IN THE UNITED STATES DISTRICT COURT

FOR THE DISTRICT OF DELAWARE

FCI USA INC., and FCI AMERICAS TECHNOLOGY INC., Plaintiffs, v. MOLEX INCORPORATED Defendant.	Case No. 1:07-cv-00049 (JJF)

DEFENDANT'S REPLY TO PLAINTIFFS' OPPOSITION TO DEFENDANT'S MOTION TO DISMISS, STAY OR TRANSFER

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I. SUMMARY OF THE ARGUMENT

Molex's Motion To Dismiss, Transfer, or Stay this action should be granted. Molex's declaratory judgment action pending in Nevada is the first-filed action and should proceed in the absence of exceptional circumstances.

In this case, there are no exceptional circumstances. Contrary to Plaintiffs' assertions, Molex did not in any way mislead Plaintiffs during license negotiations or engage in gamesmanship of any sort. Molex was clear in expressing its belief that its I-Trac product does not infringe any of the claims of the patents-in-suit. Nevertheless, Plaintiffs proposed commercially unreasonable licensing terms to which Molex frankly was unable to respond. The negotiations thus were stalled from the outset, and Plaintiffs cannot credibly argue that they believed Molex was willing to accept a license on the terms proposed or to continue negotiations using such terms as a starting point.

Moreover, Plaintiffs' argument regarding convenience is incredible in view of the fact that (a) neither FCI Americas nor FCI USA is a Delaware resident, (b) Nevada is FCI Americas's home state and (c) both FCI Americas and FCI USA have demonstrated their ability, and indeed preference, to litigate the very same family of patents against similar products in the remote jurisdiction of the Eastern District of Texas, without regard to the perceived inconvenience to parties or witnesses that they now assert.

For all of these reasons, Nevada is the proper place for this action to go forward and accordingly this Court should grant Defendant's Motion To Dismiss, Transfer or Stay.

II. STATEMENT OF ADDITIONAL FACTS

This action, as originally filed, is the mirror image of Defendant's first-filed declaratory judgment action pending in Nevada. The only difference between this action as originally filed and the Nevada action is that an additional Plaintiff is named, FCI USA, Inc. ("FCI USA"), alleged to be the exclusive licensee of the patents-in-suit. Importantly, however, FCI Americas is the record owner of each of the patents-in-suit. *See* Exh. A. Defendant filed its declaratory judgment action in Nevada because FCI Americas is a corporation organized under the laws of the State of Nevada, has a principal place of business in Reno, Nevada, and has an agent for service of process in Nevada. *See* Exh. B.

One month after this action was filed, on February 27, 2007, and only a week after Defendant agreed to an extension of FCI Americas's time to answer or otherwise plead in the Nevada action, FCI Americas filed an Amended Complaint asserting an additional claim of infringement of U.S. Patent 7,182,643 ("the '643 patent). This Amended Complaint was filed in this action the same day the '643 patent was issued by the U.S. Patent & Trademark Office. The '643 patent issued from U.S. Patent Application No. 11/326,175, which was identified in the allegations of Defendant's Complaint filed in the Nevada action. *See* Complaint, attached Exh. C, p. 3 at ¶ 6. The '643 patent relates to the same subject matter as the '883 and '964 patents and claims priority to the same parent application as the '883 and '964 patents. *See* Exh. D. In addition, Plaintiffs allege in the Amended Complaint that the '643 patent is infringed by the same product that is alleged to infringe the '883 and '964 patents.

On March 22, 2007, the same day Molex filed the instant motion, FCI Americas moved to dismiss or stay the first-filed Nevada Action. On March 30, 2007, the parties held a Fed. R. Civ. P. 26(f) conference during which they agreed that the discovery schedules for both the Nevada and Delaware action should be identical and that, in order to avoid delay while the competing motions to dismiss are being decided, discovery obtained in either action can be used in the other action. Accordingly, this action and the Nevada action presently are proceeding concurrently at the same pace.

III. ARGUMENT

Plaintiffs admit that the Nevada action is the first-filed action, but insist that the circumstances justify departure from the first-filed rule. Plaintiffs have the burden to present some exceptional circumstances why the court should depart from the first-filed rule. *See Arrow Communication Labs., Inc. v. John Mezzalingua Assocs., Inc.*, No. Civ. 05-201-SLR, 2005 WL 2786691, *3 (D. Del. Oct. 26, 2005); *Miteq, Inc. v. Comtech Telecomm. Corp.*, No. Civ. A. 02-1336-SLR, 2003 WL 179991, *2 (D. Del. Jan. 23, 2003). Plaintiffs have failed to prove such exceptional circumstances exist in this case.

A. Molex's Filing Of The Declaratory Judgment Action In Nevada Was Proper

Plaintiffs argue the first-filed rule should be disregarded because Molex's filing of its declaratory judgment complaint was inconsistent with the Declaratory Judgment Act. Specifically Plaintiffs accuse Molex of engaging in a "preemptive tactical move" and "misleading" them during the licensing negotiations. However, contrary to Plaintiffs' assertions, Molex's filing of the declaratory judgment action in Nevada was not an improper use of the Declaratory Judgment Act.

1. Molex Did Not Mislead Plaintiffs In Any Way During Negotiations Relating to Its I-Trac Product

Since mid-November 2006, the parties have been engaged in discussions regarding licenses related to various patents and a number of different products, one of which is Molex's I-Trac product that is at issue in this action. *See* Exh. E, Declaration of Charles S. Cohen, at ¶ 3. Since the beginning of these discussions, Molex has made it clear that Molex believes the I-Trac product does not infringe any claims of the patents-in-suit. *See* Exh. E at ¶ 4. On December 14, 2006, the parties met in person to discuss the asserted infringement issues. Throughout the discussions, Plaintiffs continued to assert that Molex's I-Trac product infringed the '883 and '964 patents, as well as claims of an allowed application which ultimately issued as the '643 patent. *See* Exh. E at ¶ 5. While Molex expressed a willingness to consider a business solution despite its firm belief that it did not infringe the '883 or '964 patents, the terms and conditions upon which Plaintiffs ultimately offered to license Molex's I-Trac product were not commercially viable. *See* Exh. E at ¶ 6. Indeed, Molex believed that the license offered, if accepted, would prevent it from competing effectively in the marketplace with its I-Trac product. *See id.* Among other issues, the scope of the license was narrower than Molex desired, the royalty rate presented was prohibitively high, and the offer did not provide for the second-source licensing freedom which is a necessity in this business. *See id.*

In response to the patently unreasonable offer, Molex stated that it stood by its positions of invalidity and non-infringement relative to the patents, but would be willing to discuss a license on *reasonable* terms. *See* Exh. E at ¶ 7. When no such reasonable

terms were offered, on January 5, 2007 Molex again asked Plaintiffs if they truly intended to seek such a high royalty rate under terms that made it commercially unviable. *See* Exh. E at ¶ 8. FCI responded that they did not believe their terms were out of line with market realities and so maintained the original offer. *See* Exh. E at ¶ 9. This led Molex to believe that further discussions were unlikely to result in an acceptable business solution. *See id.*

Plaintiffs' proposal of such commercially unreasonable licensing terms must be viewed in the proper context. The license negotiations between the parties relating to other products discussed during this timeframe continued to move forward. The license negotiation regarding the I-Trac product was in fact the only negotiation that failed to proceed. *See* Exh. E at ¶ 10. Also, Molex received reports that Plaintiffs had asserted to Molex customers that Molex's I-Trac product infringed FCI Americas' patents and believed that such assertions threatened its sales of the I-Trac product. *See* Exh. E at ¶ 11. Moreover, Plaintiffs had already demonstrated their desire to enforce the patents in suit by bringing suit in the Eastern District of Texas against a mutual competitor of FCI and Molex involving the competitor's technology and patents from the same patent family. *See* Exh. E at ¶ 12. With all of this as background, Molex was justified in believing that Plaintiffs were not truly interested in licensing the patents-in-suit on reasonable terms.

Also, Plaintiffs cannot credibly argue that Molex "misled" it during these negotiations. Contrary to Plaintiffs' assertions, the parties were not involved in "active" negotiations regarding a license for the I-Trac product at the time this action was filed.

Rather the negotiation had clearly stalled. *See* Exh. E at ¶ 10. Though Molex indicated it was willing to discuss reasonable licensing terms, no such terms were ever proposed by Plaintiffs. *See* Exh. E at ¶ 13. And Molex's silence in response to the proposed terms, viewed in the proper context, was a clear indication that the negotiations relating to the I-Trac product were going nowhere. Indeed, Plaintiffs' assertion that "Molex initiated the Nevada litigation while FCI and Molex were discussing a potential license agreement" is belied by Plaintiffs' own statement that Molex's "only substantive response during the discussions was to initiate the Nevada action." *See* Opposition at pp. 9, 10.

Moreover, although Plaintiffs state the contrary, Molex has not been engaged in any ongoing negotiations regarding the proposed licensing terms for the I-Trac product since this action was filed. *See* Exh. E at ¶ 14. Indeed at no time has Molex made a counteroffer to Plaintiffs' unreasonable offer, and Plaintiffs have never presented any acceptable changes to the terms and conditions of their initial offer. *See* Exh. E at ¶ 13. Thus Plaintiffs assertion that Molex's filing of the declaratory judgment complaint was "purely a tactical maneuver to gain bargaining power" is simply not borne out by the facts.

2. The Instant Facts Are Distinguishable From The Cases Cited By Plaintiffs

Plaintiffs assert the present facts are inconsistent with the Declaratory Judgment Act pursuant to *EMC Corp. v. Norand Corp.* 89 F.3d 807 (Fed. Cir. 1996). However, *EMC* is entirely distinguishable. In *EMC*, the district court noted three factors which led it to conclude that EMC's declaratory judgment complaint should be dismissed: (1) the

parties were still in active license or sale negotiations, (2) the defendant patentee was not a competitor of the plaintiff, and (3) the defendant patentee was considering entering negotiations with other companies. *Id.* at 809. The Federal Circuit noted additional factors supporting the district court's decision to dismiss the complaint, namely (4) EMC filed the complaint shortly after the defendant patentee informed EMC of its plans to enter negotiations with EMC's competitors, and (5) the day after the complaint was filed, EMC's IP counsel explained to the defendant patentee that the declaratory judgment filing was "merely a defensive step," that EMC wished "to continue to discuss all the options" and that suit was filed because "they just thought it was in their interest to protect themselves first and continue discussions." *Id.* at 813.

None of these factors is present here. As described above, the license negotiations relating to Molex's I-Trac product were clearly going nowhere, particularly when viewed in the context of the rest of the negotiations between the parties regarding unrelated products and patents. *See* Exh. E at ¶ 10. Also, in this case Molex and FCI are direct competitors in the high speed shieldless backplane connector market. *See* Exh. E at ¶ 2. There is no evidence FCI was considering entering into negotiations with other companies, and after the complaint was filed, there was no statement by Molex that the filing was merely a defensive maneuver to protect itself as it moved forward during negotiations. Molex filed this action because it had become clear that a business solution was not going to occur. The parties were entrenched in their positions and no acceptable compromise was deemed likely.

Plaintiffs' reliance on *Charles Schwab & Co. v. Duffy* is similar misplaced. No. C 98-03612-MMC, 1998 WL 879659 (N.D. Cal. Dec. 8, 1998). In *Charles Schwab*, the Northern District of California concluded that the first-filed rule should be disregarded because the plaintiff's declaratory judgment filing was anticipatory in view of the fact that plaintiff filed suit after sending a letter to the defendant which the court concluded may have misled the defendant as to the plaintiff's settlement intentions. *Id.* at *1. No such facts are presented here. As Plaintiffs acknowledge, the discussions between the parties related to the patents-in-suit had stalled. *See* Opposition, at 10 ("Molex only "won" the race to the courthouse by stalling during licensing negotiations.") Molex sent no communication to Plaintiffs which could be reasonably interpreted to have "misled" Plaintiffs, and Plaintiffs cite nothing to the contrary.

The situation between the parties is the type of situation intended by the Declaratory Judgment Act, and accordingly it would be improper for this court to set aside the first-filed rule on this basis.

3. Subject Matter Jurisdiction Is Not In Question In The Nevada Action

Plaintiffs additionally suggest this action should proceed rather than the first-filed action in Nevada because "unlike the Nevada litigation, there is no question that this Court has subject matter jurisdiction." *See* Opposition, p. 11. However, this argument is both factually and legally incorrect.

Contrary to Plaintiffs' assertion, FCI Americas has not moved the Nevada court to dismiss for lack of subject matter jurisdiction. Indeed, FCI Americas has not even suggested to the Nevada court that no Article III case or controversy exists that gives rise

to declaratory judgment jurisdiction. Rather FCI Americas has requested that the Nevada court *exercise its discretion* to dismiss the declaratory judgment action over which it properly has jurisdiction. Clearly the Nevada court does not have discretion to dismiss an action over which it has no subject matter jurisdiction.

In any event, the Nevada court unmistakably does have subject matter jurisdiction. The Federal Circuit has recently acknowledged that the Declaratory Judgment Act no longer requires a plaintiff to have an "imminent" or even a "reasonable apprehension of suit," in view of the Supreme Court's decision in *MedImmune v. Genentech, Inc.*, 127 S. Ct. 764 (2007). *Sandisk Corp. v. STMicroelectronics, Inc.*, No. 05-1300, 2007 WL 881008 (Fed. Cir. Mar. 26, 2007). Thus, under the current law, a declaratory judgment plaintiff need not have been rendered "helpless and immobile" by the license negotiations before it is able to bring action. To the contrary, all that is required is that a declaratory judgment plaintiff be placed "in the position of either pursuing arguably illegal behavior or abandoning that which he claims a right to do." *Id.* at *7. As the Federal Circuit further explained:

> Where a patentee asserts rights under a patent based on certain identified ongoing or planned activity of another party, and where that party contends that it has the right to engage in the accused activity without license, the Article III case or controversy will arise and the party need not risk a suit for infringement by engaging in the identified activity before seeking a declaration of its legal rights.

Id.

In this case, as is discussed in more detail above, Molex repeatedly asserted its belief that its I-Trac product did not infringe either of the '883 or '964 patents and FCI repeatedly asserted its belief that Molex's I-Trac product infringed those patents. *See*

Exh. E, at ¶ 5. Thus, Molex was placed in the position of either pursuing the sale of its I-Trac product at risk of being sued by FCI for infringement, or abandon its I-Trac product despite its belief that it had a right to sell such product. In view of these facts, Molex's position was exactly the type of situation covered by the Declaratory Judgment Act and Plaintiffs cannot credibly argue that subject matter jurisdiction in Nevada is questionable.

B. Plaintiffs Cannot Argue Nevada Is An Inconvenient Forum For This Action

Plaintiffs argue the first-filed rule should be set aside because Delaware is a more convenient forum than Nevada. However Plaintiffs' own actions contradict their assertions regarding convenience.

1. Nevada Is Plaintiff FCI Americas' Home State

Plaintiff FCI Americas, the owner of all of the patents-in-suit, elected Nevada as its state of incorporation, the location of its corporate address, and the location of its agent for service of process. Indeed Molex chose to file its declaratory judgment action in Nevada because it was the patent owner FCI Americas' home state and Molex had few other options in which to sue FCI Americas where it could be assured there were sufficient contacts to satisfy personal jurisdiction. If FCI Americas preferred to be sued in Delaware rather than Nevada, it should have foregone the benefits of being a Nevada citizen of which it elected to avail itself when it chose to incorporate and locate itself in Nevada.

Moreover, because FCI Americas is a Nevada corporation, Nevada has a special interest in protecting FCI Americas. Despite Plaintiffs' assertions to the contrary, the Nevada court is surely capable of trying this patent case. This case is in its most infant

stages and this Court has not gained any special familiarity with the patents or technology that would give it an advantage over the Nevada court. In any event, the Nevada court's experience or lack thereof with this or any patent case is not a basis upon which to disregard application of the first-filed rule.

2. Plaintiffs Are Litigating The Same Subject Matter In Texas Without Regard To The Alleged Inconvenience

In direct conflict with their assertions regarding convenience in this action, both plaintiff FCI Americas and its alleged patent licensee FCI USA recently initiated litigation in the Eastern District of Texas in the Marshall division. *See* Exh. F, docket sheet from *FCI USA Inc. et al. v. Tyco Electronics Corp.*, C.A. No. 2:06-cv-00128-TJW. The Texas action involves FCI Americas and FCI USA's claims of patent infringement against Tyco Electronics Corporation, a New Jersey-based entity, and relates to similar technology and patents from the same family of patents that are at issue in this action. *See* Exh. G, Complaint from *FCI USA Inc. et al. v. Tyco Electronics Corp.*, C.A. No. 2:06-cv-00128-TJW, and Exh. C (patent family). The Marshall, Texas court is ~1,800 miles from Reno, Nevada where FCI Americas is located, and ~1,300 miles from Etters, PA where FCI USA is located.

Texas is in fact so convenient for FCI Americas and FCI USA that they actually opposed Tyco's motion to change the venue from the Eastern District of Texas case to the Middle District of Pennsylvania. *See* Exh. F, docket sheet entries 12, 23, 36. Accordingly FCI Americas and FCI USA are clearly willing and able to litigate this subject matter in 'distant' courts. Plaintiffs' argument regarding convenience is a blatant

attempt to manipulate the judicial system. The Court should not reward Plaintiffs' attempt to game the judicial system by denying this motion to dismiss or stay.

Plaintiffs argue that *Miteq, Inc. v. Comtech Telecomm. Corp.*, supports their claim that the inconvenience to them of having to litigate in Nevada is a sufficient reason to depart from the first-filed rule. *See* Opposition at p. 8-9. However Plaintiffs misstate the facts of *Miteq*. Contrary to Plaintiffs' assertions, this Court in *Miteq* concluded that none of the second-filed plaintiff's arguments regarding convenience "show that there are any exceptional circumstances requiring the court to depart from the first-filed rule." *Miteq*, 2003 WL 179991 at *2. As the court observed: "Mere inconvenience to one party does not rise to the level of exceptional circumstances that would require the court to depart from the well-established principles of the first-filed rule." *Id.* While the court additionally observed that denial of the first-filed defendant's motion to transfer would merely transfer the inconvenience from one party to the other, this fact was not necessary to the Court's ruling. *Id.*[1]

C. The First-Filed Rule Should Not Be Disregarded Simply Because The Two Actions Are Not Identical

1. The Presence Of An Additional Party Is Irrelevant To Application Of The First-Filed Rule

This Court has recognized that the fact that the first-filed rule should not be disregarded simply because a party is named in the second filed case that was not named

[1] Plaintiffs' assertion that the defendant [sic - plaintiff] in *Genfoot, Inc. v. Payless Shoesource, Inc.*, No. 03-398-SLR, 2003 WL 22953183 (D. Del. Dec. 3, 2003) did not allege an exception to the first-filed rule is similarly incorrect. *See* Opposition at p. 8. Although the court's opinion does not summarize plaintiff Genfoot's arguments as to why the first-filed rule should not apply, it simply cannot be the case that the Delaware court applied the first-filed rule "by default" given that Genfoot filed a brief opposing the defendant's motion to transfer for consolidation with the first-filed action.

in the first, even when that party is a necessary party in the first-filed case. *See Schering Corp. v. Amgen, Inc.*, 969 F. Supp. 258, 267 (D. Del. 1997); *Whelan v. United Pacific Industries, Inc.*, No. Civ. A. 02-2519, 2002 WL 31513432, *2 (E.D. Pa. Nov. 1, 2002) (*citing National Foam, Inc. v. Williams Fire & Hazard Control, Inc.*, No. Civ. A. 97-3105, 1997 WL 700496, *5 (E.D. Pa. Oct. 29, 1997)).

Despite this precedent, and without citing case law to the contrary, Plaintiffs argue the first-filed rule should not apply because FCI USA was not named in Nevada, alleging FCI USA is the exclusive licensee of the patents-in-suit and the real party in interest in this action. However, under Delaware law, the failure to name FCI USA in the first-filed action provides absolutely no basis upon which to disregard the first-filed rule. Moreover, even if FCI USA is an exclusive U.S. licensee of the patents-in-suit, an exclusive licensee by definition has fewer than all substantial rights in the patent at issue and Plaintiffs have provided no evidence FCI USA has any right to assert the patents in an infringement action. Indeed, a licensee normally does not have standing to sue without the joinder of the patent owner. *See Sicom Sys. Ltd. v. Agilent Techs., Inc.*, 427 F.3d 971, 976 (Fed. Cir. 2005). Moreover, a patent grantee or assignee always is a real party in interest in an action involving the patent. *See Waterman v. MacKenzie*, 138 U.S. 252 (1891). Molex's first-filed declaratory judgment action names FCI Americas, the patent owner of record and necessary party. The failure to include FCI USA, the alleged licensee, does not defeat Molex's claim of priority in filing.

2. The Presence Of Other Claims Here Does Not Alter The Proper Application Of The First-Filed Rule

Plaintiffs assert that the presence of the additional '643 patent in this case, which Plaintiffs added in the Amended Complaint after securing Defendant's agreement to an extension of time for Plaintiff FCI Americas' response in Nevada case, is sufficient reason to disregard the first-filed rule.

However Plaintiffs' case law is readily distinguishable. Plaintiffs cite *APV North America, Inc. v. Sig Simonazzi North America, Inc.*, 295 F. Supp. 2d 393, 397-98 (D. Del. 2002), for the proposition that where a second filed action implicates different patents, the first-filed rule should not apply. *See* Opposition at p. 10-11. However in *APV*, this Court concluded that the additional patents present in the later-filed action were directed to *different technology*. *APV*, 295 F. Supp. 2d at 398. Specifically, the Court found that the additional patents, which were asserted by the alleged infringer as a counterclaim, involved different facts because the claims were directed to "the entire structure of a bakery conveyor" as opposed to "the magnetic grids for holding the baking pans to the conveyor." *Id.* at 396-97. In this case, unlike *APV*, all of the patents at issue were asserted by Plaintiffs against Molex and relate to Molex's same allegedly infringing product. Moreover, unlike *APV*, all of the claims of the patents-in-suit are directed to an electrical connector having a particular configuration of electrical contacts. Accordingly, unlike *APV*, the additional patent at issue in this action relates to the same issues, facts, and technology as the patents at issue in the first-filed Nevada action.

Plaintiffs also cite *Thales Airborne Sys. S.A. v. Univ. Avionics Sys. Corp.*, No. 05-583-SLR, 2006 WL 1749399 at *11-12 (D. Del. June 21, 2006), in support of their

argument, *see* Opposition at p. 11, but fail to mention that in *Thales* the court granted the first-filed plaintiff's motion to enjoin the second-filed action to the extent it involved the same patents. *Thales*, 2006 WL 1749399 at *4. Thus, contrary to Plaintiffs' assertion, *Thales* actually supports the proposition that the first-filed rule should not be disregarded simply because the second-filed case contains an additional patent.

Furthermore, Plaintiffs argument ignores the fact that, pursuant to Fed. R. Civ. P. 13(a), Plaintiffs' claims related to the '643 patent *must* be litigated in the Nevada action and *may not* be resolved in this action. The '643 patent is directed to the same shieldless high speed backplane connector subject matter as the '883 and '964 patents, and is a continuation application claiming priority to the same parent application as the '883 and '964 patents. Indeed, because of the closeness of these patents, the application from which the '643 patent issued was cited by Molex in its Complaint filed in Nevada and would have been included in this action but for the fact that the application had not yet issued at the time the Nevada action was filed. Because the later added claim of infringement of the '643 patent clearly derives from the same transaction or occurrence as the claim of infringement of the '883 and '964 patents, all of the claims of infringement presented in this action are compulsory counterclaims in the Nevada action.

D. That This Action Was Filed One Day After The Nevada Action Is Not A Basis To Disregard The First-Filed Rule

Plaintiffs argue the first-filed rule should be disregarded because they filed suit one day later in Delaware. However, the Federal Circuit has already considered and rejected this argument:

> We are not unmindful that this declaratory action was filed in Indiana only one day before the California infringement action. However, the rule favoring the right of the first litigant to choose the forum, absent countervailing interests of justice or convenience, is supported by reasons just as valid when applied to the situation where one suit precedes the other by a day as they are in a case where a year intervenes between suits.

Genentech, Inc. v. Eli Lilly & Co., 998 F.2d 931, 938 (Fed. Cir. 1993) (citations and internal quotations omitted), *abrograted on other grounds by Wilton v. Seven Falls Co.*, 515 U.S. 277 (1995) (*citing Martin v. Graybar Elec. Co.*, 266 F.2d 202, 205 (7th Cir. 1959) (*quoting Crosley Corp. v. Westinghouse Elec. & Mfg. Co.*, 130 F.2d 474, 475 (3d Cir. 1942))).

As a result, both the Federal Circuit and the Courts in this district uniformly have accorded first-filed status to the complaint filed first-in-time, regardless of the time difference between the filing of the two complaints. *See id.* (first-filed rule applied to complaint filed one day earlier than parallel complaint); *Laboratory Corp. of America Holdings v. Chiron Corp.*, 384 F.3d 1326, 1327, 1332-33 (Fed. Cir. 2004) (affirming this Court's determination of first-filed status where parallel action was filed only four and one-half hours after first complaint); *Thales Airborne Sys. v. Univ. Avionics Sys.*, No. Civ. 05-853-SLR, 2006 WL 1749399 (D. Del. June 21, 2006) (applying the first-filed rule to parallel actions commenced only one hour apart); *Chase Manhattan Bank, USA v. Freedom Card, Inc.*, 265 F. Supp. 2d 445, 447, 451 (D. Del. 2003) (applying the first-filed rule to parallel actions commenced only one and a half hours apart); *Datex-Ohmeda Inc. v. Hill-ROM Services, Inc.*, 185 F. Supp. 2d 507, 408, 412 (D. Del. 2002) (applying first filed rule to parallel cases filed on the same day); *Matsushita Battery Industrial Co. v. Energy Conversion Devices, Inc.*, No. Civ. A. 96-101-SLR, 1996 WL 328594, at * 1,

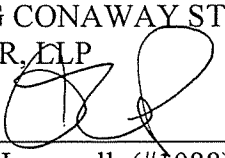
*2-3 (D. Del. Apr. 23, 1996) (granting declaratory plaintiff's motion to enjoin an infringement action filed one day after the declaratory action).

Plaintiffs ignore controlling Delaware case law in their brief, preferring to cite cases from New York and West Virginia without explaining why this Court should ignore its own precedent. This Court should not base its decision on such a distortion of the law.

IV. CONCLUSION

For the reasons set forth above, the Court should grant Defendant's Motion to Dismiss, Transfer, or Stay this action.

YOUNG CONAWAY STARGATT & TAYLOR, LLP



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Dated: April 16, 2007

CERTIFICATE OF SERVICE

I, Adam Poff, Esquire, hereby certify that on April 16, 2007, I caused to be electronically filed a true and correct copy of the foregoing document with the Clerk of the Court using CM/ECF, which will send notification that such filing is available for viewing and downloading to the following counsel of record:

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MORRIS, NICHOLS, ARSHT & TUNNELL
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Wilmington, DE 19801
tgrimm@mnat.com

I further certify that I caused a copy of the foregoing document to be served by hand delivery and e-mail on the above-listed counsel of record and on the following counsel in the manner indicated below:

By E-Mail

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/S/ ADAM W. POFF (NO. 3990)

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Wilmington, Delaware 19801
(302) 571-6600
Attorneys for Defendant

EXHIBIT A

United States Patent and Trademark Office

Assignments on the Web > Patent Query

Patent Assignment Abstract of Title

NOTE:Results display only for issued patents and published applications. For pending or abandoned applications please consult USPTO staff.

Total Assignments: 2

Patent #: 6981883 **Issue Dt:** 01/03/2006 **Application #:** 10918565 **Filing Dt:** 08/13/2004

Publication #: US20050020109 **Pub Dt:** 01/27/2005

Inventors: Alan Raistrick, Joseph B. Shuey

Title: IMPEDANCE CONTROL IN ELECTRICAL CONNECTORS

Assignment: 1

Reel/Frame: 015692/0345 **Recorded:** 08/13/2004 **Pages:** 4

Conveyance: ASSIGNMENT OF ASSIGNORS INTEREST (SEE DOCUMENT FOR DETAILS).

Assignors: RAISTRICK, ALAN **Exec Dt:** 08/05/2004

SHUEY, JOSEPH B. **Exec Dt:** 08/05/2004

Assignee: FCI AMERICAS TECHNOLOGY, INC.
ONE EAST FIRST STREET
RENO, NEVADA 89501

Correspondent: WOODCOCK WASHBURN LLP
JOSEPH R. CONDO
ONE LIBERTY PLACE - 46TH FLOOR
PHILADELPHIA, PA 19103-7301

Assignment: 2

Reel/Frame: 017400/0192 **Recorded:** 03/31/2006 **Pages:** 29

Conveyance: SECURITY AGREEMENT

Assignor: FCI AMERICAS TECHNOLOGY, INC. **Exec Dt:** 03/31/2006

Assignee: BANC OF AMERICA SECURITIES LIMITED, AS SECURITY AGENT
5 CANADA SQUARE
LONDON, UNITED KINGDOM E14 5AQ

Correspondent: KIRKLAND & ELLIS LLP
200 EAST RANDOLPH DRIVE
DONNA GASIOROWSKI, SR. LEGAL ASSISTANT
CHICAGO, IL 60601

Search Results as of: 04/06/2007 03:49 PM
If you have any comments or questions concerning the data displayed, contact PRD / Assignments at 571-272-3350.
Web interface last modified: February 22, 2007 v.2.0



United States Patent and Trademark Office



Assignments on the Web > Patent Query

Patent Assignment Abstract of Title

NOTE:Results display only for issued patents and published applications. For pending or abandoned applications please consult USPTO staff.

Total Assignments: 4

Patent #: 7114964 **Issue Dt:** 10/03/2006 **Application #:** 11052167 **Filing Dt:** 02/07/2005

Publication #: US20050287849 **Pub Dt:** 12/29/2005

Inventors: Joseph B. Shuey, Timothy A. Lemke, Gregory A. Hull, Stephen B. Smith et al

Title: CROSS TALK REDUCTION AND IMPEDANCE MATCHING FOR HIGH SPEED ELECTRICAL CONNECTORS

Assignment: 1

Reel/Frame: 018056/0649 **Recorded:** 08/04/2006 **Pages:** 4

Conveyance: ASSIGNMENT OF ASSIGNORS INTEREST (SEE DOCUMENT FOR DETAILS).

Assignor: LEMKE, TIMOTHY A. **Exec Dt:** 01/20/2003

Assignee: FCI AMERICAS TECHNOLOGY, INC.
ONE EAST FIRST STREET
RENO, NEVADA 89501

Correspondent: WOODCOCK WASHBURN LLP
ONE LIBERTY PLACE
46TH FLOOR
PHILADELPHIA, PA 19103

Assignment: 2

Reel/Frame: 018056/0737 **Recorded:** 08/04/2006 **Pages:** 4

Conveyance: ASSIGNMENT OF ASSIGNORS INTEREST (SEE DOCUMENT FOR DETAILS).

Assignor: SERCU, STEFAAN **Exec Dt:** 01/20/2003

Assignee: FCI AMERICAS TECHNOLOGY, INC.
ONE EAST FIRST STREET
RENO, NEVADA 89501

Correspondent: WOODCOCK WASHBURN LLP
ONE LIBERTY PLACE
46TH FLOOR
PHILADELPHIA, PA 19103

Assignment: 3

Reel/Frame: 018056/0632 **Recorded:** 08/04/2006 **Pages:** 6

Conveyance: ASSIGNMENT OF ASSIGNORS INTEREST (SEE DOCUMENT FOR DETAILS).

Assignors: WININGS, CLIFFORD L. **Exec Dt:** 01/29/2003
SHUEY, JOSEPH B. **Exec Dt:** 01/29/2003
HULL, GREGORY A. **Exec Dt:** 01/29/2003
SMITH, STEPHEN B. **Exec Dt:** 01/29/2003
HOUTZ, TIMOTHY **Exec Dt:** 01/29/2003

Assignee: FCI AMERICAS TECHNOLOGY, INC.
ONE EAST FIRST STREET

RENO, NEVADA 89501

Correspondent: WOODCOCK WASHBURN LLP
ONE LIBERTY PLACE
46TH FLOOR
PHILADELPHIA, PA 19103

Assignment: 4

Reel/Frame: 017400/0192 **Recorded:** 03/31/2006 **Pages:** 29

Conveyance: SECURITY AGREEMENT

Assignor: FCI AMERICAS TECHNOLOGY, INC. **Exec Dt:** 03/31/2006

Assignee: BANC OF AMERICA SECURITIES LIMITED, AS SECURITY AGENT
5 CANADA SQUARE
LONDON, UNITED KINGDOM E14 5AQ

Correspondent: KIRKLAND & ELLIS LLP
200 EAST RANDOLPH DRIVE
DONNA GASIOROWSKI, SR. LEGAL ASSISTANT
CHICAGO, IL 60601

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Web interface last modified: February 22, 2007 v.2.0

EXHIBIT B

1 of 100 DOCUMENTS

THIS DATA IS FOR INFORMATIONAL PURPOSES ONLY

CERTIFICATION CAN ONLY BE OBTAINED THROUGH THE ISSUING GOVERNMENT AGENCY

NEVADA SECRETARY OF STATE

Company Name: FCI AMERICAS TECHNOLOGY, INC.

Type: Domestic Corporation

Status: Active

Standing: CURRENTLY IN GOOD STANDING

Status Date: 2/22/2006

Filing Date: 1/22/1993

State or Country of Incorporation: NEVADA

Registered Agent:
CORPORATION TRUST COMPANY OF NEVADA
Creation Date: 1/22/1993

Registered Office:
6100 NEIL ROAD
STE 500
RENO, NEVADA 89511

Filing Number: C613-1993

Stock Information:
Shares Issued: 1,000
Par Value: $ 0.01

Officers, Directors:
JEAN-LUCIEN LAMY
Director
145 RUE YVES LE COZ
VERSAILLES 78035

JEAN-LUCIEN LAMY
President
145 RUE YVES LE COZ
VERSAILLES 78035

B JILL STEPS

NEVADA SECRETARY OF STATE

Secretary
145 RUE YVES LE COZ
VERSAILLES 78035

B JILL STEPS
Secretary
825 OLD TRAIL ROAD
ETTERS, PENNSYLVANIA 17319

DONALD J CALLAHAN
Treasurer
145 RUE YVES LE COZ
VERSAILLES 78035

DONALD J CALLAHAN
Treasurer
28100 CABOT #100
NOVI, MICHIGAN 48377

History:

File Date: 1/22/1993
Transaction: Articles of Incorporation

File Date: 10/29/1999
Comments: CORPORATION TRUST COMPANY OF NEVAD KFA ONE EAST FIRST STREET RENO
Transaction: Resident Agent Address Change

File Date: 6/11/1999
Comments: (1)PG. MMR BERG TECHNOLOGY, INC. MMRB 00001
Transaction: Amendment

File Date: 1/27/2005
Comments: List of Officers for 2005 to 2006
Transaction: Annual List

File Date: 2/21/2006
Transaction: Annual List

EXHIBIT C

Complaints and Other Initiating Documents

3:07-cv-00039 Molex Incorporated v. FCI Americas Technology Inc.

