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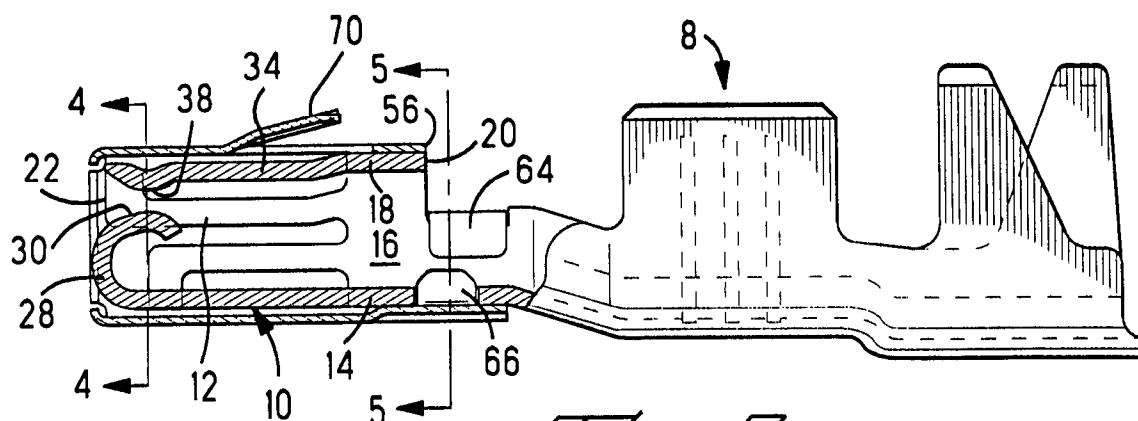
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(54) Asymmetric electrical receptacle terminal

(57) A receptacle terminal (2) comprises an inner contact body (4) and an outer spring body (6) positioned over a contact section (10) of the inner spring body. The inner contact body comprises contact arms (24) extending from a base wall and opposed contact arms (34) extending along a top wall, the contact arms (24,34) being supported by side wall support beams (40,42). The upper contact arm (34) acts as a reference contact for positioning of the terminal with respect to comple-

mentary mating tabs. The lower contact has a reversely folded contact section (28) separated from the upper contact by a gap (G) at the tab receiving end to provide a tab insertion guide and an arcuate contact surface (30). The bend of the contact section (28) can be varied easily to adjust the gap G between opposing contacts for mating with tabs of different thicknesses, without varying any other dimensions of the terminal.

**Fig. 2****EP 0 727 843 A2**

Description

This invention relates to an electrical receptacle terminal for mating with tab terminals, the terminal having opposed contact surfaces supported on resilient members, one of the surfaces providing a reference for positioning the tab with respect to a housing within which the terminal is mounted, such that various sized tabs can be mated with the receptacle terminal and specifically positioned with respect to the referenced contact, the receptacle terminal in particular for high current applications.

It is known to provide asymmetric terminals having opposed contact surfaces, where one of the contact surfaces is on a substantially rigid base, and the opposed contact being on a resilient member that is biased away from the base when a mating tab terminal is inserted between the contacts. In such a situation, one surface of the tab terminal is always positioned in a specified manner with respect to the terminal, independent of the thickness of the tab. Use of such a feature is desired in certain applications because tabs of different thicknesses are aligned in rows set at a specified pitch with respect to each other. Normally, receptacle terminals for mating with tabs of various thicknesses also have varying sizes. When a receptacle terminal has a symmetrical design, for example with opposed cantilever beam contact arms extending from a box-shaped body, outer edges of the box-shaped bodies of adjacent terminals with different sizes will not be in the same plane. This may be a problem when requiring secondary locking members that are inserted behind the terminal bodies for retention of the terminals within cavities of the housing, because a single secondary locking feature cannot be made in the simple manner to be inserted behind all of the receptacle terminals of a same row due to their outer edges positioned at different levels. It would therefore be desirable to have receptacle contacts having surfaces, for example for secondary locking, at specified positions within the connector housing whilst nevertheless for contacting tabs of different thicknesses.

In many applications, there is a need for terminals to carry high electrical current whilst nevertheless having low mating forces when mated to a complementary male terminal. Furthermore, the terminal must be robust and able to withstand high mechanical and thermal solicitation over its lifetime, for example the harsh conditions experienced in automotive applications.

There is a need to combine the above characteristics in a terminal that is nevertheless compact and cost-effective.

It is therefore an object of this invention to provide a receptacle terminal able to carry high electrical currents, yet require a relatively low mating force with a complementary male terminal, in a compact and cost-effective design having a reference surface for specified positioning within a connector housing.

It is another object of this invention to provide a high current receptacle terminal with relatively low mating

force when coupling to a complementary male terminal, which furthermore is robust and can withstand harsh mechanical and thermal solicitation such as found in automotive applications.

