Abstract: Preferred embodiments of power contacts have alignment features that can maintain conductors of the power contacts in a state of alignment during and after insertion of the power contacts into a housing.
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ELECTRICAL CONNECTORS HAVING POWER CONTACTS WITH ALIGNMENT FEATURES

FIELD OF THE INVENTION

[0001] The present invention is related to electrical contacts and connectors used to transmit power to and from electrical components such as printed circuit structures.

BACKGROUND OF THE INVENTION

[0002] Power contacts used in electrical connectors can include two or more conductors. The conductors can be mounted in a side by side relationship within an electrically-insulative housing of the connector, and can be held in the housing by a press fit or other suitable means. The conductors typically include contact beams for mating with a power contact of another connector, and terminals such as solder pins for mounting the connector on a substrate.

[0003] The conductors of the power contact should be maintained in a state of alignment during and after insertion into their housing, to help ensure that the connector functions properly. For example, misalignment of the conductors can prevent the contact beams of the conductors from establishing proper electrical and mechanical contact with the power contact of the mating connector. Misalignment of the conductors can also prevent the terminals of one or both of the conductors from aligning with the through holes, solder pads, or other mounting features on the substrate. Misalignment of the conductors can occur, for example, while forcing the
conductors into their housing to establish a press fit between the conductors and the housing.

[0004] Consequently, an ongoing need exists for a power contact having features that maintain two or more conductors of the power contact in a state of alignment during and after installation of the conductors in their housing.

SUMMARY OF THE INVENTION

[0005] Preferred embodiments of power contacts have alignment features that can maintain conductors of the power contacts in a state of alignment during and after insertion of the power contacts into a housing.

[0006] The present invention includes a housing and a power contact mounted on the housing. The power contact comprises a first conductor and a second conductor that mates with the first conductor. The first conductor restrains the second conductor in a first and a second substantially perpendicular direction when the first and second conductors are mated.

[0007] One embodiment of the present invention includes an electrical connector that includes a housing and a power contact mounted on the housing. The power contact includes a first conductor plate and a second conductor plate that mates with the first conductor plate, wherein the first conductor plate has an integral projection that extends from a first planar portion of the first conductor plate and the second conductor plate has a through hole that extends through a second planar portion of the second conductor plate. The integral projection and through hole are formed by one or more punches that each have the same outer diameter.

[0008] The first conductor plate may be mated with the second conductor plate by inserting the integral projection into the through hole. The integral projection
may have a substantially uniform cross section along a length of the integral projection, and an end of the integral projection may be flat. The integral projection has an outer diameter approximately equal to an inner diameter of the through hole, although the outer diameter of the integral projection may be slightly larger due to material thickness of the first conductor plate. If a cylindrical punch is used, the integral projection may have a substantially circular or tubular cross section.

[0009] Preferred methods for manufacturing a power contact comprise forming a projection on a first conductor of the power contact by displacing material of the first conductor using a punch, without penetrating the material. The method also comprises forming a through hole a second conductor of the power contact by penetrating material of the second conductor using the punch. The present invention may also include providing a first punch with a fixed outer diameter, pushing the first punch into a planar portion of a first conductive plate to form a projection, and forming a through hole in the second conductive plate by pushing a second punch with the fixed outer diameter through the second conductive plate. An additional step of passing the projection into the through hole holds the first conductive plate and the second conductive plate together via an interference fit.

[0010] The housing may have a guide projection formed proximate a center thereof. The guide projection becomes disposed in a guide reception cavity formed in a housing of a second connector during connector mating. The first and second conductor plates may each comprise a current guiding slot or channel. A portion of the power contact may be located in an aperture formed in the housing. A top portion of the housing has an opening formed therein, and the opening places the aperture in fluid communication an ambient environment around the connector. The housing may also
have a silo formed therein, wherein the silo receives the power contact. The silo and an inner surface of the housing define a passage that facilitates heat transfer from the power contact. An upper portion of the silo may be spaced from an upper wall of the housing to form the passage and the silo may also have an aperture formed therein that facilitates heat transfer from the power contact.

[0011] The first conductor plate may comprise a first and a second contact beam adjoining the first conductor plate and the second conductor plate may comprises a third and a fourth contact beam adjoining the second conductor plate. The first contact beam opposes the third contact beam when the first and second conductor plates are mated and the second contact beam opposes the fourth contact beam when the first and second conductor plates are mated so that second and fourth contact beams form a contact blade. The first and third contact beams are pushed apart by a contact blade of a power contact of a mating connector when the connector is mated with the mating connector and the second and fourth contact beams are pressed between a pair of contact beams of the power contact of the mating connector when the connector is mated with the mating connector. The pressing of the contact beams of the power contact of the mating connector clamp the second and fourth contact beams together so that the first and second conductors are prevented from separating. In addition, as the first and third contact beams are spread apart, rear edges of the first connector plate and the second connector plate are pressed together as the connectors are mated together. This reduces stress on the housing, which can be problematic as the temperature of the housing increases.

