity. Due to this lack of rigidity, however, conventional terminal-to-housing assembly methods have proven impractical or impossible, because the terminals are not rigid enough to withstand physical insertion into a terminal cavity in a housing.

[0003] In an effort to manufacture a connector having very small terminals, it is known to manufacture connectors by a process known as "insert-molding," sometimes referred to as "over-molding." Insert-molding involves placing the terminals within a mold cavity, then injection-molding a resin into the cavity which cures to form a rigid insulative housing around the terminals. More specifically, at least one surface of each terminal desirably lies against a surface of the mold cavity during injection of the housing resin. This surface is not covered with the resin and thereby remains exposed. Once cured, the rigid housing provides support against an underside of the terminals. The exposed terminal surfaces act as a contact surface for the connector.

[0004] To better secure the terminals to withstand contact forces during use of the connector, frontward tips of the terminals that are bent in an S-shaped curve to form a step that extends inwardly within the mold cavity. Accordingly, the inwardly-projecting tips become fully surrounded by the injected housing resin and are thus securely embedded in the housing. This helps secure the terminals in the housing and prevents the front tips from prying away from the housing.

[0005] Unfortunately, during the insert-molding process of known electrical connectors, the injected housing resin frequently seeps over contact surfaces of the terminals in the mold cavity which are intended to remain uncovered, forming a "burr" or resin film. In particular, the resin undesirably flows around the contact surfaces of the terminals placed against the side of the terminal cavity. Such undesired injection behavior is known to occur at the curved steps at the frontward tips of the terminals. This is problematic, as the contact surfaces of the terminals need to be exposed for establishing electrical contact. The undesired "burr" over the terminal contact surface can prevent such electrical contact from occurring.

[0006] Undesired burr formation is particularly problematic with high viscosity resins. In an effort to control or eliminate burr formation, it is necessary to use highly precise molds and/or to use a molding resin of a grade having a low burring property.

[0007] In conventional connectors, quality control is made more difficult because the burr formation is inconsistent in dimension over the terminal contact surface. The burr shape characteristics are inconsistent among connectors, resulting in manufacturing imprecision due to the difficulty of predicting the location and length of the resulting exposed terminal surface. It is desirable to minimize the length of a burr, or eliminate the burr altogether, in order to provide the terminal with maximal exposed contact portion, thereby maximizing an effective insertion length.

[0008] Thus, an improved connector is needed which overcomes the problems associated with known connectors manufactured by insert-molding. In particular, a connector is needed which eliminates or reduces the formation of film of housing resin material on a terminal contact surface known as a "burr."

Summary of the Invention

[0009] The present invention overcomes the aforementioned problems by providing an improved electrical connector. The present invention advantageously provides a connector that prevents the formation of a burr or film over a contact surface of the conductive terminals, the contact surface consistently remaining exposed and uncovered by housing material.

[0010] In an embodiment, a connector according to the invention includes a terminal having a specially shaped tip. In particular, terminal has an intermediate contact portion that forms a contact surface and reduced-thickness tip portion recessed or offset from the contact surface and which extends in a forward direction from the contact portion, defining a stepped profile. The contact portion has a first thickness, and the tip portion has a second thickness less than the first thickness. A generally planar surface extends at a generally right angle from the contact surface to the tip.

[0011] To assemble the terminals with an insulative housing, the terminals are positioned within a mold cavity and a resin of housing material is then insert-molded over the terminals. The resin cures to form the insulative housing. The housing includes a terminal support platform extending along a side of the contact portions of the terminals, providing rigid structural support when the terminal contact surfaces are subjected to contact forces.

[0012] The reduced thickness tip of each connector is embedded in a frontward portion of the housing terminal platform. More specifically, the housing material covers an upper side of the tip.

[0013] In an embodiment, the tip portion of the ter-

minal has a thickness of about one-half the thickness of the contact portion.

[0014] An advantage of the present invention is that the reduced-thickness tip of the stepped-profile terminal prevents the flow of resin over the contact surface during insert-molding of the insulative housing material over the terminal.

[0015] The embedded reduced-thickness tip securely fixes the forward part of the conductive terminal within the housing. This advantageously prevents separation of the terminal from the housing.

[0016] A further advantage of the present invention is to provide an improved terminal which may be used in prior housing molds, yet which provides improved non-burring performance during insert-molding.

[0017] Additional features of the present invention are described in, and will be apparent from, the following description, drawings and claims.

Brief Description of the Drawings

[0018]

FIG. 1 is a side cross-sectional view of a conventional insert-molded electrical connector.

FIG. 2 is enlarged fragmentary cross-sectional view of the housing terminal platform and terminal of the conventional connector of FIG. 1.