United States District Court

District of Nevada

Notice of Electronic Filing

The following transaction was received from Wilson, Thomas R entered on 1/25/2007 at 1:56 PM PST and filed on 1/25/2007

Case Name: Molex Incorporated v. FCI Americas Technology Inc.
Case Number: 3:07-cv-39
Filer: Molex Incorporated
Document Number: 1

Docket Text:
COMPLAINT against FCI Americas Technology Inc. (Filing fee $ 350 receipt number 464371), filed by Molex Incorporated. Certificate of Interested Parties due by 2/4/2007. (Attachments: # (1) Exhibit Exhibit C# (2) Exhibit Exhibit C-E)(Wilson, Thomas)

The following document(s) are associated with this transaction:

Document description: Main Document
Original filename: n/a
Electronic document Stamp:
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Document description: Exhibit Exhibit C
Original filename: n/a
Electronic document Stamp:
[STAMP dcecfStamp_ID=1101333072 [Date=1/25/2007] [FileNumber=3343154-1
] [11387b75a3ce52c056911652262c032e8fb2a25807f17a62614a8ef918c94c88829
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Document description: Exhibit Exhibit C-E
Original filename: n/a
Electronic document Stamp:
[STAMP dcecfStamp_ID=1101333072 [Date=1/25/2007] [FileNumber=3343154-2
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3:07-cv-39 Notice will be electronically mailed to:

3:07-cv-39 Notice will be delivered by other means to:

John F.. Murtha
Woodburn and Wedge
6100 Neil Road #500
Reno, NV 89505

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Facsimile: (775) 788-2020

Attorneys for Plaintiff Molex Incorporated

IN THE UNITED STATES DISTRICT COURT

FOR THE DISTRICT OF NEVADA

* * * * *

MOLEX INCORPORATED, a Delaware corporation,

Plaintiffs,

v.

FCI AMERICAS TECHNOLOGY INC., a Nevada corporation,

Defendants.

Case No._____

COMPLAINT

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P.O. BOX 2670 • RENO, NEVADA 89505-2670
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Plaintiff Molex Incorporated ("Molex"), by its attorneys, and as and for its Complaint against defendant FCI Americas Technology, Inc. ("FCI"), alleges and states as follows:

NATURE OF ACTION

This action arises under the Declaratory Judgment Act, 28 U S C §§ 2201 and 2202 and the patent laws of the United States, Title 35 U.S.C § 1 et seq

THE PARTIES

Plaintiff Molex is a corporation organized and existing under the laws of the State of Delaware, having a principal place of business at 2222 Wellington Court, Lisle, Illinois 60532-1682

Upon information and belief, defendant FCI is a corporation organized and existing under the laws of the State of Nevada, having a principal place of business at One East First Street, Reno, Nevada, 89501

JURISDICTION AND VENUE

This is an action for a declaratory judgment of non-infringement and invalidity. This Court has subject matter jurisdiction pursuant to 28 U.S.C §§ 1331, 1338(a) and 2201(a)

This Court has personal jurisdiction over FCI FCI is citizen of and is qualified to do business in the State of Nevada, and has an agent for the service of judicial process in this District Upon information and belief, FCI also is a resident of and has a regular and established place of business in this District at One East First Street, Reno, Nevada, 89501, and is and has been doing business in this District at all times relevant hereto

Venue is proper in this judicial district pursuant to 28 U S.C. §§ 1391(a)-(c)

GENERAL ALLEGATIONS

On information and belief, FCI claims to own a family of United States patents and patent applications that are all based on two patent applications filed in 2001 and 2002, respectively

The patent family, as shown in Exhibit A, currently consists of eight issued patents and eight pending patent applications, two of which are allowed and have had the issue fees paid

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FCI has broadly asserted that the patents in this family give it exclusive patent rights to shieldless high speed backplane connectors

In 2006, FCI filed a patent infringement suit in the United States against a mutual competitor of Molex and FCI asserting that that company's manufacture and sale of shieldless high speed backplane connectors infringed three of the patents in this family

At the time FCI filed suit against the mutual competitor for infringement, upon information and belief, FCI notified the industry including at least one customer of Molex that FCI planned to enforce its patents covering shieldless high speed backplane connectors and did not intend to license those patents for products other than FCI's AirMax products

Specifically, FCI claims to be the owner of U S Patent Nos 6,981,883 (the "'883 patent") and 7,114,964 (the "'964 patent"). They are appended hereto as Exhibits B and C, respectively

An actual controversy exists between the parties hereto regarding the non-infringement and invalidity of the '883 and '964 patents

In addition, FCI claims to be the owner of U S Patent Application Nos 11/326,011 (the "011 application") and 11/326,175 (the "'175 application").

On December 28, 2006, the U S Patent and Trademark Office mailed a Notice of Allowance with respect to claims 1-52 of the '011 application The issue fee for that application was paid on January 4, 2007, and the '011 application presently is proceeding to issuance On December 28, 2006, the U S Patent and Trademark Office mailed a Notice of Allowance with respect to claims 28, 29, and 31-37 of the '175 application The issue fee for that application was paid on January 4, 2007, and the '175 application presently is proceeding to issuance. The allowed claims for the '011 and '175 application are appended hereto as Exhibits D and E, respectively

An actual controversy will exist between the parties hereto regarding the noninfringement and invalidity of the allowed claims of the '011 and '175 applications upon issuance of those applications

Molex manufactures, sells, and offers for sale, shieldless high speed backplane connectors under the name I-Trac in direct competition with FCI's AirMax products

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Upon information and belief, FCI has made allegations to the industry including at least one customer of Molex that Molex's manufacture and sale of I-Trac connectors is allegedly infringing one or more of its patents covering shieldless high speed backplane connectors

Upon information and belief, FCI has asserted to the industry including at least one customer of Molex that FCI intends to sue Molex for infringement of one or more of its patents covering shieldless high speed backplane connectors

FCI has made allegations to representatives of Molex that Molex's manufacture and sale of I-Trac connectors is infringing the '883 and '964 patents, and that Molex by virtue of those actions will also infringe the claims of at least the allowed '011 application upon its issuance.

FCI's conduct has created on the part of Molex a reasonable apprehension that it will be faced with a patent infringement action by FCI if it continues to manufacture and/or sell its accused I-Trac connectors

The terms and conditions under which FCI has offered to license Molex's I-Trac connectors under its patents, including the '883 and '964 patents, are not commercially viable and if accepted by Molex would prevent Molex from competing effectively in the marketplace with its I-Trac product

Molex has preliminarily explained to FCI why Molex's I-Trac connectors do not infringe the '883 and '964 patents Nevertheless, FCI continues to assert that Molex, by its manufacture and sale of I-Trac connectors, has infringed and continues to infringe the '883 and '964 patents, and that those activities will infringe the allowed claims of at least the '011 application upon its issuance

Based on FCI's actions and statements to date, Molex has a current, real, reasonable and imminent apprehension that FCI will file a civil action against Molex charging infringement of the '883 and '964 patents based upon its manufacture, sale, and/or offer for sale of Molex's I-Trac connectors, and, upon their issuance, bring suit for patent infringement of the patents issuing on the allowed '011 and '175 applications.

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As a result of FCI's actions and statements, an actual justiciable controversy regarding the non-infringement and invalidity of at least the '883 and '964 patents now exists by virtue of Molex's continuing manufacture, sale, and/or offer for sale of its I-Trac connectors.

COUNT ONE

DECLARATORY JUDGMENT OF

NON-INFRINGEMENT OF THE '883 PATENT

Molex repeats and realleges the averments of paragraphs 1-25 as if fully set forth herein

There is an actual controversy between Molex and FCI as to the non-infringement of the claims of the '883 patent

Molex's manufacture, sale, and/or offer for sale of its I-Trac connectors has not infringed and does not infringe the claims of the '883 patent.

COUNT TWO

DECLARATORY JUDGMENT OF

NON-INFRINGEMENT OF THE '964 PATENT

Molex repeats and realleges the averments of paragraphs 1-28 as if fully set forth herein

There is an actual controversy between Molex and FCI as to the non-infringement of the claims of the '964 patent.

Molex's manufacture, sale, and/or offer for sale of its I-Trac connectors has not infringed and does not infringe the claims of the '964 patent

COUNT THREE

DECLARATORY JUDGMENT OF

INVALIDITY OF THE '883 PATENT

Molex repeats and realleges the averments of paragraphs 1-31 as if fully set forth herein

There is an actual controversy between Molex and FCI as to the invalidity of the '883 patent

To the extent that Molex's I-Trac connectors are asserted to infringe one or more claims of the '883 patent, those claims are, upon information and belief, invalid for failure to comply

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with the patent laws of the United States, including the requirements of one or more of the provisions of 35 U S C. §§ 102, 103, and 112

COUNT FOUR

DECLARATORY JUDGMENT OF

INVALIDITY OF THE '964 PATENT

Molex repeats and realleges the averments of paragraphs 1-34 as if fully set forth herein

There is an actual controversy between Molex and FCI as to the invalidity of the '964 patent

To the extent that Molex's I-Trac connectors are asserted to infringe one or more claims of the '964 patent, those claims are, upon information and belief, invalid for failure to comply with the patent laws of the United States, including the requirements of one or more of the provisions of 35 U S C. §§ 102, 103, and 112

PRAYER FOR RELIEF

WHEREFORE, plaintiff Molex respectfully requests that this Court enter judgment against FCI, including:

a a declaration that Molex's manufacture, sale, and/or offer for sale of its I-Trac connector products has not infringed and is not infringing the claims of the '883 and '964 patents;

b a declaration that each claim asserted to be infringed of the '883 and '964 patents is invalid;

c an injunction prohibiting FCI from alleging that Molex's manufacture, sale, and/or offer for sale of its I-Trac connector products infringes of the claims of the '883 and '964 patents by Molex;

d an award of costs and attorneys fees and other expenses Molex has been forced to incur; and

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P.O. BOX 2670 • RENO, NEVADA 89505-1670
PHONE 775-788-2000 • FAX 775-788-2020

e such further relief as this Court may deem just and proper

Dated this 25th day of January, 2007

Respectfully submitted:

Thomas R. C. Wilson, Esq.
Nevada State Bar #1568
McDonald Carano Wilson LLP
100 W. Liberty Street, 10th Floor
P.O. Box 2670
Reno, NV 89505-2670
Telephone: (775) 788-2000
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EXHIBIT "A"

EXHIBIT "A"

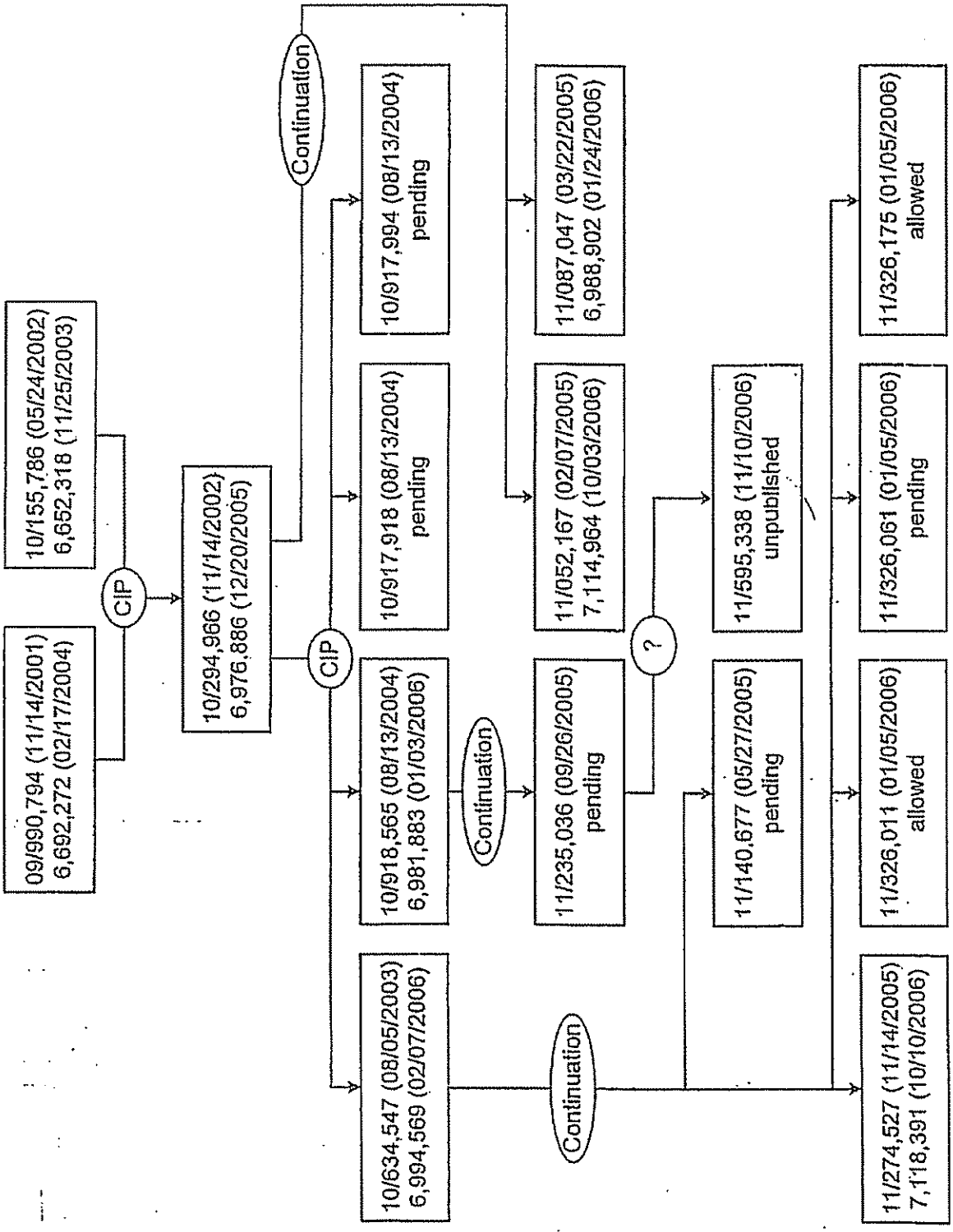

09/990,794 (11/14/2001)
6,692,272 (02/17/2004)
10/155,786 (05/24/2002)
6,652,318 (11/25/2003)
CIP
10/294,966 (11/14/2002)
6,976,886 (12/20/2005)
Continuation
CIP
10/917,994 (08/13/2004)
pending
11/087,047 (03/22/2005)
6,988,902 (01/24/2006)
10/917,918 (08/13/2004)
pending
11/052,167 (02/07/2005)
7,114,964 (10/03/2006)
10/918,565 (08/13/2004)
6,981,883 (01/03/2006)
Continuation
11/235,036 (09/26/2005)
pending
?
11/595,338 (11/10/2006)
unpublished
11/326,061 (01/05/2006)
pending
11/326,175 (01/05/2006)
allowed
10/634,547 (08/05/2003)
6,994,569 (02/07/2006)
Continuation
11/140,677 (05/27/2005)
pending
11/326,011 (01/05/2006)
allowed
11/274,527 (11/14/2005)
7,118,391 (10/10/2006)

EXHIBIT "B"

EXHIBIT "B"



(12) **United States Patent**
Raistrick et al.

(10) Patent No.: US 6,981,883 B2
(45) Date of Patent: Jan. 3, 2006

(54) IMPEDANCE CONTROL IN ELECTRICAL CONNECTORS

(75) Inventors: Alan Raistrick, Rockville, MD (US); Joseph B. Shuey, Camp Hill, PA (US)

(73) Assignee: FCI Americas Technology, Inc., Reno, NV (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U S C 154(b) by 0 days

(21) Appl No : 10/918,565

(22) Filed: Aug. 13, 2004

(65) Prior Publication Data

US 2005/0020109 A1 Jan 27, 2005

Related U S. Application Data

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(51) Int. Cl.
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(52) U.S. Cl. ... 439/74

(58) Field of Classification Search 439/74, 439/75, 79, 701, 941, 608, 715
See application file for complete search history

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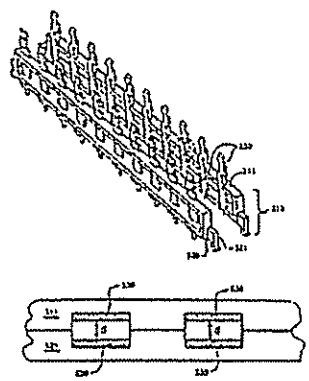
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(57) ABSTRACT

The invention provides a high speed connector wherein differential signal pairs are arranged so as to limit the level of cross talk between adjacent differential signal pairs The connector comprises lead frame assembly having a pair of overmolded lead frame housings Each lead frame housing has a respective signal contact extending therethrough The lead frame housings may be operatively coupled such that the signal contacts form a broadside-coupled differential signal pair The contacts may be separated by a gap having a gap width that enables insertion loss and cross talk between signal pairs to be limited

31 Claims, 13 Drawing Sheets



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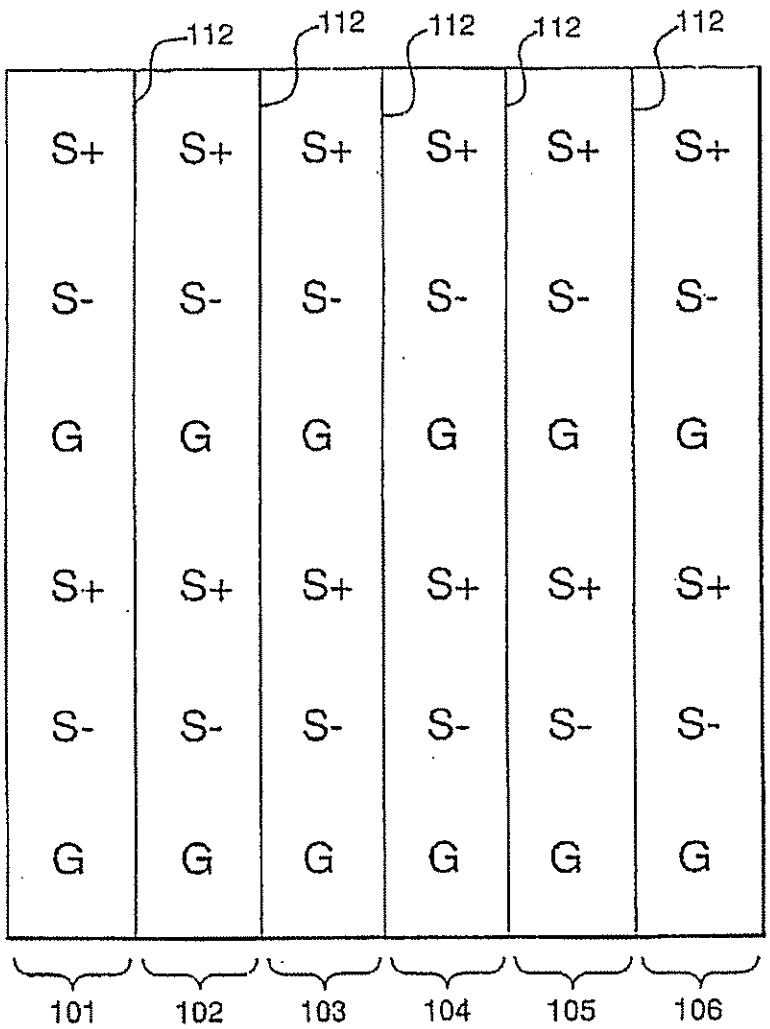


FIG. 1A
(PRIOR ART)

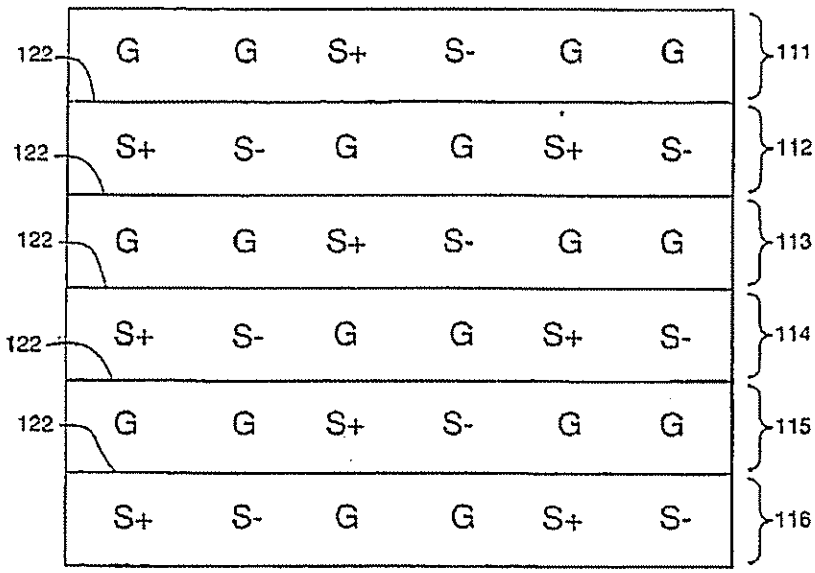


FIG. 1B
(PRIOR ART)

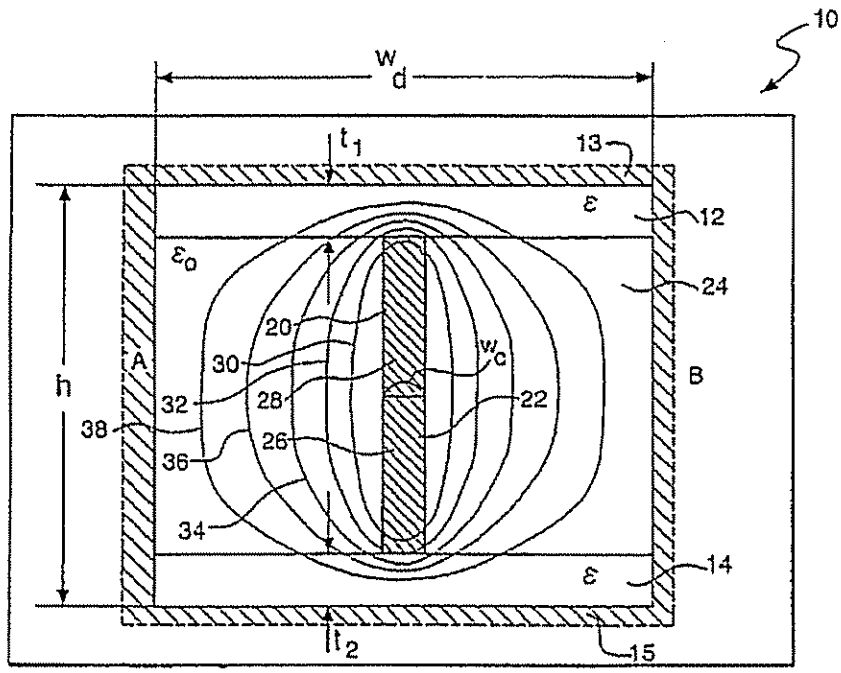


FIG. 2A
(PRIOR ART)

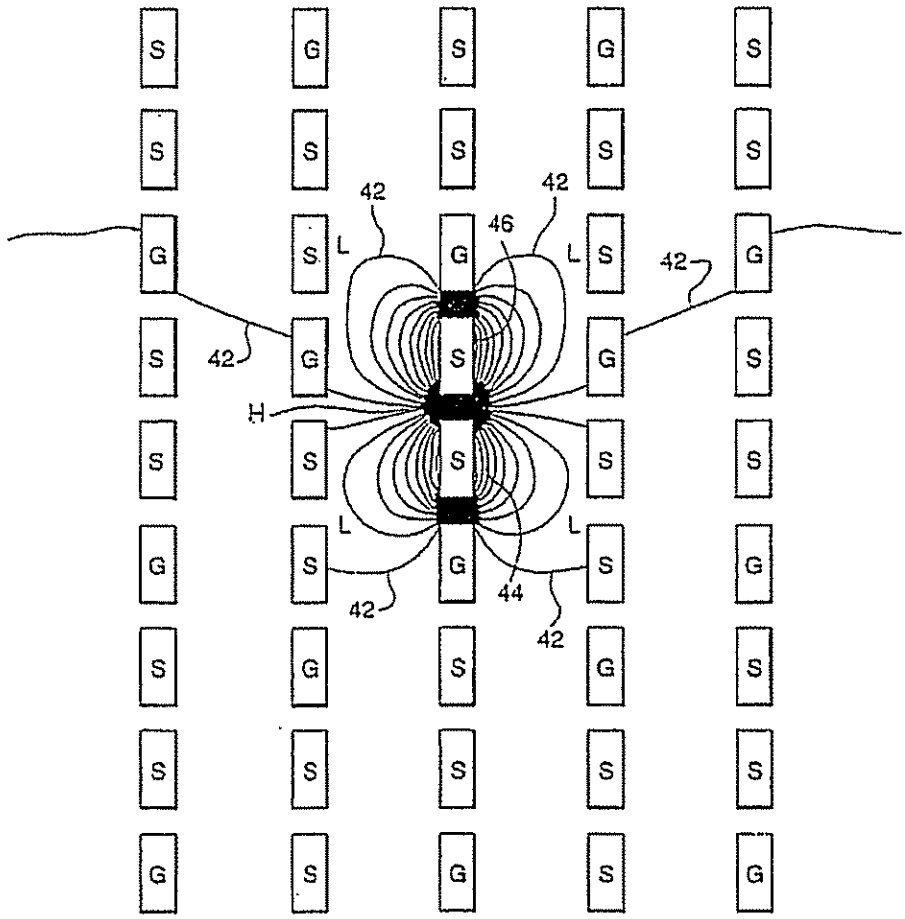


FIG. 2B

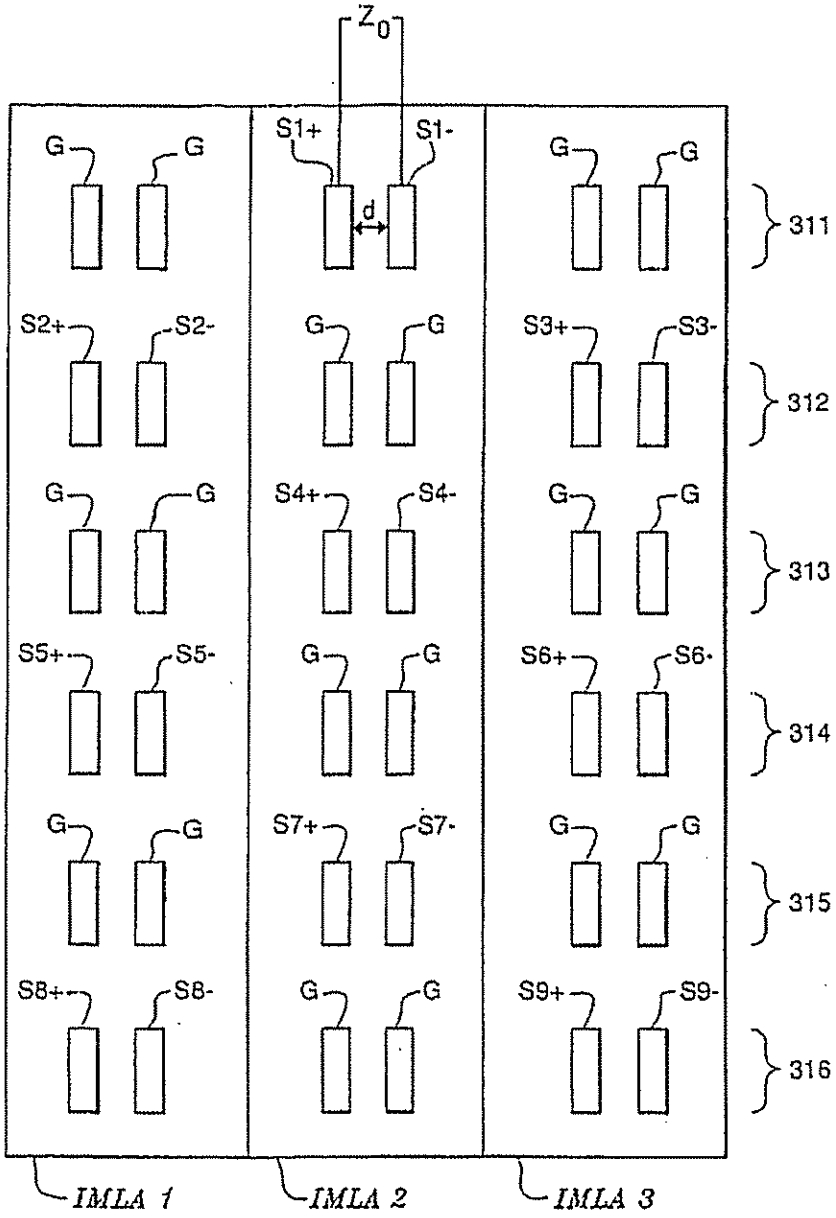

Z0
G
S1+
S1-
d
311
S2+
S2-
312
S3+
S3-
S4+
S4-
313
S5+
S5-
314
S6+
S6-
S7+
S7-
315
S8+
S8-
316
S9+
S9-
IMLA 1
IMLA 2
IMLA 3