The objects of this invention have been achieved by providing a receptacle terminal comprising an inner contact body having a connection section and a contact section extending between a connection end and a mating tab receiving end, the contact section comprising a base wall, side walls and a top wall, with opposed lower and upper contact arms extending along the base and top walls respectively, characterized in that the side walls comprise spring support beams attached to the contact arms for enhanced spring strength thereof, the lower contact arm having a reversely bent lower contact section extending from the tab receiving end over the base wall. The lower contact section forms a contact surface opposed to a contact surface of the upper contact arm, and separated therefrom by a gap. The upper contact surface is proximate the top wall's roughly planar surface and acts as a reference contact. The spring support beams increase the spring force of both the upper and lower contacts, yet allow sufficient flexibility to compensate for tolerances in the mating tab thickness. Furthermore, due to the high spring force and flexibility of both upper and lower contacts, a gap can be provided between contacts, that reduces mating forces. The gap can also be easily designed to various sizes by adjusting the curvature of the lower contact section without varying the external dimensions of the terminal, nor changing the position of the reference contact provided by the upper contact section.

The preferred embodiment of this invention will now be described with reference to the figures, whereby;

Figure 1 is a top view of a terminal according to this invention;

Figure 2 is a cross-sectional view through lines 2-2 of Figure 1;

Figure 3 is a view in the direction of arrow 3 of Figure 1;

Figure 4 is a cross-sectional view through lines 4-4 of Figure 1;

Figure 5 is a cross-sectional view through lines 5-5 of Figure 1;

Figure 6 is a bottom view of an inner body of the terminal of Figure 1;

Figure 7 is a view in the direction of arrow 7 of Figure 6;

Figure 8 is a view in the direction of arrow 8 of Figure 7;

Figure 9 is a side view of an outer spring body of the terminal of Figure 1;

Figure 10 is a view in the direction of arrow 10 of Figure 9;

Figure 11 is a cross-sectional side view of an alternative embodiment of a terminal according to this invention where the view generally corresponds to that taken in Figure 2; and

Figure 12 is a front view of the terminal shown in Figure 11.

Referring first to Figures 1 and 2, an electrical terminal 2 comprises an inner contact body 4 and an outer spring body 6. The terminal 2 has a conductor connection section 8 for crimping to a conducting wire, and a contact section 10 extending therefrom defining a tab receiving cavity 12 for receiving a complementary tab terminal therein for electrical contact therewith.

The contact section 10 of the inner body 4 comprises a base wall 14, side walls 16 extending from lateral edges thereof, and a top wall 18 forming a box-shaped structure surrounding the cavity 12, extending between a connection end 20 attached to the connection section 8, and a tab receiving end 22.

Referring now to Figures 6, 7 and 8, the bottom wall 14 comprises cantilever beam contact arms that extend from proximate the connection section 20 axially towards the tab receiving end 22 where they curl reversely backwards over the base wall 14 to free ends 26 that are spaced above the base wall 14. This curled-over portion forms a contact section 28 of the contact arms 24, having an arcuate upper contact surface 30 resiliently biasable against a complementary tab terminal. The reversely-folded contact section 28 also provides a smooth tab guide for insertion of the tab into the contact cavity 12. There are a pair of contact arms 24 extending along the base wall 14 which are separated from each other, from the tab receiving end 22 to a position proximate the connection end 20, via a slot 32 to allow greater individual movement of the contacts 30 and added flexibility thereof.

The top wall 18 also comprises cantilever beam contact arms 34 that extend from proximate the connection end 20 to their free ends 36 at the tab receiving end 22. A depression in the contact arms 34 proximate the end 36 and opposite the lower contact surface 30 forms an arcuate upper contact surface 38 for resilient biasing against the complementary tab terminal. The opposed contact surfaces 30,38 are separated by a gap G that is less than the thickness of the tab to be received therebetween. There are also a pair of contact arms 34 extending along the top wall 18, the pair of contact arms separated by a slot 40 extending from proximate the connection end 20 to their free ends 36. The slot 40 is aligned with a seam 42 resulting from the folding together of the body from sheet metal strip. The seam 42 can be joined rigidly together if desired by welding or other fixing means (not shown). The upper contact arms 34 thus have enhanced individual movement and greater flexibility due to the slot 40.

The side walls 16 comprise lower support beams 40 and upper support beams 42 that extend from proximate the connection end 20 to proximate the tab receiving end 22, the upper and lower beams separated from each other by a slot 44 to enable independent resilient movement of the beams 42,40 away from each other. Each lower beam 40 of the corresponding side wall 16

is attached proximate the tab receiving end 22 via a right angled corner portion 46 to the contact arms 24, to increase the spring strength of the contact arm 24. The beams 40 are however separated from the base wall by a slot 48 that extends from the right-angled bridging portion 46 to proximate the connection end 20, the slot 48 allowing greater suppleness in deflection of the contact arm 24 when resiliently biased. The right-angled bridging portion 46 of the side wall spring beams 40 is attached to the contact arm 24 prior to extension of the contact section 28, to allow the contact section 28 to bias resiliently in addition to resilient biasing of the contact arm 24. The latter thus enhances the flexible elastic movement of the contact point 30.

The upper contact arms 34 are similarly attached to the side wall spring beams 42 via right-angled bridging portions 50 at the free ends 36 of the contact arms 34. The side wall spring beam 42 is separated from the contact arm 34 by a slot 52 extending from proximate the free end 36 to proximate the connection end 20 to allow the contact arms 34 to have certain suppleness. The upper contact arms 34 can be made to a different degree of suppleness than the lower contact arms if desired, by varying the relative length and rigidity (width) of the spring support beam 40,42 respectively.