FIG. 3 is a plan view of an insert-molded electrical connector in accordance with an embodiment of the present invention.

FIG. 4 is a side cross-sectional view of a connector according to the invention as taken generally along line IV-IV of FIG. 3.

FIG. 5 is a front end view of the connector of FIG. 3, as looking in an insertion direction into the connector.

FIG. 6 is an enlarged, fragmentary cross-sectional view of the housing terminal platform and terminal of the connector of FIG. 3.

FIGS. 7-9 are schematic side views of a terminal during various sequential manufacturing stages according to the invention. FIG. 7 shows the terminal on a work table prior to coining. FIG. 8 shows the terminal during a step of coining under exertion from a coining tool for forming the reduced-thickness, stepped profile tip. FIG. 9 illustrates the coined terminal with a broken line indicating where excess material is cut from the tip.

Detailed Description of the Preferred Embodiment

[0019] Now referring to the drawings, wherein like numerals designate like components, FIGS. 1 and 2 illustrate a conventional connector 304 of a type having an insert-molded housing 301. As shown in FIG. 1, the conventional connector 304 generally includes the insulative housing 301, a plurality of geometrically parallel conductive terminals 303 residing in the housing, and a conductive shield 302. The shield 302 generally encloses two sides and an upper side of the housing.

[0020] The shield 302 has a front opening 305 shaped to cooperatively receive a mated plug connector (not shown). The mated plug connector fits over a terminal platform 306 of the housing so that contacts from the plug are received in sliding contact over the terminals 303.

[0021] Still referring to FIG. 1, the housing 301 of the conventional connector 304 includes base portion 311 and a cantilevered terminal platform 306 extending forwardly from the base 311 toward the opening 305 in the shield 302. The housing 301 is formed over the terminals 303 by a generally known insert-molding method whereby an insulative housing resin is injected into a mold cavity containing the terminals 303, as pre-inserted into the mold. Thereby, the terminals 303 extend through the base 311 and are recessed into the terminal platform 306 so that a contact surface 309 of each terminal faces upwardly away from the terminal platform 306. The contact surface 309 is desirably exposed for readily establishing conductive contact with the plug received in the opening 305, but unfortunately, keeping the contact surface exposed during manufacture has been difficult.

[0022] More specifically, as illustrated in FIG2. 1 and 2, the terminal platform 306 of the conventional terminal 303 is bent in an S-curved portion 308 to form a lowered forward tip 307. The lowered tip 307 is embedded or sunken into the material of the housing 301 to help hold front end of the terminal 303 secure. Notably, the conventional terminal 303 is generally consistent in thickness along its length, including at the tip 307.

[0023] Unfortunately, it has been found that with a conventional terminal 303 formed by bending with an S-curve portion 309, the contact surface 30 frequently gaps away from the mold during the insert-molding process, allowing the formation of an undesired "burr" 310 or film of housing resin over the contact surface 309. This burr 310 covers some or all of the length of the contact surface 309, lessening the quality of electrical contact, or shortening the effective area of the contact surface 309. Removal of the burrs 310 greatly increases expenses.

[0024] In order to overcome the problems associated with formation of burrs on terminals during insert molding, the present invention, in an embodiment, provides a connector including a terminal having an improved, reduced-thickness, stepped profile at its tip. A terminal with this improved shape has been found to resist gapping away from the mold cavity during injection of the housing resin, thereby preventing the flow resin onto the contact surface and the associated formation of burrs.

[0025] For example, FIGS. 3-6 illustrate a miniature connector 10 according to an embodiment of the invention. Generally, as illustrated in FIGS. 4 and 5, the con-

nector 10 includes an insulative housing 12, a plurality of conductive terminals 14. In order to construct the connector 10 in a miniature size, the insulative housing 12 is insert-molded over the terminals 14. The connector 10 is configured to receive a mated plug connector (not shown).

[0026] Additionally, to protect the connector from electromagnetic interference, the illustrated connector 10 has an outer conductive shield 16, as shown in FIGS. 3 and 5. The shield 16 has an upper wall 18 and two opposed side walls 20. For mounting the connector 10 to a circuit board (not shown) or other surface, a plurality of mounting flanges 22 (four, as shown in the illustrated embodiment) project outwardly from the side walls 20 of the shield 16. As illustrated in FIGS. 4 and 5, the shield 16 is unitary and wraps peripherally around the insulative housing 12, forming a rigid exterior of the connector 10. Ends of the shield 16 are defined by a pair of oppositely-projecting tabs 24 and 26. The tabs 24, 26 meet at an underside of the connector 10 in a cooperatively engaged manner, thereby securing the housing 12 within the shield 16.