BRIEF DESCRIPTION OF THE DRAWINGS
The foregoing summary, as well as the following detailed description of a preferred embodiment, are better understood when read in conjunction with the appended diagrammatic drawings. For the purpose of illustrating the invention, the drawings show an embodiment that is presently preferred. The invention is not limited, however, to the specific instrumentalities disclosed in the drawings. In the drawings:

[0013] Figure IA is a front perspective view of a preferred embodiment of an electrical connector;

[0014] Figure IB is a rear perspective view of the electrical connector shown in Figure IA;

[0015] Figure 1C is a magnified front view of the area designated "E" in Figure IA;

[0016] Figure 2A is a front perspective view of a second connector capable of mating with the connector shown in Figures IA and IB;

[0017] Figure 2B is a rear perspective view of the second connector shown in Figure 2A;

[0018] Figure 2C is a magnified front view of the area designated "F" in Figure 2A;

[0019] Figure 3 is a perspective of the connector shown in Figures IA and IB, depicting a power contact having a first and a second conductor being inserted into a housing, and depicting a cross-section of the housing taken through the line "B-B" of Figure IA;

[0020] Figure 4 is a rear perspective view of the first and a second conductors of the power contact shown in Figure 3, depicting the first and second conductors in an unmated condition;
[0021] Figure 5 is a side, cross-sectional view of the housing shown in Figure 3, taken through the line "A-A" of Figure 1A;
[0022] Figure 6 is a rear perspective view of the first conductor shown in Figures 3 and 4;
[0023] Figure 7 is a rear perspective view the second conductor shown in Figures 3 and 4;
[0024] Figure 8 is a rear view of the first and second conductors shown in Figures 3, 4, 6, and 7, in an unmated condition;
[0025] Figure 9 is a rear cross-sectional view of the first and second conductors shown in Figures 3, 4, and 6-8, in a mated condition and depicting projections of the first conductor positioned within corresponding through holes of the second conductor, taken through the line "C-C" of Figures 6 and 7;
[0026] Figure 10 is a magnified view of the area designated "D" in Figure 9;
[0027] Figures 11A and 11B are perspective views depicting a punch forming a projection in the first conductor shown in Figures 3, 4, 6, and 8-10;
[0028] Figures 12A and 12B are perspective views depicting a punch forming a projection in the second conductor shown in Figures 3, 4, and 7-9;
[0029] Figure 13 is a front perspective view of an alternative embodiment of the connector shown in Figure 1;
[0030] Figure 14A is a front perspective view of a connector capable of mating with the connector shown in Figure 13;
[0031] Figure 14B is a rear view of the connector shown in Figure 14A;
[0032] Figure 15 is a perspective view of another alternative embodiment of the connector shown in Figure 1;
Figure 16 is a front view of a receptacle connector that mates with the connector shown in Figure 15;

Figure 17 is a perspective view of the connectors shown in Figures 15 and 16, in a mated condition;

Figure 18 is a perspective view of another receptacle connector that mates with the connector shown in Figure 15;

Figure 19 is a perspective view of the connectors shown in Figures 15 and 18, in a mated condition;

Figure 20 is a magnified, top-front perspective view of a portion of the area designated "E" in Figure 1; and

Figure 21 is a top view of one of the power contacts depicted in Figure 20.

DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

Figures 1A-IC, 3-12B, 21, and 22 depict a preferred embodiment of an electrical connector 10, and various individual components thereof. The figures are each referenced to a common coordinate system 11 depicted therein. Direction terms such as "top," "bottom," "vertical," "horizontal," "above," "below," etc. are used with reference to the component orientations depicted in Figure 1A. These terms are used for illustrative purposes only, and are not intended to limit the scope of the appended claims.

The connector 10 is a plug connector. The present invention is described in relation to a plug connector for exemplary purposes only; the principles of the invention can also be applied to receptacle connectors.
The connector 10 can be mounted on a substrate 12, as shown in Figures IA and IB. The connector 10 comprises a housing 14 formed from an electrically insulative material such as plastic. The connector 10 also includes eight power contacts 15 mounted in the housing 14. Alternative embodiments of the connector 10 can include less, or more than eight of the power contacts 15. The connector 10 can also include an array of signal contacts 19 positioned in apertures formed in the housing 14, proximate the center thereof.