FIG. 3

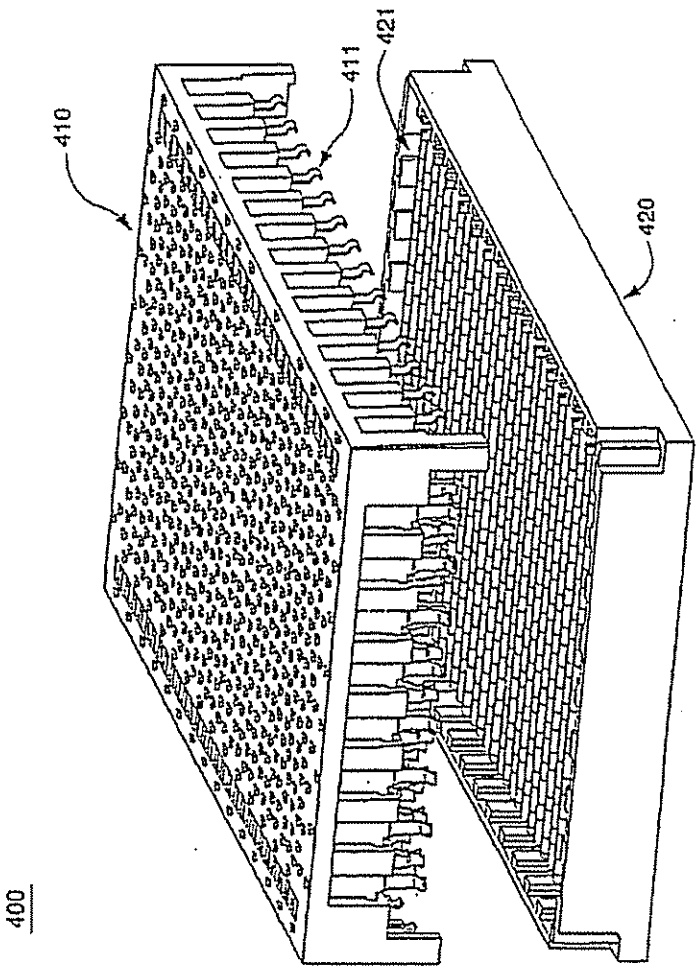


FIG. 4

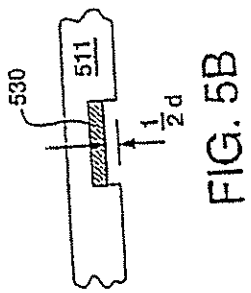


FIG. 5B

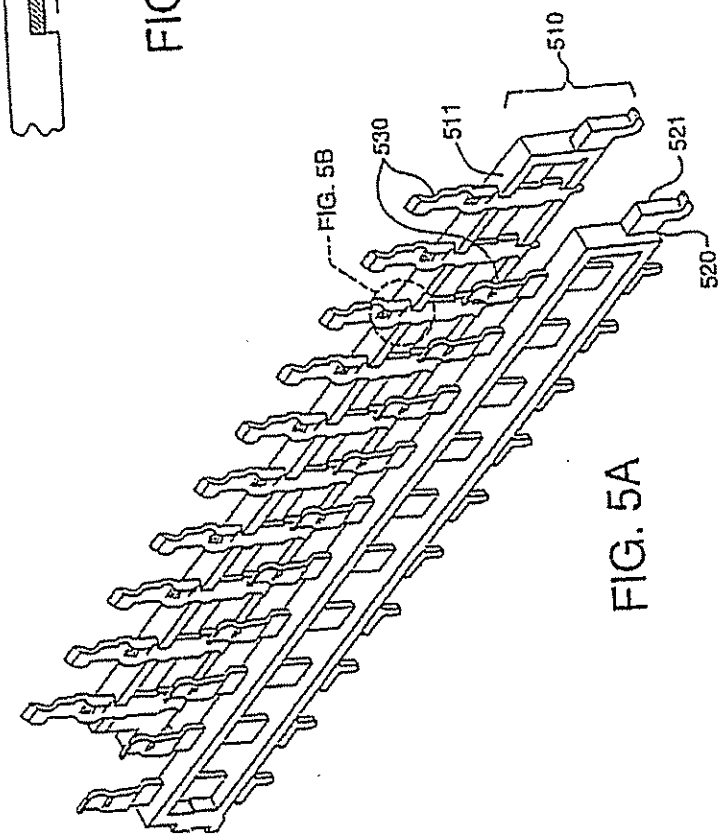


FIG. 5A

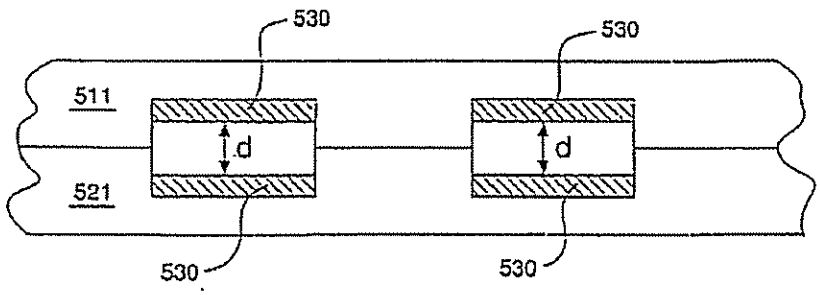


FIG. 5C

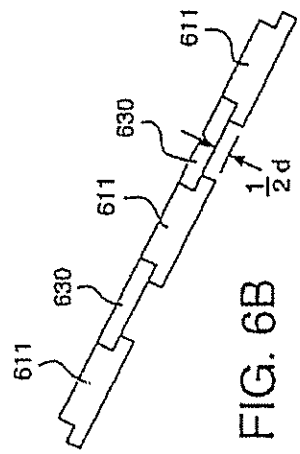


FIG. 6B

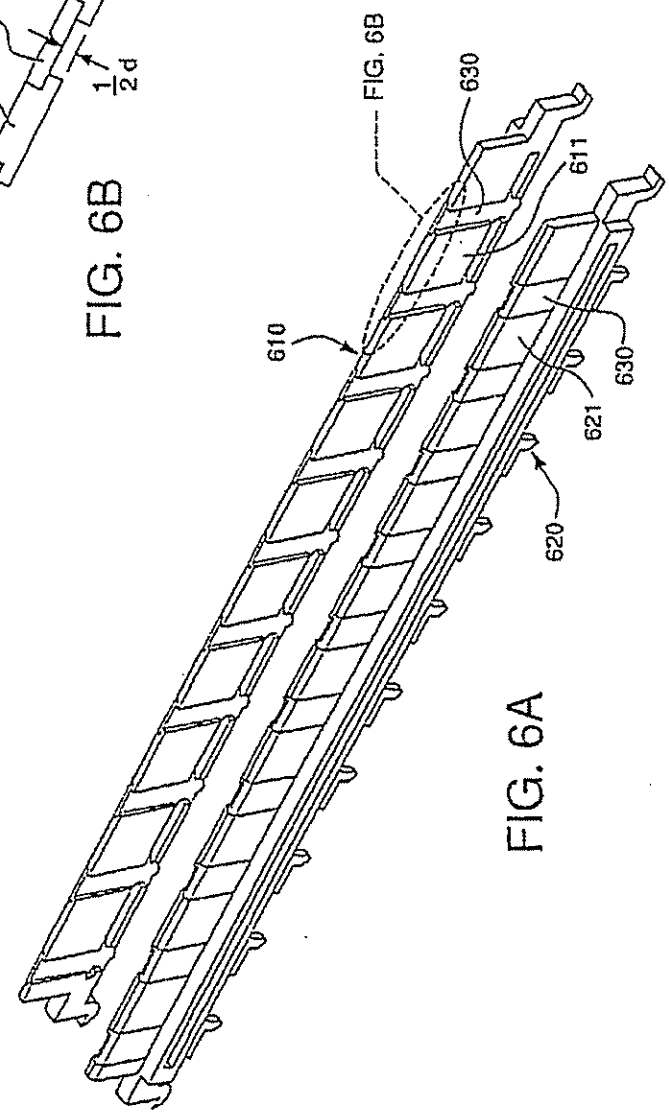


FIG. 6A

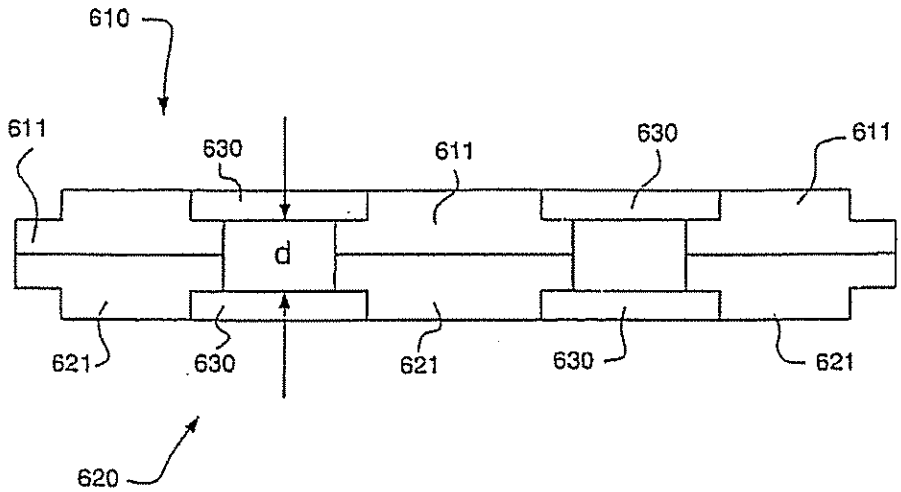


FIG. 6C

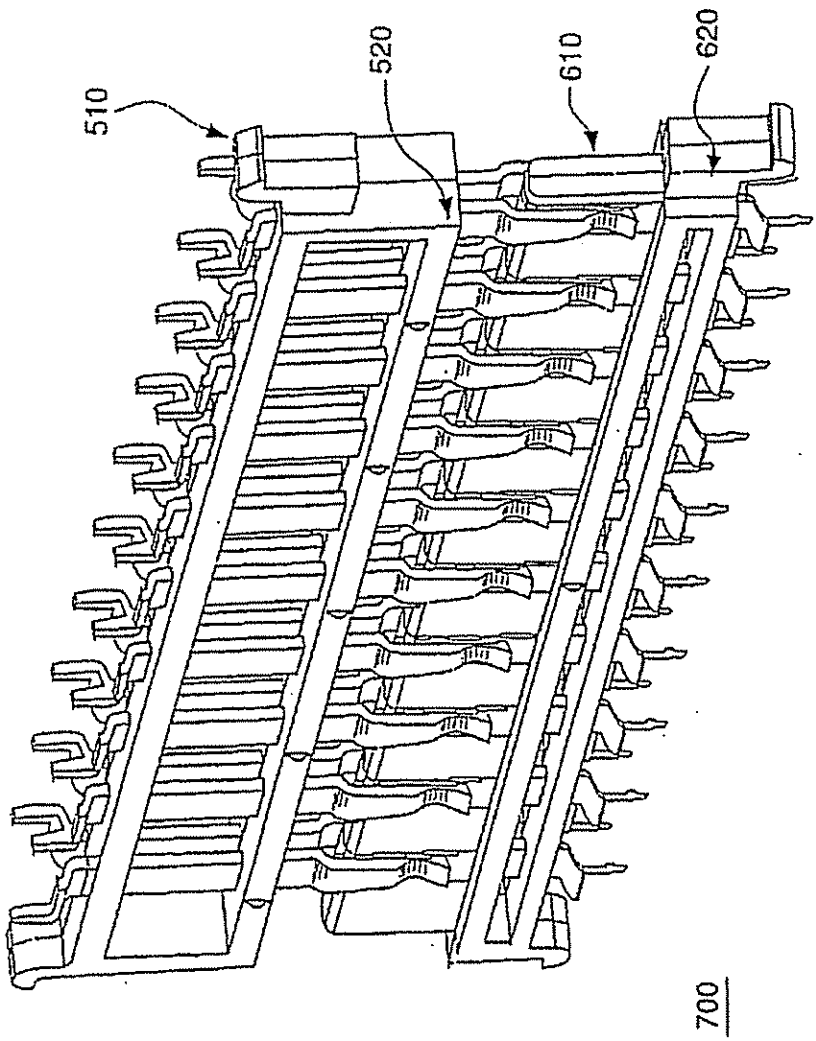


FIG. 7

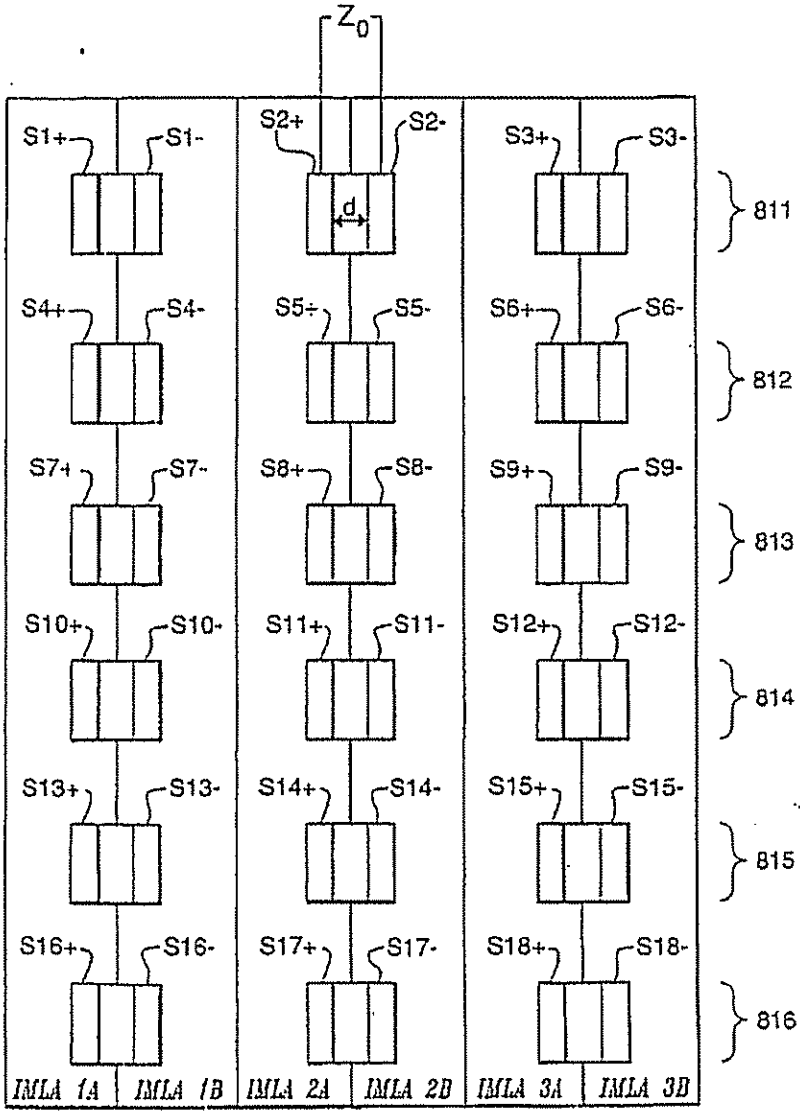

Z0
S1+
S1-
S2+
S2-
S3+
S3-
d
811
S4+
S4-
S5+
S5-
S6+
S6-
812
S7+
S7-
S8+
S8-
S9+
S9-
813
S10+
S10-
S11+
S11-
S12+
S12-
814
S13+
S13-
S14+
S14-
S15+
S15-
815
S16+
S16-
S17+
S17-
S18+
S18-
816
IMLA 1A
IMLA 1B
IMLA 2A
IMLA 2B
IMLA 3A
IMLA 3B

FIG. 8A

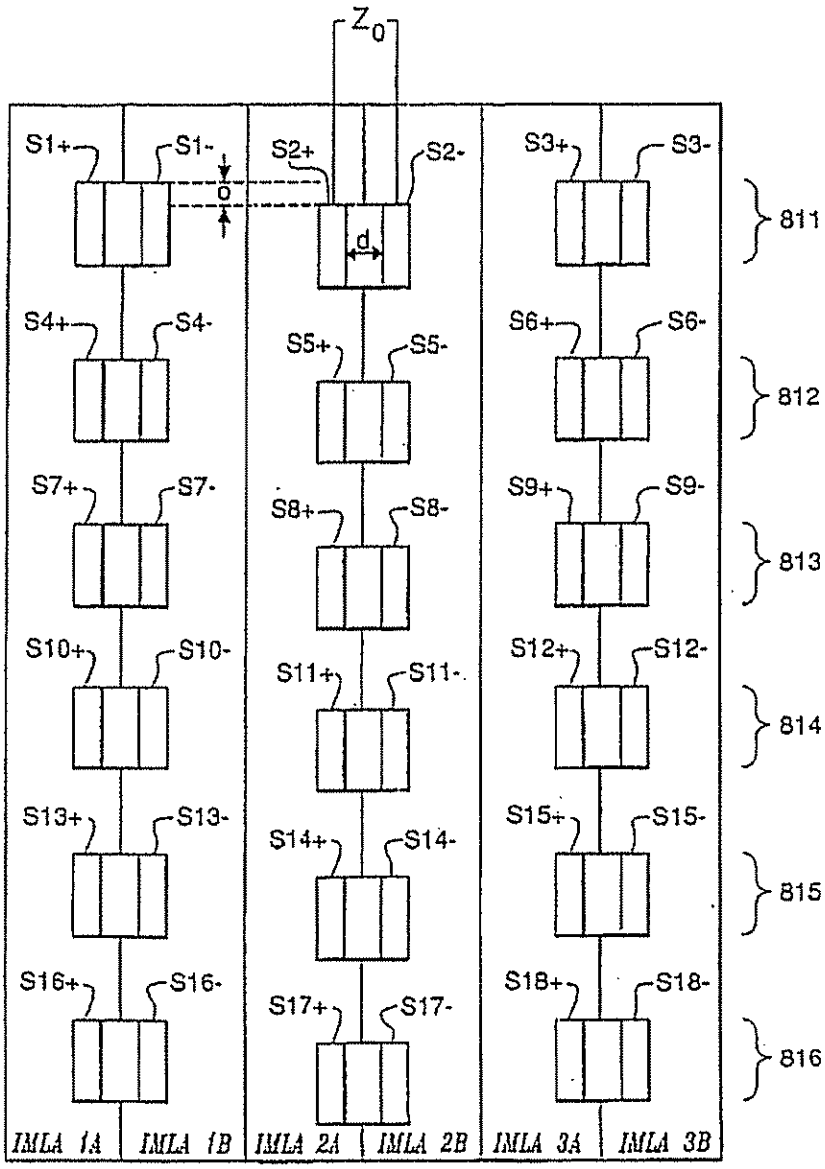

Z0
S1+
S1-
o
S2+
S2-
d
S3+
S3-
811
S4+
S4-
S5+
S5-
S6+
S6-
812
S7+
S7-
S8+
S8-
S9+
S9-
813
S10+
S10-
S11+
S11-
S12+
S12-
814
S13+
S13-
S14+
S14-
S15+
S15-
815
S16+
S16-
S17+
S17-
S18+
S18-
816
IMLA 1A
IMLA 1B
IMLA 2A
IMLA 2B
IMLA 3A
IMLA 3B

FIG. 8B

IMPEDANCE CONTROL IN ELECTRICAL CONNECTORS

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of co-pending U.S. patent application Ser. No 10/294,966, filed Nov 14, 2002, which is a continuation-in-part of U.S. patent application Ser. No. 09/990,794, filed Nov 14, 2001, now U.S Pat Nos. 6,692,272, and 10/155,786, filed May 24, 2002, now U S. Pat No 6,652,318 The contents of each of the above-referenced U.S. patents and patent applications is herein incorporated by reference in its entirety

FIELD OF THE INVENTION

Generally, the invention relates to the field of electrical connectors. More particularly, the invention relates to an impedance-controlled insert molded leadframe assembly ("IMLA") in a "split" configuration

BACKGROUND OF THE INVENTION

Electrical connectors provide signal connections between electronic devices using signal contacts. Often, the signal contacts are so closely spaced that undesirable interference, or "cross talk;" occurs between adjacent signal contacts As used herein, the term "adjacent" refers to contacts (or rows or columns) that are next to one another Cross talk occurs when one signal contact induces electrical interference in an adjacent signal contact due to intermingling electrical fields, thereby compromising signal integrity With electronic device miniaturization and high speed, high signal integrity electronic communications becoming more prevalent, the reduction of cross talk becomes a significant factor in connector design

One commonly used technique for reducing cross talk is to position separate electrical shields, in the form of metallic plates, for example, between adjacent signal contacts. Another commonly used technique to block cross talk between signal contacts is to place ground contacts amongst the signal contacts of a connector. The shields and ground contacts act to block cross talk between the signal contacts by blocking the intermingling of the contacts' electric fields. FIGS 1A and 1B depict exemplary contact arrangements for electrical connectors that use shields to block cross talk

FIG 1A depicts an arrangement in which signal contacts S and ground contacts G are arranged such that differential signal pairs S+, S− are positioned along columns 101–106. As can be seen in FIG 1A, the signal pairs are edge coupled (i.e., where the edge of one contact is adjacent to the edge of an adjacent contact) Shields 112 can be positioned between contact columns 101–105 A column 101–106 can include any combination of signal contacts S+, S− and ground contacts G The ground contacts G serve to block cross talk between differential signal pairs in the same column The shields 112 serve to block cross talk between differential signal pairs in adjacent columns

FIG. 1B depicts an arrangement in which signal contacts S and ground contacts G are arranged such that differential signal pairs S+, S− are positioned along rows 111–116. As can be seen in FIG. 1B, the signal pairs are broadside-coupled (i e , where the broad side of one contact is adjacent to the broad side of an adjacent contact) Shields 122 can be positioned between rows 111–116. A row 111–116 can include any combination of signal contacts S+, S− and ground contacts G The ground contacts G serve to block cross talk between differential signal pairs in the same row. The shields 122 serve to block cross talk between differential signal pairs in adjacent rows

Because of the demand for smaller, lower weight communications equipment, it is desirable that connectors be made smaller and lower in weight, while providing the same performance characteristics. Shields and ground contacts take up valuable space within the connector that could otherwise be used to provide additional signal contacts, and thus limit contact density (and, therefore, connector size). Additionally, manufacturing and inserting such shields and ground contacts substantially increase the overall costs associated with manufacturing such connectors For example, in some applications, shields are known to make up 40% or more of the cost of the connector Another known disadvantage of shields is that they lower impedance Thus, to make the impedance high enough in a high contact density connector, the contacts would need to be so small that they would not be robust enough for many applications Furthermore, ground contacts can take up a large percentage of the available contacts in a connector, thus causing an increase in size and weight of the connector for a given number of differential signal pairs

Therefore, a need exists for a lightweight, high-speed electrical connector that reduces the occurrence of cross talk without the need for separate shields or ground contacts, and provides for a variety of other benefits not found in prior art connectors More particularly, what is needed is an impedance-controlled insert molded leadframe assembly (IMLA) that maintains a distance between broadside coupled signal pairs such that cross-talk between signal pairs may be limited without the use of shields or ground contacts

SUMMARY OF THE INVENTION

The invention provides a high speed connector wherein differential signal pairs are arranged so as to limit the level of cross talk between adjacent differential signal pairs The connector comprises a plurality of signal contact pairs, where the contacts of each pair are separated by a gap The gap is formed over a distance such that insertion loss and cross talk between the plurality of signal contact pairs are limited. Thus, shields and/or ground contacts are not needed in an embodiment

In one embodiment, the connector may be comprised of a header leadframe assembly and a receptacle leadframe assembly Each leadframe assembly may include an overmolded housing and a set of contacts that extend through the housing Each leadframe assembly may be adapted to maintain the width of the gap between contacts that form a pair along respective portions of the contacts that extend through the housing

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is further described in the detailed description that follows, by reference to the noted drawings by way of non-limiting illustrative embodiments of the invention, in which like reference numerals represent similar parts throughout the drawings, and wherein:

FIGS 1A and 1B depict exemplary prior art contact arrangements for electrical connectors that use shields to block cross talk;

FIG 2A is a schematic illustration of a prior art electrical connector in which conductive and dielectric elements are arranged in a generally "I" shaped geometry;

FIG. 2B depicts equipotential regions within an arrangement of signal and ground contacts;

FIG 3 depicts a conductor arrangement in which signal pairs are arranged in rows;

FIG 4 depicts a mezzanine-style connector assembly in accordance with an example embodiment of the invention;

FIGS 5A-C depict a receptacle IMLA pair in accordance with an embodiment of the present invention;

FIGS 6A-C depict a header IMLA pair in accordance with an embodiment of the present invention;

FIG. 7 depicts a header and receptacle IMLA pair in operative communications in accordance with an embodiment of the present invention; and

FIGS 8A-B depict exemplary contact arrangements for an electrical connector in accordance with an embodiment of the present invention.

DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

The subject matter of the present invention is described with specificity to meet statutory requirements However, the description itself is not intended to limit the scope of this patent Rather, the inventors have contemplated that the claimed subject matter might also be embodied in other ways, to include different steps or elements similar to the ones described in this document, in conjunction with other present or future technologies Moreover, certain terminology may be used in the following description for convenience only and should not be considered as limiting the invention in any way. For example, the terms "top," "bottom," "left," "right," "upper," and "lower" designate directions in the figures to which reference is made Likewise, the terms "inwardly" and "outwardly" designate directions toward and away from, respectively, the geometric center of the referenced object The terminology includes the words above specifically mentioned, derivatives thereof, and words of similar import.

FIG. 2A is a schematic illustration of an electrical connector in which conductive and dielectric elements are arranged in a generally "I" shaped geometry Such connectors are embodied in the assignee's "I-BEAM" technology, and are described and claimed in U S Pat No. 5,741,144, entitled "Low Cross And Impedance Controlled Electric Connector," the disclosure of which is hereby incorporated herein by reference in its entirety. Low cross talk and controlled impedance have been found to result from the use of this geometry

The originally contemplated I-shaped transmission line geometry is shown in FIG 2A As shown, the conductive element can be perpendicularly interposed between two parallel dielectric and ground plane elements The description of this transmission line geometry as I-shaped comes from the vertical arrangement of the signal contact shown generally at numeral 10 between the two horizontal dielectric layers 12 and 14 having a dielectric constant ϵ and ground planes 13 and 15 symmetrically placed at the top and bottom edges of the conductor The sides 20 and 22 of the conductor are open to the air 24 having an air dielectric constant ϵ_0. In a connector application, the conductor could include two sections, 26 and 28, that abut end-to-end or face-to-face The thickness, t_1 and t_2 of the dielectric layers 12 and 14, to first order, controls the characteristic impedance of the transmission line and the ratio of the overall height h to dielectric width w_d controls the electric and magnetic field penetration to an adjacent contact Original experimentation led to the conclusion that the ratio h/w_d needed to minimize interference beyond A and B would be approximately unity (as illustrated in FIG. 2A).

The lines 30, 32, 34, 36 and 38 in FIG. 2A are equipotentials of voltage in the air-dielectric space. Taking an equipotential line close to one of the ground planes and following it out towards the boundaries A and B, it will be seen that both boundary A or boundary B are very close to the ground potential. This means that virtual ground surfaces exist at each of boundary A and boundary B. Therefore, if two or more I-shaped modules are placed side-by-side, a virtual ground surface exists between the modules and there will be little to no intermingling of the modules' fields In general, the conductor width w_c and dielectric thicknesses t_1, t_2 should be small compared to the dielectric width W_d or module pitch (i.e., distance between adjacent modules)

Given the mechanical constraints on a practical connector design, it was found in actuality that the proportioning of the signal contact (blade/beam contact) width and dielectric thicknesses could deviate somewhat from the preferred ratios and some minimal interference might exist between adjacent signal contacts. However, designs using the above-described I-shaped geometry tend to have lower cross talk than other conventional designs

In accordance with an embodiment of the invention, the basic principles described above were further analyzed and expanded upon and can be employed to determine how to even further limit cross talk between adjacent signal contacts Such analysis first addresses the need to remove shields from between the contacts by determining an appropriate arrangement and geometry of the signal and ground contacts. FIG 2B includes a contour plot of voltage in the neighborhood of an active column-based differential signal pair S+, S− in a contact arrangement of signal contacts S and ground contacts G according to the invention As shown, contour lines 42 are closest to zero volts, contour lines 44 are closest to −1 volt, and contour lines 46 are closest to +1 volt. It has been observed that, although the voltage does not necessarily go to zero at the "quiet" differential signal pairs that are nearest to the active pair, the interference with the quiet pairs is near zero. That is, the voltage impinging on the positive-going quiet differential pair signal contact is about the same as the voltage impinging on the negative-going quiet differential pair signal contact. Consequently, the noise on the quiet pair, which is the difference in voltage between the positive- and negative-going signals, is close to zero

Thus, as shown in FIG 2B, the signal contacts S and ground contacts G can be scaled and positioned relative to one another such that a differential signal in a first differential signal pair produces a high field H in the gap between the contacts that form the signal pair and a low (i e., close to ground potential) field L (close to ground potential) near an adjacent signal pair Consequently, cross talk between adjacent signal contacts can be limited to acceptable levels for the particular application In such connectors, the level of cross talk between adjacent signal contacts can be limited to the point that the need for (and cost of) shields between adjacent contacts is unnecessary, even in high speed, high signal integrity applications

Through further analysis of the above-described I-shaped model, it has been found that the unity ratio of height to width is not as critical as it first seemed It has also been found that a number of factors can affect the level of cross talk between adjacent signal contacts For example, it has been found that one such factor is the distance between the broadside-coupled contacts that form a differential signal pair In an embodiment, therefore, the careful control of the distance between the broadside-coupled contacts may be

used to maintain an appropriate differential impedance Z_0 so as to reduce cross talk between signal pairs Such a configuration is particularly suitable for mezzanine-style connectors, and such a connector will be discussed below in connection with FIGS 5A–8 However, it will be appreciated that the invention is not limited to mezzanine connectors, and may be employed in a variety of connector applications.

FIG. 3 depicts a conductor arrangement in which signal pairs and ground contacts are arranged in rows The conductor arrangement of FIG. 3 is shown for purposes of comparison, as the arrangement does not depict the "split IMLA" configuration to be discussed below in connection with FIGS. 4–8B As shown in FIG. 3, each row 311–316 comprises a repeating sequence of two ground contacts and a differential signal pair Row 311, for example, comprises, in order from left to right, two ground contacts G, a differential signal pair S1+, S1–, and two ground contacts G Row 312, for example, comprises, in order from left to right, a differential signal pair S2+, S2–, two ground contacts G, and a differential signal pair S3+, S3– In the embodiment shown in FIG. 3, it can be seen that the columns of contacts can be arranged as insert molded leadframe assemblies ("IMLAs"), such as IMLAs 1–3 The ground contacts may serve to block cross talk between adjacent signal pairs However, the ground contacts take up valuable space within the connector. As can be seen, the embodiment shown in FIG. 3 is limited to only nine differential signal pairs for an arrangement of 36 contacts because of the presence of the ground contacts.

Regardless of whether the signal pairs are arranged into rows (broadside-coupled) or columns (edge coupled), each differential signal pair has a differential impedance Z_0 between the positive and negative conductors of the differential signal pair. Differential impedance is defined as the impedance existing between two signal contacts of the same differential signal pair, at a particular point along the length of the differential signal pair As is well known, it is desirable to control the differential impedance Z_0 to match the impedance of the electrical device(s) to which the connector is connected Matching the differential impedance Z_0 to the impedance of an electrical device minimizes signal reflection and/or system resonance that can limit overall system bandwidth Furthermore, it is desirable to control the differential impedance Z_0 such that it is substantially constant along the length of the differential signal pair, i e , such that each differential signal pair has a substantially consistent differential impedance profile. The distance d of an air dielectric between the contacts that form a differential signal pair (such as signal contacts S1+ and S1–, for example) can determine the impedance Z_0 between each of the contacts

As noted above, the differential impedance profile can be controlled by the positioning of the signal and ground contacts. Specifically, differential impedance Z_0 can be determined by the proximity of an edge of a signal contact to an adjacent ground and by the gap distance d between edges of signal contacts within a differential signal pair However, and significantly, if a proper geometry of broadside-coupled differential signal pairs is attained by precisely maintaining the distance between the contacts of the signal pair, the cross talk between multiple differential signal pairs can be reduced to the point that ground contacts are unnecessary In other words, the signal quality that results from precisely maintaining an appropriate distance between broadside-coupled signal pairs is high enough to render any additional improvement in signal quality that may be gained by the presence of ground contacts either irrelevant for the connector's intended application, or not worth the attendant increase in size and/or weight of the connector

To maintain acceptable differential impedance Z_0 control for high bandwidth systems, it is desirable to control the gap distance d between contacts to within a few thousandths of an inch Gap variations beyond a few thousandths of an inch may cause unacceptable variation in the impedance profile; however, the acceptable variation is dependent on the speed desired, the error rate acceptable, and other design factors, any weighing or consideration of which is equally consistent with an embodiment of the present invention. When both contacts of a given signal pair are formed within the same IMLA, the distance d is difficulty to maintain at the levels of precision desired for establishing and maintaining a near-constant differential impedance Z_0

According to an embodiment of the invention, a "split" IMLA configuration is provided where each IMLA has two lengthwise housing halves, each half corresponding to a respective contact column. It will be appreciated in the discussion that follows that the placing of one contact of a signal pair in a recess of each portion of the lead frame assembly (e g , the header or receptacle portions of the IMLA) enables greater precision in maintaining the gap distance d between contacts As a result, the differential impedance Z_0 can be controlled so as to minimize cross-talk between signal pairs to such an extent as necessary to enable removal of the ground contacts.

Referring now to FIG 4, a mezzanine-style connector assembly in accordance with one embodiment of the invention is depicted. It will be appreciated that a mezzanine connector is a high-density stacking connector used for parallel connection of printed circuit boards and the like. Such a mezzanine connector can be used to relocate, for example, high pin count devices onto mezzanine or module cards to simplify board routing without compromising system performance. The mezzanine connector assembly 400 illustrated in FIG 4 comprises a receptacle 410 having receptacle grounds 411 arranged around the outside of the receptacle 410, and a header 420 having header grounds 421 arranged around the outside of the header 420. The header 420 also contains header IMLAs (not individually labeled in FIG. 4 for clarity) and the receptacle 410 contains receptacle IMLAs (also not individually labeled in FIG 4 for clarity). It will be appreciated that the receptacle 410 and header 420 can be mated to operatively connect the receptacle and header IMLAs. It will also be appreciated that, according to one embodiment of the invention, the grounds shown in FIG 4, may be the only grounds in the connector

As noted above, maintaining careful control of the distance between broadside-coupled contacts that form signal pairs can reduce cross talk between signal pairs In an embodiment of the invention, such distance control is maintained by using each "split" half of an IMLA (e g , receptacle and header IMLAs) to maintain precise spacing between contacts of a differential signal pair throughout a connector

FIGS. 5A–C depict a receptacle IMLA pair in accordance with an embodiment of the invention. Referring first to FIG. 5A, a first receptacle IMLA 510 comprises an overmolded housing 511 and a series of receptacle contacts 530, and a second receptacle IMLA 520 comprises an overmolded housing 521 and a series of receptacle contacts 530 As can be seen in FIG 5A, the receptacle contacts 530 are recessed into the housings of receptacle IMLAs 510 and B 520. It will be appreciated that fabrication techniques permit the recesses in each portion of the IMLA 510, 520 to be sized very precisely As a result, the gap distance d between each

signal contact can be maintained throughout a connector fabricated in accordance with an embodiment of the present invention

Turning now to FIG. 5B, a detailed view of one such recessed receptacle contact 530 in receptacle IMLA 510 is shown. As can be seen in FIG 5B, the housing 511 of receptacle IMLA 510 is recessed so the contact 530 sits within the housing such that the distance from the outside broad side of the contact 530 to the outside edge of the housing 511 is ½d The total distance d extends from the outside broad side of the contact 530 to the outside broad side of a contact 530 of receptacle IMLA 520 (not shown in FIG. 5B for clarity), with which IMLA 510 will be operatively coupled It will readily be appreciated that the distance provided by either IMLA 510 or IMLA 520 can be any fraction of d, so long as the total distance d is formed when IMLA 510 and IMLA 520 are operatively coupled.

FIG 5C shows a detailed view of receptacle IMLA 510 operatively coupled to receptacle IMLA 520. It will be appreciated that in an embodiment any manner of operatively coupling receptacle IMLAs 510 and B 520 may be used Thus, in an interference fit, fasteners and the like may be used alone or in any combination to affect such coupling.

In FIG. 5C, it can be seen that the housing 511 of receptacle IMLA 510 abuts the housing 521 of receptacle IMLA 520 Contacts 530 sit within respective recesses in the housings 511 and 521 It will be appreciated that operatively coupling the overmolded housings 511 and 521 as shown in FIG. 5C places a broad side of each contact 530 (i.e., the broad side that is facing the opposing contact 530) at a distance d from the opposing contact 530 In an embodiment, the distance d is able to be maintained at a high level of precision because of the low tolerances possible with overmolded housing fabrication, as well as contact fabrication Because the distance d only depends on these two, highly-precise components, the distance d can be maintained within the very low acceptable variations that are needed to maintain an appropriate differential impedance Z_0.

It will be appreciated that, in an embodiment of the invention, the distance d may be bridged by an air dielectric as discussed above Thus, the weight of the resulting connector, of which the receptacle IMLAs 510 and 520 are a part, may be minimized. It will also be appreciated that the ability to closely control the size of the recess within each overmolded housing 511, 521 enables the impedance Z_0 between the contacts that form signal pairs (and, consequently, cross-talk between signal pairs) to be closely controlled

Because the above-mentioned differential impedance Z_0 (and therefore cross talk between signal pairs) is controlled by maintaining a precise distance d, it will be appreciated that a header ILMLA that is to be coupled to a receptacle IMLA should also carefully maintain a precise distance d between signal pairs Therefore, and turning now to FIGS 6A–C, a header IMLA pair in accordance with an embodiment of the present invention is depicted Referring first to FIG. 6A, header IMLA 610 comprises an overmolded housing 611 and a series of header contacts 630, and header IMLA 620 comprises an overmolded housing 621 and a series of header contacts 630. As can be seen in FIG. 6A, the header contacts 630 are recessed into the housings of header IMLAs 610 and 620.

Turning now to FIG. 6B, a detailed view of one such recessed header contact 630 in header IMLA 610 is shown. As can be seen in FIG 6B, the housing 611 of IMLA 610 is recessed so the contact 630 sits within the housing such that the distance from the inside broad side of the contact 630 to the inside edge of the housing 611 (i.e., the side of the housing 611 that will abut the housing 621 of header IMLA 620—not shown in FIG 6B for clarity) is ½ the total distance d from the inside broad side of the contact 630 to the inside broad side of a contact 630 of IMLA 620 Again, it will readily be appreciated that the distance provided by either IMLA 610 or IMLA 620 can be any fraction of d, so long as the distance d is formed when IMLA 610 and IMLA 620 are operatively coupled

FIG 6C shows a detailed view of header IMLA 610 operatively coupled to header IMLA 620 It will be appreciated that in an embodiment any manner of operatively coupling header IMLAs 610 and 620 may be used. Thus, an interference fit, fasteners and the like may be used alone or in any combination to affect such coupling, and any such coupling may be accomplished by the same or a different method used to operatively couple the receptacle IMLAs discussed above in connection with FIGS. 5A–C.

In FIG. 6C, it can be seen that the housing 611 of header IMLA 610 abuts the housing 621 of header IMLA 620 Within respective recesses in both housings 611 and 621 are contacts 630 It will be appreciated that operatively coupling the housings 611 and 621 as shown in FIG 6C places a respective broad side of each contact 630 (i.e., the broad side that is facing the opposing contact 630) at a distance d from the opposing contact 630. Thus, the differential impedance Z_0 as discussed above in connection with FIG. 3 may be established because of the distance d maintained between the contacts 630 of header IMLAs 610 and 620. It will also be appreciated that the aforementioned ability to closely control the size of the recess within each housing 611, 621, as well as the contact size, enables differential impedance Z_0 and cross-talk to be closely controlled.

Turning now to FIG 7, a header and receptacle IMLA pair in operative communications in accordance with an embodiment of the present invention is depicted. In FIG 7, it can be seen that header IMLAs 610 and B 620 are operatively coupled to form a single and complete header IMLA. Likewise, receptacle IMLAs 510 and B 520 are operatively coupled to form a single and complete receptacle IMLA. While FIG. 7 illustrates an interference fit between the contacts 630 of the receptacle IMLA and the contacts of the header IMLA, it will be appreciated that any method of causing electrical contact, and/or for operatively coupling the header IMLA to the receptacle IMLA, is equally consistent with an embodiment of the present invention

As can be seen in FIG 7, the contacts of the receptacle IMLA may be flared to accept the contacts of the header IMLA As a result, the precise maintenance of the distance d between contacts within both the receptacle IMLA and the header IMLA enables the differential impedance Z_0 to be carefully controlled through the connector. This, in turn, minimizes cross talk between signal pairs, even in the absence of ground contacts.

Turning now to FIG 8A, a conductor arrangement is depicted in which signal pairs are arranged in rows As can be seen in FIG. 8A, each row 811–816 comprises a plurality of differential signal pairs First row 811 comprises, in order from left to right, three differential signal pairs: S1+ and S1–, S2+ and S2–, and S3+ and S3–. Each additional row in the exemplary arrangement of FIG. 8A contains three differential signal pairs In the embodiment shown in FIG. 8A, and as was the case with FIG 3, it can be seen that the columns of contacts can be arranged as IMLAs, such as IMLAs 1–3 In addition, each IMLA has two lengthwise halves in a split configuration, A and B, that correspond to each column Unlike the arrangement discussed above in

connection with FIG. 3, no ground contacts are needed because the cross talk between adjacent signal pairs may be minimized by the proper selection of the differential impedance Z_0 that is possible by maintaining a precise distance d between signal contacts. Thus, in an embodiment of the invention, and as shown in FIG 8A, the connector may be devoid of ground contacts

As can be seen, therefore, the embodiment shown in FIG. 8A provides 18 differential signal pairs for an arrangement of 36 contacts, which is a significant improvement over the nine differential signal pairs in the arrangement depicted above in FIG 3 Thus, a connector according to the invention may be lighter and smaller for a given number of differential signal pairs, or have a greater concentration of differential signal pairs for a given weight and/or size of the connectors.