[0027] More specifically, each of tabs 24 and 26 have respectively stepped profiles which cooperatively fit against each other, as illustrated in FIG. 5. Referring to the sectional view of FIG. 4, tab 24 includes a post 25 that is closely received in a hole 27 in the opposite tab 26 with an interference fit.

[0028] At a front of the connector 10, an opening 28 is defined interiorly the upper wall 18, side walls 20 and bottom tabs 24, 26 of the shield 16. The opening 28 is sized to matably receive the aforementioned plug connector.

[0029] The sectional views of FIGS. 4 and 6 illustrate the terminals 14 within the insulative housing 12. A plurality of terminals 14 are provided (four as illustrated) in a geometrically parallel arrangement residing in the housing 12. The housing 12 accommodates the terminals 14 in respective terminal cavities 15.

[0030] Referring now to FIG. 4, the insert-molded housing 12 of the connector 10 includes base portion 30 and a cantilevered terminal platform 32 extending forwardly from the base portion 30 toward the opening 28 in the shield 16. A front end of the terminal platform 32 is tapered in shape for mated insertion into a cooperative receptacle of the plug. When the mated plug connector is inserted into the connector 10, the plug fits over the terminal platform 32 of the housing so that contacts from the plug are received in sliding contact over the terminals 14.

[0031] Still referring to FIG. 4, each of the terminals 14 has an elongated contact portion 34 that resides in a recessed manner in the terminal platform 32. The terminal 14 extends rearwardly through the base portion 30 of the housing 12. At a rear of the connector 10, the terminal 14 has a tail portion 36, as shown in FIGS. 3 and 4. The tail portion 36 is connected to a contact on a circuit board by solder or other known means.

[0032] To establish contact with the plug, the contact portion 34 of the terminal 14 has an upwardly-exposed contact surface 38. Preferably, the exposed contact surface 38 extends substantially along a length of the terminal platform 32 from the base 30 of the housing 12 toward the front opening 28. This maximizes the sliding contact length.

[0033] According to an aspect of the invention, a front of the terminal 14 includes a reduced-thickness tip portion 40 having a cornered, stepped profile offset from the contact surface. Due to the stepped profile, insulative housing resin can surround the tip portion 40 during the molding process. Upon curing of the resin, the tip portion 40 is recessed or embedded within the housing 12, having a portion of housing material g (FIG. 6) disposed vertically above the tip portion 40 and forwardly of the contact surface 38. The embedded tip portion 40 secures the terminal 14 to the terminal platform 32, preventing the terminal 14 from prying loose from the terminal platform 32 when subjected to sliding insertion forces from the plug.

[0034] Particularly, the contact portion 34 of the terminal 14 has a first thickness, and the tip portion has a second thickness that is less than the first thickness. For example, in the illustrated embodiment, the thickness of the tip portion 40 is about one-half the thickness of the contact portion 34. A substantially planar surface 42 extends at a generally right angle from the contact surface 38 to the tip portion 40. It should be understood, however, that the connector 10 is miniature in size, and the precision of the geometry described herein is limited to the abilities of manufacturing terminals 14 at a small scale. Additionally, the invention is not limited to a right-angle profile. Rather, it is intended that the invention encompass non-curved corner profiles at the front edge of the terminal contact surface 38. Thus, though the described reduced-thickness, right-angle, stepped profile 40 is preferred, it is intended that the claims herein should encompass such tip shapes within equivalent variations and reasonable manufacturing tolerances. A forward surface 44 extends approximately parallel to the planar surface 42.

[0035] The stepped profile of the tip portion 40 has been found to reduce the formation of burrs, as was problematic with prior art connectors. In particular, the contact surface 38 and/or planar surface 42 of the terminal stay in contact against a side of the mold cavity as the resin is injected, surrounding the tip portion 40. A resin film or burr is not formed on the contact surface 38 because resin is sufficiently blocked from flowing rearwardly of the step surface 42 of the terminal.

[0036] In a preferred embodiment, the length of the tip portion 40 is slightly longer than the thickness of the contact portion 34. However, the length of the tip portion 40 may be any appropriate length to provide the necessary securing force depending on the dimensions and strength of the components overall, including the strength of the housing material g.

[0037] To form the reduced thickness tip portion, in an embodiment, the terminals are manufactured with a coining process, as shown in FIGS. 7-9. First, referring to FIG. 7, a plate or metal blank 114 is provided from which the terminals are to be made. The coining process described herein forms the desired reduced-thickness, stepped profile at one time to the blank 114, from which many terminals are to be made, thereby optimizing efficiency.