Each power contact 15 comprises a first portion in the form of a first conductor 16, and a second portion in the form of a second conductor 18 as shown, for example, in Figures 3-7. The first and second conductors 16, 18, as discussed below, include features that help to maintain the first and second conductors 16, 18 in a state of alignment during and after insertion into the housing 14.

The housing 14 includes a plurality of apertures 17 that accommodate the power contacts 15, as shown in Figure 5. The first and second conductors 16, 18 are disposed in a side by side relationship within their associated aperture 17, as shown in Figure 3. The first conductors 16 and the second conductors 18 are configured in right hand and left hand configurations, respectively. In other words, the first and second conductors 16, 18 of each power contact 15 are disposed in a substantially symmetrical manner about a vertically-oriented plane passing through the center of the power contact 15. The first and second conductors 16, 18 can be non-symmetric in alternative embodiments.

The first conductor 16 comprises a major portion in the form of a first substantially flat conductor plate 20a, and the second conductor 18 comprises a major portion in the form of a second substantially flat conductor plate 20b as shown, for
example, in Figures 3-7. The first conductor plate 20a and the second conductor plate 20b abut when the first and second conductors 16, 18 are mounted in their associated aperture 17, as depicted in Figure 3.

[0045] Each of the first and second conductors 16, 18 also comprises three contact beams 24. Each contact beam 24 of the first conductor 16 faces an associated contact beam 24 of the second conductor 18 when the first and second conductors 16, 18 are mounted in the housing 14.

[0046] Each pair of associated contact beams 24 can receive a portion of a contact, such as a contact blade 29a, of another connector such a receptacle connector 30 shown in Figures 2A-2C. The receptacle connector 30 can include power contacts 15a that are substantially similar to the power contacts 15, including the below-described alignment features associated with the power contacts 15.

[0047] A portion of each contact beam 24 of the power contact 15 is curved outwardly and inwardly, when viewed from above. This feature causes the opposing contact beams 24 to resiliently deflect and develop a contact force when a contact blade 29a of the receptacle connector 30 is inserted therebetween. The housing 14 is configured so that a clearance 31 exists between each contact beam 24 and the adjacent portion of the housing 14, as shown in Figures 1C and 20. The clearance 31 facilitates the noted deflection of the contact beams 24. The housing of the receptacle connector 30 is likewise configured with clearances to facilitate deflection of contact beams 24a of the power contacts 15a.

[0048] The contact beams 25 each have a substantially straight configuration, as shown in Figure 4. Each contact beam 25 of the first conductor 16 abuts an associated contact beam 25 of the second conductor 18 when the first and second
conductors 16, 18 are mounted in the housing 14. Each pair of associated contact beams 25 forms a contact blade 29. The contact blade 29 can be received between two opposing contact beams 24a of the receptacle connector 30 when the connector 10 and the receptacle connector 30 are mated.

[0049] Alternative embodiments of the first and second contacts 16, 18 can be configured with more or less than three of the contact beams 24 and two of the contact beams 25. Other alternative embodiments can be configured with contact beams shaped differently than the contact beams 24 and the contact beams 25.

[0050] Each of the first and second conductors 16, 18 may also include a substantially S-shaped portion 27, and a plurality of terminals in the form of solder or press-fit tails 26. The S-shaped portion 27 adjoins the lower end of the corresponding first and second conductor plates 20a, 20b as shown, for example, in Figure 8. The solder tails 26 extend from a bottom edge 27a of the corresponding S-shaped portion 27. The S-shaped portions 27 cause the first and second conductors 16, 18 to flare outward, as shown in Figure 3. The S-shaped portions thus provide an offset between the solder tails 26 of the first conductor 16 and the solder tails 26 of the second conductor 18.

[0051] Each solder tail 26 can be received in a corresponding plated through hole or other mounting provision on the substrate 12. The solder tails 26 thus facilitate the transfer of power between the connector 10 and the substrate 12. Alternative embodiments of the first and second conductors 16, 18 can include press fit tails or other types of terminals in lieu of the solder tails 26.

[0052] Each of the first and second conductor plates 20a, 20b can include a current-guiding feature than can promote even distribution of the current flow among
the contact beams 24, 25, and among the solder or press-fit tails 26. The current-guiding feature can be, for example, a slot or groove 40 formed in each of the first and second conductor plates 20a, 20b and shown in Figures 3-7. Alternative embodiments of the first and second conductors 16, 18 can be formed without current guiding features. Current guiding helps distribute current so that the solder or press-fit tails 26 receive equal amounts of current and more evenly radiated equal amounts of heat.