Generally speaking, in order to carry higher electrical currents, a high contact force between mated terminals is necessary, as well as an increased number of contact points. The rise in temperature of an electrical terminal due to resistance usually limits its electrical current carrying capabilities, where much of the heat is often generated by the contact resistance. A number of problems however arise when increasing the contact resistance, one of these problems being that mating forces between the complementary terminals increases, and flexibility of the terminal contact arms decreases. The latter often means that variation in tolerances of the material thickness of a mating tab terminal will effect the contact force significantly, thereby creating inconsistent contact forces. In order to overcome these problems, greater flexibility of the contact arms is necessary as well as providing a means for reducing the insertion forces.

In this invention, insertion forces are reduced by providing a gap G between opposing contact surfaces 38,30. This eliminates peak insertion force generated by initial opening of contact beams that abut against each other, the reversely-folded contact section also 28 providing a very gentle tab guide to further reduce the insertion force. High contact forces are achieved by providing extra support to the contact arms 24,34 with the side wall beams 40,42 whilst nevertheless allowing a certain flexibility by providing the slots 48,52.

The terminals 2 are for use and positioning within cavities of connector housings for mating with complementary connectors having tab terminals mounted therein. The complementary connector may typically have rows of tab contacts that are aligned along a straight line, each of these rows being separated from

each other at a specific (standardized) pitch. Some connectors may comprise tabs of different widths depending on the amount of electrical current they need to carry, the wider ones being for higher current carrying capability. A row of tabs may for example have six tabs of small widths and one tab of larger width, these tabs being stamped all from the same strip of sheet metal. In other words, on the sheet metal strip one would stamp six smaller tabs and one wider tab in the juxtaposed manner with one set of tooling. An advantageous manner of assembling these tabs to the complementary connector housings, is by "stitching" the tabs into pre-moulded through holes of the complementary connector housing where an interference fit holds the tabs to the housing. This manufacturing method is more advantageous (for cost reasons) than, for example, overmoulding the tab contacts with the housing. Also, a further advantage of this manufacturing method is that the interference fit provides a very strong retention and mounting of the tab contacts to the housing (more so than with overmoulding), in particular under severe mechanical and thermal solicitation. The alignment of different sized tabs in rows at specified pitches, requires accurate positioning of the receptacle terminal contact surfaces 38,30 in the connector for mating with a complementary connector. The need for this accuracy is enhanced when higher contact forces are required due to the reduced flexibility of high current contacts, and therefore the greater sensitivity to variations in tolerance (in position or thickness). Furthermore, conventional receptacle terminals for mating with tab terminals of different widths usually have very different outer dimensions which increases the complexity of the receptacle connector. The reason for the latter is that, not only are different cavity sizes necessary for receiving the various receptacle connectors, but due to their different sizes, their outer edges are not aligned with each other which presents a problem for secondary locking mechanisms. It is common to have secondary locking mechanisms that comprise some sort of a bar or plate member that is movable behind a shoulder which is commonly formed by the outer edge of the box-shaped contact section. In the embodiment of this invention, the connection end 20 of the box-shaped contact section 10 serves as a shoulder for receiving a secondary locking member therebehind. It would thus be advantageous to provide a secondary locking shoulder such as the connection end 20 with an upper edge 56 defining the corner of the secondary locking shoulder, aligned with the corners of other receptacle terminals mounted in a connector housing, where some terminals are for mating tab terminals of different widths.

The latter is achieved in this invention by providing the contact asymmetry, where the upper contact arms 34 are substantially planar and extend from the corner portion 56 that defines the edge of the secondary locking shoulder 20. Although the upper and lower contact arms are relatively stiff compared to conventional cantilever beam spring contact arms, the flexibility provided

by the separation of the support spring beams 40,42 by the slots 48,52 respectively, with the contact arms 24,34, enable sufficient flexibility to adjust to variations in tolerance of the thickness of a mating tab terminal, whilst ensuring high contact force and lower insertion force. Due to the relative stiffness, the contact surface 38 thus acts as a reference contact surface with respect to the corner 56 and is always in substantially the same position with respect thereto independent of the position of the opposing contact surface 30.

If desirable, it is possible to reduce the flexibility of the upper contact arm 34 with respect to the lower contact arm 24 to ensure that the biasing apart of the contact surface 38 is similar for different sized contacts, where variations in thickness of the tab will be absorbed more greatly by the more flexible contact arm, which is the lower contact arm 24. The upper contact arms would nevertheless still be provided with a certain flexibility for more reliable contact, in particular under mechanical and thermal solicitation over the desired lifetime of the terminal.

In order to accommodate tabs of different thicknesses, the gap G can be modified quite easily by reversely folding the contact section 28 more or less tightly over the base wall 14 without varying the outer dimensions of the terminal, nor effecting the position of the reference contact surface 38 thereby requiring no modifications to the connector housing design which receives the receptacle terminals 2. This is a particularly advantageous feature of the invention.