[0038] The blank 114 is placed upon a sturdy surface or work table 116. A hammer die 118 is positioned along a front edge of the blank 114. The die 118 has a notch 120 with a tooth 122 that are appropriately shaped to stamp the desired stepped terminal profile defining, for example, a right-angle. The notch 120 has a depth h equivalent to the desired thickness of the terminal tip portion.

[0039] The hammer die 118 is driven downwardly in the direction A (FIG. 7), stamping or coining the front edge of the metal blank 114 with the desired stepped profile, as shown in FIG. 8. Metal deformed under the notch 32 draws forwardly, forming the reduced-thickness tip portion 40 and the stepped planar surface 42 disposed at a right angle to the contact surface 38.

[0040] Turning to FIG. 9, in order to make the tip portion a desired length, excess material is removed from the forward edge of the tip portion 40 in a cutting step using some appropriate know cutting device, for example a shear, laser, etc. As illustrated, material to the right of the broken line B is cut away and discarded to leave forward surface 44 (FIG. 6).

[0041] Thereafter, the individual terminals 14 are cut from the blank 114 and are bent to form the tail portions 36. Optionally, plating may be applied to the terminals at this point. In order to minimize the number of manufacturing steps, the cutting operation of FIG. 8 could, for example, also serve to separate the individual terminals 14 from the blank 114.

[0042] The above-described embodiment is an example of an embodiment in which the surface 42 of the terminal 14 is formed at a right angle. However, a terminal 14 having a reduced thickness tip portion 40 according to the invention can also be produced in which the surface 42 is at an angle other than 90 degrees. The coining operation of FIGS. 7 and 8 may be used to form such a profile. For example, the surface 42 may be formed at either an acute angle or obtuse angle approximating to a right angle.

[0043] The present invention is not limited to the exemplary embodiments specifically described herein. To the contrary, it is recognized that various changes and modifications to the embodiments specifically described herein would be apparent to those skilled in the art, and that such changes and modifications may be made without departing from the spirit and scope of the present invention. Accordingly, the appended claims are intended to cover such changes and modifications as well.

Claims

1. An electrical connector (10) comprising:

a plurality of conductive terminals (14); and
a housing (12) insert-molded over the terminals (14), the housing including a terminal support platform (32), said plurality of terminals disposed in said housing;
wherein each terminal (14) includes:
a contact portion (34) having an exposed contact surface (38) for mating with a respective terminal of a mating connector, the contact portion having a first thickness; and
a tip portion (40) extending frontwardly from the contact portion (32), the tip portion having a second thickness less than the first thickness to form a stepped profile offset from the contact surface, the housing embedding the tip portion.

2. The electrical connector (10) according to claim 1, wherein the terminal (14) includes a substantially planar surface (38) that extends at an angle of about 90 degrees downwardly from the contact surface (38) to the tip portion (40).

3. The electrical connector (10) according to claim 1, further comprising a unitary conductive shield (16), the shield having two oppositely-projecting tabs (24, 26) which meet so that said shield wraps peripherally around the housing (12), each of the tabs has a stepped profile so that the stepped profiles cooperatively fit against each other in a cooperative manner.

4. The electrical connector (10) according to claim 3, wherein one of said tabs (24) includes a post (25) extending therefrom and the other tab (26) has a hole receiving the post with an interference fit.

5. The electrical connector (10) according to claim 3, wherein said shield (16) further includes a top wall (18) and a pair of side walls (20) oppositely extending from said top wall, said tabs (24, 26) projecting from respective side walls.

6. An electrical connector (10) according to claim 1, wherein the housing (12) further comprises a housing base (30), the terminal platform (32) extending forwardly from the housing base; and
wherein the terminal (14) further comprises a tail portion (36) for engaging a respective conductor on a circuit board on which the connector is to be mounted.

7. An electrical connector (10) comprising:

at least one conductive terminal (14), the termi-

nal including a contact portion (34) defining a contact surface (38), the contact portion having a first thickness and a tip portion (40) extending frontwardly from the contact portion, the tip portion having a second thickness less than the first thickness and being offset from the contact surface;

an insulative housing (12) forming a terminal platform (32), wherein the tip portion (40) of the terminal is embedded in the housing so that the contact surface is exposed and the tip portion is covered by the housing.

8. The connector (10) according to claim 7, wherein the second thickness is about half of the first thickness.

9. The connector (10) according to claim 7, wherein the housing (12) is formed by insert-molding an insulative resin over the terminal (14).

10. The connector (10) according to claim 7, wherein the tip portion (40) extends from the contact portion (34) in a step-like manner.

11. The connector (10) according to claim 7, wherein the terminal (14) has a surface (42) disposed at about a right angle relative to the contact surface, the surface extending to the tip portion (40).