[0053] The rearward end of each aperture 17 is open, as shown in Figures 1B and 3. The power contacts 15 are inserted into their associated apertures 17 from behind. The portions of the housing 14 that define the sides of each aperture 17 have grooves 42 formed therein, as is best shown in Figure 5. The grooves 42 receive the contact beams 24 as the first and second conductors 16, 18 are inserted in and moved forward through their associated apertures 17.

[0054] The grooves 42 are bordered by surface portions 43 of the housing 14, as is best shown in Figure 5. Each surface portion 43 faces another surface portion 43 on the opposite side the associated aperture 17. The surface portions 43 are spaced apart so that the first and second conductor plates 20a, 20b of the associated first and second conductors 16, 18 fit between the surface portions 43 with no substantial clearance therebetween. The resulting frictional forces between the surface portions 43 and the first and second conductor plates 20a, 20b help to retain the first and second conductors 16, 18 in the housing 14.

[0055] A forward end of each aperture 17 is defined by a forward portion 50 of the housing 14, as shown in Figure 5. The forward portion 50 has slots 52 formed therein. The slots 52 permit the contact beams 24, 25 of the associated power contact 15 to extend through the forward portion 50. The first and second conductor plates
20a, 20b of the first and second conductors 16, 18 contact the forward portion 50 when the first and second conductors 16, 18 have been fully inserted into their associated aperture 17. The forward portion 50 thus acts as a forward stop for the power contacts 15. The forward portion 50 also helps to support the power contacts 15 by way of the contact beams 24, 25 extending therethrough.

[0056] The first and second conductors 16, 18 can each include a resilient prong or tang 58, as shown in Figures 3-7. Each tang 58 adjoins one of the first and second conductor plates 20a, 20b of the associated first or second conductors 16, 18, proximate an upper rearward corner thereof. The tangs 58 are angled outwardly, i.e., in the "x" direction, from their respective points of contact with the first and second conductor plates 20a, 20b.

[0057] The housing 14 includes a plurality of lips 59, as shown in Figures IB, 3, and 5. Two of the lips 59 are associated with each aperture 17. The lips 59 are located proximate an upper, rearward end of the associated aperture 17. The tangs 58 of each power contact 15 pass between two of the lips 59 during insertion of the power contact 15 into its associated aperture 17. The tangs 58 are urged inward by contact with the lips 59. The resilience of the tangs 58 causes the tangs 58 to spring outward the once the tangs 58 have cleared the lip 59. Interference between the tangs 58 and the lips 59 prevents the associated power contact 15 from backing out of its aperture 17.

[0058] The housing 14 has a top portion 46. The top portion 46 can have a plurality of slots 48 formed therein, as shown in Figures IA, IB, 3, and 5. Each slot 48 is aligned with, and adjoins an associated aperture 17. The slots 48 can facilitate convective heat transfer from the power contacts 15 positioned in the associated
apertures 17. Alternative embodiments of the housing 14 can be formed without the
slots 48.

[0059] The housing 14 has an openings 76 formed in a bottom thereof, as
shown in Figures IB, 3 and 5. The openings 76 accommodate the S-shaped portions 27
and the solder tails 26 of the first and second conductors 16, 18. The portions of the
housing 14 that define the openings 76 are preferably contoured to substantially match
the shape of the S-shaped portions 27.

[0060] The housing 14 can be equipped with a socket or cavity 80, as shown in
Figure IA. The projection 80 becomes disposed in a socket or cavity 82 formed in a
housing of the second connector 30 as the connector 10 is mated with the second
connector 30. The projection 82 helps to guide the connector 10 during mating. The
projection 82 and the cavity 80 are configured to allow the connector 10 and the second
connector 30 to be misaligned by as much as approximately 3.5 mm in the "x"
direction, and as much as 2.5 mm in the "y" direction at the start of the mating process.
The configuration of the projection 80 and the cavity 82 also permits the connector 10
and the second connector 30 to be angled in relation to each other in the "x-z" plane by
as much as approximately 6° at the start of the mating process.

[0061] Alternative embodiments of the connector 10 and the second connector
30 can be formed without the projection 82 or the cavity 80. For example, Figures 13-
14B depict a receptacle connector 150 and a plug connector 152. The housing of the
receptacle connector 150 has two pins 154 formed proximate opposite ends thereof.
The pins 154 become disposed in sockets 156 formed in the housing of the plug
connector 152 as the receptacle connector 150 and the plug connector 152 are mated.
The pins 154 and the housing surfaces that define the sockets 156 are contoured so as to guide the receptacle connector 150 and the plug connector 152 into alignment during mating. The receptacle connector 150 and the plug connector 152 otherwise are substantially identical to the connector 10 and the second connector 20, respectively.