It will be appreciated that an embodiment of the present invention encompasses any number of conductor arrangements. For example, the conductor arrangement depicted in FIG 8B shows that adjacent columns of broadside-coupled pairs may be offset from each other. The conductor arrangement, like the arrangement of FIG 8A, above, has 36 contacts in 18 signal pairs that are equally divided between IMLAs 1–3 in rows 811–816 It can be seen that IMLAs 1–3 are in the aforementioned split configuration, where each IMLA has a lengthwise half denoted as A and B In addition, and as noted above, each contact in a given signal pair is separated by a precisely-maintained distance d, which enables the differential impedance Z_0 to be carefully controlled through the connector.

Unlike the connector of FIG 8A, however, the pairs disposed along IMLA 2 are offset from the pairs disposed along IMLAs 1 and 3 by an offset distance o. For comparison, it can be seen that in FIG 8A, the IMLAs 1–3 are arranged such that the conductor pairs that comprise each row 811–816 are in alignment. It will be appreciated that the magnitude of the offset distance o in FIG 8B may be determined by any number and type of considerations, such as for example the intended application of the connector or the like In addition, it will be appreciated that any or all of the IMLAs present in a given connector may be offset from any other IMLA within the connector by any offset distance o In such embodiments, the offset distance o between any two IMLAs may be the same as or different from the offset distance o between any other IMLAs within the connector.

It will be further appreciated that the offset distance o and the distance d may be set so as to achieve a desired differential impedance Z_0 Therefore, while some embodiments may achieve a desired differential impedance Z_0 by precisely maintaining the distance d alone, other embodiments may achieve a desired differential impedance Z_0 by maintaining the distance d in combination with setting one or more offset distances o

Thus, a method and system for split IMLA impedance control has been disclosed It is to be understood that the foregoing illustrative embodiments have been provided merely for the purpose of explanation and are in no way to be construed as limiting of the invention. Words which have been used herein are words of description and illustration, rather than words of limitation Further, although the invention has been described herein with reference to particular structure, materials and/or embodiments, the invention is not intended to be limited to the particulars disclosed herein Rather, the invention extends to all functionally equivalent structures, methods and uses, such as are within the scope of the appended claims. Those skilled in the art, having the benefit of the teachings of this specification, may affect numerous modifications thereto and changes may be made without departing from the scope and spirit of the invention in its aspects

What is claimed:

1 An electrical connector comprising:

a first leadframe housing having a portion of a first electrical contact extending therethrough; and

a second leadframe housing having a portion of a second electrical contact extending therethrough,

wherein the second leadframe housing is disposed adjacent to the first leadframe housing such that an air gap is formed between the respective portions of the electrical contacts that extend through the leadframe housings,

wherein the gap has a gap width that provides for a desired impedance profile between the electrical contacts, and

wherein the impedance profile is a uniform impedance profile along the respective portions of the contacts that extend through the leadframe housings

2 The electrical connector of claim 1, wherein the electrical contacts form a differential signal pair

3 The electrical connector of claim 1, wherein the electrical contacts are broadside-coupled

4. The electrical connector of claim 1, wherein the first leadframe housing is made of an electrically insulating material

5. The electrical connector of claim 1, wherein the first leadframe housing is made of a plastic

6. The electrical connector of claim 1, wherein the first leadframe housing is insert molded

7 The electrical connector of claim 1, wherein the first and second leadframe housings are coupled with an interference fit

8. The electrical connector of claim 1, wherein the first leadframe housing has a first recess, and the first electrical contact sits in the first recess, the second leadframe housing has a second recess, and the second electrical contact sits in the second recess.

9. The electrical connector of claim 8, wherein the first recess has a first depth, the first electrical contact has a first thickness, the second recess has a second depth, and the second electrical contact has a second thickness, and wherein the first and second depths and first and second thicknesses together define the gap width

10 The electrical connector of claim 1, wherein the first leadframe housing has a recess, and the first electrical contact sits in the recess

11. The electrical connector of claim 10, wherein the gap has a gap width, and the recess has a depth that at least partially defines the gap width

12 The electrical connector of claim 10, wherein the first leadframe housing comprises a face that at least partially defines the recess, and the first electrical contact abuts the face.

13 The electrical connector of claim 10, wherein the first leadframe housing comprises a plurality of faces that collectively define the recess, and the first electrical contact abuts each of the faces

14 The electrical connector of claim 10, wherein the second leadframe housing has a recess, and the second electrical contact sits in the recess of the second leadframe housing.

15 The electrical connector of claim 14, wherein the gap has a gap width, and the recesses have respective depths that at least partially define the gap width.

16 The electrical connector of claim 15, wherein each of the electrical contacts has a respective thickness that at least partially defines the gap width

17. An electrical connector comprising:

a first lead frame assembly comprising a first leadframe housing, a first signal contact, and a second signal contact adjacent to the first signal contact; and

a second lead frame assembly comprising a second leadframe housing, a third signal contact, and a fourth signal contact adjacent to the third signal contact, the first and third signal contacts forming a first differential signal pair and the second and fourth signal contacts forming a second differential signal pair,

wherein a first air gap is formed between respective portions of the first and third signal contacts that extend through the respective leadframe housings, and a second air gap is formed between respective portions of the second and fourth signal contacts that extend through the respective leadframe housings

wherein the first air gap has a gap width that provides for a uniform impedance profile along the respective portions of the first and third contacts that extend through the respective leadframe housings

18 The electrical connector of claim 17, wherein the air gaps have respective gap widths that limit cross-talk between the differential signal pairs.

19. The electrical connector of claim 17, wherein the connector is a mezzanine-style electrical connector

20 The electrical connector of claim 17, wherein the differential signal pairs are broadside-coupled.

21. The electrical connector of claim 17, wherein the connector is devoid of shields between adjacent differential signal pairs.

22 The electrical connector of claim 17, wherein the first air gap has a gap width that limits interference from the first differential signal pair at the second differential signal pair

23. The electrical connector of claim 22, wherein the second air gap has a second gap width that limits interference from the second differential signal pair at the first differential signal pair

24 The electrical connector of claim 23, wherein the first leadframe housing has a first and second recess, and the second leadframe housing has a third and fourth recess, and wherein the first, second, third and fourth signal contacts sit in the first, second, third, and fourth recesses, respectively

25 The electrical connector of claim 24, wherein the first, second, third, and fourth recesses have first, second, third and fourth depths, respectively, and wherein the first, second, third, and fourth signal contacts have first, second, third, and fourth thicknesses, respectively

26 The electrical connector of claim 25, wherein the first depth and thickness and the third depth and thickness together define the first gap width.

27 The electrical connector of claim 25, wherein the second depth and thickness and the fourth depth and thickness together define the second gap width

28. An electrical connector comprising:

a first leadframe housing having a portion of a first electrical contact extending therethrough; and

a second leadframe housing having a portion of a second electrical contact extending therethrough,

wherein an air gap is formed between the respective portions of the electrical contacts that extend through the leadframe housings, the gap having a gap width that provides for a desired impedance profile between the electrical contacts,

wherein the impedance profile is a uniform impedance profile along the respective portions of the contacts that extend through the leadframe housings

29 The electrical connector of claim 28, wherein the first leadframe housing has a first recess, and the first electrical contact sits in the first recess

30. The electrical connector of claim 29, wherein the second leadframe housing has a second recess, and the second electrical contact sits in the second recess

31 The electrical connector of claim 30, wherein the first and second recesses have a first and second depths, respectively, and the first and second electrical contacts have a first and second thicknesses, respectively, and the first and second depths and the first and second thicknesses together define the gap width

* * * * *

EXHIBIT "C"

EXHIBIT "C"



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(54) CROSS TALK REDUCTION AND IMPEDANCE MATCHING FOR HIGH SPEED ELECTRICAL CONNECTORS

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(58) Field of Classification Search 439/701, 439/108, 608, 79
See application file for complete search history.

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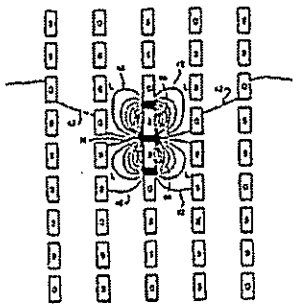
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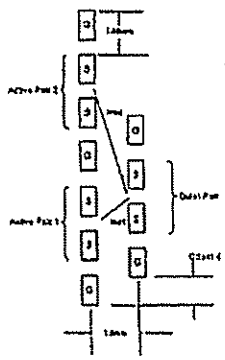
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(57) ABSTRACT

Lightweight, low-cost, high-density electrical connectors are disclosed that provide impedance-controlled, high-speed, low-interference communications, even in the absence of shields between the contacts, and that provide for a variety of other benefits not found in prior art connectors. An example of such an electrical connector may include a first signal contact positioned within a first linear array of electrical contacts and a second signal contact positioned within a second linear array of electrical contacts that is adjacent to the first linear array. Either of the signal contacts may be a single-ended signal conductor, or one of a differential signal pair. The connector may be devoid of shields between the signal contacts, and of ground contacts adjacent to the signal contacts.

56 Claims, 38 Drawing Sheets





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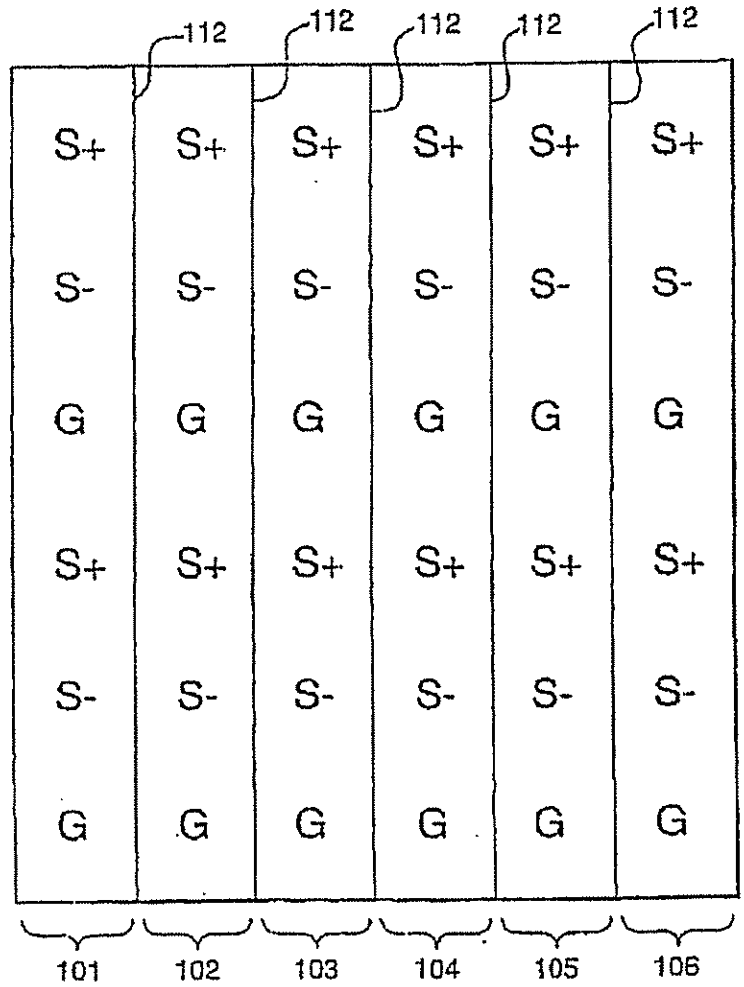


FIG. 1A
(PRIOR ART)

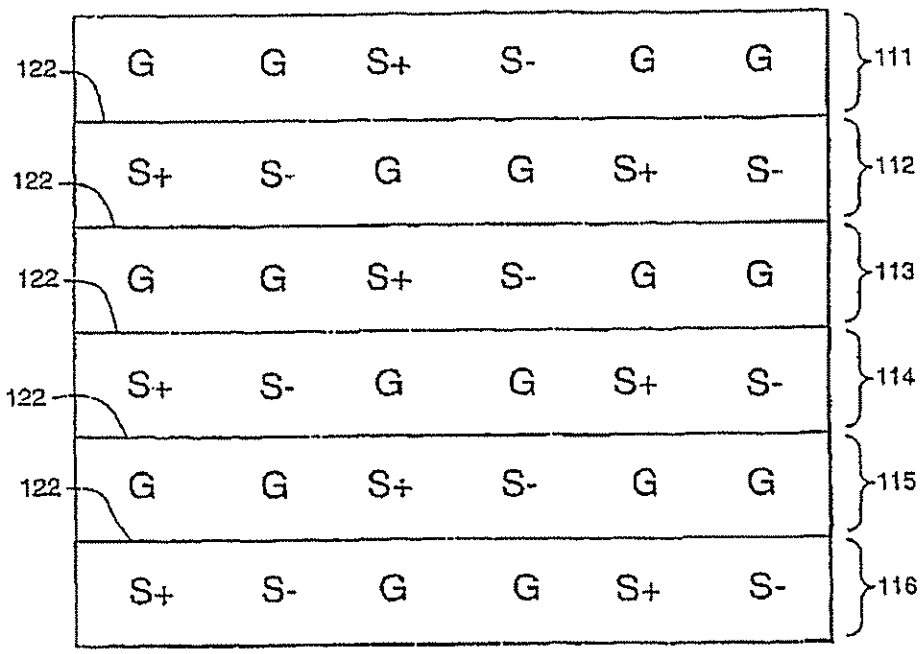


FIG. 1B
(PRIOR ART)

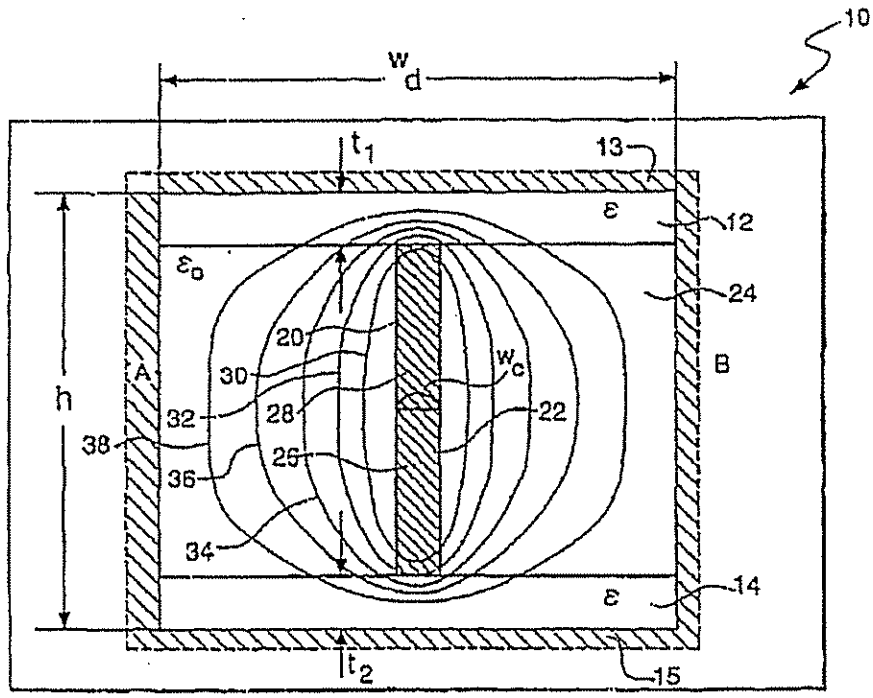


FIG. 2A
(PRIOR ART)

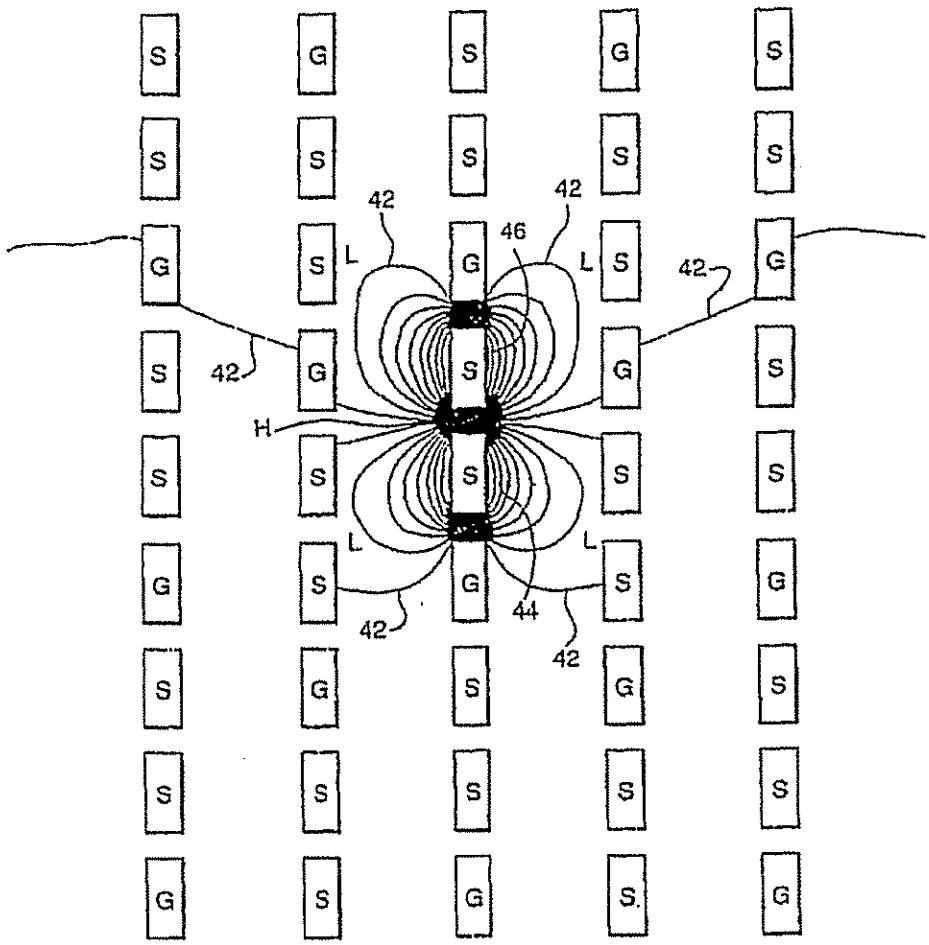


FIG. 2B

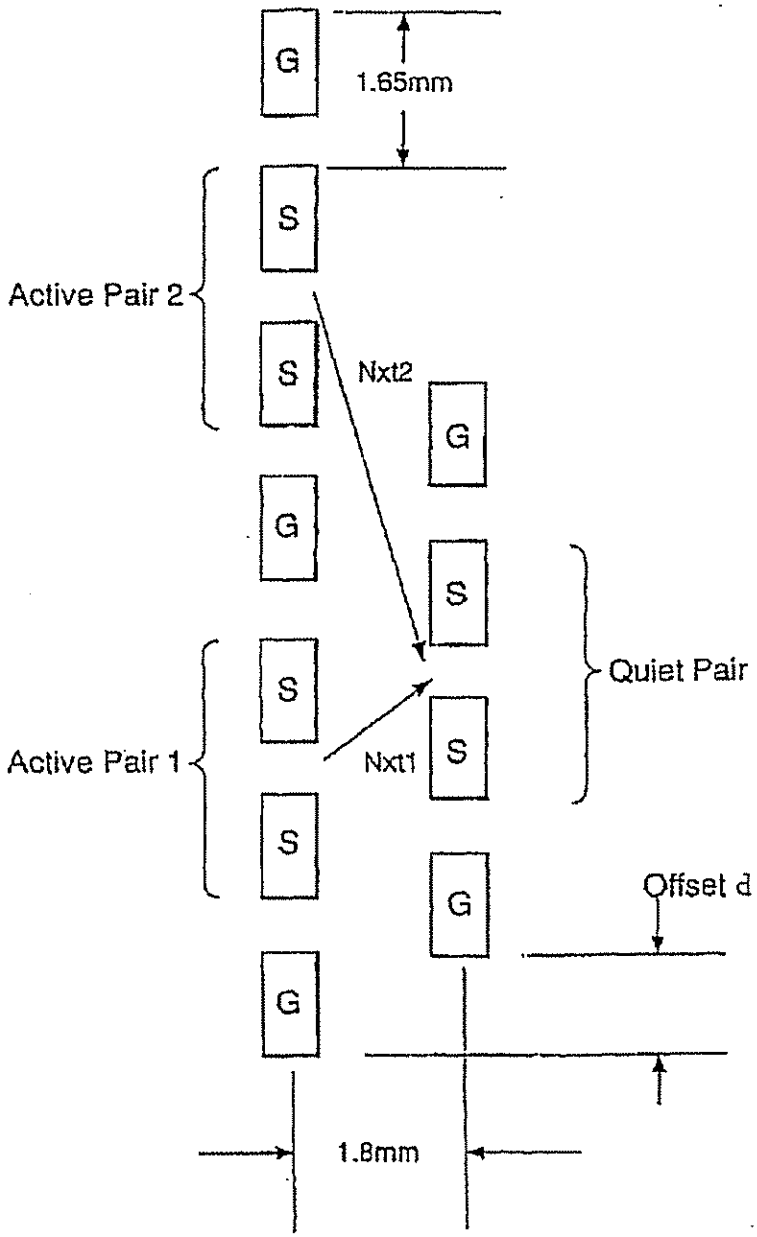

G
1.65mm
S
Active Pair 2
S
Nxt2
G
G
S
Quiet Pair
S
Active Pair 1
Nxt1
S
S
G
Offset d
G
1.8mm

FIG. 3A

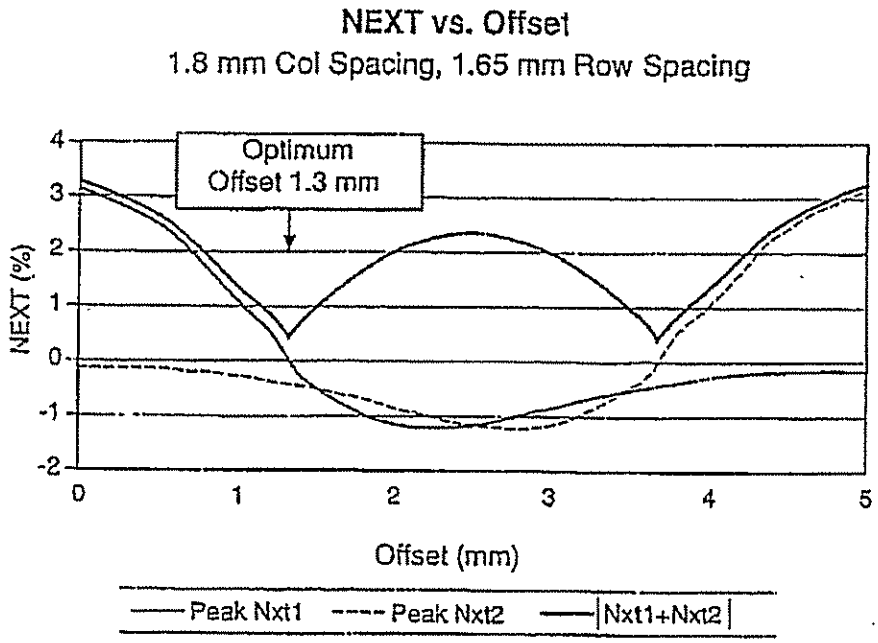

NEXT vs. Offset
1.8 mm Col Spacing, 1.65 mm Row Spacing
Optimum
Offset 1.3 mm
NEXT (%)
4
3
2
1
0
-1
-2
0
1
2
3
4
5
Offset (mm)
Peak Nxt1
Peak Nxt2
Nxt1+Nxt2

FIG. 3B

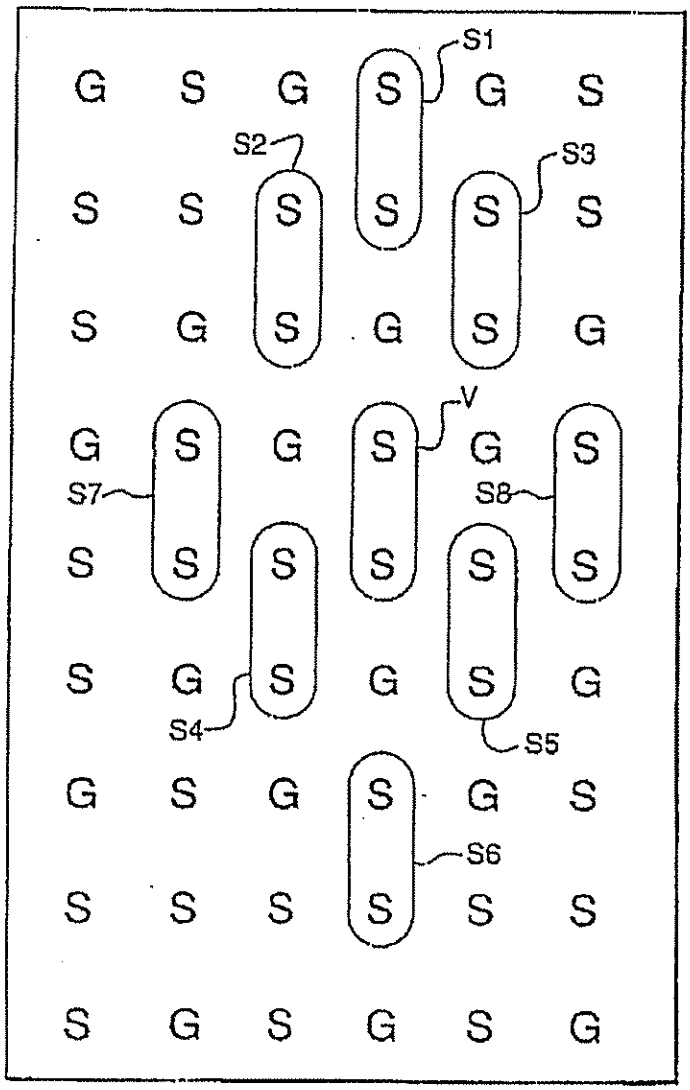


FIG. 3C

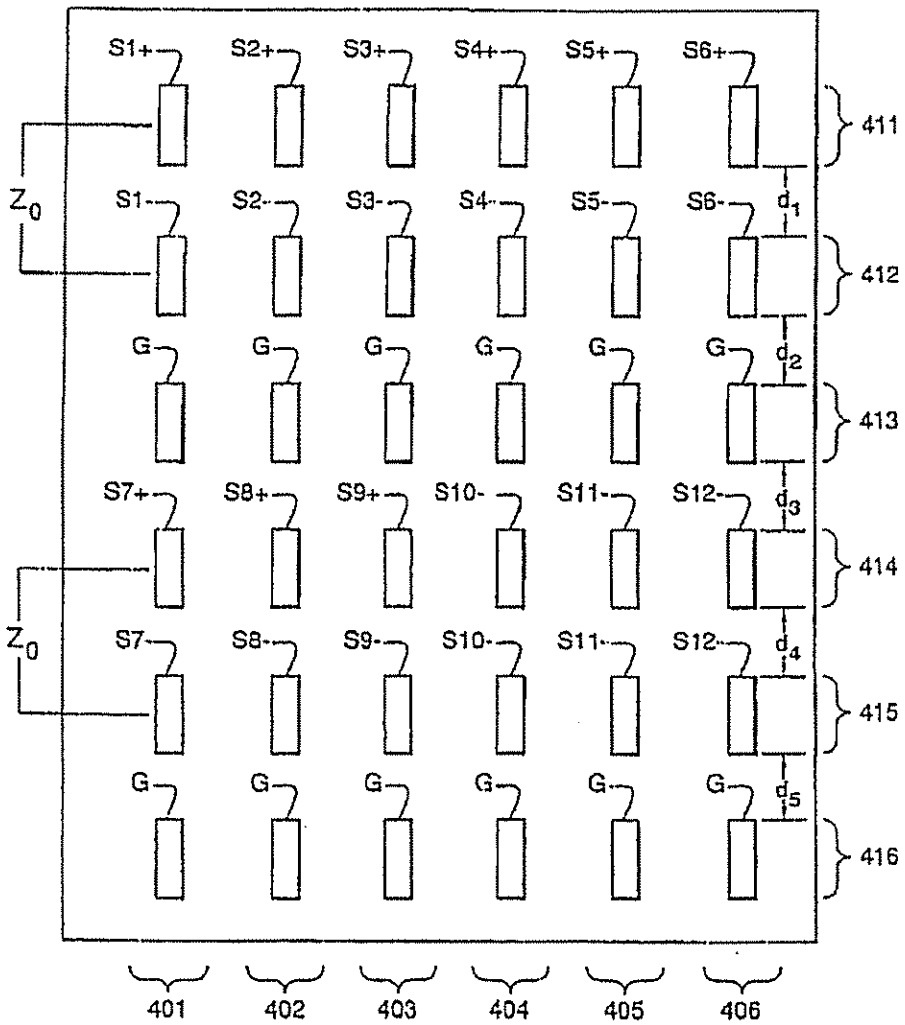

S1+
S2+
S3+
S4+
S5+
S6+
411
Z_0
S1-
S2-
S3-
S4-
S5-
S6-
d_1
412
G
d_2
413
S7+
S8+
S9+
S10-
S11-
S12-
d_3
414
Z_0
S7-
S8-
S9-
S10-
S11-
S12-
d_4
415
d_5
416
401
402
403
404
405
406

FIG. 4A

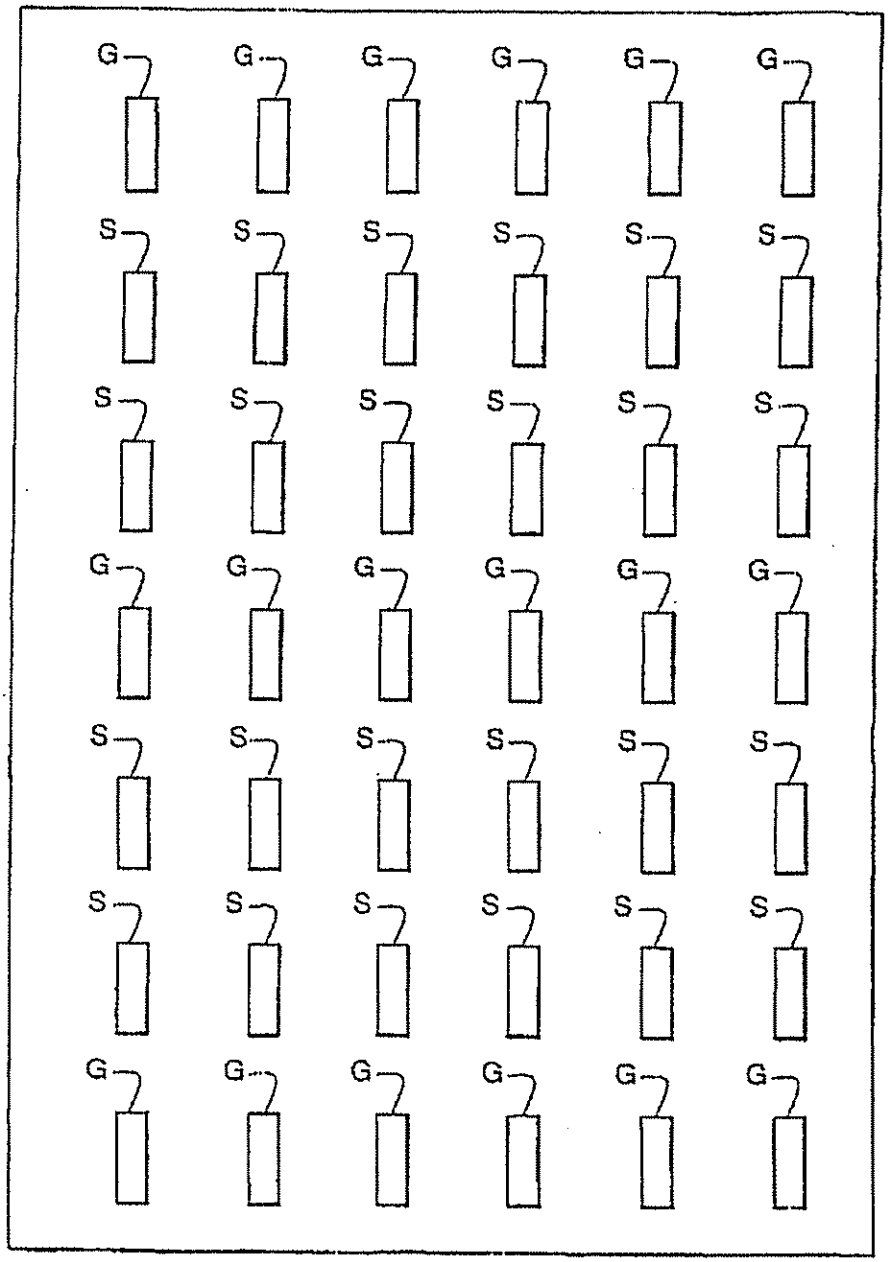


FIG. 4B

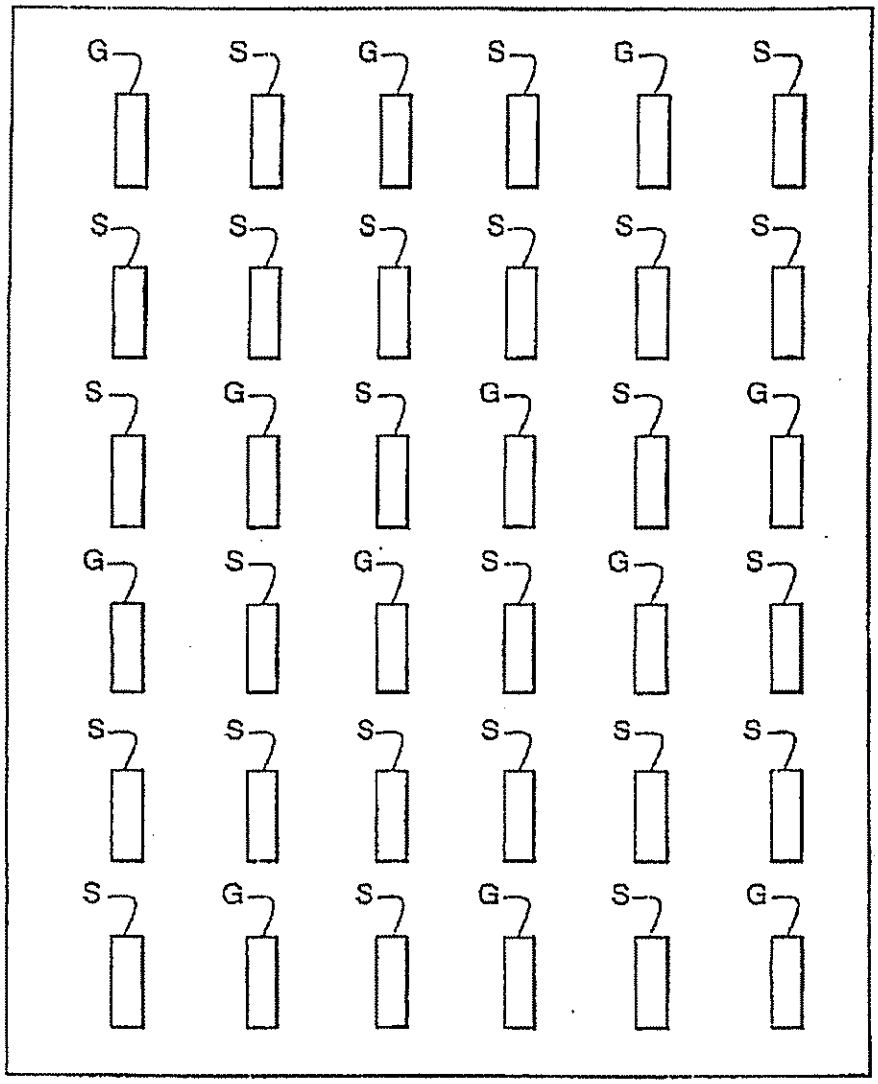


FIG. 4C

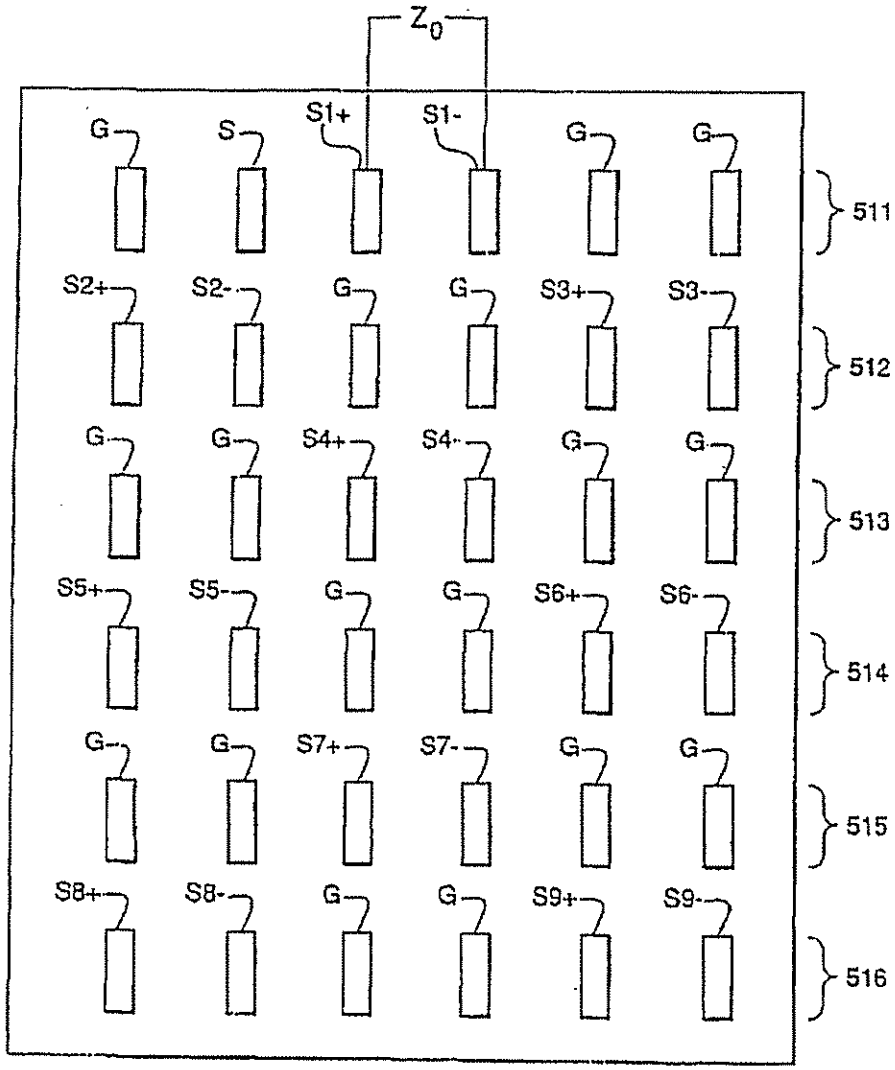

Z_0
G
S
S1+
S1-
G
G
511
S2+
S2-
G
G
S3+
S3-
512
G
G
S4+
S4-
G
G
513
S5+
S5-
G
G
S6+
S6-
514
G
G
S7+
S7-
G
G
515
S8+
S8-
G
G
S9+
S9-
516