12. The connector (10) according to claim 7, further comprising a unitary conductive shield (16), the shield having two oppositely-projecting tabs (24, 26) which meet so that said shield wraps peripherally around the housing (12), wherein each of the tabs has a stepped profile so that the stepped profiles cooperatively fit against each other in a cooperative manner.

13. The electrical connector (10) according to claim 12, wherein one of said tabs (24) includes a post extending therefrom and the other tab (26) has a hole receiving the post with an interference fit.

14. A process of manufacturing an electrical connector (10) comprising the steps of:

providing a metal blank (114) having a first thickness;

coining an edge of the metal blank to form a tip (140) with a stepped profile, the tip having a second thickness less than the first thickness;

cutting a plurality of individual terminals (14) from the blank (114), such that each terminal is shaped with a tip (40) having said stepped profile.

15. The process according to claim 14, further comprising the step of cutting excess material from the coined tip.

16. The process according to claim 14, wherein said coining step includes driving a die (118) against an edge of said blank (114).

17. The process according to claim 13 further comprising the steps of:

placing a plurality of the terminals (14) in a mold cavity;

injecting a resin into the mold cavity to form a housing (12).

18. The process according to claim 15, further comprising the step of positioning a portion (34) of the terminal having said first thickness against a wall of the mold cavity.

19. An electrical connector (10) comprising:

a housing (12) insert-molded over a plurality of conductive terminals (14) and including a terminal support platform (32), each terminal including a contact portion (34) having an exposed contact surface (38) for mating with a respective terminal of a mating connector and a tip portion (40) extending from the contact portion (34) and covered by the housing; and

a unitary conductive shield (16) with two projecting tabs (24, 26) that wrap around the housing,

one of said tabs (24) including a post (25) extending therefrom and the other tab (26) having a hole (27) receiving the post with an interference fit.

20. The electrical connector according to claim 19, wherein each of the tabs (24, 26) has a stepped profile so that the stepped profiles cooperatively fit against each other in a cooperative manner.

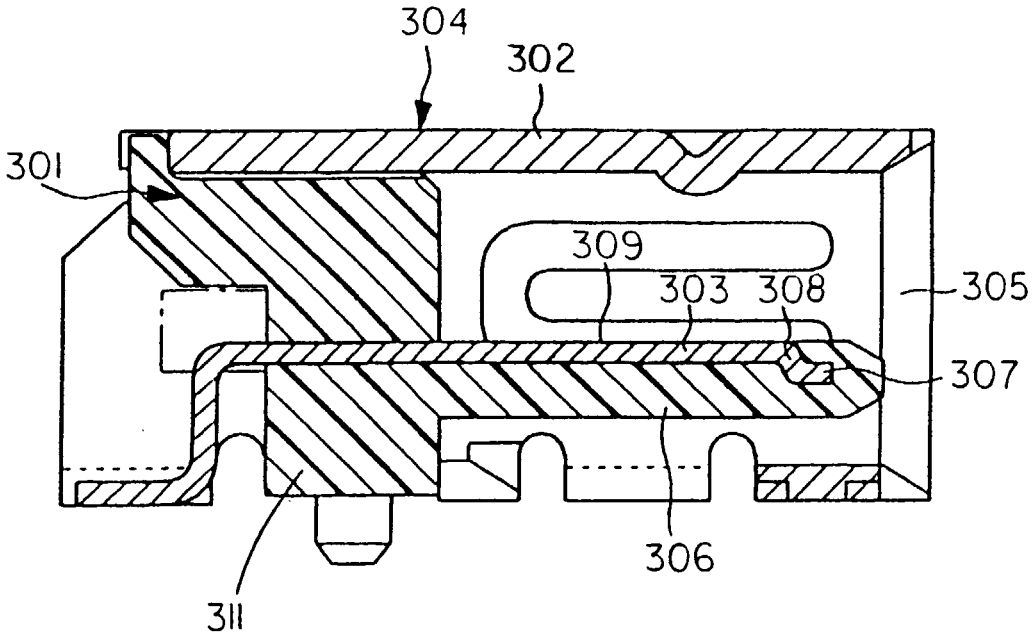

FIG. 1 (PRIOR ART)

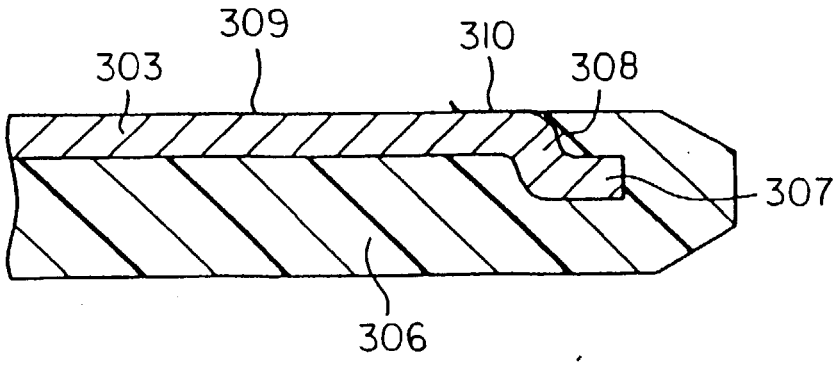

FIG. 2 (PRIOR ART)