The outer spring body 6 comprises a stainless steel rectangular box-shaped structure stamped and formed from sheet metal and positioned around the contact section 10 of the inner contact body 4. The outer spring body 6 thus also has bottom, side and top walls 60,62,64 respectively positioned adjacent the inner contact bottom, side and top walls. The outer spring body is securely attached to the inner contact body by tabs 66 extending from the side walls 64 for clinching over the inner contact body side walls 16 proximate the connection section 8. Further tabs 66 stamped from the base wall 60 are pushed through cutouts 68 in the inner contact body base wall 14. The outer spring body is thus securely held to the inner contact body proximate the connection section 8, and extends just beyond the inner contact body tab receiving end 22 thereby substantially surrounding the whole inner contact body contact section 10. At the tab receiving end 22 of the outer spring body outer edges 69 of the walls 64,62,60 are inwardly folded to provide a smooth rounded front end for insertion of the terminal within a corresponding housing cavity. The bottom and top walls 60,62 of the outer spring body are separated from the contact arms 24,34 of the inner contact body by a certain gap to allow outward biasing thereof, in particular for mating with a complementary tab terminal.

The outer body top wall 62 comprises a pair of resilient cantilever beam locking lances 70 projecting obliquely upwardly therefrom for locking against a com-

plementary shoulder of a connector housing cavity. The locking lances 70 have increased strength with respect to buckling by being arcuately deformed 72, and further having a sheared tab 74 along their end locking faces 76 to spread the pressure forces against the housing retention shoulder and thereby reduce the risk of damage thereto.

The outer spring body further has a polarizing extension 78 in the plane of the side wall 64 and which serves to correctly orient the terminal with respect to a connector housing cavity complementary thereto. The folding together of the outer body produces a seam 80 that abuts the side wall 64 having the extension 78, the seam being closed with welds 82, but other fixing means could be used. Due to the positioning of the locking lances 72, and to their advantageous reinforced structure, the terminal 2 can withstand high forces tending to extract the terminal from the housing cavity.

The contact section 28 of the inner contact body lower contact arms 24 is not only advantageous due to the enhanced flexibility and effective tab insertion guide whilst nevertheless producing high contact forces, but also requires little material due to the free end 26 being proximate the contact section 30 and spaced from the base wall 14. Furthermore, the reverse fold of the contact section 28 can be very easily modified to adjust to complementary tab terminals with different thicknesses without changing the outer dimensions of the contact, and with only some very minor changes to the dies for stamping the terminal. All of the above is of course effectuated whilst retaining a reference contact 38 that has a certain flexibility for increased reliability of the contact.

With reference now to Figure 11 and Figure 12, an alternative embodiment of the invention will be described using reference numbers that relate generally to those used above. In this embodiment, a receptacle terminal 102 is shown having a contact body 104 and an outer spring body 106 positioned over a contact section 110 of the inner contact body 104. The inner contact body 104 at the receptacle portion 110 includes a base wall 114, side walls 116 and top wall 118 that form a box shaped structure as described above. The base wall 114 extends forwardly through a curled-over portion that acts as contact arms 124, described in detail above. Opposite the curled-over portion 124 is an opposed contact surface 138 that is located opposite a contact surface 130 on the curled over contact arm 124.

A cantilevered auxiliary contact arm 180 extends out of the base 114 such that its free end is disposed near the top wall 118. The auxiliary contact arm 180 is rearward of the curled-over contact arm 124 relative to the direction of insertion of the mating tab terminal (not shown). A contacting surface 182 is formed thereupon. The top wall 118 is segmented by slits 184 such that the opposed contact surface 138 is on a forward portion 186 of the top wall 118 and a rearward portion 118 is defined. The rearward portion 118 is approximately located opposite the free end 190 of the auxiliary con-