FIG. 5

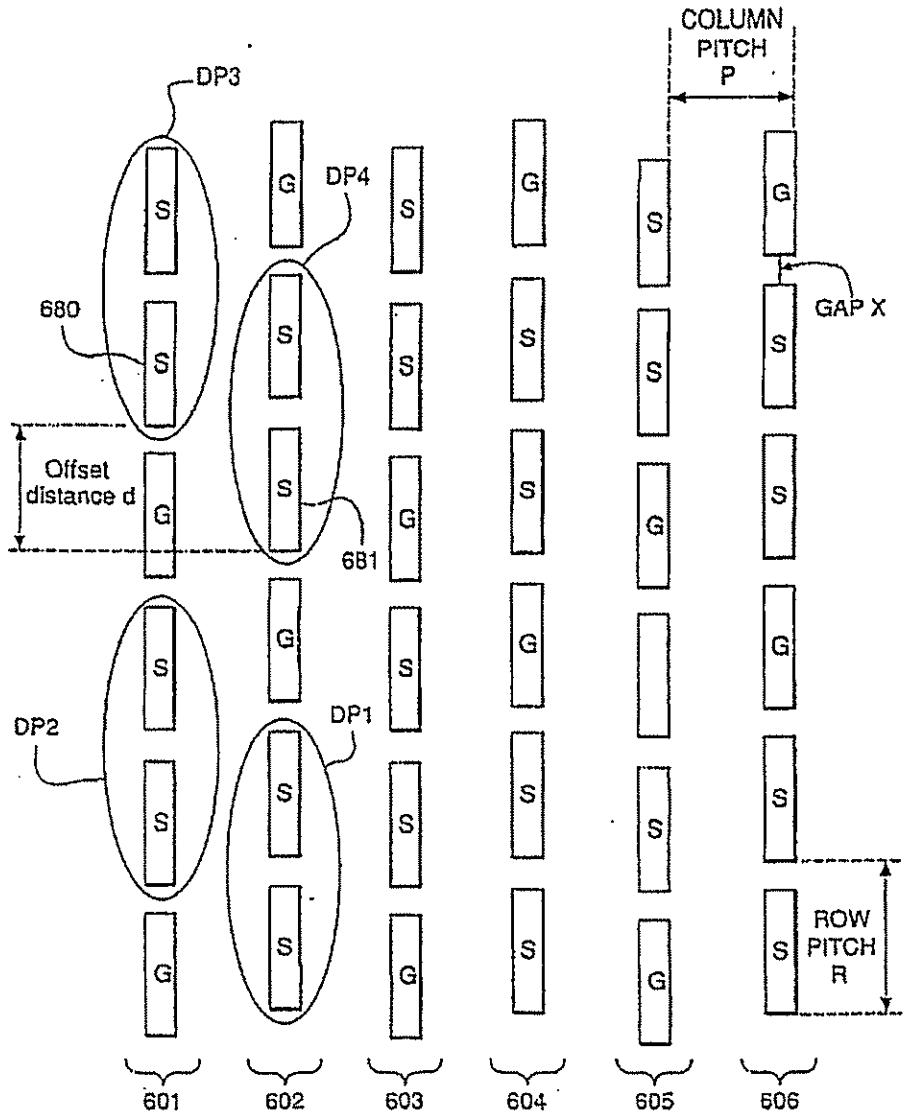

COLUMN PITCH P
DP3
DP4
680
681
GAP X
Offset distance d
DP2
DP1
ROW PITCH R
S
G
601
602
603
604
605
606

FIG. 6

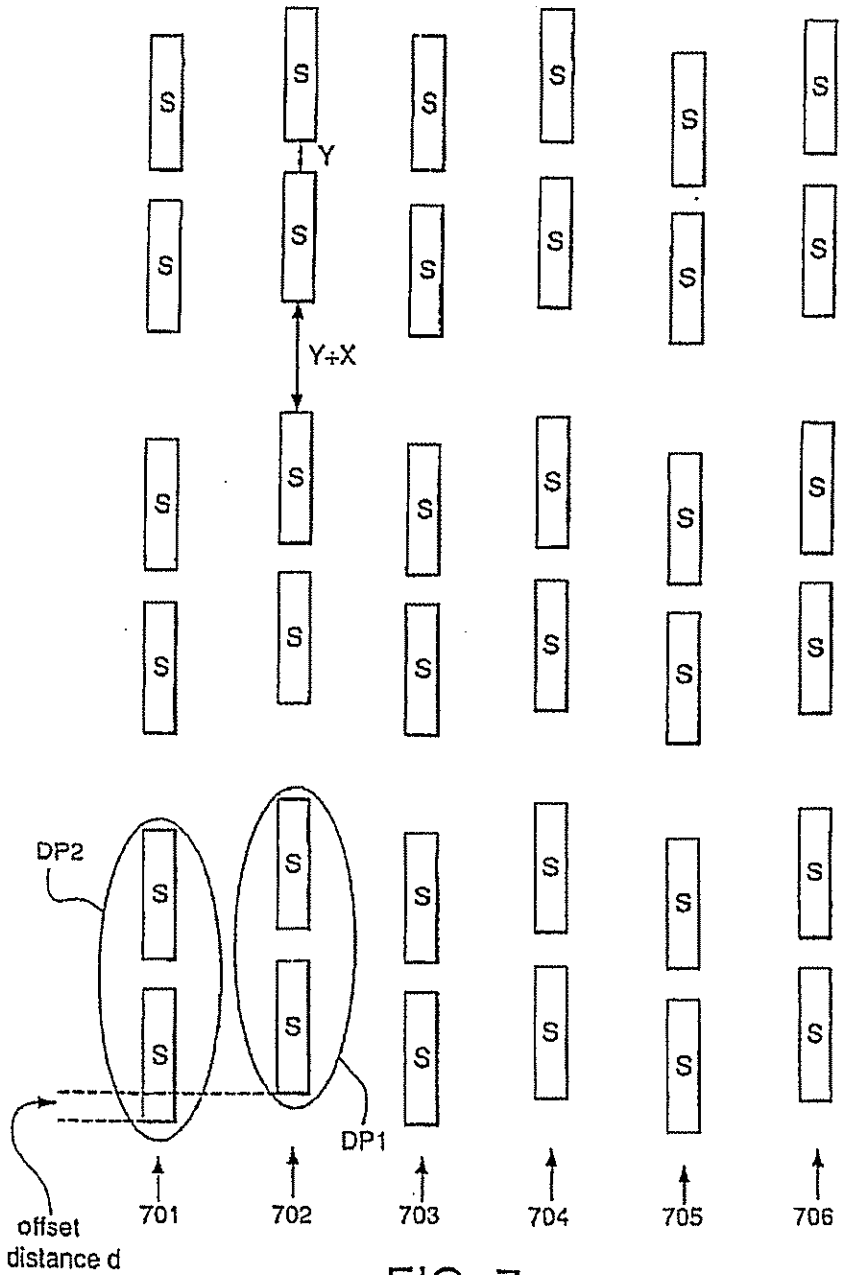


FIG. 7

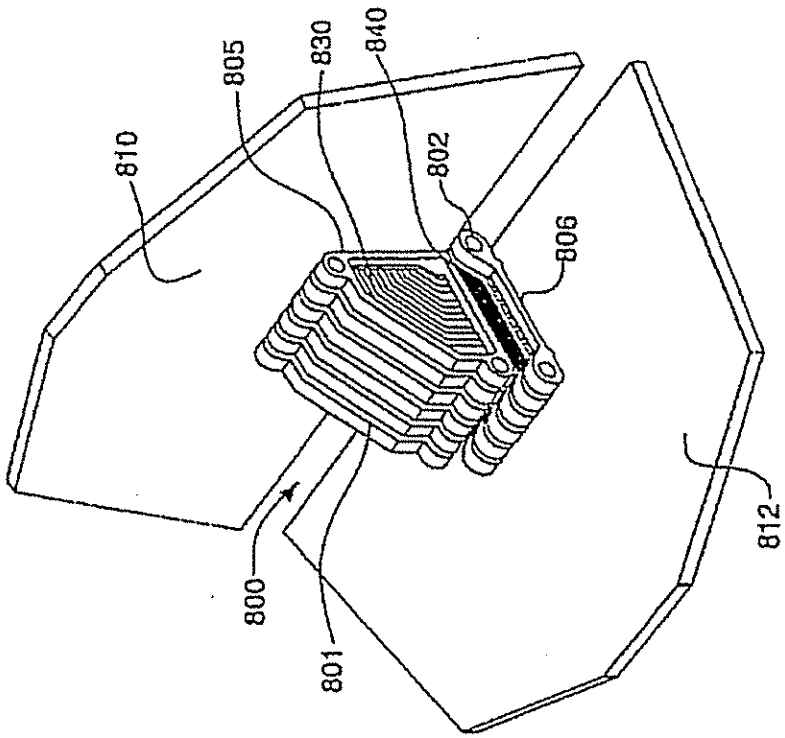


FIG. 8

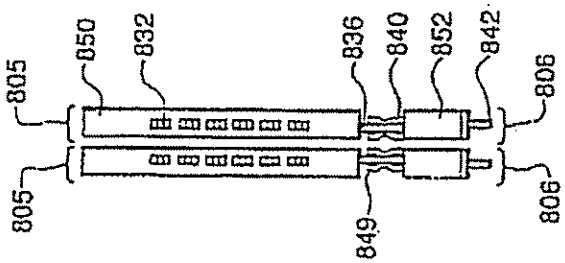


FIG. 10

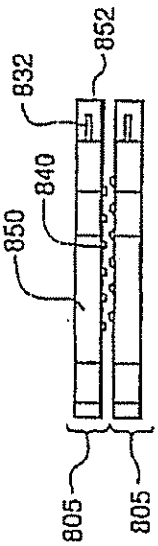


FIG. 11

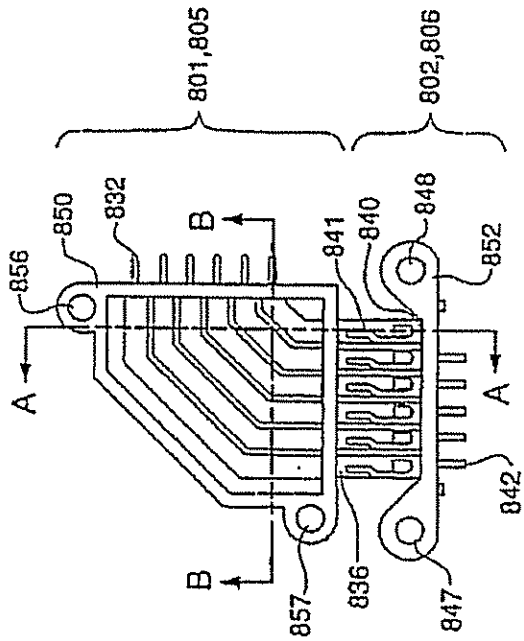


FIG. 9

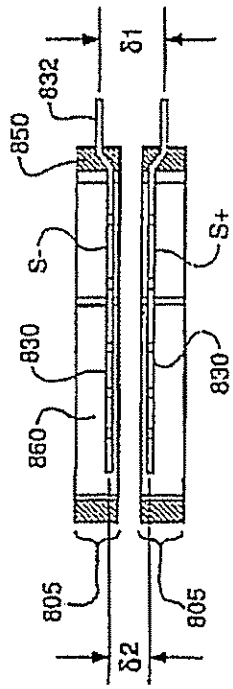


FIG. 12

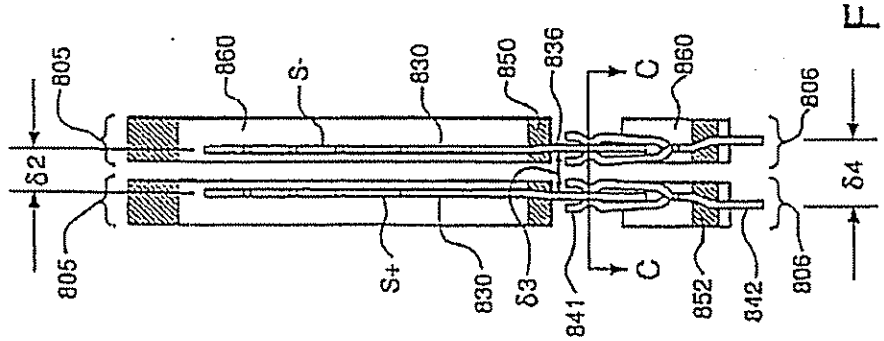


FIG. 13A

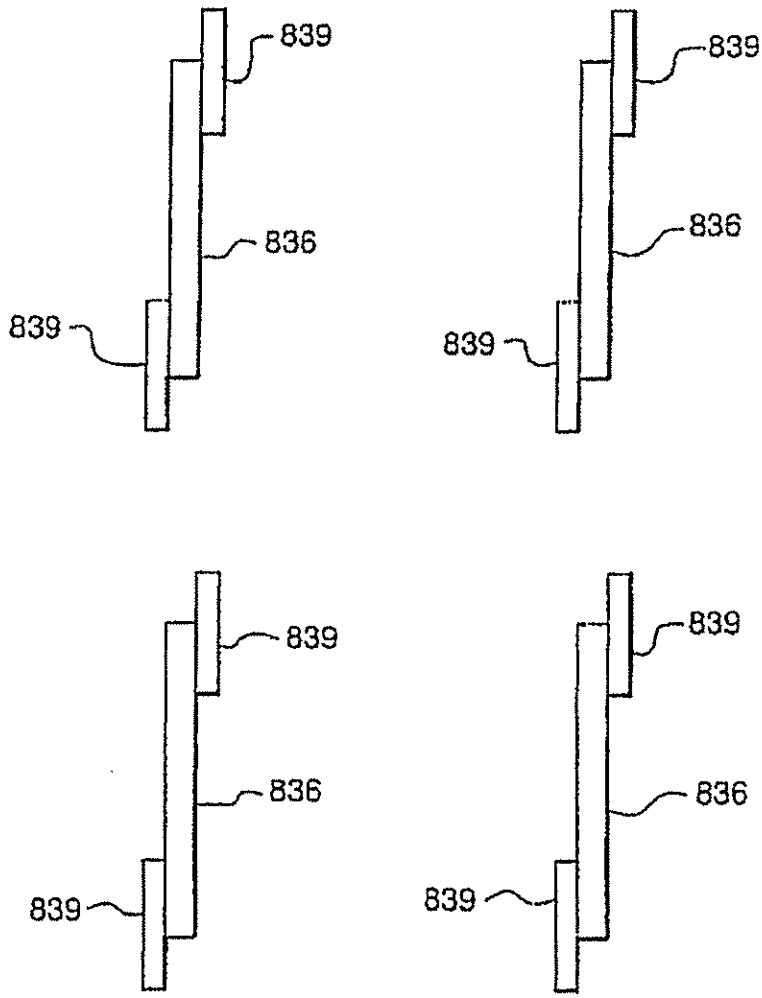


FIG. 13B

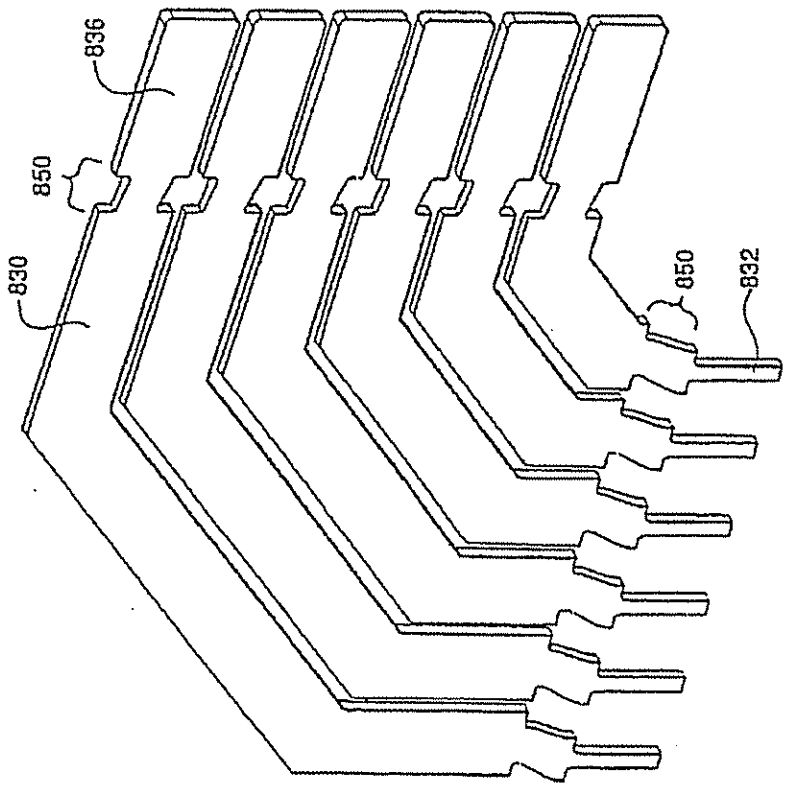


FIG. 14

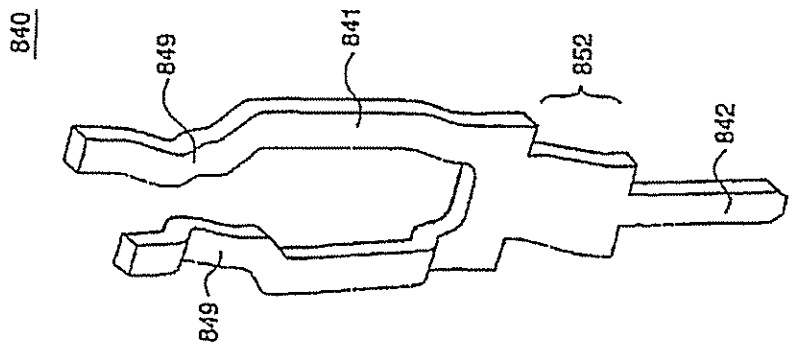


FIG. 15

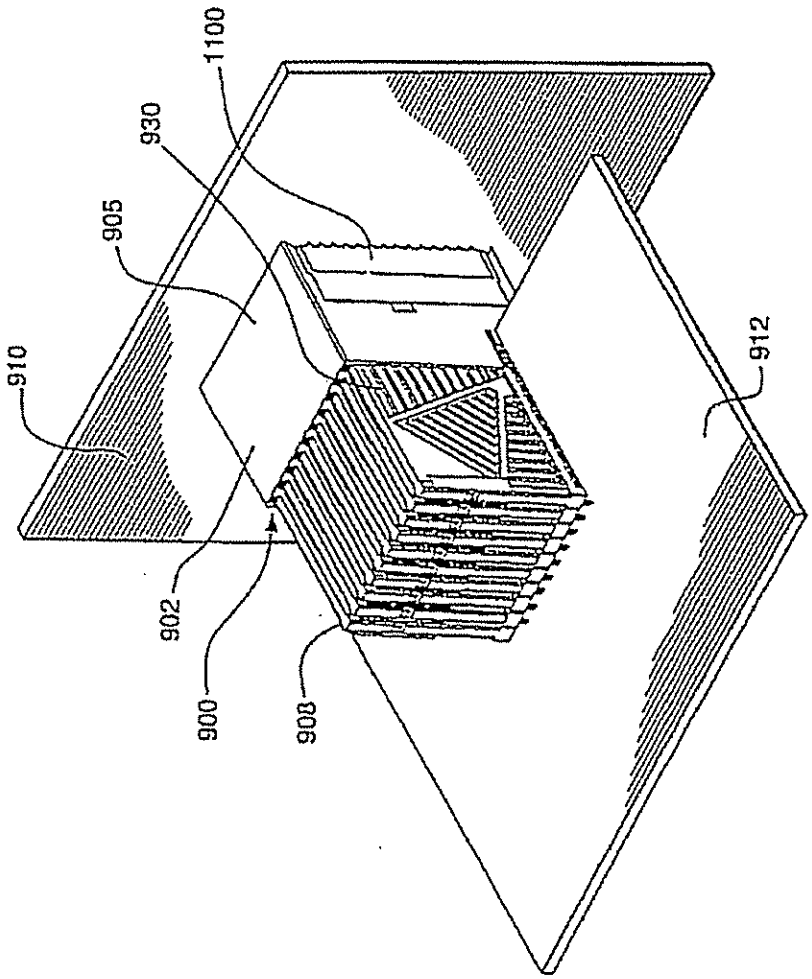


FIG. 16A

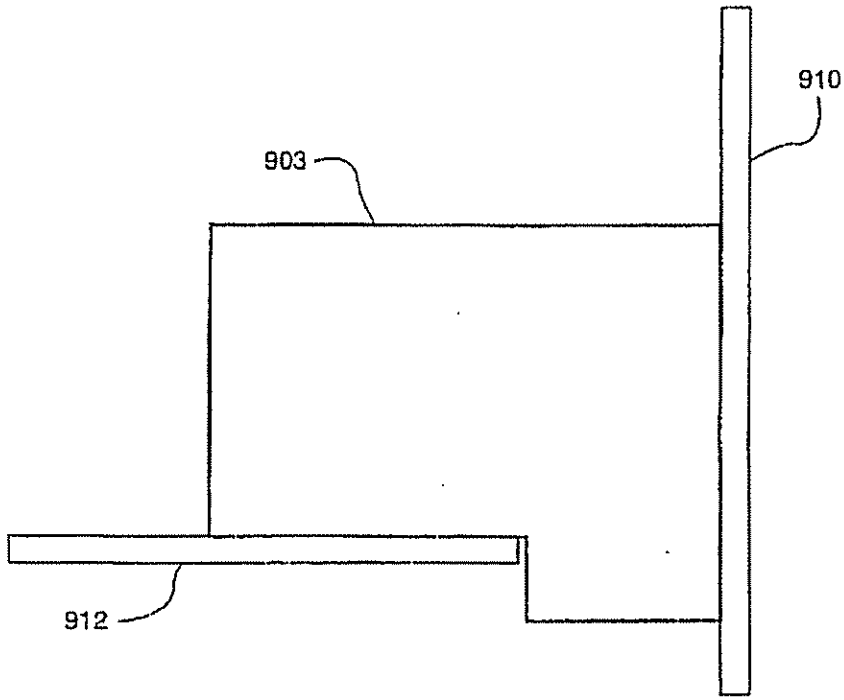


FIG. 16B

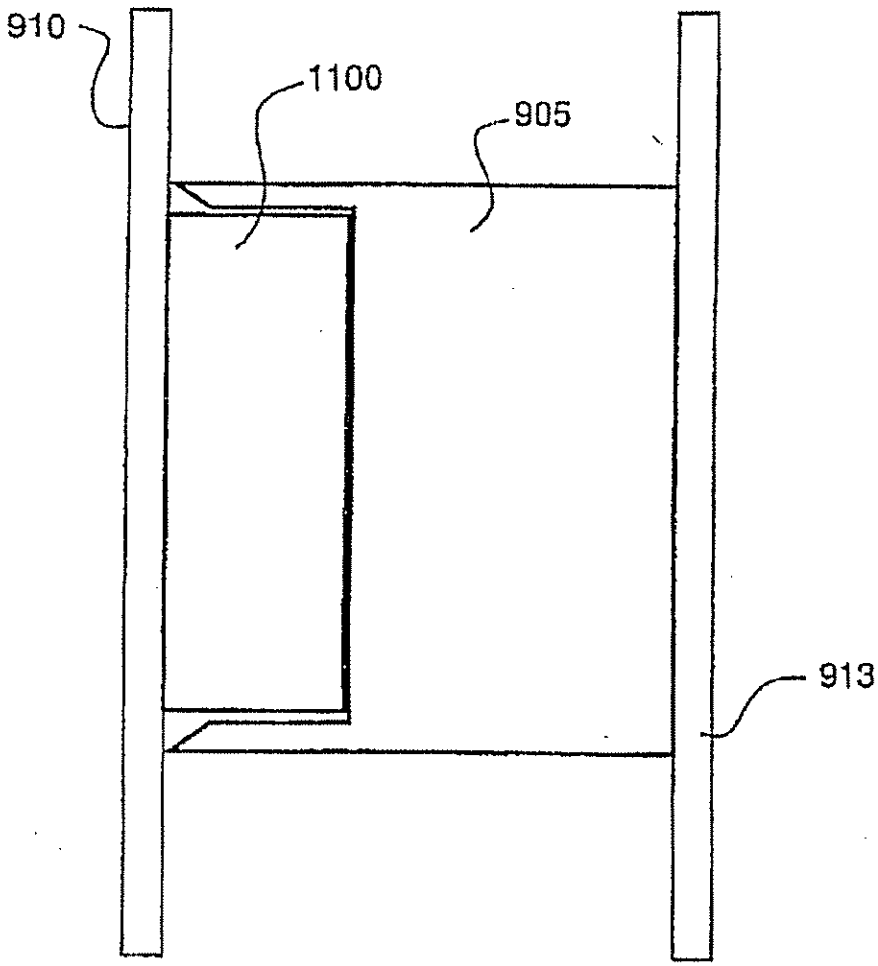


FIG. 16C

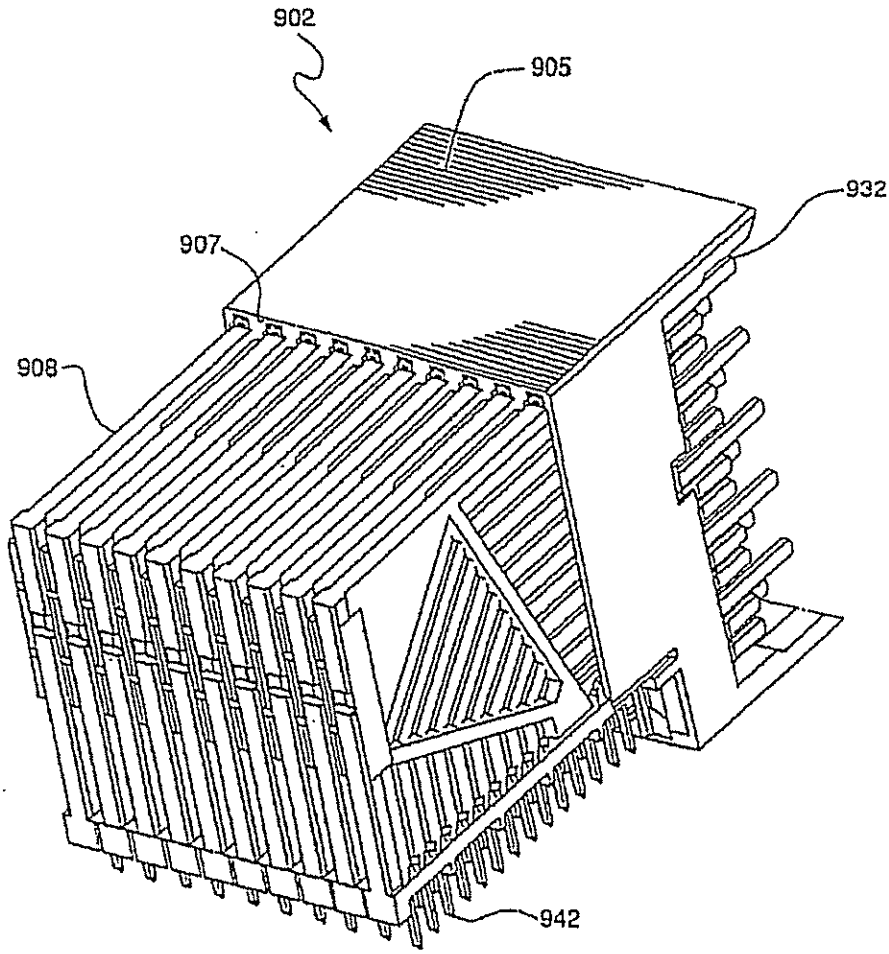


FIG. 17

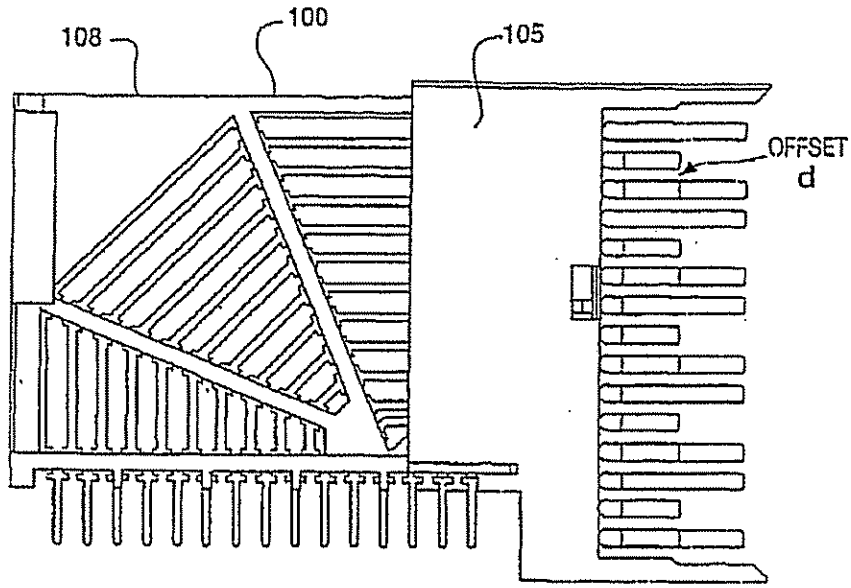


FIG. 18

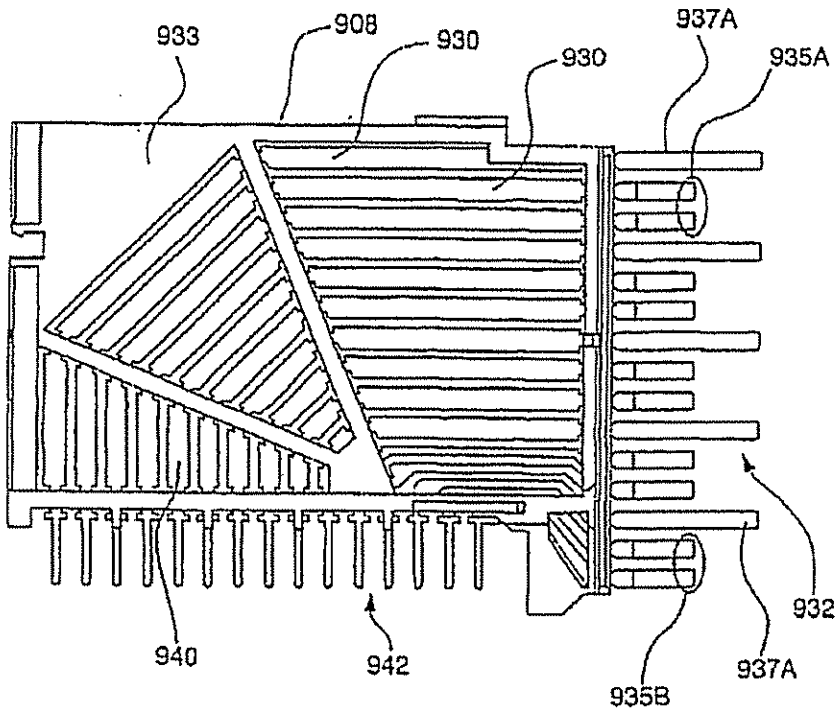


FIG. 19A

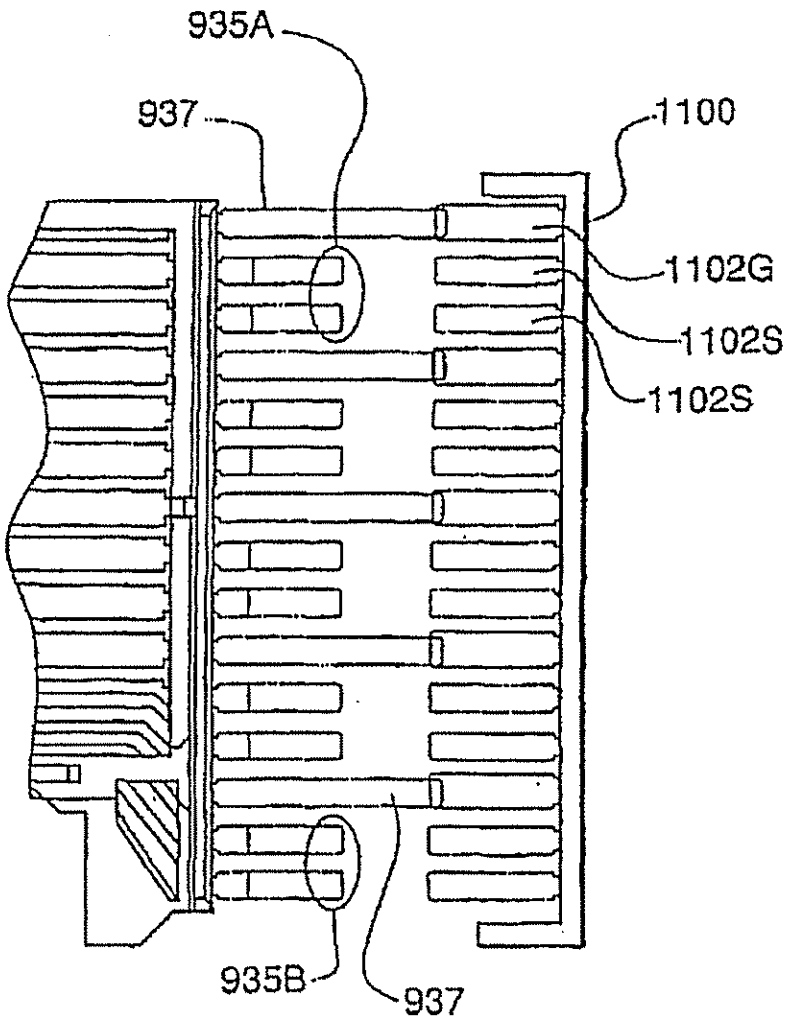


FIG. 19B

Thomas R. C. Wilson

From: Novack, Gerald [gerald.novack@klgates.com]
Sent: Thursday, January 25, 2007 12:59 PM
To: lkalmen@sulphco.com
Cc: Paul J. Georgeson; Thomas R. C. Wilson
Subject: McDonald invoice and retainer

Loren

Could you confirm by return email to all of us above that the $68,000 wire was sent to the McDonald firm today? Thanks.