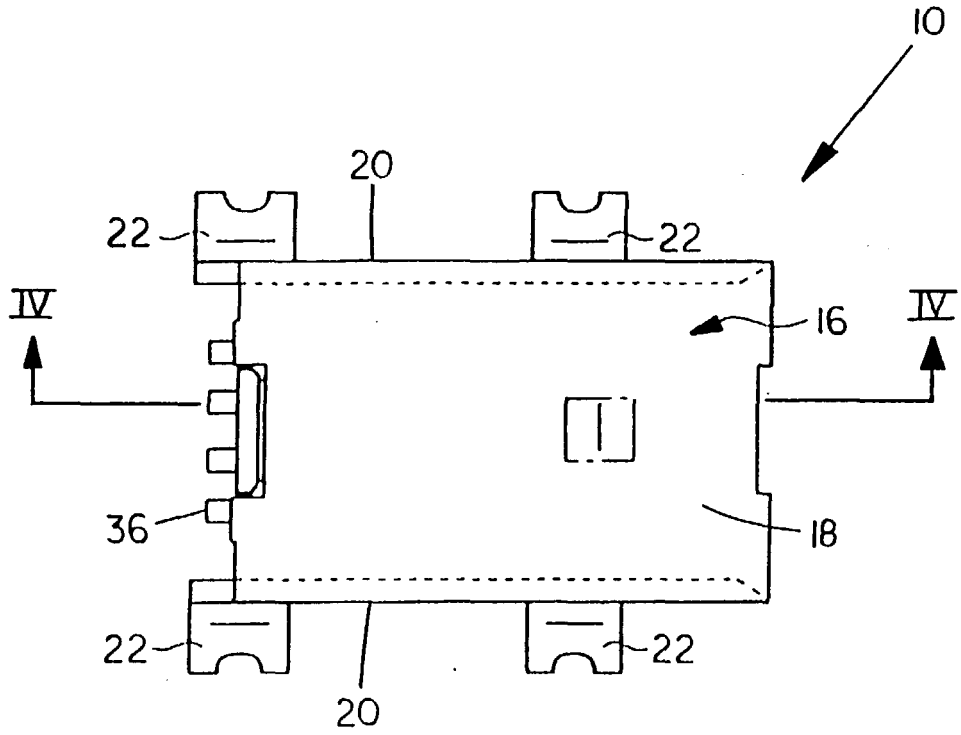
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FIG. 3

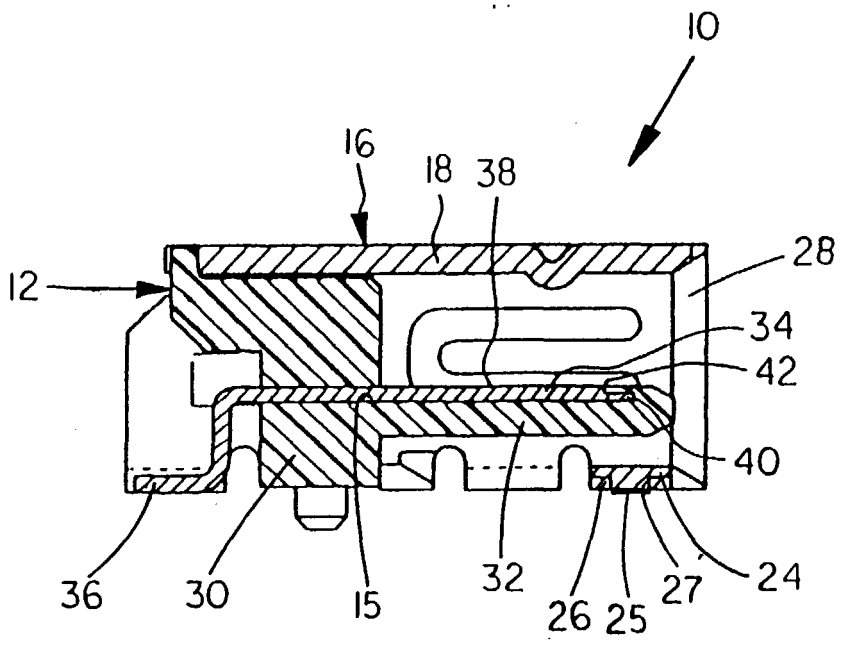
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FIG. 4