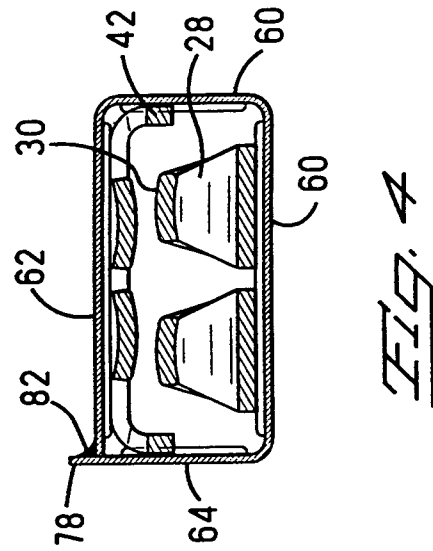
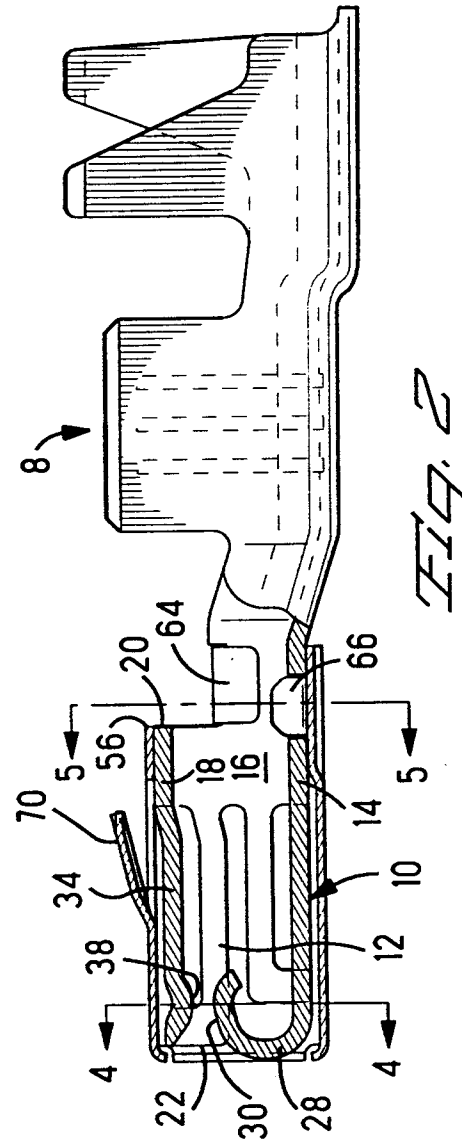
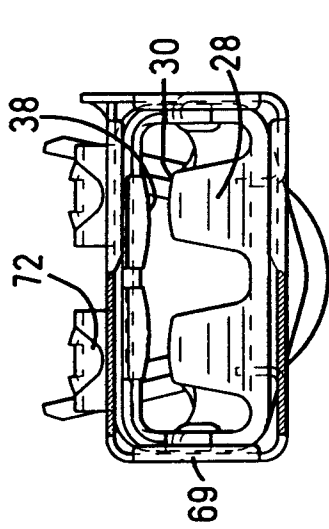
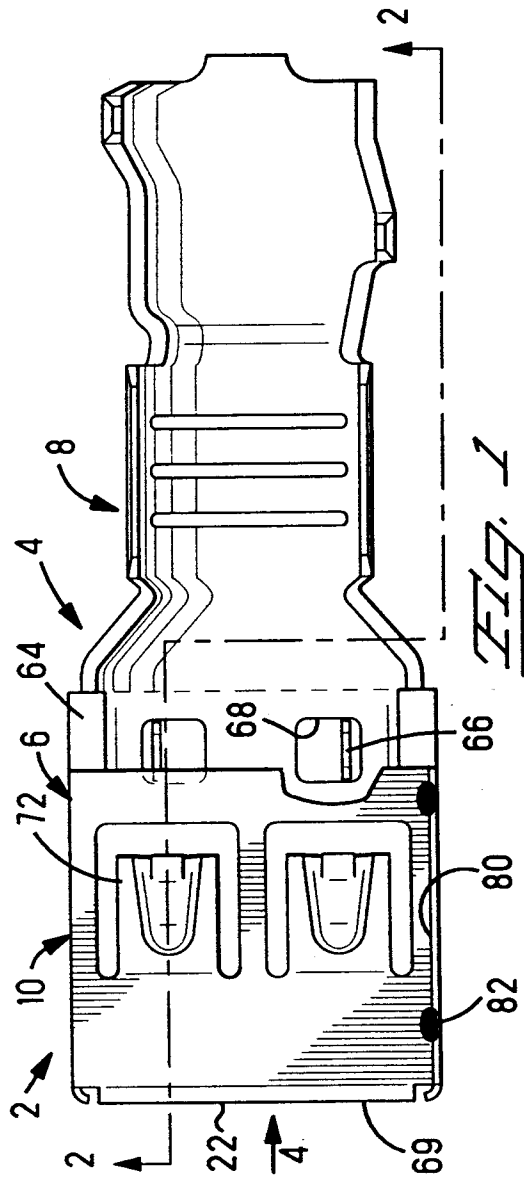
tact arm 180. If desired, dimples 192 can be formed in the rear portion 188 of the upper wall 118 for engaging the mating terminal. For stability, these dimples would be spaced apart from the auxiliary contact arm 182 such that a total of seven contact points could be defined. The seven contact points would include four contact points at the front between the pair of contact arms 124 and their corresponding opposite contact surfaces 138 in the front portion 186 of the top wall 118, and the three contact points consisting of the auxiliary contact arm 180 and the two spaced apart dimples 192. It is advantageous that this embodiment provides for additional stabilization of the tab terminal to be received therein, additional contact points for enhanced electrical transmission characteristics between the mating contacts, and reduced insertion forces due to the staggering of engagement points.