Gerald A. Novack, Esq. | K&L Gates | 599 Lexington Avenue | New York, NY 10022-6030 | Tel: (212) 536-3918 | Fax: (212) 536-3901 | E-mail: gerald.novack@klgates.com| www.klgates.com

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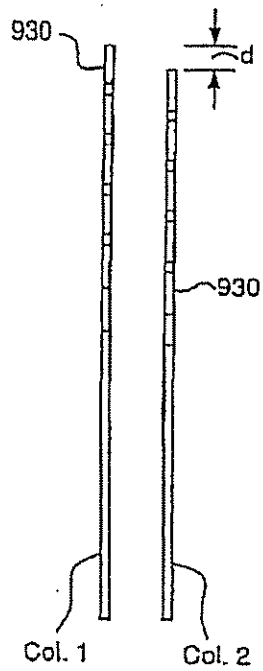


FIG. 20

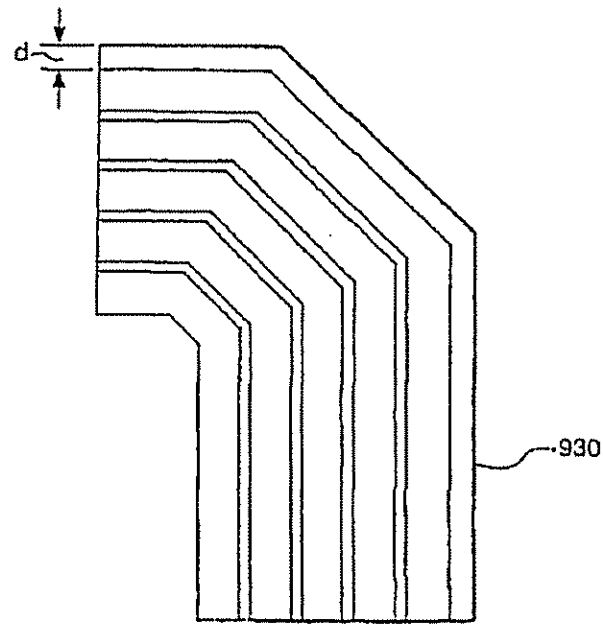


FIG. 21

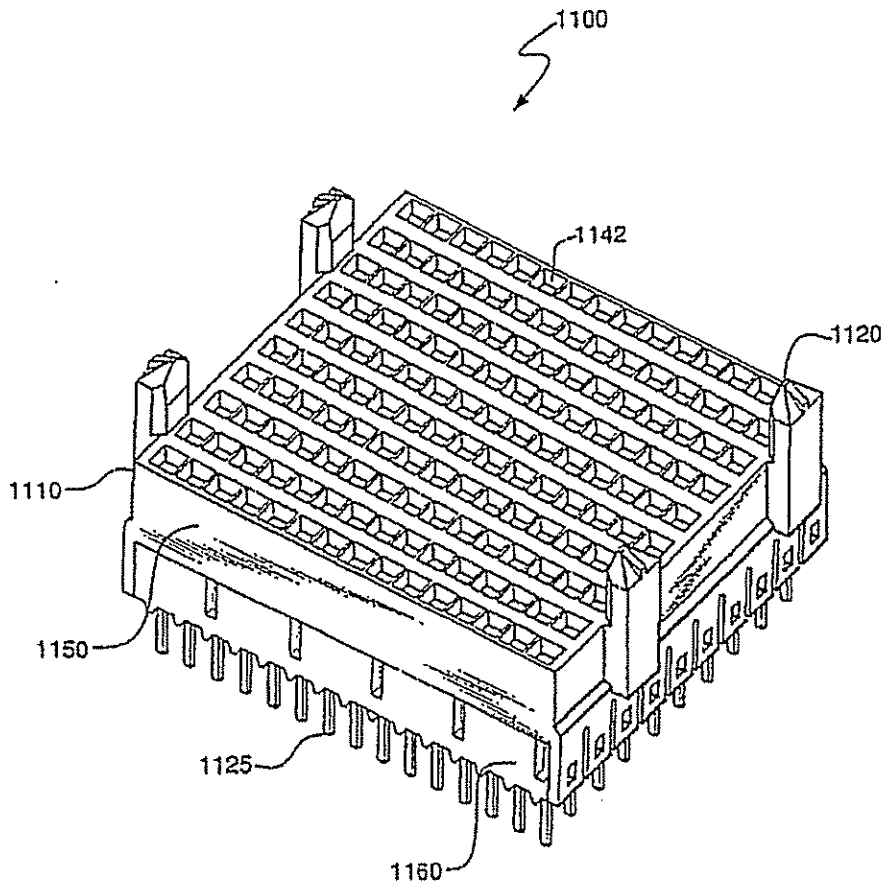


FIG. 22

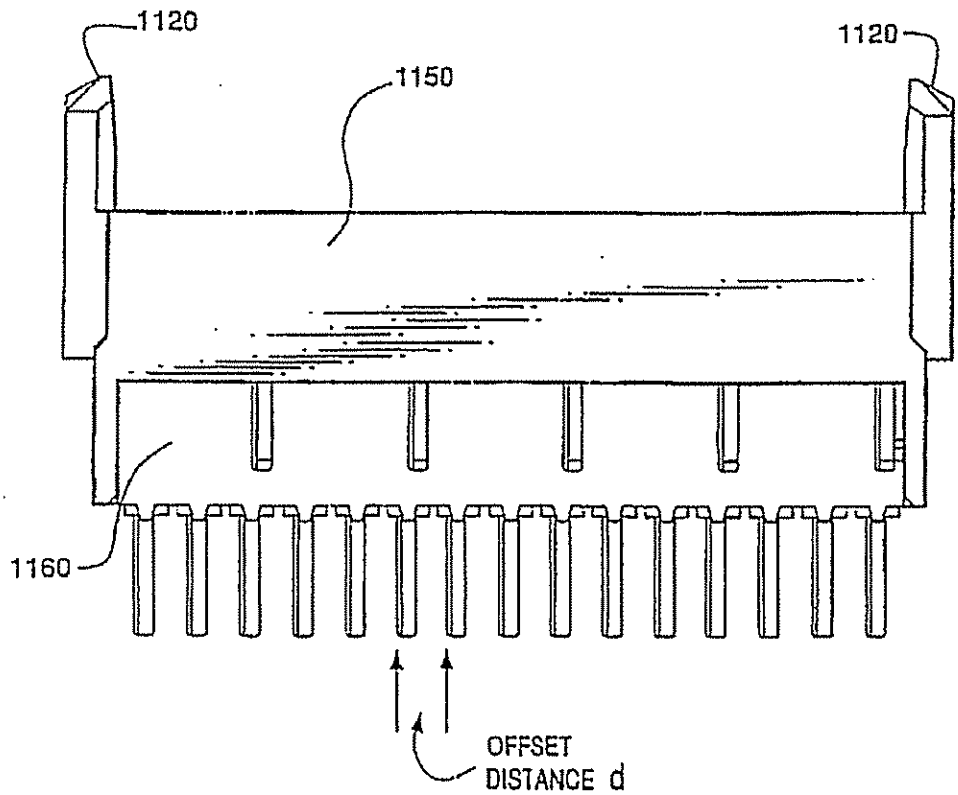


FIG. 23

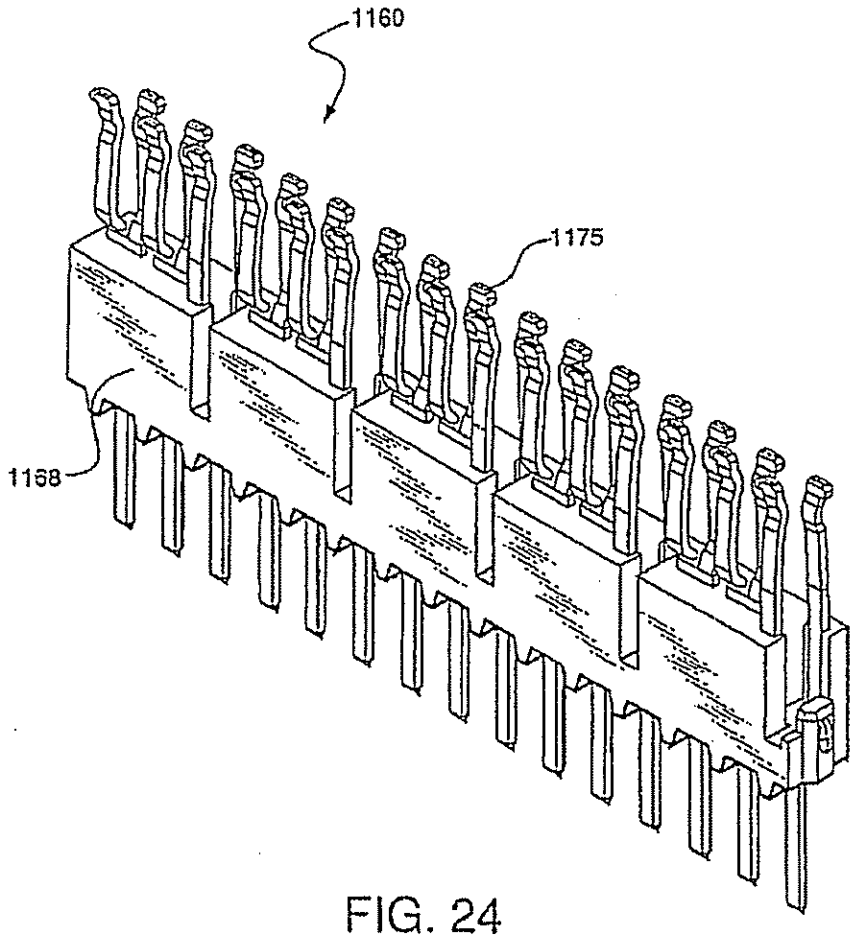


FIG. 24

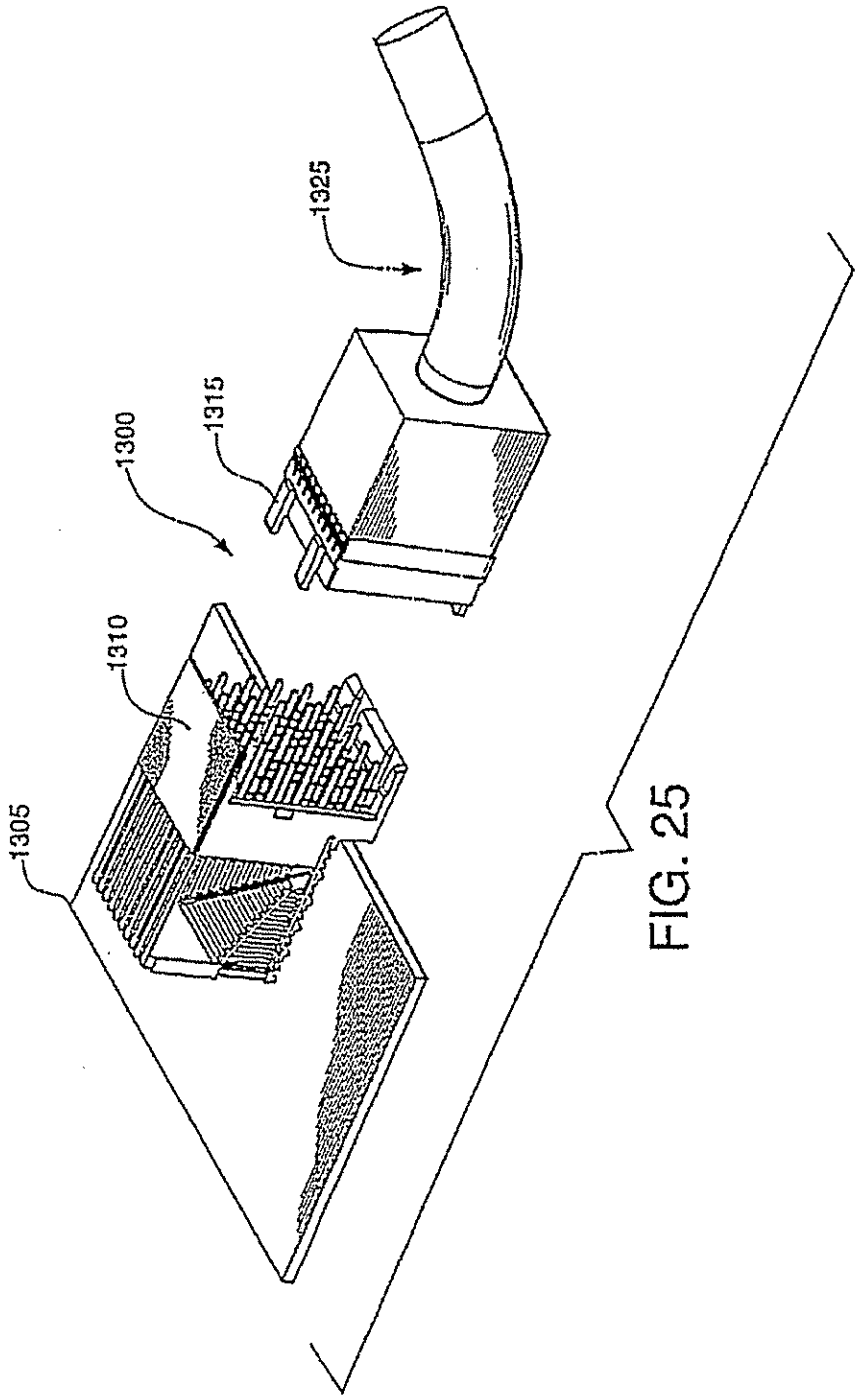


FIG. 25

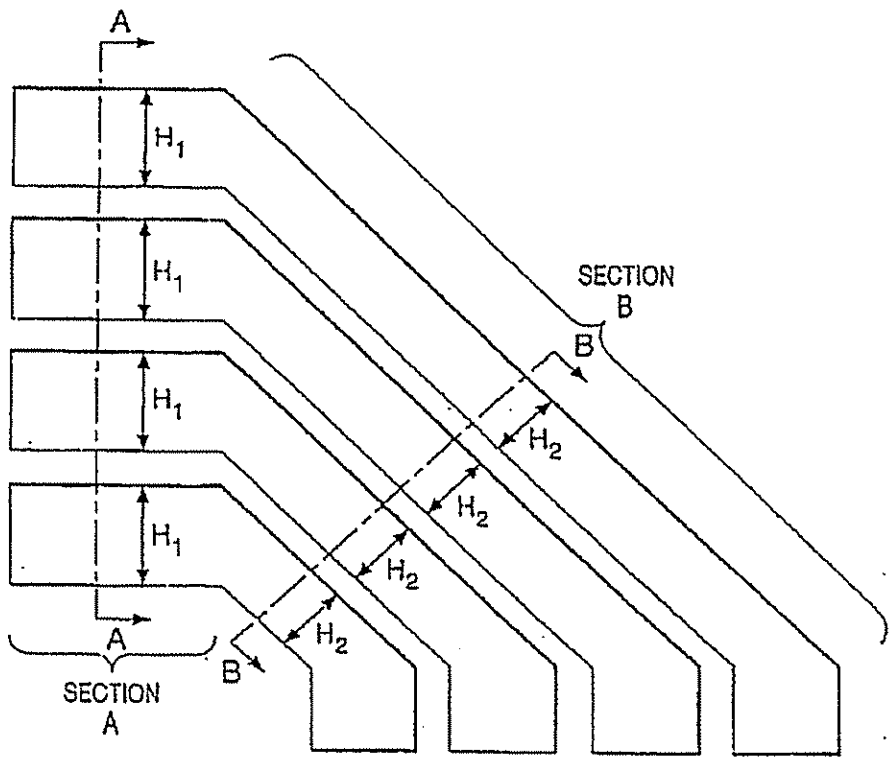
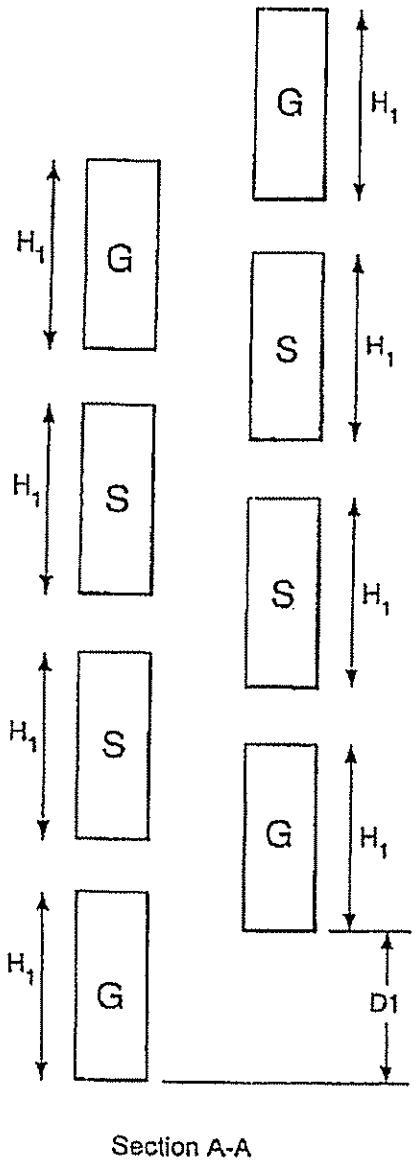
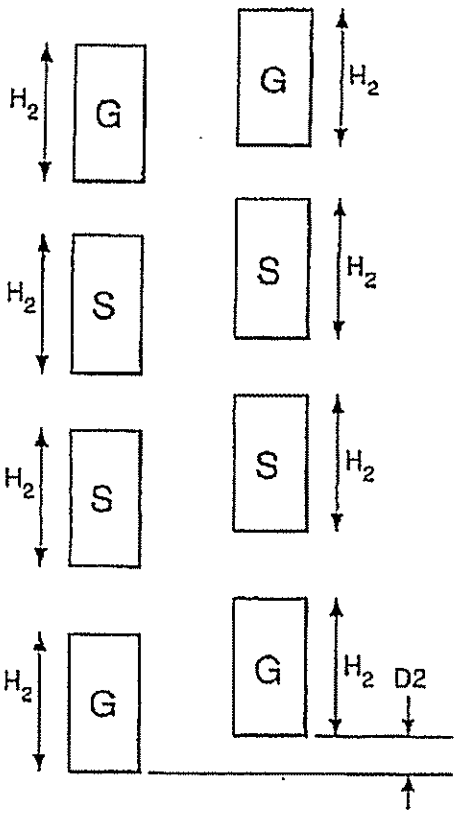


FIG. 26



Section A-A

FIG. 27



Section B-B

FIG. 28

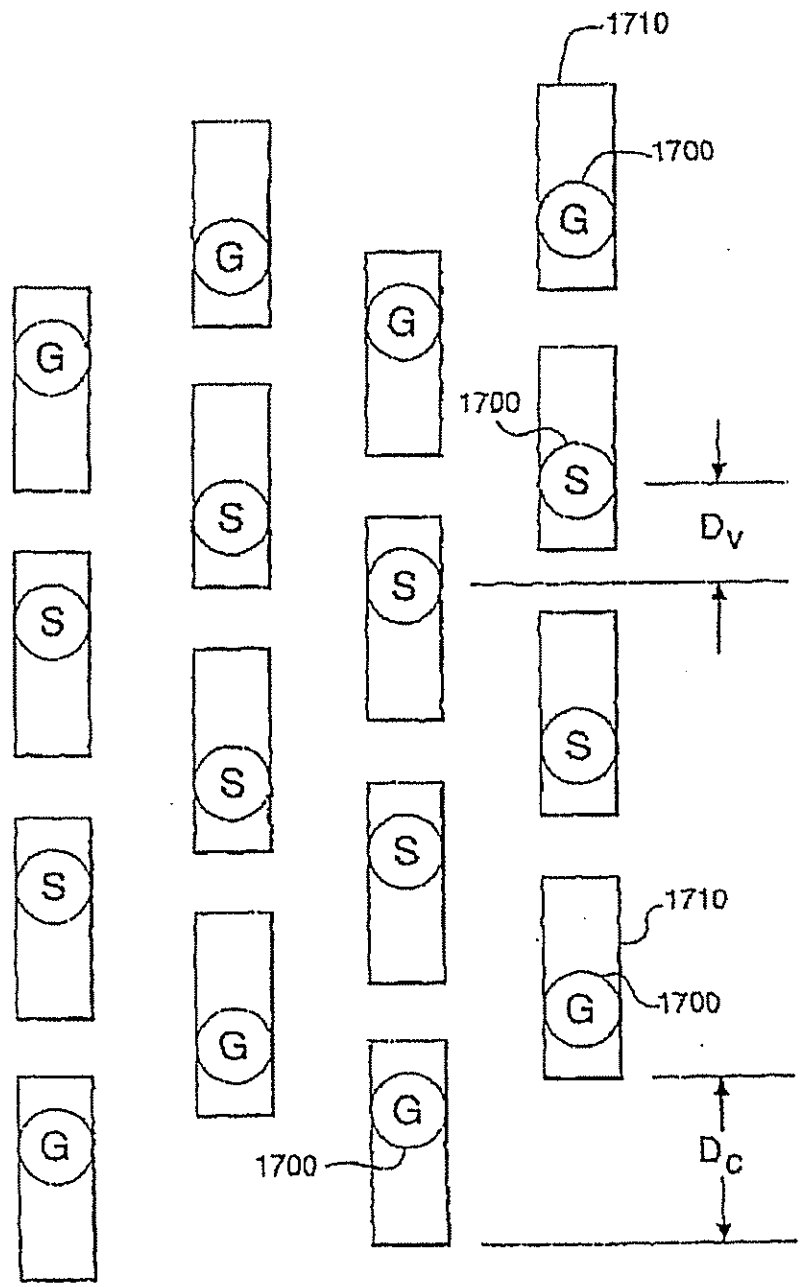


FIG. 29

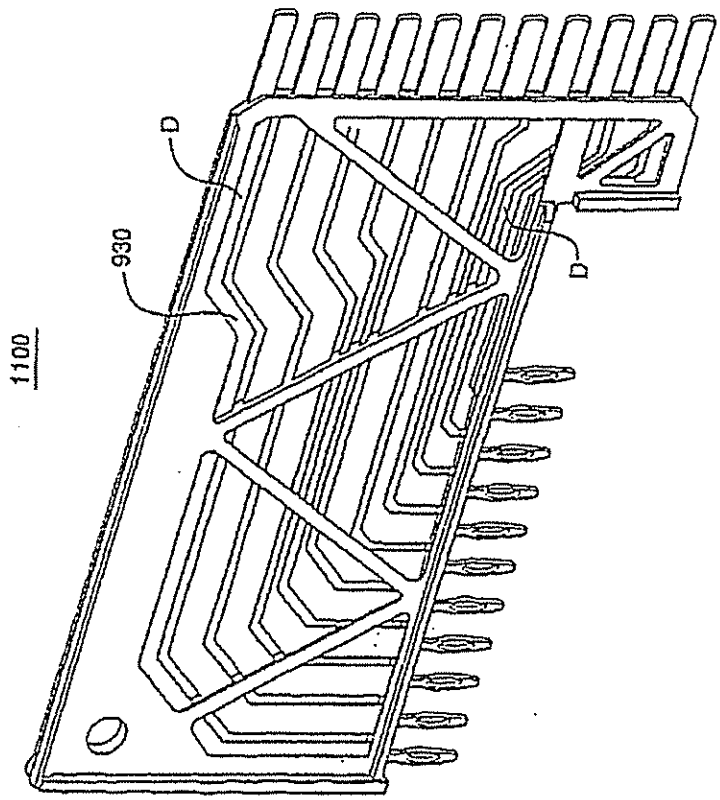


FIG. 30

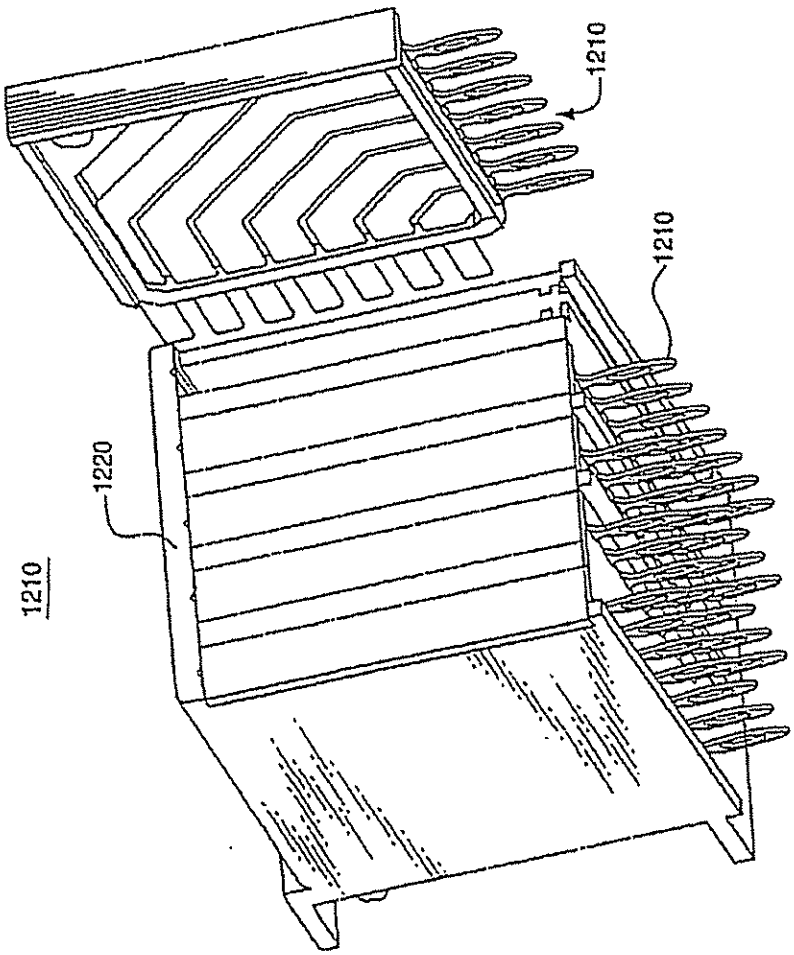


FIG. 31

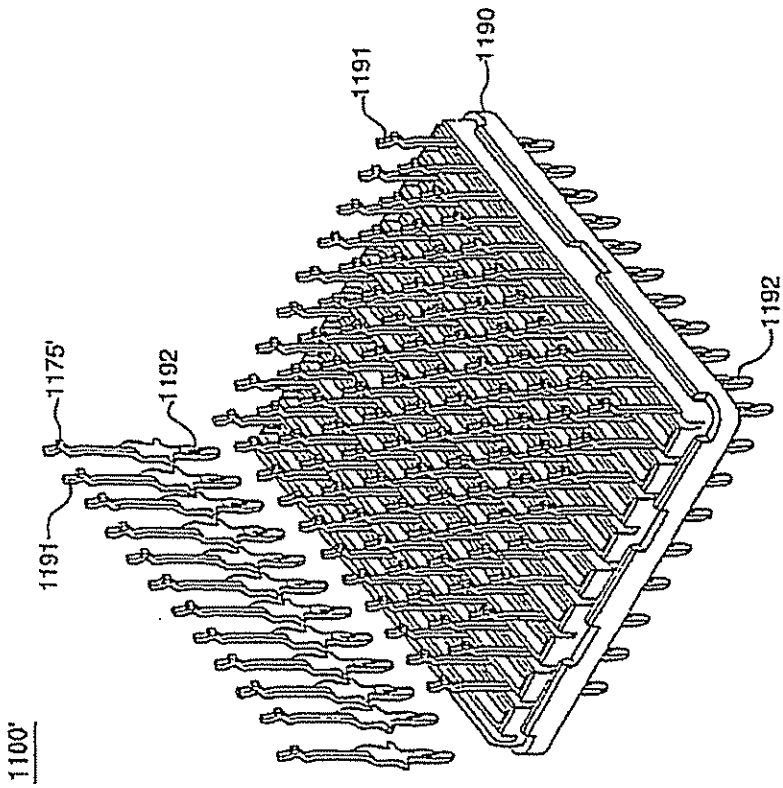


FIG. 32

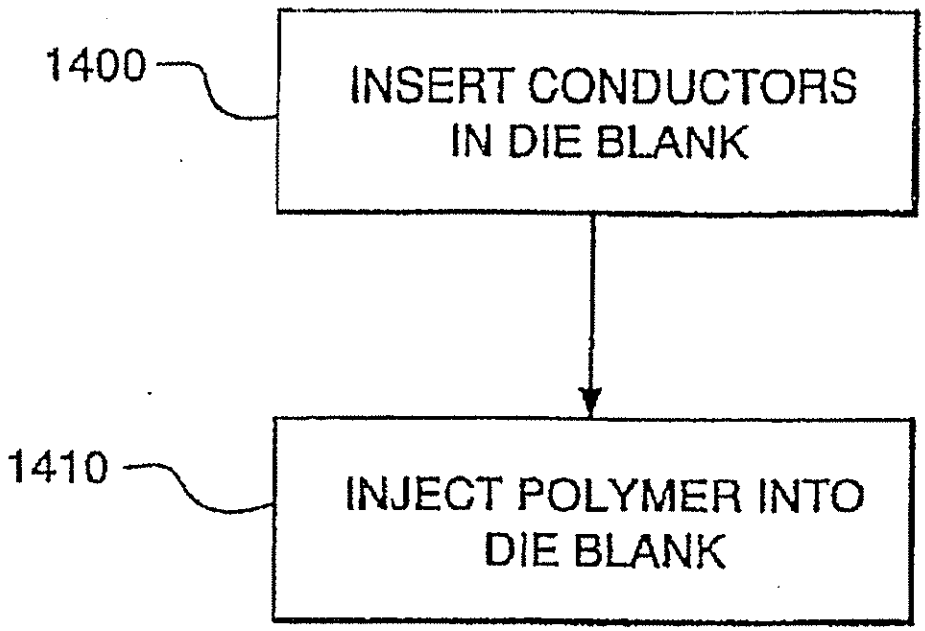

1400
INSERT CONDUCTORS IN DIE BLANK
1410
INJECT POLYMER INTO DIE BLANK

FIG. 33

CROSS TALK REDUCTION AND IMPEDANCE MATCHING FOR HIGH SPEED ELECTRICAL CONNECTORS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 10/294,966, filed Nov. 14, 2002, now U.S Pat. No. 6,976,886 which is a continuation-in-part of U S patent application Ser No 09/990,794, filed Nov 14, 2001, now U S Pat. No. 6,692,272, and of U.S. patent application Ser. No 10/155,786, filed May 24, 2002, now U S Pat No. 6,652,318 The contents of each of the above-referenced patents and patent applications is incorporated herein by reference

FIELD OF THE INVENTION

Generally, the invention relates to the field of electrical connectors More particularly, the invention relates to lightweight, low cost, high density electrical connectors that provide impedance controlled, high-speed, low interference communications, even in the absence of shields between the contacts, and that provide for a variety of other benefits not found in prior art connectors

BACKGROUND OF THE INVENTION

Electrical connectors provide signal connections between electronic devices using signal contacts. Often, the signal contacts are so closely spaced that undesirable interference, or "cross talk," occurs between adjacent signal contacts As used herein, the term "adjacent" refers to contacts (or rows or columns) that are next to one another. Cross talk occurs when one signal contact induces electrical interference in an adjacent signal contact due to intermingling electrical fields, thereby compromising signal integrity With electronic device miniaturization and high speed, high signal integrity electronic communications becoming more prevalent, the reduction of cross talk becomes a significant factor in connector design

One commonly used technique for reducing cross talk is to position separate electrical shields, in the form of metallic plates, for example, between adjacent signal contacts The shields act to block cross talk between the signal contacts by blocking the intermingling of the contacts' electric fields FIGS. 1A and 1B depict exemplary contact arrangements for electrical connectors that use shields to block cross talk

FIG. 1A depicts an arrangement in which signal contacts S and ground contacts G are arranged such that differential signal pairs S+, S− are positioned along columns 101–106. As shown, shields 112 can be positioned between contact columns 101–106 A column 101–106 can include any combination of signal contacts S+, S− and ground contacts G .The ground contacts G serve to block cross talk between differential signal pairs in the same column The shields 112 serve to block cross talk between differential signal pairs in adjacent columns

FIG 1B depicts an arrangement in which signal contacts S and ground contacts G are arranged such that differential signal pairs S+, S− are positioned along rows 111–116. As shown, shields 122 can be positioned between rows 111–116 A row 111–116 can include any combination of signal contacts S+, S− and ground contacts G The ground contacts G serve to block cross talk between differential signal pairs in the same row The shields 122 serve to block cross talk between differential signal pairs in adjacent rows

Because of the demand for smaller, lower weight communications equipment, it is desirable that connectors be made smaller and lower in weight, while providing the same performance characteristics Shields take up valuable space within the connector that could otherwise be used to provide additional signal contacts, and thus limit contact density (and, therefore, connector size) Additionally, manufacturing and inserting such shields substantially increase the overall costs associated with manufacturing such connectors. In some applications, shields are known to make up 40% or more of the cost of the connector Another known disadvantage of shields is that they lower impedance. Thus, to make the impedance high enough in a high contact density connector, the contacts would need to be so small that they would not be robust enough for many applications.