[0062] The power contacts 15 include features that help to maintain the first and second conductors 16, 18 in a state of alignment during, and after insertion of the first and second conductors 16, 18 into the housing 14. In particular, the first conductor 16 includes two buttons, or projections 100 extending from a major surface 102 of the first conductor plate 20a, as shown in Figures 3, 4, 6, and 8-10. The second conductor plate 20b of the second conductor 18 has two penetrations, or through holes 106 formed therein, as depicted in Figures 3, 4, and 7-10. The projections 100 and the through holes 106 are positioned so that each through hole 106 receives an associated one of the projections 100 when the first and second conductors 16, 18 are aligned as shown in Figures 3 and 8.

[0063] Each projection 100 is preferably hollow, and preferably has a substantially cylindrical shape as depicted, for example, in Figure 10. Preferably, the cross-section of each projection 100 is substantially uniform over the length thereof. The projections 100 preferably extend in a direction substantially perpendicular to the major surface 102 of the first conductor plate 20a, so that an outer peripheral surface 104 of the projection 100 is substantially perpendicular to the major surface 102 of the first conductor plate 20a.

[0064] The projections 100 are preferably formed so as to minimize the radius at the interface between the outer surface 104 and the major surface 102; this radius is denoted by the reference symbol "r" in Figure 10. Minimizing the radius "r" allows the
major surface 102 to lie substantially flat against the adjacent surface of the second conductor plate 20b of the second conductor 18, when the first and second conductors 16, 18 are mated.

[0065] Each through hole 106 is defined by a surface 108 of the second conductor plate 20b, as shown in Figures 7 and 10. The projections 100 and the through holes 106 are preferably sized so that each projection 100 fits within its associated through hole 106 with substantially no clearance between the surface 108, and the outer surface 104 of the projection 100. A clearance is depicted between the surface 108 and the outer surface 104 in Figure 10, for clarity of illustration. Alternative embodiments can be configured so that a minimal clearance exists between the surface 108 and the outer surface 104. An interference fit eliminates the need for a rivet or other attachment devices.

[0066] Preferably, the end of each projection 100 distal the major surface 102 is substantially flat. The length of each projection 100 is preferably selected so that the projection 100 extends into, but not beyond the corresponding through hole 106, as shown in Figure 10. The extent to which the projection 100 extends into the through hole 106 can be greater or less than that shown in Figure 10 in alternative embodiments.

[0067] The engagement of the outer surface 104 of each projection 100 and the associated surface 108 of the second conductor plate 20b causes the first conductor 16 to exert a restraining force on the second conductor 18. The restraining force acts in both the "y" and "z" directions. The restraining force helps to maintain the first and second conductors 16, 18 in a state of alignment during and after insertion into the housing 14.
Maintaining the first and second conductors 16, 18 in a state of alignment can help ensure that the first and second conductors 16, 18 initially assume, and remain in their proper respective positions within the associated aperture 17 of the housing 14. Hence, the projections 100 and the through holes 106 can help minimize the potential for misalignment between the contact beams 24, 25 of the first and second conductors 16, 18, thereby promoting proper mating with the second connector 30. The potential for misalignment between the solder tails 26 and the associated through holes in the substrate 12 can also be minimized through the use of the projections 100 and the through holes 106.

The ability of the projections 100 to maintain a first and a second conductor, such as the first and second conductors, 16, 18, in a state of alignment can be particularly beneficial in applications, such as the connector 10, where an interference fit is created as the conductors are inserted into their associated housing.

Each projection 100 can be formed using a punch 110, as shown in Figures 11A and 11B. The punch 110 can be actuated by a suitable means such as a hydraulic or pneumatic press (not shown). The same punches 110 can also be used to form the through holes 106, as shown in Figures 12A and 12B. More particularly, each punch 110 can be moved through a relatively short stroke during formation of the projections 100, so that the punches 110 displace, but do not penetrate through the material of the first conductor plate 20a, as shown in Figures 11A and 11B. The direction of motion of the punches 110 is denoted by the arrows 111 in Figures 11-12B. The punches 110 can be moved through a longer stroke when forming the through holes 106, so that the punches 110 penetrate through the second conductor plate 20b as shown in Figures 12A and 12B.
[0071] The use of punches 110 to form the projections 100 and the through holes 106 is disclosed for exemplary purposes only. The projections 100 and the through holes 106 can be formed by other suitable means in the alternative.

[0072] The configuration of the power contacts 15 can help minimize stresses on the housing 14 of the connector 10 when the power contacts 15 are mated with the complementary power contacts 15a of the receptacle connector 30, as follows.