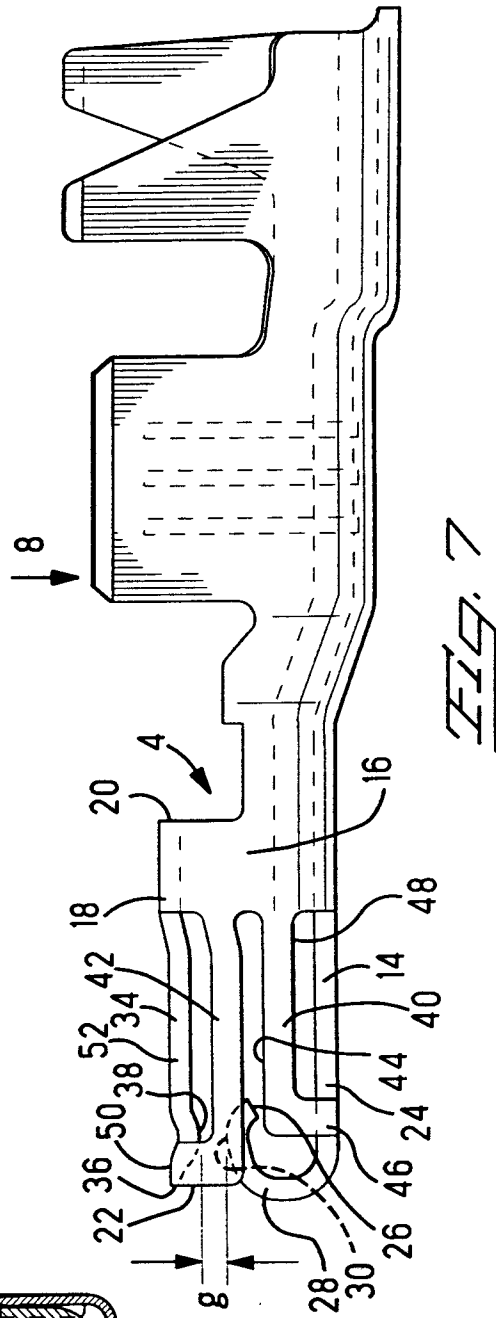
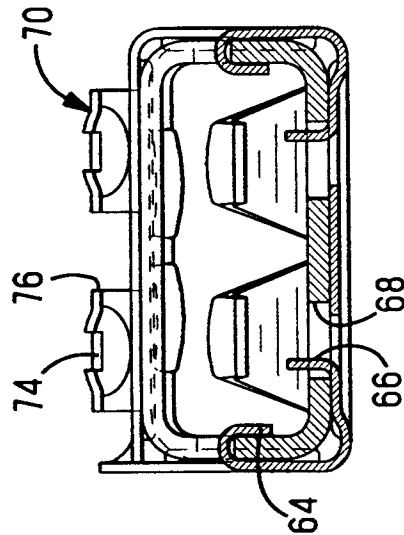
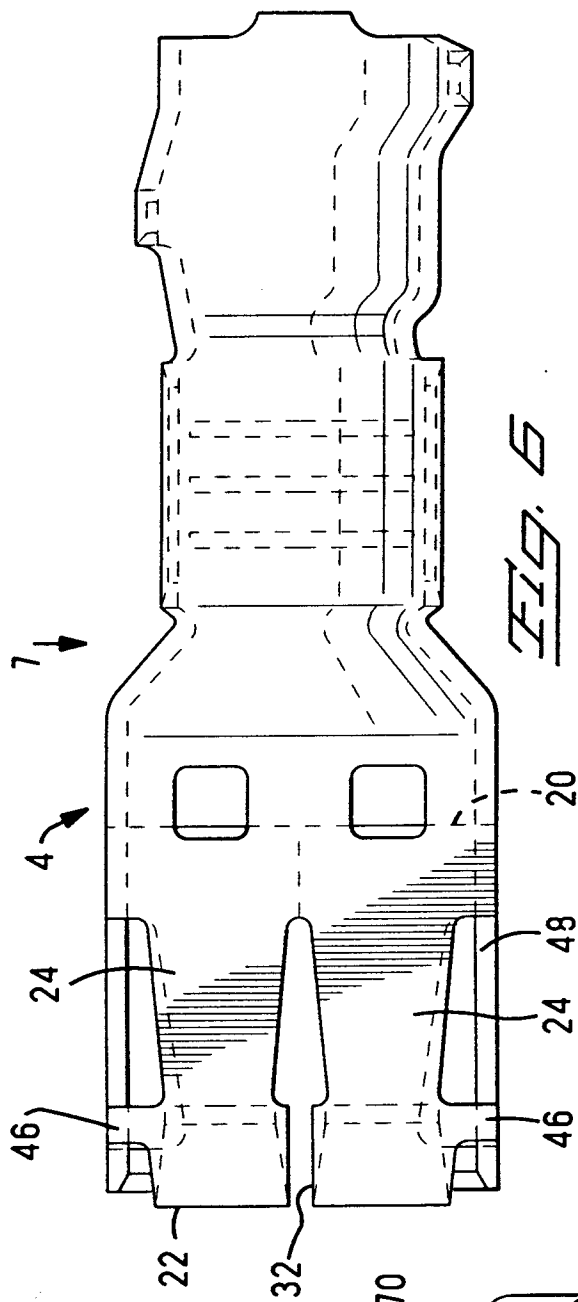
Advantageously therefore, the receptacle terminal according to this invention provides high contact forces yet relatively low insertion forces whilst providing a reference surface for more cost-effective connector designs. Furthermore, the reference contact has a certain flexibility for greater flexibility and therefore improved resistance to thermal and mechanical solicitation. Another advantage is the easy adaptability of the contact section to tabs of varying thicknesses and an efficient use of material. The outer spring body further provides effective protection to the inner contact body, good seating within a connector housing cavity, and very high retention forces.