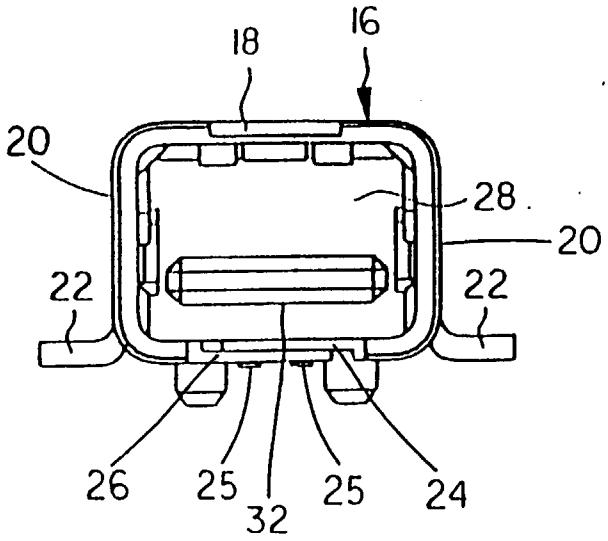

FIG. 5

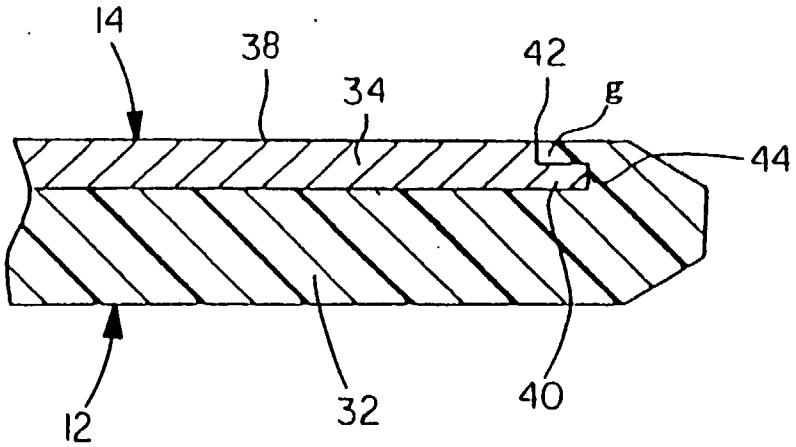

FIG. 6

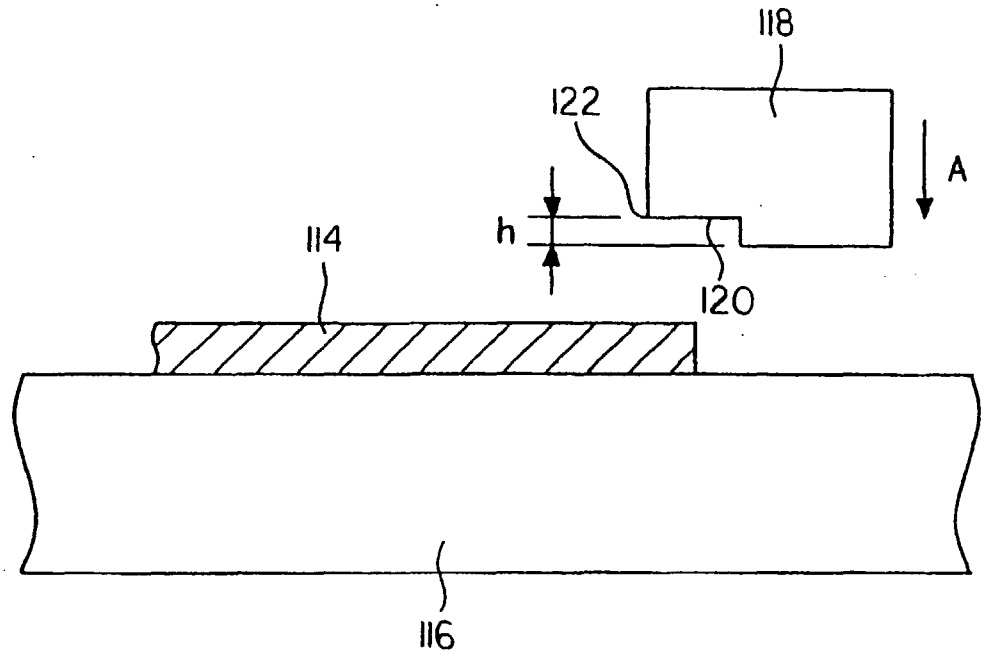

FIG. 7

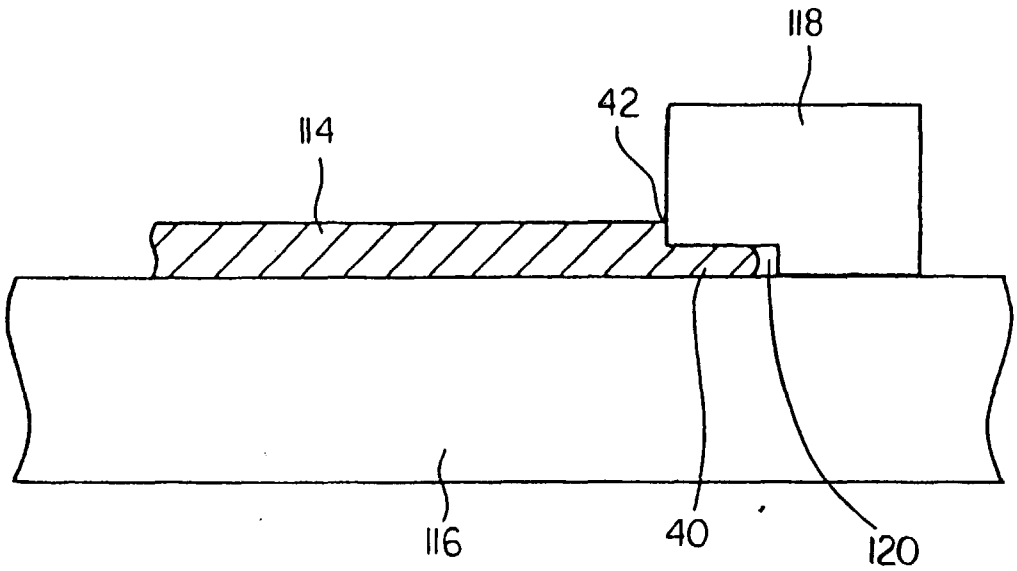

FIG. 8

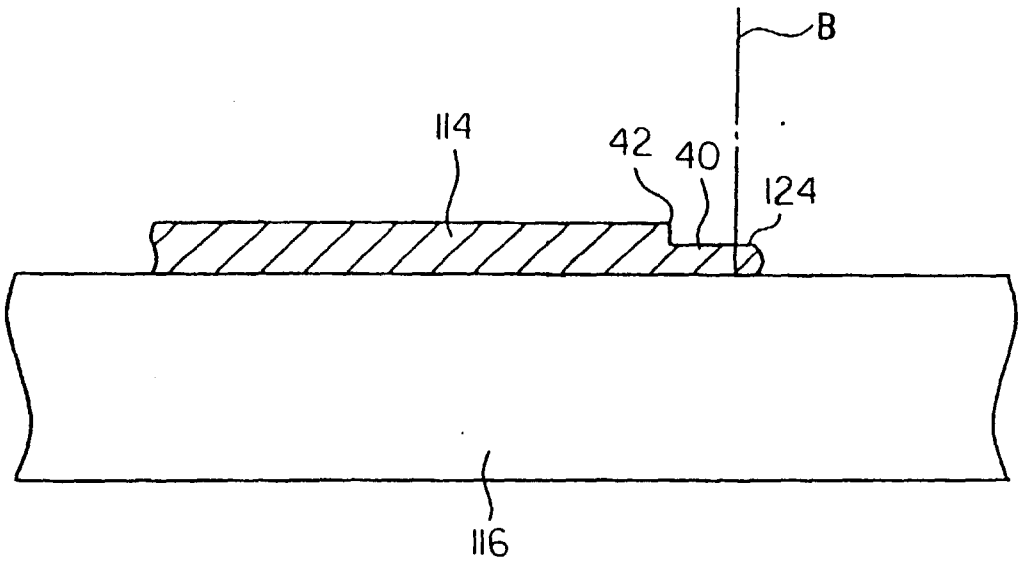

FIG. 9

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 00 11 3238

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	US 5 201 883 A (ATOH KIYOSHI ET AL) 13 April 1993 (1993-04-13)	1,2,7-11	H01R43/24 H01R43/16
Y		3-6,12, 13,19,20	
A	* column 3, line 6 - column 5, line 8 * * figure 4 *	14-18	

Y	DE 44 19 293 A (FUJITSU LTD) 20 April 1995 (1995-04-20) * column 5, line 28 - column 6, line 22 * * figure 4 *	3-6,12, 13,19,20	

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A	US 3 987 264 A (SEIDLER JACK) 19 October 1976 (1976-10-19) * column 3, line 63 - column 5, line 12 * * figure 11 *	14-16	
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	29 August 2000	Stirn, J-P

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 00 11 3238

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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29-08-2000

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