[0073] Each contact beam 24 of the first conductor 16 faces a corresponding contact beam 24 of the second conductor 18 to form associated pairs of contact beams 24 as shown, for example, in Figures 20 and 21. Each pair of associated contact beams 24 receives a contact blade 29a from a power contact 15a of the receptacle connector 30 when the connector 10 and the receptacle connector 30 are mated. The pair of associated contact beams 24 resiliency deflect outwardly, i.e., away from each other, when the contact blade 29a is inserted therebetween.

[0074] The resilient deflection of the contact beams 24 of the power contact 15 causes the associated contact beams 25a of the power contact 15a to exert reactive forces on the contact beams 24. These forces are designated "F_l" in Figures 20 and 21. The power contact 15a is not shown in Figures 20 and 21, for clarity. Details of the power contacts 15a are shown, for example, in Figure 2C.

[0075] The forces F_l are believed to be of substantially equal magnitude, and act in substantially opposite directions. As the contact beams 24 adjoin the forward portions of the first and second conductor plates 20a, 20b of the respective conductors 16, 18, the forces F_l urge the forward portions of the first and second conductor plates 20a, 20b outwardly, away from each other.
[0076] Each contact beam 25 of the first conductor 16 of the power contact 15 faces a corresponding contact beam 25 of the second conductor 18 to form a contact blade 29. Each contact blade 29 of the power contact 15 is received between an associated pair of contact beams 24a on the power contact 15a when the connector 10 and the receptacle connector 30 are mated. The contact beams 24a of the power contact 15a resiliently deflect in an outward direction, i.e., away from each other, when the contact blade 29 is inserted therebetween.

[0077] The resilient deflection of the contact beams 24a of the power contact 15a causes the contact beams 24a to generate reactive forces denoted by the symbol "F2" in Figures 20 and 21. The forces F2 act inwardly, in opposing directions, against the associated contact beams 25 of the power contact 15, and are believed to be of substantially equal magnitude. The forces F2 thus urge the contact beams 25 toward each other.

[0078] The contact beams 25, in turn, urge the adjoining forward portions of the first and second conductor plates 20a, 20b of the power contact 15 toward each other. In other words, the contact beams 24a of the power contact 15a clamp the associated contact beams 25 of the power contact 15 together. This clamping action prevents the forward portions of the first and second conductor plates 20a, 20b of the power contact 15 from separating due to the outward forces F1 associated with the contact beams 24 of the power contact 15.

[0079] The forces F1, in combination with the clamping effect of the contact beams 24a on the forward portions of the plates 20a, 20b of the power contact 15, are believed to generate moments on the first and second conductor plates 20a, 20b. These moments are designated "M" in Figures 20 and 21. The moments M are of
substantially equal magnitude, and act in substantially opposite directions. The moments "M" urge the rearward ends of the first and second conductor plates 20a, 20b of the power contact 15 toward each other, in the directions denoted by the arrows 96 in Figure 21.

[0080] The configuration of the power contacts 15 thus causes the forward and rearward ends of the first and second conductor plates 20a, 20b to be drawn toward each other when the connector 10 is mated with the receptacle connector 30. The first and second conductors 16, 18 therefore do not exert a substantial force on the adjacent walls of the housing 14. In other words, the structure of the power contact 15 itself, rather than the housing 14, holds the first and second conductors 16, 18 together when the connector 10 and the receptacle connector 30 are mated. As the housing 14 does not perform the function of holding the first and second conductors 16, 18 together, the housing 14 is not subjected to the stresses associated with that function.

[0081] The foregoing description is provided for the purpose of explanation and is not to be construed as limiting the invention. Although the invention has been described with reference to preferred embodiments or preferred methods, it is understood that the words which have been used herein are words of description and illustration, rather than words of limitation. Furthermore, although the invention has been described herein with reference to particular structure, methods, and embodiments, the invention is not intended to be limited to the particulars disclosed herein, as the invention extends to all structures, methods and uses that are within the scope of the appended claims. Those skilled in the relevant art, having the benefit of the teachings of this specification, may effect numerous modifications to the invention.
as described herein, and changes may be made without departing from the scope and
spirit of the invention as defined by the appended claims.

[0082] For example, the principles of the invention have been described in
relation to the connector 10 for exemplary purposes only. The present invention can
be applied to other types of connectors comprising contacts formed by two or more
abutting conductors.

[0083] Alternative embodiments of the first and second conductors can
include more, or less than two of the projections 100 and two of the through holes 106.
Moreover, the projections 100 can have a configuration other than cylindrical in
alternative embodiments. For example, the projections having a substantially square or
rectangular cross sections can be used in the alternative.

[0084] The projections 100 and the through holes 106 can be located in
positions other than those depicted in the figures, in alternative embodiments.
Moreover, alternative embodiments of the second conductor 18 can include
indentations in the second conductor plate 20b in lieu of the through holes 106, to
accommodate the projections 100.