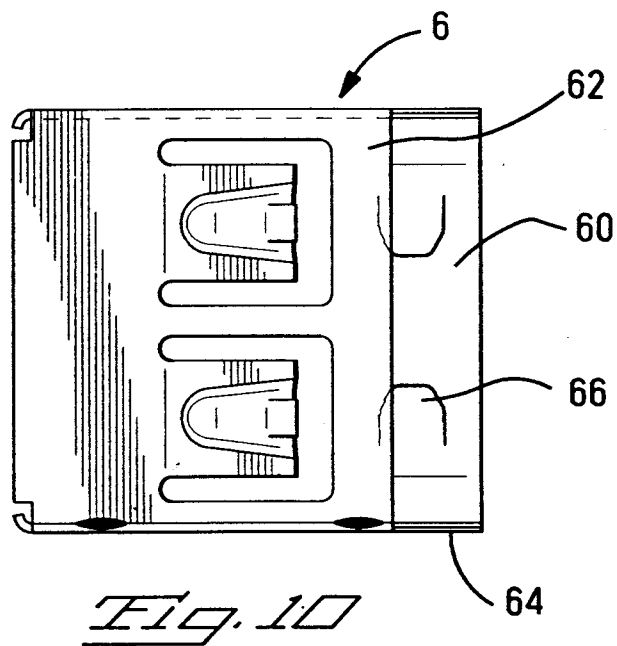
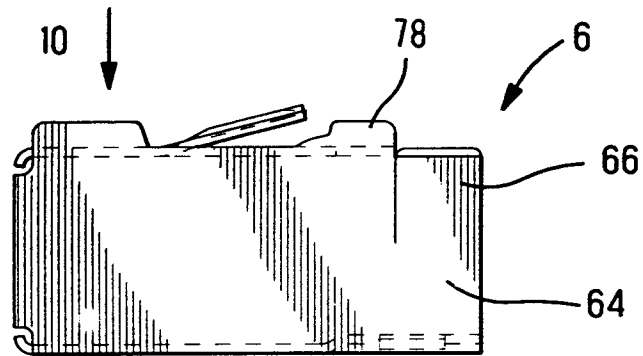
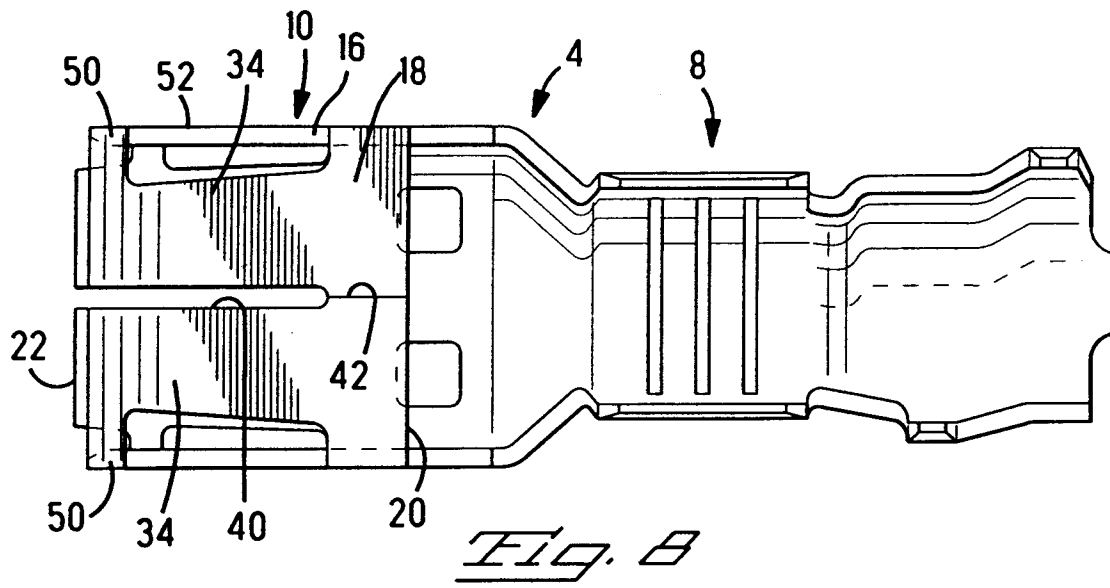
Claims

1. An electrical receptacle terminal (2,102) for mating with a complementary pin or tab contact, the receptacle terminal comprising an inner contact body (4,104) having a connection section (8) and a contact section (10), the contact section extending between a connection end (20) and a tab receiving end (22) and comprising a base wall (14), side walls (16) and a top wall (18,118) forming a box-shape having a cavity (12) for receiving the tab contact therein, and opposed lower and upper contact arms (24,34) extending along the base and top walls respectively, characterized in that the side walls (16) comprise lower and upper support beams (40,42) attached to the lower and upper contact arms (24,34) respectively, attachment locations being proximate the tab receiving end (22), the upper contact arm (34) having a contact surface (38,138) proximate the top wall (18), the lower contact arm (24) having a contact section (28) extending from the tab receiving end (22) of the lower contact arm and reversely bent over the base wall (24) to form lower contact surface (30,130) substantially opposite and separated by a gap (G) from the upper contact surface (38).