The dielectrics that are typically used to insulate the contacts and retain them in position within the connector also add undesirable cost and weight.

Therefore, a need exists for a lightweight, high-speed electrical connector (i.e , one that operates above 1 Gb/s and typically in the range of about 10 Gb/s) that reduces the occurrence of cross talk without the need for separate shields, and provides for a variety of other benefits not found in prior art connectors

BRIEF SUMMARY OF THE INVENTION

An electrical connector according to the invention may include a first signal contact positioned within a first linear array of electrical contacts and a second signal contact positioned within a second linear array of electrical contacts that is adjacent to the first linear array Either of the signal contacts may be a single-ended signal conductor, or one of a differential signal pair The connector may be devoid of shields between the signal contacts The connector may be devoid of shields between the first linear array and the second linear array. The connector may be devoid of ground contacts adjacent to the signal contacts

The connector may include a third signal contact or a ground contact disposed within the first linear array adjacent to the first signal contact: The first and third signal contacts may have a gap between them of between about 0 3 mm and 0 4 mm, and may be edge-coupled to one another Such a connector may comprise a first column of electrical contacts comprising a first arrangement of differential signal pairs separated from one another by first ground contacts, a second column of electrical contacts comprising a second arrangement of differential signal pairs separated from one another by second ground contacts, wherein one differential signal pair in the second arrangement of differential signal pairs is a victim differential signal pair, and a third column of electrical contacts comprising a third arrangement of differential signal pairs separated from one another by third ground contacts The second column may be adjacent to the first column, and the third column adjacent to the second column The connector may be devoid of electrical shields between the first column and the second column, and between the second column and the third column The contacts in the first column may be spaced apart from the contacts in the second column by a column-spacing distance of about 1 8–2 0 millimeters, and the contacts in the second column may be spaced apart from the contacts in the third column by the same column-spacing distance Each of the differential signal pairs may define a gap distance between the electrical contacts that form the pair The gap distance

relative to the column-spacing distance may be such that differential signals with rise times of 200 picoseconds in the six differential signal pairs in the first, second, and third columns that are closest to the victim pair produce no more than 6% worst-case, multi-active cross talk on the victim differential signal pair

The connector may be a high-speed connector, i e , a connector that operates at signal speeds in a range of about one gigabit/sec to about ten gigabits/sec Such a high-speed connector may comprise a first column of electrical contacts comprising a first arrangement of differential signal pairs each separated from one another by first ground contacts a second column of electrical contacts comprising a second arrangement of differential signal pairs each separated from one another by second ground contacts, wherein one differential signal pair in the second arrangement of differential signal pairs is a victim pair and a third column of electrical contacts comprising a third arrangement of differential signal pairs each separated from one another by third ground contacts The second column may be adjacent to the first column, and the third column may be adjacent to the second column The connector may be devoid of electrical shields between the first column and the second column, and between the second column and the third column The first column, the second column, and the third column may be evenly spaced apart from one another by an equal column-spacing distance of about 1 8 to 2 millimeters Each of the differential signal pairs may define a gap distance between electrical contacts that form each differential signal pair The gap distance relative to the column-spacing distance may be such that differential signals with rise times of 40 picoseconds in the six differential signal pairs in the first, second, and third columns that are closest to the victim pair produce no more than an acceptable level of worst-case, multi-active cross talk on the victim pair

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is further described in the detailed description that follows, by reference to the noted drawings by way of non-limiting illustrative embodiments of the invention, in which like reference numerals represent similar parts throughout the drawings, and wherein:

FIGS 1A and 1B depict exemplary contact arrangements for electrical connectors that use shields to block cross talk;

FIG 2A is a schematic illustration of an electrical connector in which conductive and dielectric elements are arranged in a generally "I" shaped geometry;

FIG 2B depicts equipotential regions within an arrangement of signal and ground contacts;

FIG 3A illustrates a conductor arrangement used to measure the effect of offset on multi-active cross talk;

FIG 3B is a graph illustrating the relationship between multi-active cross talk and offset between adjacent columns of terminals in accordance with one aspect of the invention;

FIG 3C depicts a contact arrangement for which cross talk was determined in a worst case scenario;

FIGS. 4A–4C depict conductor arrangements in which signal pairs are arranged in columns;

FIG 5 depicts a conductor arrangement in which signal pairs are arranged in rows;

FIG 6 is a diagram showing an array of six columns of terminals arranged in accordance with one aspect of the invention;

FIG 7 is a diagram showing an array of six columns arranged in accordance with another embodiment of the invention;

FIG 8 is a perspective view of an illustrative right angle electrical connector, in accordance with the invention;

FIG 9 is a side view of the right angle electrical connector of FIG 8;

FIG 10 is a side view of a portion of the right angle electrical connector of FIG. 8 taken along line A—A;

FIG 11 is a top view of a portion of the right angle electrical connector of FIG. 8 taken along line B—B;

FIG 12 is a top cut-away view of conductors of the right angle electrical connector of FIG 8 taken along line B—B;

FIG 13A is a side cut-away view of a portion of the right angle electrical connector of FIG. 8 taken along line A—A;

FIG 13B is a cross-sectional view taken along line C—C of FIG 13A;

FIG 14 is a perspective view of illustrative conductors of a right angle electrical connector according to the invention;

FIG 15 is a perspective view of another illustrative conductor of the right angle electrical connector of FIG 8;

FIG 16A is a perspective view of a backplane system having an exemplary right angle electrical connector;

FIG 16B is a simplified view of an alternative embodiment of a backplane system with a right angle electrical connector;

FIG 16C is a simplified view of a board-to-board system having a vertical connector;

FIG 17 is a perspective view of the connector plug portion of the connector shown in FIG. 16A;

FIG 18 is a side view of the plug connector of FIG 17;

FIG 19A is a side view of a lead assembly of the plug connector of FIG 17;

FIG 19B depicts the lead assembly of FIG 19 during mating;

FIG 20 is a side view of two columns of terminals in accordance with one embodiment of the invention;

FIG 21 is a front view of the terminals of FIG. 20;

FIG. 22 is a perspective view of a receptacle in accordance with another embodiment of the invention;

FIG. 23 is a side view of the receptacle of FIG 22;

FIG. 24 is a perspective view of a single column of receptacle contacts;

FIG. 25 is a perspective view of a connector in accordance with another embodiment of the invention;

FIG. 26 is a side view of a column of right angle terminals in accordance with another aspect of the invention;

FIGS. 27 and 28 are front views of the right angle terminals of FIG 26 taken along lines A—A and lines B—B respectively;

FIG 29 illustrates the cross section of terminals as the terminals connect to vias on an electrical device in accordance with another aspect of the invention;

FIG 30 is a perspective view of a portion of another illustrative right angle electrical connector, in accordance with the invention;

FIG 31 is a perspective view of another illustrative right angle electrical connector, in accordance with the invention;

FIG 32 is a perspective view of an alternative embodiment of a receptacle connector; and

FIG. 33 is a flow diagram of a method for making a connector in accordance with the invention

DETAILED DESCRIPTION OF THE INVENTION

Certain terminology may be used in the following description for convenience only and should not be considered as limiting the invention in any way For example, the terms "top," "bottom," "left," "right," "upper," and "lower"

designate directions in the figures to which reference is made Likewise, the terms "inwardly" and "outwardly" designate directions toward and away from, respectively, the geometric center of the referenced object. The terminology includes the words above specifically mentioned, derivatives thereof, and words of similar import.

I-Shaped Geometry for Electrical Connectors—Theoretical Model

FIG 2A is a schematic illustration of an electrical connector in which conductive and dielectric elements are arranged in a generally "I" shaped geometry Such connectors are embodied in the assignee's "I-BEAM" technology, and are described and claimed in U S. Pat No. 5,741,144, entitled "Low Cross And Impedance Controlled Electric Connector," the disclosure of which is hereby incorporated herein by reference in its entirety Low cross talk and controlled impedance have been found to result from the use of this geometry

The originally contemplated I-shaped transmission line geometry is shown in FIG 2A As shown, the conductive element can be perpendicularly interposed between two parallel dielectric and ground plane elements The description of this transmission line geometry as I-shaped comes from the vertical arrangement of the signal conductor shown generally at numeral 10 between the two horizontal dielectric layers 12 and 14 having a dielectric constant ϵ and ground planes 13 and 15 symmetrically placed at the top and bottom edges of the conductor The sides 20 and 22 of the conductor are open to the air 24 having an air dielectric constant ϵ_0 In a connector application, the conductor could include two sections, 26 and 28, that abut end-to-end or face-to-face The thickness, t_1 and t_2 of the dielectric layers 12 and 14, to first order, controls the characteristic impedance of the transmission line and the ratio of the overall height h to dielectric width w_d controls the electric and magnetic field penetration to an adjacent contact Original experimentation led to the conclusion that the ratio h/w_d needed to minimize interference beyond A and B would be approximately unity (as illustrated in FIG. 2A)

The lines 30, 32, 34, 36 and 38 in FIG 2A are equipotentials of voltage in the air-dielectric space Taking an equipotential line close to one of the ground planes and following it out towards the boundaries A and B, it will be seen that both boundary A or boundary B are very close to the ground potential This means that virtual ground surfaces exist at each of boundary A and boundary B. Therefore, if two or more I-shaped modules are placed side-by-side, a virtual ground surface exists between the modules and there will be little to no intermingling of the modules' fields. In general, the conductor width w_c and dielectric thicknesses t_1, t_2 should be small compared to the dielectric width w_d or module pitch (i.e., distance between adjacent modules)

Given the mechanical constraints on a practical connector design, it was found in actuality that the proportioning of the signal conductor (blade/beam contact) width and dielectric thicknesses could deviate somewhat from the preferred ratios and some minimal interference might exist between adjacent signal conductors However, designs using the above-described I-shaped geometry tend to have lower cross talk than other conventional designs

Exemplary Factors Affecting Cross Talk Between Adjacent Contacts

In accordance with the invention, the basic principles described above were further analyzed and expanded upon and can be employed to determine how to even further limit cross talk between adjacent signal contacts, even in the absence of shields between the contacts, by determining an appropriate arrangement and geometry of the signal and ground contacts FIG 2B includes a contour plot of voltage in the neighborhood of an active column-based differential signal pair S+, S− in a contact arrangement of signal contacts S and ground contacts G according to the invention As shown, contour lines 42 are closest to zero volts, contour lines 44 are closest to −1 volt, and contour lines 46 are closest to +1 volt. It has been observed that, although the voltage does not necessarily go to zero at the "quiet" differential signal pairs that are nearest to the active pair, the interference with the quiet pairs is near zero That is, the voltage impinging on the positive-going quiet differential pair signal contact is about the same as the voltage impinging on the negative-going quiet differential pair signal contact. Consequently, the noise on the quiet pair, which is the difference in voltage between the positive- and negative-going signals, is close to zero

Thus, as shown in FIG. 2B, the signal contacts S and ground contacts G can be scaled and positioned relative to one another such that a differential signal in a first differential signal pair produces a high field H in the gap between the contacts that form the signal pair and a low (i.e., close to ground potential) field L (close to ground potential) near an adjacent signal pair Consequently, cross talk between adjacent signal contacts can be limited to acceptable levels for the particular application In such connectors, the level of cross talk between adjacent signal contacts can be limited to the point that the need for (and cost of) shields between adjacent contacts is unnecessary, even in high speed, high signal integrity applications

Through further analysis of the above-described I-shaped model, it has been found that the unity ratio of height to width is not as critical as it first seemed It has also been found that a number of factors can affect the level of cross talk between adjacent signal contacts. A number of such factors are described in detail below, though it is anticipated that there may be others Additionally, though it is preferred that all of these factors be considered, it should be understood that each factor may, alone, sufficiently limit cross talk for a particular application. Any or all of the following factors may be considered in determining a suitable contact arrangement for a particular connector design:

a) Less cross talk has been found to occur where adjacent contacts are edge-coupled (i e, where the edge of one contact is adjacent to the edge of an adjacent contact) than where adjacent contacts are broad side coupled (i e., where the broad side of one contact is adjacent to the broad side of an adjacent contact) or where the edge of one contact is adjacent to the broad side of an adjacent contact The tighter the edge coupling, the less the coupled signal pair's electrical field will extend towards an adjacent pair and the less the towards the unity height-to-width ratio of the original I-shaped theoretical model a connector application will have to approach Edge coupling also allows for smaller gap widths between adjacent connectors, and thus facilitates the achievement of desirable impedance levels in high contact density connectors without the need for contacts that are too small to perform adequately For example, it has been found that a gap of about 0.3–0.4 mm is adequate to provide an impedance of about 100 ohms where the contacts are edge coupled, while a gap of about 1 mm is necessary where the same contacts are broad side coupled to achieve the same impedance. Edge coupling also facilitates changing contact width, and therefore gap width, as the contact extends through dielectric regions, contact regions, etc;

b) It has also been found that cross talk can be effectively reduced by varying the "aspect ratio," i.e., the ratio of column pitch (i.e., the distance between adjacent columns) to the gap between adjacent contacts in a given column;

c) The "staggering" of adjacent columns relative to one another can also reduce the level of cross talk. That is, cross talk can be effectively limited where the signal contacts in a first column are offset relative to adjacent signal contacts in an adjacent column. The amount of offset may be, for example, a full row pitch (i.e., distance between adjacent rows), half a row pitch, or any other distance that results in acceptably low levels of cross talk for a particular connector design. It has been found that the optimal offset depends on a number of factors, such as column pitch, row pitch, the shape of the terminals, and the dielectric constant(s) of the insulating material(s) around the terminals, for example. It has also been found that the optimal offset is not necessarily "on pitch," as was often thought. That is, the optimal offset may be anywhere along a continuum, and is not limited to whole fractions of a row pitch (e.g., full or half row pitches).

FIG. 3A illustrates a contact arrangement that has been used to measure the effect of offset between adjacent columns on cross talk. Fast (e.g., 40 ps) rise-time differential signals were applied to each of Active Pair 1 and Active Pair 2. Near-end crosstalk Nxt1 and Nxt2 were determined at Quiet Pair, to which no signal was applied, as the offset d between adjacent columns was varied from 0 to 5.0 mm. Near-end cross talk occurs when noise is induced on the quiet pair from the current carrying contacts in an active pair.

As shown in the graph of FIG. 3B, the incidence of multi-active cross talk (dark line in FIG. 3B) is minimized at offsets of about 1.3 mm and about 3.65 mm. In this experiment, multi-active cross talk was considered to be the sum of the absolute values of cross talk from each of Active Pair 1 (dashed line in FIG. 3B) and Active Pair 2 (thin solid line in FIG. 3B). Thus, it has been shown that adjacent columns can be variably offset relative to one another until an optimum level of cross talk between adjacent pairs (about 1.3 mm, in this example);

d) Through the addition of outer grounds, i.e., the placement of ground contacts at alternating ends of adjacent contact columns, both near-end cross talk ("NEXT") and far-end cross talk ("FEXT") can be further reduced;

e) It has also been found that scaling the contacts (i.e., reducing the absolute dimensions of the contacts while preserving their proportional and geometric relationship) provides for increased contact density (i.e., the number of contacts per linear inch) without adversely affecting the electrical characteristics of the connector.

By considering any or all of these factors, a connector can be designed that delivers high-performance (i.e., low incidence of cross talk), high-speed (e.g., greater than 1 Gb/s and typically about 10 Gb/s) communications even in the absence of shields between adjacent contacts. It should also be understood that such connectors and techniques, which are capable of providing such high speed communications, are also useful at lower speeds. Connectors according to the invention have been shown, in worst case testing scenarios, to have near-end cross talk of less than about 3% and far-end cross talk of less than about 4%, at 40 picosecond rise time, with 63.5 mated signal pairs per linear inch. Such connectors can have insertion losses of less than about 0.7 dB at 5 GHz, and impedance match of about 100±8 ohms measured at a 40 picosecond rise time.

FIG. 3C depicts a contact arrangement for which cross talk was determined in a worst case scenario. Cross talk from each of six attacking pairs S1, S2, S3, S4, S5, and S6 was determined at a "victim" pair V. Attacking pairs S1, S2, S3, S4, S5, and S6 are six of the eight nearest neighboring pairs to signal pair V. It has been determined that the additional affects on cross talk at victim pair V from attacking pairs S7 and S8 is negligible. The combined cross talk from the six nearest neighbor attacking pairs has been determined by summing the absolute values of the peak cross talk from each of the pairs, which assumes that each pair is fairing at the highest level all at the same time. Thus, it should be understood that this is a worst case scenario, and that, in practice, much better results should be achieved.

Exemplary Contact Arrangements According to the Invention

FIG. 4A depicts a connector 100 according to the invention having column-based differential signal pairs (i.e., in which differential signal pairs are arranged into columns). (As used herein, a "column" refers to the direction along which the contacts are edge coupled. A "row" is perpendicular to a column.) As shown, each column 401–406 comprises, in order from top to bottom, a first differential signal pair, a first ground conductor, a second differential signal pair, and a second ground conductor. As can be seen, first column 401 comprises, in order from top to bottom, a first differential signal pair comprising signal conductors S1+ and S1–, a first ground conductor G, a second differential signal pair comprising signal conductors S7+ and S7–, and a second ground conductor G. Each of rows 413 and 416 comprises a plurality of ground conductors G. Rows 411 and 412 together comprise six differential signal pairs, and rows 514 and 515 together comprise another six differential signal pairs. The rows 413 and 416 of ground conductors limit cross talk between the signal pairs in rows 411–412 and the signal pairs in rows 414–415. In the embodiment shown in FIG. 4A, arrangement of 36 contacts into columns can provide twelve differential signal pairs. Because the connector is devoid of shields, the contacts can be made relatively larger (compared to those in a connector having shields). Therefore, less connector space is needed to achieve the desired impedance.

FIGS. 4B and 4C depict connectors according to the invention that include outer grounds. As shown in FIG. 4B, a ground contact G can be placed at each end of each column. As shown in FIG. 4C, a ground contact G can be placed at alternating ends of adjacent columns. It has been found that the placement of a ground contact G at alternating ends of adjacent columns results in a 35% reduction in NEXT and a 65% reduction in FEXT as compared to a connector having a contact arrangement that is otherwise the same, but which has no such outer grounds. It has also been found that basically the same results can be achieved through the placement of ground contacts at both ends of every contact column, as shown in FIG. 4B. Consequently, it is preferred to place outer grounds at alternating ends of adjacent columns in order to increase contact density (relative to a connector in which outer grounds are placed at both ends of every column) without increasing the level of cross talk.

Alternatively, as shown in FIG. 5, differential signal pairs may be arranged into rows. As shown in FIG. 5, each row 511–516 comprises a repeating sequence of two ground conductors and a differential signal pair. First row 511 comprises, in order from left to right, two ground conductors G, a differential signal pair S1+, S1–, and two ground conductors G. Row 512 comprises in order from left to right, a differential signal pair S2+, S2–, two ground conductors G,

and a differential signal pair S3+, S3−. The ground conductors block cross talk between adjacent signal pairs In the embodiment shown in FIG 5, arrangement of 36 contacts into rows provides only nine differential signal pairs

By comparison of the arrangement shown in FIG 4A with the arrangement shown in FIG 5, it can be understood that a column arrangement of differential signal pairs results in a higher density of signal contacts than does a row arrangement. However, for right angle connectors arranged into columns, contacts within a differential signal pair have different lengths, and therefore, such differential signal pairs may have intra-pair skew Similarly, arrangement of signal pairs into either rows or columns may result in inter-pair skew because of the different conductor lengths of different differential signal pairs Thus, it should be understood that, although arrangement of signal pairs into columns results in a higher contact density, arrangement of the signal pairs into columns or rows can be chosen for the particular application

Regardless of whether the signal pairs are arranged into rows or columns, each differential signal pair has a differential impedance Z_o between the positive conductor Sx+ and negative conductor Sx− of the differential signal pair. Differential impedance is defined as the impedance existing between two signal conductors of the same differential signal pair, at a particular point along the length of the differential signal pair. As is well known, it is desirable to control the differential impedance Z_o to match the impedance of the electrical device(s) to which the connector is connected Matching the differential impedance Z_o to the impedance of electrical device minimizes signal reflection and/or system resonance that can limit overall system bandwidth. Furthermore, it is desirable to control the differential impedance Z_o such that it is substantially constant along the length of the differential signal pair, i e , such that each differential signal pair has a substantially consistent differential impedance profile

The differential impedance profile can be controlled by the positioning of the signal and ground conductors Specifically, differential impedance is determined by the proximity of an edge of signal conductor to an adjacent ground and by the gap between edges of signal conductors within a differential signal pair

As shown in FIG 4A, the differential signal pair comprising signal conductors S6+ and S6− is located adjacent to one ground conductor G in row 413. The differential signal pair comprising signal conductors S12+ and S12− is located adjacent to two ground conductors G, one in row 413 and one in row 416. Conventional connectors include two ground conductors adjacent to each differential signal pair to minimize impedance matching problems Removing one of the ground conductors typically leads to impedance mismatches that reduce communications speed. However, the lack of one adjacent ground conductor can be compensated for by reducing the gap between the differential signal pair conductors with only one adjacent ground conductor For example, as shown in FIG 4A, signal conductors S6+ and S6− can be located a distance d_1 apart from each other and signal conductors S12+ and S12− can be located a different distance d_2 apart from each other. The distances may be controlled by making the widths of signal conductors S6+ and S6− wider than the widths of signal conductors S12+ and S12− (where conductor width is measured along the direction of the column).

For single ended signaling, single ended impedance can also be controlled by positioning of the signal and ground conductors Specifically, single ended impedance is determined by the gap between a signal conductor and an adjacent ground. Single ended impedance is defined as the impedance existing between a signal conductor and ground, at a particular point along the length of a single ended signal conductor

To maintain acceptable differential impedance control for high bandwidth systems, it is desirable to control the gap between contacts to within a few thousandths of an inch Gap variations beyond a few thousandths of an inch may cause unacceptable variation in the impedance profile; however, the acceptable variation is dependent on the speed desired, the error rate acceptable, and other design factors.

FIG. 6 shows an array of differential signal pairs and ground contacts in which each column of terminals is offset from each adjacent column The offset is measured from an edge of a terminal to the same edge of the corresponding terminal in the adjacent column. The aspect ratio of column pitch to gap width, as shown in FIG 6, is P/X It has been found that an aspect ratio of about 5 (i e , 2 mm column pitch; 0.4 mm gap width) is adequate to sufficiently limit cross talk where the columns are also staggered Where the columns are not staggered, an aspect ratio of about 8–10 is desirable

As described above, by offsetting the columns, the level of multi-active cross talk occurring in any particular terminal can be limited to a level that is acceptable for the particular connector application As shown in FIG 6, each column is offset from the adjacent column, in the direction along the columns, by a distance d Specifically, column 601 is offset from column 602 by an offset distance d, column 602 is offset from column 603 by a distance d, and so forth. Since each column is offset from the adjacent column, each terminal is offset from an adjacent terminal in an adjacent column For example, signal contact 680 in differential pair DP3 is offset from signal contact 681 in differential pair DP4 by a distance d as shown.

FIG 7 illustrates another configuration of differential pairs wherein each column of terminals is offset relative to adjacent columns. For example, as shown, differential pair DP1 in column 701 is offset from differential pair DP2 in the adjacent column 702 by a distance d In this embodiment, however, the array of terminals does not include ground contacts separating each differential pair Rather, the differential pairs within each column are separated from each other by a distance greater than the distance separating one terminal in a differential pair from the second terminal in the same differential pair. For example, where the distance between terminals within each differential pair is Y, the distance separating differential pairs can be Y+X, where Y+X/Y >>1 It has been found that such spacing also serves to reduce cross talk

Exemplary Connector Systems According to the Invention

FIG 8 is a perspective view of a right angle electrical connector according to the invention that is directed to a high speed electrical connector wherein signal conductors of a differential signal pair have a substantially constant differential impedance along the length of the differential signal pair As shown in FIG. 8, a connector 800 comprises a first section 801 and a second section 802 First section 801 is electrically connected to a first electrical device 810 and second section 802 is electrically connected to a second electrical device 812 Such connections may be SMT, PIP, solder ball grid array, press fit, or other such connections Typically, such connections are conventional connections having conventional connection spacing between connection pins; however, such connections may have other spacing between connection pins First section 801 and second

section 802 can be electrically connected together, thereby electrically connecting first electrical device 810 to second electrical device 812

As can be seen, first section 801 comprises a plurality of modules 805. Each module 805 comprises a column of conductors 830 As shown, first section 801 comprises six modules 805 and each module 805 comprises six conductors 830; however, any number of modules 805 and conductors 830 may be used Second section 802 comprises a plurality of modules 806 Each module 806 comprises a column of conductors 840. As shown, second section 802 comprises six modules 806 and each module 806 comprises six conductors 840; however, any number of modules 806 and conductors 840 may be used

FIG. 9 is a side view of connector 800. As shown in FIG. 9, each module 805 comprises a plurality of conductors 830 secured in a frame 850 Each conductor 830 comprises a connection pin 832 extending from frame 850 for connection to first electrical device 810, a blade 836 extending from frame 850 for connection to second section 802, and a conductor segment 834 connecting connection pin 832 to blade 836

Each module 806 comprises a plurality of conductors 840 secured in frame 852 Each conductor 840 comprises a contact interface 841 and a connection pin 842. Each contact interface 841 extends from frame 852 for connection to a blade 836 of first section 801 Each contact interface 840 is also electrically connected to a connection pin 842 that extends from frame 852 for electrical connection to second electrical device 812

Each module 805 comprises a first hole 856 and a second hole 857 for alignment with an adjacent module 805. Thus, multiple columns of conductors 830 may be aligned Each module 806 comprises a first hole 847 and a second hole 848 for alignment with an adjacent module 806. Thus, multiple columns of conductors 840 may be aligned

Module 805 of connector 800 is shown as a right angle module That is, a set of first connection pins 832 is positioned on a first plane (e g , coplanar with first electrical device 810) and a set of second connection pins 842 is positioned on a second plane (e.g., coplanar with second electrical device 812) perpendicular to the first plane To connect the first plane to the second plane, each conductor 830 turns a total of about ninety degrees (a right angle) to connect between electrical devices 810 and 812

To simplify conductor placement, conductors 830 can have a rectangular cross section; however, conductors 830 may be any shape. In this embodiment, conductors 830 have a high ratio of width to thickness to facilitate manufacturing. The particular ratio of width to thickness may be selected based on various design parameters including the desired communication speed, connection pin layout, and the like.

FIG 10 is a side view of two modules of connector 800 taken along line A—A and FIG 11 is a top view of two modules of connector 800 taken along line B—B. As can be seen, each blade 836 is positioned between two single beam contacts 849 of contact interface 841, thereby providing electrical connection between first section 801 and second section 802 and described in more detail below Connection pins 832 are positioned proximate to the centerline of module 805 such that connection pins 832 may be mated to a device having conventional connection spacing Connection pins 842 are positioned proximate to the centerline of module 806 such that connection pins 842 may be mated to a device having conventional connection spacing Connection pins, however, may be positioned at an offset from the centerline of module 806 if such connection spacing is supported by the mating device Further, while connection pins are illustrated in the Figures, other connection techniques are contemplated such as, for example, solder balls and the like.

Returning now to illustrative connector 800 of FIG 8 to discuss the layout of connection pins and conductors, first section 801 of connector 800 comprises six columns and six rows of conductors 830 Conductors 830 may be either signal conductors S or ground conductors G Typically, each signal conductor S is employed as either a positive conductor or a negative conductor of a differential signal pair; however, a signal conductor may be employed as a conductor for single ended signaling In addition, such conductors 830 may be arranged in either columns or rows

In addition to conductor placement, differential impedance and insertion losses are also affected by the dielectric properties of material proximate to the conductors Generally, it is desirable to have materials having very low dielectric constants adjacent and in contact with as much as the conductors as possible. Air is the most desirable dielectric because it allows for a lightweight connector and has the best dielectric properties While frame 850 and frame 852 may comprise a polymer, a plastic, or the like to secure conductors 830 and 840 so that desired gap tolerances may be maintained, the amount of plastic used is minimized Therefore, the rest of connector comprises an air dielectric and conductors 830 and 840 are positioned both in air and only minimally in a second material (e g , a polymer) having a second dielectric property. Therefore, to provide a substantially constant differential impedance profile, in the second material, the spacing between conductors of a differential signal pair may vary

As shown, the conductors can be exposed primarily to air rather than being encased in plastic The use of air rather than plastic as a dielectric provides a number of benefits For example, the use of air enables the connector to be formed from much less plastic than conventional connectors. Thus, a connector according to the invention can be made lower in weight than convention connectors that use plastic as the dielectric. Air also allows for smaller gaps between contacts and thereby provides for better impedance and cross talk control with relatively larger contacts, reduces cross-talk, provides less dielectric loss, increases signal speed (i.e , less propagation delay)

Through the use of air as the primary dielectric, a lightweight, low-impedance, low cross talk connector can be provided that is suitable for use as a ball grid assembly ("BGA") right-angle connector. Typically, a right angle connector is "off-balance, i e , disproportionately heavy in the mating area Consequently, the connector tends to "tilt" in the direction of the mating area. Because the solder balls of the BGA, while molten, can only support a certain mass, prior art connectors typically are unable to include additional mass to balance the connector. Through the use of air, rather than plastic, as the dielectric, the mass of the connector can be reduced. Consequently, additional mass can be added to balance the connector without causing the molten solder balls to collapse

FIG 12 illustrates the change in spacing between conductors in rows as conductors pass from being surrounded by air to being surrounded by frame 850. As shown in FIG 12, at connection pin 832 the distance between conductor S+ and S− is δ1 Distance δ1 may be selected to mate with conventional connector spacing on first electrical device 810 or may be selected to optimize the differential impedance profile As shown, distance δ1 is selected to mate with a conventional connector and is disposed proximate to the

centerline of module 805. As conductors S+ and S− travel from connection pins 832 through frame 850, portions 833 of conductors S+, S− jog towards each other, culminating in a separation distance δ2 in air region 860. Distance δ2 is selected to give the desired differential impedance between conductor S+ and S−, given other parameters, such as proximity to a ground conductor G. For example, given a spacing δ1, spacing δ2 may be chosen to provide for a constant differential impedance Z along the length of the conductor S+, S−. The desired differential impedance Z_0 depends on the system impedance (e.g., of first electrical device 810), and may be 100 ohms or some other value. Typically, a tolerance of about 5 percent is desired; however, 10 percent may be acceptable for some applications. It is this range of 10% or less that is considered substantially constant differential impedance.

As shown in FIG. 13A, conductors S+ and S− are disposed from air region 860 towards blade 836 and portions 835 jog outward with respect to each other within frame 850 such that blades 836 are separated by a distance δ3 upon exiting frame 850. Blades 836 are received in contact interfaces 841, thereby providing electrical connection between first section 801 and second section 802. As contact interfaces 841 travel from air region 860 towards frame 852, contact interfaces 841 jog outwardly with respect to each other, culminating in connection pins 842 separated by a distance of δ4. As shown, connection pins 842 are disposed proximate to the centerline of frame 852 to mate with conventional connector spacing.

FIG. 14 is a perspective view of conductors 830. As can be seen, within frame 850, conductors 830 jog, either inwardly or outwardly to maintain a substantially constant differential impedance profile along the conductive path.

FIG. 15 is a perspective view of conductor 840 that includes two single beam contacts 849, one beam contact 849 on each side of blade 836. This design may provide reduced cross talk performance, because each single beam contact 849 is further away from its adjacent contact. Also, this design may provide increased contact reliability, because it is a "true" dual contact. This design may also reduce the tight tolerance requirements for the positioning of the contacts and forming of the contacts.

As can be seen, within frame 852, conductor 840 jogs, either inward or outward to maintain a substantially constant differential impedance profile and to mate with connectors on second electrical device 812. For arrangement into columns, conductors 830 and 840 are positioned along a centerline of frames 850, 852, respectively.

FIG. 13B is a cross-sectional view taken along line C—C of FIG. 13A. As shown in FIG. 13B, terminal blades 836 are received in contact interfaces 841 such that beam contacts 839 engage respective sides of blades 836. Preferably, the beam contacts 839 are sized and shaped to provide contact between the blades 836 and the contact interfaces 841 over a combined surface area that is sufficient to maintain the electrical characteristics of the connector during mating and unmating of the connector.

As shown in FIG. 13B, the contact design allows the edge-coupled aspect ratio to be maintained in the mating region. That is, the aspect ratio of column pitch to gap width chosen to limit cross talk in the connector, exists in the contact region as well, and thereby limits cross talk in the mating region. Also, because the cross-section of the unmated blade contact is nearly the same as the combined cross-section of the mated contacts, the impedance profile can be maintained even if the connector is partially unmated. This occurs, at least in part, because the combined cross-section of the mated contacts includes no more than one or two thickness of metal (the thicknesses of the blade and the contact interface), rather than three thicknesses as would be typical in prior art connectors (see FIG. 13B, for example). Unplugging a connector such as shown in FIG. 13B results in a significant change in cross-section, and therefore, a significant change in impedance (which causes significant degradation of electrical performance if the connector is not properly and completely mated). Because the contact cross-section does not change dramatically as the connector is unmated, the connector (as shown in FIG. 13A) can provide nearly the same electrical characteristics when partially unmated (i.e., unmated by about 1–2 mm) as it does when fully mated.

FIG. 16A is a perspective view of a backplane system having an exemplary right angle electrical connector in accordance with an embodiment of the invention. As shown in FIG. 16A, connector 900 comprises a plug 902 and receptacle 1100.

Plug 902 comprises housing 905 and a plurality of lead assemblies 908. The housing 905 is configured to contain and align the plurality of lead assemblies 908 such that an electrical connection suitable for signal communication is made between a first electrical device 910 and a second electrical device 912 via receptacle 1100. In one embodiment of the invention, electrical device 910 is a backplane and electrical device 912 is a daughtercard. Electrical devices 910 and 912 may, however, be any electrical device without departing from the scope of the invention.

As shown, the connector 902 comprises a plurality of lead assemblies 908. Each lead assembly 908 comprises a column of terminals or conductors 930 therein as will be described below. Each lead assembly 908 comprises any number of terminals 930.

FIG. 16B is backplane system similar to FIG. 16A except that the connector 903 is a single device rather than mating plug and receptacle. Connector 903 comprises a housing and a plurality of lead assemblies (not shown). The housing is configured to contain and align the plurality of lead assemblies (not shown) such that an electrical connection suitable for signal communication is made between a first electrical device 910 and a second electrical device 912.

FIG. 16C is a board-to-board system similar to FIG. 16A except that plug connector 905 is a vertical plug connector rather than a right angle plug connector. This embodiment makes electrical connection between two parallel electrical devices 910 and 913. A vertical back-panel receptacle connector according to the invention can be insert molded onto a board, for example. Thus, spacing, and therefore performance, can be maintained.

FIG. 17 is a perspective view of the plug connector of FIG. 16A shown without electrical devices 910 and 912 and receptacle connector 1100. As shown, slots 907 are formed in the housing 905 that contain and align the lead assemblies 908 therein. FIG. 17 also shows connection pins 932, 942. Connection pins 942 connect connector 902 to electrical device 912. Connection pins 932 electrically connect connector 902 to electrical device 910 via receptacle 1100. Connection pins 932 and 942 may be adapted to provide through-mount or surface-mount connections to an electrical device (not shown).