[0085] Figures 15, 17, and 19 depict an alternative embodiment of the
connector 10 in the form of a plug connector 200. Components of the connector 200
that are substantially similar to those of the connector 10 are represented by identical
reference characters in the figures.

[0086] The connector 200 can be mounted on a substrate such as a daughter
card 205. The connector 200 can be mounted on other types of substrates in the
alternative. The connector 200 can include one or more power contacts 201 for
conducting alternating (AC) current, and a housing 203. Each contact 201 can include
a first and a second portion having alignment features such as the projections 100 and the through holes 106, as described above in relation to the contacts 15. The connector 200 can also include one or more of the power contacts 15 for conducting direct (DC) current.

[0087] The housing 203 includes a plurality of silos 204, as shown in Figure 1. Each silo 204 is associated with a corresponding one of the contacts 201. Each contact 201 is received in an aperture 208 formed in its associated silo 204. The contacts 201 can be retained in their associated apertures 208 in the manner described above in relation to the power contacts 15 and the apertures 17 of the housing 14 of the connector 10.

[0088] The housing 203 includes an upper wall 212. The upper wall 212 is spaced apart from upper portions of the silos 204 to form a vent or passage 210 within the housing 203, as shown in Figure 15. The passage 210 extends between the front and back of the housing 203, from the perspective of Figure 15. The aperture 208 of each silo 204 adjoins the passage 210, and facilitates convective heat transfer between the associated contact 201 and the passage 210 as the contacts 201 become heated during operation of the connector 200.

[0089] Apertures 215 are formed in the upper wall 212 of the housing 203, as shown in Figures 15 and 17. The apertures 215 adjoin the passage 210, and facilitate convective heat transfer from the passage 210 and into the ambient environment around the connector 200 during operation of the connector 200. More specifically, air heated by the contacts 201 can rise out of the associated silos 204, and enter the passage 210 by way of the apertures 208 in the silos 204. The airflow paths that are believed to exist in and around the connector 200 during operation are represented by the arrows
216 in the figures. It should be noted that the arrows 216 are included for illustrative purposes only, and are not intended to fully represent the relatively complex airflow patterns that may actually exist in and around the connector 200.

[0090] The heated air can rise out of the passage 210 and exit into the ambient environment by way of the apertures 215. Relatively cool air can enter the passage 210 to replace the heated air that exits the passage 210 by way of the apertures 215.

[0091] The connector 200 also includes an array of signal contacts 19 as described above in relation to the connector 10. A vent or passage 220 can be formed between the array of signal contacts 19 and the upper wall 212, as shown in Figure 17. Apertures 222 that adjoin the passage 220 can be formed in the upper wall 212. Air heated by the signal contacts 19 can rise into the passage 220, and exit the connector 200 by way of the apertures 222. Relatively cool air can enter the passage 220 to replace the heated air that exits the passage 220 by way of the apertures 222.

[0092] Apertures 223 can be formed in the upper wall 212, above each of the contacts 15, to facilitate convective heat transfer from the contacts 15 to the ambient environment.

[0093] The connector 200 can mate with a receptacle connector 230 to form a co-planar connector system, as shown in Figures 16 and 17. The connector 230 can be mounted on a substrate such as a daughter card 207. The connector 230 can be mounted on other types of substrates in the alternative.

[0094] The connector 230 can include receptacle contacts 232 for receiving the signal contacts 91 of the connector 200, and one or more AC power contacts 234 for mating with the contacts 201 of the connector 200. The connector 230 can also
include one or more DC power contacts 235 that mate with the contacts 15 of the connector 200.

[0095] The connector 230 also includes a housing 236 that receives the contacts 232, 234, 235. The contacts 234 are housed in silos 237 of formed in the housing 236, as shown in Figure 16. The silos 237 are substantially similar to the silos 204 of the connector 200.

[0096] The housing 236 includes a passage 238 formed above the silos 237, and a passage 240 formed above the array of receptacle contacts 232. The passage 238 and the passage 240 extend between the front and back of the connector 230, from the perspective of Figure 16. The passage 238 and the passage 240 face the respective passages 210, 220 of the connector 200 when the connector 230 is mated with the connector 200.

[0097] Apertures 270 that adjoin the passage 238 can be formed in an upper wall 272 of the housing 236, as shown in Figure 19. Apertures 274 that adjoin the passage 240 can also be formed in the upper wall 272.