2. The receptacle terminal of claim 1 characterized in that the contact section (28) has a free end (26) proximate the lower contact surface (30) and spaced above the base wall (14). 5
3. The receptacle terminal of claims 1 or 2 characterized in that the lower support beam (40) is shorter than the upper support beam (42).
4. The receptacle terminal of claims 1, 2 or 3 characterized in that the support beams (40,42) are attached to their corresponding contact arms (24,34) via right-angled bridging portions (46,50), and separated from the contact arms between the connection end and tab receiving end attachment locations by slots (48,52) respectively. 10 15
5. The terminal of any preceding claim characterized in that the upper contact surface (38) formed by a slight depression in the top wall (18), the contact surface (38) being almost in planar alignment with the top wall (18). 20
6. The terminal of any preceding claim characterized in that the connection end (20) of the contact body comprises a shoulder transverse to the tab insertion direction and extending from the top wall (18) towards the base wall (18), for use as secondary locking shoulder cooperable with a connector housing secondary locking member. 25 30
7. The terminal of claim 6 characterized in that the connection section (8) for electrical connection to a conductor, extends integrally from the base wall (14). 35
8. The terminal of any preceding claim characterized in that there are a pair of upper contact arms (34) and a pair of lower contact arms (24), the pairs of arms being separated by slots (32,40) therebetween, the slots extending from the tab receiving end (22) to proximate the connection end (20). 40
9. The terminal of any preceding claim characterized in that the terminal comprises an outer spring body (6) surrounding the inner contact body contact section (10). 45
10. The terminal of claim 9 characterized in that the outer spring body (6) is securely fixed to the inner contact body proximate the connection end (20), and extends therefrom over the contact arms (24,34), the outer body being slightly spaced from the contact arms to allow outward biasing thereof. 50 55
11. The terminal of claim 10 characterized in that the outer spring body (6) has inwardly rounded edges at the tab receiving end extending over the inner contact body tab receiving end (22) for smooth insertion into a cavity of a connector housing.
12. The terminal of claim 11 characterized in that the outer spring body (6) comprises an obliquely outwardly biased, resilient locking lance in the shape of a cantilever beam having a bulge formed therealong for rigidifying the lance with respect to buckling, and the free end comprising a sheared offset portion (74) to distribute the pressure against a complementary housing retention shoulder.
13. The terminal of any one of the preceding claims characterized in that the inner contact body (104) further includes an auxiliary contact arm (180) rearward of the contact arm (124) that extends out of the base wall (114) towards the top wall (118) for electrical engagement with the mating contact.
14. The terminal of claim 13 characterized in that a pair of dimples (192) are formed in the top wall (118) on either side of the auxiliary contact arm (180).
15. The terminal of claim 14 characterized in that the dimples (192) are spaced from the upper arm contact surface (138) by at least on slit (184).
16. The terminal of claim 15 wherein slits (184) are formed in the top wall (118) and extend transversely to the direction of mating of the terminal to a complementary tab.







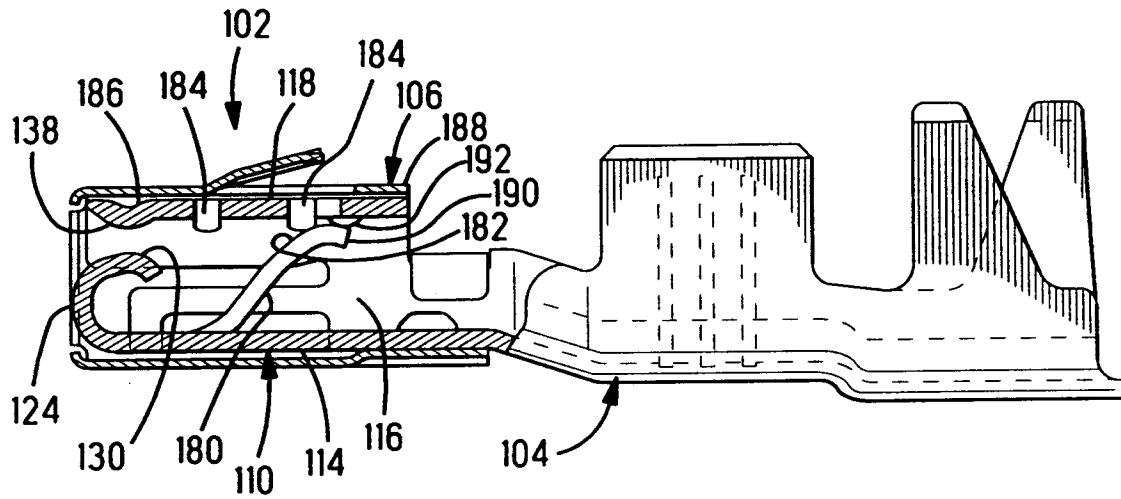


Fig. 11

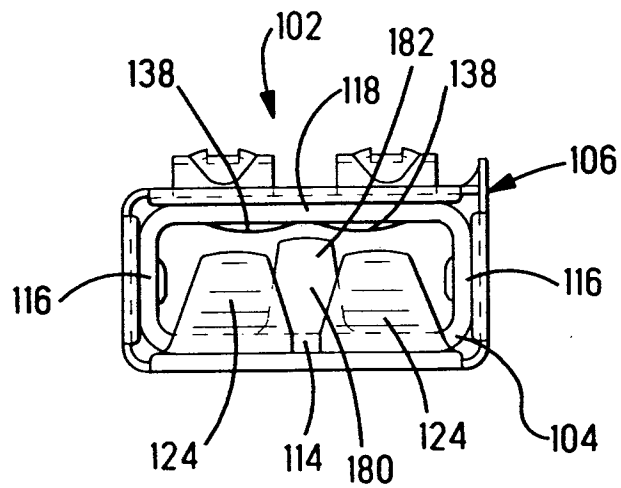


Fig. 12