[0098] The passages 238, 240 and the apertures 270, 274 can facilitate heat transfer from the contacts 234 and the receptacle contacts 232, in the manner discussed above in relation to the passages 210, 220 and the apertures 215, 222 of the connector 200. Air can also flow between the passage 238 and the passage 210, and between the passage 240 and the passage 220, if a temperature differential exists therebetween.

[0099] Apertures 276 can be formed in the upper wall 272, above each of the contacts 235, to facilitate convective heat transfer from the contacts 235 to the ambient environment.
[0100] The connector 200 can also mate with a receptacle connector 246, as shown in Figures 17 and 18. The connector 246 can be mounted on a substrate such as a backplane 209, so that the connector 246 and the connector 200 form a backplane connector system. The connector 246 can be mounted on other types of substrates in the alternative.

[0101] The connector 246 includes receptacle contacts 248, AC power contacts 250, and DC power contacts 252. The contacts 248, 250, 252 are adapted for use with a backplane such as the backplane 209, but are otherwise similar to the respective receptacle contacts 232, AC power contacts 234, and DC power contacts 235 of the receptacle connector 230.

[0102] The connector 246 also includes a housing 252 that receives the contacts 248, 250, 252. The housing 252 includes a passage 254 located above the receptacle contacts 248, and a passage 256 located above silos 257 that house the contacts 235, as shown in Figure 18. The passages 254, 256 extend between the front and back of the housing 252, from the perspective of Figure 18. The passages 254, 256 extend through an upper wall 258 of the housing 252, proximate the rearward end thereof. The housing 252 also includes vertically-oriented passages 260 formed along the rearward end thereof. Each passage 260 is associated with one of the power contacts 252. The passages 254, 256, 260 permit heated air to exit the housing 252, while allowing relatively cool air to enter.
What is Claimed:

1. An electrical connector, comprising:
   a housing; and
   a power contact mounted on the housing and comprising a first conductor plate and a second conductor plate that mates with the first conductor plate, wherein the first conductor plate has an integral projection that extends from a first planar portion of the first conductor plate and the second conductor has a through hole in a second planar portion, and the integral projection and through hole are formed by one or more punches that each have the same outer diameter.

2. The connector of claim 1, wherein the first conductor is mated with the second conductor through the insertion of the integral projection into the through hole.

3. The connector of claim 1, wherein the integral projection has a substantially uniform cross section along a length of the integral projection.

4. The connector of claim 1, an end of the integral projection is flat.

5. The connector of claim 1, wherein the integral projection has an outer diameter approximately equal to an inner diameter of the through hole.

6. The connector of claim 1, wherein the integral projection has a substantially circular cross section.
7. The connector of claim 1, wherein the housing has a guide projection formed proximate a center thereof, the guide projection becomes disposed in a guide reception cavity formed in a housing of a second connector.

8. The connector of claim 1, wherein the first and second conductor plates each comprise a current guiding slot.

9. The connector of claim 1, wherein a portion of the power contact is located in an aperture formed in the housing, a top portion of the housing has an opening formed therein, and the opening places the aperture in fluid communication an ambient environment around the connector.

10. The connector of claim 1, wherein the housing has a silo formed therein, the silo receives the power contact, and the silo and an inner surface of the housing define a passage that facilitates heat transfer from the power contact.

11. The connector of claim 10, wherein an upper portion of the silo is spaced from an upper wall of the housing to form the passage.

12. The connector of claim 10, wherein the silo has an aperture formed therein that facilitates heat transfer from the power contact to the passage.

13. The connector of claim 1, wherein:
the first conductor plate comprises a first and a second contact beam adjoining the first conductor plate;
the second conductor plate comprises a third and a fourth contact beam adjoining the second conductor plate;
the first contact beam opposes the third contact beam when the first and second conductor plates are mated;
the second contact beam opposes the fourth contact beam when the first and second conductor plates are mated so that second and fourth contact beams form a contact blade;
the first and third contact beams are pushed apart by a contact blade of a power contact of a mating connector when the connector is mated with the mating connector; and
the second and fourth contact beams are pressed between a pair of contact beams of the power contact of the mating connector when the connector is mated with the mating connector so that the contact beams of the power contact of the mating connector clamp the second and fourth contact beams together so that the first and second conductors are prevented from separating.

14. The connector of claim 13, wherein rear edges of the first connector plate and the second connector plate are pressed together as the connectors are mated together.

15. The connector of claim 1, wherein the first connector plate and the second connector plate each have a spring tang.
16. A method of making a power contact, comprising:

providing a first punch with a fixed outer diameter;

pushing the first punch into a planar portion of a first conductive plate to form a projection; and

forming a through hole in the second conductive plate by pushing a second punch with the fixed outer diameter through the second conductive plate.

17. The method of claim 16, further comprising the step of passing the projection into the through hole.