In one embodiment, the housing 905 is made of plastic, however, any suitable material may be used. The connections to electrical devices 910 and 912 may be surface or through mount connections.

FIG. 18 is a side view of plug connector 902 as shown in FIG. 17. As shown, the column of terminals contained in

each lead assembly 908 are offset from another column of terminals in an adjacent lead assembly by a distance d. Such an offset is discussed more fully above in connection with FIGS. 6 and 7

FIG 19A is a side view of a single lead assembly 908. As shown in FIG 19A, one embodiment of lead assembly 908 comprises a metal lead frame 940 and an insert molded plastic frame 933 In this manner, the insert molded lead assembly 933 serves to contain one column of terminals or conductors 930 The terminals may comprise either differential pairs or ground contacts In this manner, each lead assembly 908 comprises a column of differential pairs 935A and 935B and ground contacts 937

As is also shown in FIG 19A, the column of differential pairs and ground contacts contained in each lead assembly 908 are arranged in a signal-signal-ground configuration In this manner, the top contact of the column of terminals in lead assembly 908 is a ground contact 937A Adjacent to ground contact 937A is a differential pair 935A comprised of a two signal contacts, one with a positive polarity and one with a negative polarity.

As shown, the ground contacts 937A and 937B extend a greater distance from the insert molded lead assembly 933 As shown in FIG 19B, such a configuration allows the ground contacts 937 to mate with corresponding receptacle contacts 1102G in receptacle 1100 before the signal contacts 935 mate with corresponding receptacle contacts 1102S Thus, the connected devices (not shown in FIG. 19B) can be brought to a common ground before signal transmission occurs between them This provides for "hot" connection of the devices

Lead assembly 908 of connector 900 is shown as a right angle module. To explain, a set of first connection pins 932 is positioned on a first plane (e g , coplanar with first electrical device 910) and a set of second connection pins 942 is positioned on a second plane (e.g., coplanar with second electrical device 912) perpendicular to the first plane. To connect the first plane to the second plane, each conductor 930 is formed to extend a total of about ninety degrees (a right angle) to electrically connect electrical devices 910 and 912

FIGS 20 and 21 are side and front views, respectively, of two columns of terminals in accordance with one aspect of the invention As shown in FIGS. 20 and 21, adjacent columns of terminals are staggered in relation to one another In other words, an offset exists between terminals in adjacent lead assemblies. In particular and as shown in FIGS 20 and 21, an offset of distance d exists between terminals in column 1 and terminals in column 2 As shown, the offset d runs along the entire length of the terminal As stated above, the offset reduces the incidence of cross talk by furthering the distance between the signal carrying contacts

To simplify conductor placement, conductors 930 have a rectangular cross section as shown in FIG 20 Conductors 930 may, however, be any shape

FIG. 22 is a perspective view of the receptacle portion of the connector shown in FIG. 16A Receptacle 1100 may be mated with connector plug 902 (as shown in FIG 16A) and used to connect two electrical devices (not shown) Specifically, connection pins 932 (as shown in FIG 17) may be inserted into apertures 1142 to electrically connect connector 902 to receptacle 1100 Receptacle 1100 also includes alignment structures 1120 to aid in the alignment and insertion of connector 900 into receptacle 1100 Once inserted, structures 1120 also serve to secure the connector once inserted into receptacle 1100 Such structures 1120 thereby prevent any movement that may occur between the connector and receptacle that could result in mechanical breakage therebetween

Receptacle 1100 includes a plurality of receptacle contact assemblies 1160 each containing a plurality of terminals (only the tails of which are shown) The terminals provide the electrical pathway between the connector 900 and any mated electrical device (not shown)

FIG 23 is a side view of the receptacle of FIG. 22 including structures 1120, housing 1150 and receptacle lead assembly 1160 As shown, FIG 23 also shows that the receptacle lead assemblies may be offset from one another in accordance with the invention As stated above, such offset reduces the occurrence of multi-active cross talk as described above

FIG. 24 is a perspective view of a single receptacle contact assembly not contained in receptacle housing 1150. As shown, the assembly 1160 includes a plurality of dual beam conductive terminals 1175 and a holder 1168 made of insulating material In one embodiment, the holder 1168 is made of plastic injection molded around the contacts; however, any suitable insulating material may be used without departing from the scope of the invention

FIG 25 is a perspective view of a connector in accordance with another embodiment of the invention. As shown, connector 1310 and receptacle 1315 are used in combination to connect an electrical device, such as circuit board 1305 to a cable 1325. Specifically, when connector 1310 is mated with receptacle 1315, an electrical connection is established between board 1305 and cable 1325 Cable 1325 can then transmit signals to any electrical device (not shown) suitable for receiving such signals

In another embodiment of the invention, it is contemplated that the offset distance, d, may vary throughout the length of the terminals in the connector. In this manner, the offset distance may vary along the length of the terminal as well as at either end of the conductor To illustrate this embodiment and referring now to FIG. 26, a side view of a single column of right angle terminals is shown As shown, the height of the terminals in section A is height H1 and the height of the cross section of terminals in section B is height H2.

FIGS 27 and 28 are front views of the columns of right angle terminals taken along lines A—A and lines B—B respectively In addition to the single column of terminals shown in FIG. 26, FIGS 27 and 28 also show an adjacent column of terminals contained in the adjacent lead assembly contained in the connector housing

In accordance with the invention, the offset of adjacent columns may vary along the length of the terminals within the lead assembly More specifically, the offset between adjacent columns varies according to adjacent sections of the terminals. In this manner, the offset distance between columns is different in section A of the terminals than in section B of the terminals

As shown in FIGS. 27 and 28, the cross sectional height of terminals taken along line A—A in section A of the terminal is H_1 and the cross sectional height of terminals in section B taken along line B—B is height H_2. As shown in FIG. 27, the offset of terminals in section A, where the cross sectional height of the terminal is H_1, is a distance D_1.

Similarly, FIG 28 shows the offset of the terminals in section B of the terminal As shown, the offset distance between terminals in section B of the terminal is D_2. Preferably, the offset D_2 is chosen to minimize crosstalk, and may be different from the offset D_2 because spacing or other

parameters are different. The multi-active cross talk that occurs between the terminals can thus be reduced, thereby increasing signal integrity

In another embodiment of the invention, to further reduce cross talk, the offset between adjacent terminal columns is different than the offset between vias on a mated printed circuit board A via is conducting pathway between two or more layers on a printed circuit board Typically, a via is created by drilling through the printed circuit board at the appropriate place where two or more conductors will interconnect

To illustrate such an embodiment, FIG 29 illustrates a front view of a cross section of four columns of terminals as the terminals mate to vias on an electrical device. Such an electric device may be similar to those as illustrated in FIG. 16A The terminals 1710 of the connector (not shown) are inserted into vias 1700 by connection pins (not shown) The connection pins, however, may be similar to those shown in FIG. 17

In accordance with this embodiment of the invention, the offset between adjacent terminal columns is different than the offset between vias on a mated printed circuit board Specifically, as shown in FIG 29, the distance between the offset of adjacent column terminals is D_c and the distance between the offset of vias in an electrical device is D_v. By varying these two offset distances to their optimal values in accordance with the invention, the cross talk that occurs in the connector of the invention is reduced and the corresponding signal integrity is maintained

FIG 30 is a perspective view of a portion of another embodiment of a right angle electrical connector 1100 As shown in FIG 30, conductors 130 are positioned from a first plane to a second plane that is orthogonal to the first plane Distance D between adjacent conductors 930 remains substantially constant, even though the width of conductor 930 may vary and even though the path of conductor 930 may be circuitous. This substantially constant gap D provides a substantially constant differential impedance along the length of the conductors

FIG 31 is a perspective view of another embodiment of a right angle electrical connector 1200 As shown in FIG 12, modules 1210 are positioned in a frame 1220 to provide proper spacing between adjacent modules 1210

FIG. 32 is a perspective view of an alternate embodiment of a receptacle connector 1100' As shown in FIG 32, connector 1100' comprises a frame 1190 to provide proper spacing between connection pins 1175'. Frame 1190 comprises recesses, in which conductors 1175' are secured. Each conductor 1175' comprises a single contact interface 1191 and a connection pin 1192 Each connect interface 1191 extends from frame 1190 for connection to a corresponding plug contact, as described above Each connection pin 1942 extends from frame 1190 for electrical connection to a second electrical device. Receptacle connector 1190 may be assembled via a stitching process

To attain desirable gap tolerances over the length of conductors 903, connector 900 may be manufactured by the method as illustrated in FIG. 33. As shown in FIG 33, at step 1400, conductors 930 are placed in a die blank with predetermined gaps between conductors 930 At step 1410, polymer is injected into the die blank to form the frame of connector 900 The relative position of conductors 930 are maintained by frame 950. Subsequent warping and twisting caused by residual stresses can have an effect on the variability, but if well designed, the resultant frame 950 should have sufficient stability to maintain the desired gap tolerances In this manner, gaps between conductors 930 can be controlled with variability of tenths of thousandths of an inch

Preferably, to provide the best performance, the current carrying path through the connector should be made as highly conductive as possible Because the current carrying path is known to be on the outer portion of the contact, it is desirable that the contacts be plated with a thin outer layer of a high conductivity material. Examples of such high conductivity materials include gold, copper, silver, a tin alloy

It is to be understood that the foregoing illustrative embodiments have been provided merely for the purpose of explanation and are in no way to be construed as limiting of the invention Words which have been used herein are words of description and illustration, rather than words of limitation Further, although the invention has been described herein with reference to particular structure, materials and/or embodiments, the invention is not intended to be limited to the particulars disclosed herein Rather, the invention extends to all functionally equivalent structures, methods and uses, such as are within the scope of the appended claims Those skilled in the art, having the benefit of the teachings of this specification, may affect numerous modifications thereto and changes may be made without departing from the scope and spirit of the invention in its aspects

What is claimed is:

1 An electrical connector, comprising:

a first column of electrical contacts comprising a first arrangement of differential signal pairs separated from one another by first ground contacts;

a second column of electrical contacts comprising a second arrangement of differential signal pairs separated from one another by second ground contacts, wherein one differential signal pair in the second arrangement of differential signal pairs is a victim differential signal pair; and

a third column of electrical contacts comprising a third arrangement of differential signal pairs separated from one another by third ground contacts,

wherein (i) the second column is adjacent to the first column, and the third column is adjacent to the second column; (ii) the connector is devoid of electrical shields between the first column and the second column, and between the second column and the third column; (iii) the contacts in the first column are spaced apart from the contacts in the second column by a column-spacing distance of about 1 8–2 0 millimeters and the contacts in the second column are spaced apart from the contacts in the third column by the column-spacing distance; (iv) each of the differential signal pairs defines a gap distance between the electrical contacts that form the pair; and (v) the gap distance relative to the column-spacing distance is such that differential signals with rise times of 200 picoseconds in the six differential signal pairs in the first, second, and third columns that are closest to the victim pair produce no more than 6% worst-case, multi-active cross talk on the victim differential signal pair

2. The electrical connector as claimed in claim 1, wherein each differential signal pair comprises two electrical signal contacts that are tightly electrically coupled to one another

3. The electrical connector as claimed in claim 1, wherein a differential signal pair in the third column is offset from the victim differential signal pair by a row pitch

4. The electrical connector as claimed in claim 1, wherein a differential signal pair in the third column is offset from the victim differential signal pair by an offset distance that is less than a row pitch

5. The electrical connector as claimed in claim 1, wherein a differential signal pair in the third column is offset from the victim differential signal pair by more than a row pitch

6. The electrical connector as claimed in claim 1, wherein the impedance of the first differential signal pair is between about 90 and 110 Ohms

7. The electrical connector as claimed in claim 1, wherein the 200 picosecond rise time represents a data transfer rate greater than 1.25 Gigabits/sec and less than 2.5 Gigabits/sec

8 The electrical connector as claimed in claim 1, wherein electrical contacts that form a differential signal pair in the first column extend from a mating face of the connector and one of the first ground contacts extend farther from the mating face than the electrical contacts

9 The electrical connector as claimed in claim 1, wherein electrical contacts that form a differential pair in the first column each terminate at a respective end thereof with a corresponding fusible mounting element.

10 The electrical connector as claimed in claim 1, wherein the worst-case, multi-active cross talk on the victim differential signal pair is 4% or less.

11. The electrical connector as claimed in claim 1, wherein the worst-case, multi-active cross talk on the victim differential signal pair is 3% or less.

12. The electrical connector as claimed in claim 1, wherein the electrical connector has an insertion loss of less than about 0.7 dB at 5 GHz.

13. The electrical connector as claimed in claim 1, wherein the differential signal pairs are broadside coupled.

14 The electrical connector as claimed in claim 1, wherein the gap distance relative to the column-spacing distance is such that differential signals with rise times of 150 picoseconds in the six differential signal pairs in the first, second, and third columns that are closest to the victim pair produce no more than 6% worst-case cross talk on the victim differential signal pair

15 The electrical connector as claimed in claim 14, wherein the 150 picosecond rise time represents a data transfer rate of about 2.5 Gigabits/sec

16 The electrical connector as claimed in claim 1, wherein the gap distance relative to the column-spacing distance is such that differential signals with rise times of 100 picoseconds in the six differential signal pairs in the first, second, and third columns that are closest to the victim pair produce no more than 6% worst-case cross talk on the victim differential signal pair

17. The electrical connector as claimed in claim 16, wherein the 100 picosecond rise time represents a data transfer rate of about 3.2 Gigabits/sec

18 The electrical connector as claimed in claim 1, wherein the gap distance relative to the column-spacing distance is such that differential signals with rise times of 50 picoseconds in the six differential signal pairs in the first, second, and third columns that are closest to the victim pair produce no more than 6% worst-case cross talk on the victim differential signal pair

19. The electrical connector as claimed in claim 18, wherein the 50 picosecond rise time represents a data transfer rate greater than 4.8 Gigabits/sec and less than 10 Gigabits/sec

20 The electrical connector as claimed in claim 1, wherein the gap distance relative to the column-spacing distance is such that differential signals with rise times of 40 picoseconds in the six differential signal pairs in the first, second, and third columns that are closest to the victim pair produce no more than 6% worst-case cross talk on the victim differential signal pair

21 The electrical connector as claimed in claim 20, wherein the 40 picosecond rise time represents a data transfer rate of about 10 Gigabits/sec

22 An electrical connector comprising:

a first electrical connector half and a second electrical connector half that mates with the first electrical connector half, the first electrical connector half and the second electrical connector half each comprising:

a first column of electrical contacts comprising a first differential signal pair of electrical contacts, a first ground contact adjacent to the first differential signal pair, a second differential signal pair of electrical contacts adjacent to the first ground contact, a second ground contact adjacent to the second differential signal pair, and a third differential signal pair of electrical contacts adjacent to the second ground contact;

a second column of electrical contacts comprising a fourth differential signal pair of electrical contacts, a third ground contact adjacent to the fourth differential signal pair, a fifth differential signal pair of electrical contacts adjacent to the third ground contact, a fourth ground contact adjacent to the fifth differential signal pair, and a sixth differential signal pair of electrical contacts adjacent to the fourth ground contact; and

a third column of electrical contacts comprising a seventh differential signal pair of electrical contacts, a fifth ground contact adjacent to the seventh differential signal pair, an eighth differential signal pair of electrical contacts adjacent to the fifth ground contact, a sixth ground contact adjacent to the eighth differential signal pair, and a ninth differential signal pair of electrical contacts adjacent to the sixth ground contact,

wherein (i) the second column of electrical contacts is adjacent to the first column of electrical contacts and the third column of electrical contacts; (ii) the connector is devoid of electrical shields between the first, second, and third columns; (iii) the electrical contacts in the first column are spaced apart from the electrical contacts in the second column by a column-spacing distance, and the contacts in the second column are spaced apart from the contacts in the third column by the column-spacing distance; (iv) the electrical contacts that comprise the first differential signal pair are spaced apart by a gap distance that is less than the column-spacing distance; and (v) differential signals with rise times of 40 picoseconds in the six differential signal pairs in the first, second, and third columns that are closest to the fifth differential signal pair produce no more than 600 worst-case, multi-active cross talk on the fifth differential signal pair

23 The electrical connector as claimed in claim 22, wherein electrical signal contacts in the first differential signal pair are tightly electrically coupled to each other

24. The electrical connector as claimed in claim 22, wherein the fourth differential signal pair is offset from the first differential signal pair by a row pitch

25 The electrical connector as claimed in claim 22, wherein the fourth differential signal pair is offset from the first differential signal pair by an offset distance that is less than a row pitch

26 The electrical connector as claimed in claim 22, wherein the fourth differential signal pair is offset from the first differential signal pair by more than a row pitch.

27 The electrical connector as claimed in claim 22, wherein the impedance of the first differential signal pair is between about 90 and 110 Ohms.

28 The electrical connector as claimed in claim 22, wherein the worst-case, multi-active, cross-talk on the fifth differential signal pair is 3% or less

29 The electrical connector as claimed in claim 22, wherein the 40 picosecond rise time represents a data transfer rate of about 10 Gigabits/sec

30 The electrical connector as claimed in claim 22, wherein electrical contacts that form a differential signal pair in the first column of the first connector extend from a mating face of the first electrical connector and one of the first ground contacts extends farther from the mating face than the electrical contacts

31 The electrical connector as claimed in claim 22, wherein electrical contacts that form the first differential signal pair each terminate at a respective end thereof with a corresponding fusible mounting element.

32 The electrical connector as claimed in claim 22, wherein worst-case, multi-active cross talk on the fifth differential signal pair is 4% or less

33 The electrical connector as claimed in claim 22, wherein worst-case, multi-active cross talk on the fifth differential signal pair is 3% or less

34. The electrical connector as claimed in claim 22, wherein the electrical connector has an insertion loss of less than about 0 7 dB at 5 GHz.

35 The electrical connector as claimed in claim 22, wherein the differential signal pairs are broadside coupled

36 The electrical connector as claimed in claim 22, wherein differential signals with rise times of 150 picoseconds in each of the six closest differential signal pairs produce no more than 6% worst-case, multi-active cross talk on the fifth differential signal pair

37. The electrical connector as claimed in claim 36, wherein the 150 picosecond rise time represents a data transfer rate of about 2 5 Gigabits/sec.

38 The electrical connector as claimed in claim 22, wherein differential signals with rise times of 100 picoseconds in each of the six closest differential signal pairs produce no more than 60% worst-case, multi-active cross talk on the fifth differential signal pair

39. The electrical connector as claimed in claim 38, wherein the 100 picosecond rise time represents a data transfer rate of about 3 2 Gigabits/sec.

40. The electrical connector as claimed in claim 22, wherein differential signals with rise times of 50 picoseconds in each of the six closest differential signal pairs produce no more than 6% worst-case, multi-active cross talk on the fifth differential signal pair

41. The electrical connector as claimed in claim 40, wherein the 50 picosecond rise time represents a data transfer rate greater than 4 8 Gigabits/sec and less than 10 Gigabits/sec

42 The electrical connector as claimed in claim 22, wherein differential signals with rise times of 200 picoseconds in each of the six closest differential signal pairs produce no more than 6% worst-case, multi-active cross talk on the fifth differential signal pair

43 The electrical connector as claimed in claim 42, wherein the 200 picosecond rise time represents a data transfer rate greater than 1 25 Gigabits/sec and less than 2 5 Gigabits/sec

44. An electrical connector comprising:

a first column of electrical contacts comprising a first arrangement of differential signal pairs each separated from one another by first ground contacts;

a second column of electrical contacts comprising a second arrangement of differential signal pairs each separated from one another by second ground contacts, wherein one differential signal pair in the second arrangement of differential signal pairs is a victim pair; and

a third column of electrical contacts comprising a third arrangement of differential signal pairs each separated from one another by third ground contacts,

wherein (i) the second column is adjacent to the first column, and the third column is adjacent to the second column (ii) the connector is devoid of electrical shields between the first column and the second column, and between the second column and the third column; (iii) the first column, the second column, and the third column are evenly spaced apart from one another by an equal column-spacing distance of about 1 8 to 2 millimeters; (iv) each of the differential signal pairs defines a gap distance between electrical contacts that form each differential signal pair; and (v) the gap distance relative to the column-spacing distance is such that differential signals with rise times of 40 picoseconds in the six differential signal pairs in the first, second, and third columns that are closest to the victim pair produce no more than an acceptable level of worst-case, multi-active cross talk on the victim pair

45. The electrical connector as claimed in claim 44, wherein electrical contacts that form the first differential signal pair each terminate at a respective end thereof with a corresponding fusible mounting element

46 The electrical connector as claimed in claim 44, wherein the impedance of the first differential signal pair is between about 90 and 110 Ohms

47 The electrical connector as claimed in claim 44, wherein the first ground contact is tightly electrically coupled to one electrical contact in the first differential signal pair

48 The electrical connector as claimed in claim 44, wherein the first linear array is staggered relative to the second linear array

49 The electrical connector as claimed in claim 44, wherein the differential signal pairs are broadside coupled

50 The electrical connector as claimed in claim 44, wherein the gap distance is approximately 0 3 to 0 4 millimeters.

51 The electrical connector as claimed in claim 50, wherein the column-spacing distance defines a column pitch between the first linear array and the second linear array, and the gap distance is based on the column pitch

52 The electrical connector as claimed in claim 51, wherein the gap distance is between approximately one-tenth of the column pitch and one-fifth of the column pitch

53. The electrical connector as claimed in claim 51, wherein the gap distance is between approximately one-tenth of the column pitch and one-eighth of the column pitch.

54 The electrical connector as claimed in claim 51, wherein the gap distance is approximately one-fifth of the column pitch

55 The electrical connector as claimed in claim 51, wherein the column pitch is approximately two millimeters and the gap distance is between approximately 0 3 millimeters and 0 4 millimeters

56. An electrical connector comprising:

a first linear array of electrical contacts comprising

a first signal contact that defines a first side and a first edge, wherein the first side is two or more times greater in length than the first edge;

a second signal contact positioned adjacent to the first signal contact, wherein the second signal contact defines a second side and a second edge and the second side is two or more times greater in length that the second edge; and

a first ground contact positioned adjacent to the first signal contact; and a second linear array of electrical contacts comprising

a third signal contact that defines a third side and a third edge, wherein the third side is two or more times greater in length than the third edge;

a fourth signal contact positioned adjacent to the third signal contact, wherein the fourth signal contact defines a fourth side and a fourth edge and the fourth side is two or more times greater in length that the fourth edge; and

a second ground contact positioned along an imaginary line that is perpendicular to the first linear array of electrical contacts,

wherein (i) the first signal contact and the second signal contact are positioned edge-to-edge and form a first differential signal pair; (ii) the third signal contact and the fourth signal contact are positioned edge-to-edge and form a second differential signal pair; (iii) the first signal contact is positioned along the imaginary line that is perpendicular to the first linear array of electrical contacts; (iv) the connector is devoid of electrical shields between the first linear array of electrical contacts and the second linear array of electrical contacts; (v) a gap distance between the first and second signal contacts is less than a distance between the first signal contact and the second ground contact, and (vi) electrical contacts that form the first differential signal pair each terminate at a respective end thereof with a corresponding fusible mounting element

* * * * *

EXHIBIT "D"

EXHIBIT "D"

DOCKET NO.: FCI-2981 (C3549E) PATENT
Application No.: 11/326,011
Notice of Allowance Dated: September 8, 2006

This listing of claims will replace all prior versions, and listings, of claims in the application.

Listing of Claims:

1 (Currently amended) An electrical connector, comprising:

a first column of electrical contacts arranged in a first pattern of signal contacts and ground contacts; and

a second column of electrical contacts arranged in a second pattern of signal contacts and ground contacts,

wherein (i) the first pattern is different from the second pattern, (ii) each of the signal contacts is one of a respective broadside-coupled differential signal pair, (iii) the first ~~linear array~~ column extends along a first direction, (iv) the signal contacts in the first ~~linear array~~ column are elongated along the first direction, (v) the ground contacts in the first ~~linear array~~ column are elongated along the first direction, thereby defining a respective broadside for each said ground contact, and (vi) each of the ground contacts is positioned broadside-to-broadside with another ground contact that is elongated along the first direction.

2. (Previously presented) The electrical connector of claim 1, wherein a first of the differential signal pairs comprises first and second signal contacts, each of said first and second signal contacts has a cross-section defining a respective edge and a respective broadside, and the first and second signal contacts are positioned broadside-to-broadside.

3. (Previously presented) The electrical connector of claim 2, wherein the connector is devoid of shields between the first and second columns.

4 (Previously presented) The electrical connector of claim 2, wherein a second of the differential signal pairs comprises third and fourth signal contacts, and wherein the first signal contact is more tightly electrically coupled to the second signal contact than it is to either of the third or fourth signal contacts

5 (Previously presented) The electrical connector of claim 2, wherein the first and second signal contacts define a gap between the broadsides thereof.

6. (Previously presented) The electrical connector of claim 5, wherein a differential signal in the first differential signal pair produces an electric field having a first electric field strength in the gap and a second electric field strength near the second differential signal pair, wherein the second electric field strength is lower than the first electric field strength.

7. (Previously presented) The electrical connector of claim 5, further comprising a dielectric material disposed between the broadsides of the first and second signal contacts.

8 (Previously presented) The electrical connector of claim 7, wherein the dielectric material is air

9. (Original) The electrical connector of claim 2, wherein the edge of the first signal contact defines a length, and the broadside of the first signal contact defines a second length that is at least twice the length defined by the edge thereof.

10 (Original) The electrical connector of claim 2, further comprising a dielectric base having a mate surface and a mount surface, wherein at least one of the ground contacts extends farther from the mate surface of the dielectric base than does either of the first or second signal contacts.

11. (Original) The electrical connector of claim 2, wherein each of the first and second signal contacts terminates with a respective fusible mounting element.

12 (Original) The electrical connector of claim 2, wherein each of the first and second signal contacts is a blade contact

13. (Previously presented) The electrical connector of claim 4, wherein the second differential signal pair is offset with respect to the first differential signal pair in a direction along which the second column of electrical contacts extends.

14. (Previously presented) The electrical connector of claim 4, wherein the second differential signal pair is offset by a row pitch or less, with respect to the first differential signal pair, in a direction along which the second column of electrical contacts extends.

15. (Previously presented) The electrical connector of claim 1, wherein the second column of electrical contacts is staggered relative to the first column of electrical contacts.

16. (Previously presented) The electrical connector of claim 1, wherein the second column of electrical contacts is staggered by a row pitch or less relative to the first column of electrical contacts.

17. (Previously presented) The electrical connector of claim 1, comprising a first leadframe assembly and second leadframe assembly adjacent to the first leadframe assembly, wherein the first column is positioned along the first leadframe assembly and the second column is positioned along the second leadframe assembly.

18. (Original) The electrical connector of claim 1, having a row pitch of about 1.4 mm.

19 (Original) The electrical connector of claim 1, having a column pitch of about 2.0 mm or less.

20 (Original) The electrical connector of claim 1, having a card pitch of about 25 mm.

21. (Original) The electrical connector of claim 1, further comprising a housing though which the contacts extend.

22 (Original) The electrical connector of claim 21, wherein the housing is filled at least in part with a dielectric material that electrically insulates the contacts.

23. (Original) The electrical connector of claim 22, wherein the dielectric material is air.

24. (Original) The electrical connector of claim 1, wherein the connector is a right-angle connector.

25. (Original) The electrical connector of claim 1, having a contact density of about 63 5 mated signal pairs per linear inch.

26. (Original) The electrical connector of claim 1, having a contact density of more than about 63 5 mated signal pairs per linear inch.

27. (Original) The electrical connector of claim 10, wherein the dielectric base defines a hole transverse to the first direction at a center portion of the dielectric base and intermediate portions of each of the first and second signal contacts are exposed to air.

28 (Original) The electrical connector of claim 10, wherein the dielectric base defines respective contact through-holes for each of the first and second signal contacts.

29. (Previously presented) An electrical connector, comprising:

a first row of electrical contacts arranged in a first pattern of signal contacts; and

a second row of electrical contacts arranged in a second pattern of signal contacts and ground contacts,

wherein (i) the first pattern is different from the second pattern, (ii) the signal contacts define broadside-coupled differential signal pairs, (iii) the first row extends along a first direction, and (iv) the contacts are elongated along a direction that is perpendicular to the first direction.

30. (Previously presented) The electrical connector of claim 29, wherein the connector is devoid of shields between the first and second rows.

31. (Previously presented) The electrical connector of claim 29, wherein a first of the differential signal pairs comprises first and second signal contacts, each of said first and second signal contacts has a cross-section defining a respective edge and a respective broadside, and the first and second signal contacts are positioned broadside-to-broadside

32. (Previously presented) The electrical connector of claim 31, wherein a second of the differential signal pairs comprises third and fourth signal contacts, and wherein the first signal contact is more tightly electrically coupled to the second signal contact than it is to either of the third or fourth signal contacts.

33. (Previously presented) The electrical connector of claim 32, wherein the first and second signal contacts define a gap between the broadsides thereof

34. (Previously presented) The electrical connector of claim 33, wherein a differential signal in the first differential signal pair produces an electric field having a first electric field strength in the gap and a second electric field strength near the second differential signal pair, wherein the second electric field strength is lower than the first electric field strength.

35. (Previously presented) The electrical connector of claim 33, further comprising a dielectric material disposed between the broadsides of the first and second signal contacts

36. (Previously presented) The electrical connector of claim 35, wherein the dielectric material is air.

37. (Previously presented) The electrical connector of claim 31, wherein each of the first and second signal contacts terminates with a respective fusible mounting element.

38 (Previously presented) The electrical connector of claim 31, wherein each of the first and second signal contacts is a blade contact

39. (Previously presented) The electrical connector of claim 29, wherein the connector is a right-angle connector.

40. (Previously presented) An electrical connector, comprising:

a first array of electrical contacts arranged in a first pattern of broadside-coupled differential signal pairs and ground contacts; and

a second array of electrical contacts arranged in a second pattern of broadside-coupled differential signal pairs and ground contacts,

wherein (i) the first pattern is different from the second pattern, (ii) the first array extends along a first direction, (iii) the connector is devoid of shields between the first array and the second array, and (iv) the signal contacts in the first array are elongated along the first direction.

41. (Previously presented) The electrical connector of claim 40, wherein the connector is devoid of shields between the first and second arrays.

42 (Previously presented) The electrical connector of claim 40, wherein a first of the differential signal pairs comprises first and second signal contacts, each of said first and second signal contacts has a cross-section defining a respective edge and a respective broadside, and the first and second signal contacts are positioned broadside-to-broadside.

43. (Previously presented) The electrical connector of claim 42, wherein a second of the differential signal pairs comprises third and fourth signal contacts, and wherein the first signal contact is more tightly electrically coupled to the second signal contact than it is to either of the third or fourth signal contacts.

44 (Previously presented) The electrical connector of claim 43, wherein the first and second signal contacts define a gap between the broadsides thereof

45 (Previously presented) The electrical connector of claim 44, wherein a differential signal in the first differential signal pair produces an electric field having a first electric field strength in the gap and a second electric field strength near the second differential signal pair, wherein the second electric field strength is lower than the first electric field strength.

46. (Previously presented) The electrical connector of claim 44, further comprising a dielectric material disposed between the broadsides of the first and second signal contacts.

47. (Previously presented) The electrical connector of claim 46, wherein the dielectric material is air.

48. (Previously presented) The electrical connector of claim 42, wherein the edge of the first signal contact defines a length, and the broadside of the first signal contact defines a second length that is at least twice the length defined by the edge thereof.

49 (Previously presented) The electrical connector of claim 42, wherein each of the first and second signal contacts terminates with a respective fusible mounting element.

50. (Previously presented) The electrical connector of claim 42, wherein each of the first and second signal contacts is a blade contact.

51 (Previously presented) The electrical connector of claim 40, comprising a first leadframe assembly and second leadframe assembly adjacent to the first leadframe assembly, wherein the first array is positioned along the leadframe assemblies.

52 (Previously presented) The electrical connector of claim 40, wherein the connector is a right-angle connector.

EXHIBIT "E"

EXHIBIT "E"

This listing of claims will replace all prior versions, and listings, of claims in the application

Listing of Claims:

1-27 (Canceled)

28 (Currently Amended) An electrical connector, comprising:

a first row of electrical contacts~~, the first row of electrical contacts~~ comprising ~~two~~ a first differential signal pair ~~pairs~~, ~~each~~ the first differential signal pair comprising two broadside-coupled electrical signal contacts positioned along a first row centerline and on opposite sides of a first column centerline, the first column centerline positioned perpendicular to the first row centerline;

a second differential signal pair comprising two broadside coupled electrical signal contacts positioned on opposite sides of a second column centerline, the second column centerline positioned parallel to the first column centerline and perpendicular to the first row centerline ~~row of electrical contacts comprising a pair of adjacent ground contacts~~;

a third ~~row of electrical contacts, the third row of electrical contacts comprising two~~ differential signal ~~pairs~~ pair~~, each differential signal pair~~ comprising two broadside-coupled electrical signal contacts that are positioned on opposite sides of a third column centerline, the third column centerline positioned parallel to the second column centerline and perpendicular to the first row centerline;

~~a fourth row of electrical contacts comprising a pair of adjacent ground contacts; and~~

~~the fifth row of electrical contacts, the fifth row comprising two differential signal pairs, each differential signal pair comprising two broadside coupled electrical signal contacts,~~

wherein (i) the first ~~row~~ column centerline is adjacent to the second ~~row,~~ column centerline and the second ~~row~~ column centerline is adjacent to the third ~~row~~ column centerline~~, the third row is adjacent to the fourth row, and the fourth row is adjacent to the fifth row, and the fifth row is adjacent to the sixth row~~ (ii) the first, second, and third~~, fourth, and fifth rows~~ differential signal pairs are evenly spaced apart by a fixed ~~row~~ column spacing distance measured from the first column centerline to the second column centerline ~~defined between centerlines of the first, second, third, fourth, and fifth rows~~; (iii) a fixed gap distance is defined between the respective two broadside coupled electrical contacts that form each of

the first, second and third differential signal pairs ~~pair~~, (iv) an aspect ratio of the fixed ~~row~~ column-spacing distance to the fixed gap distance is approximately eight to ten; and (v) a differential impedance of the differential signal pairs is matched to a system impedance, plus or minus ten ohms ~~percent~~, at data transfer rates of 1 Gigabit/sec and 10 Gigabits/sec; and (vi) the electrical connector is devoid of shields between the first differential signal pair and the second differential signal pair.

29 (Currently Amended) The electrical connector of claim 28, further comprising a first pair of elongated ground contacts positioned along the first column centerline and a second pair of elongated ground contacts positioned along the third column centerline, the first pair of elongated ground contacts comprising two electrical contacts positioned broadside-to-broadside on opposite sides of the first column centerline and the second pair of electrical ground contacts positioned broadside-to-broadside on opposite sides of the third column centerline. ~~wherein the differential signal pairs each comprise respective first and second signal contacts, each of said signal contacts having a blade end with a cross-section that defines a respective edge and a respective broadside, the first and second signal contacts being positioned broadside-to-broadside.~~

30. Canceled

31. (Currently Amended) The electrical connector of claim 28 wherein the electrical connector is devoid of shields between the second differential signal pair and the third differential signal pair. ~~30, further comprising a dielectric material disposed in the gap.~~

32 (Currently Amended) The electrical connector of claim 31, further comprising three broadside coupled differential signal pairs positioned along the first column centerline, three broadside coupled differential signal pairs positioned along the second column centerline, and three broadside coupled differential signal pairs positioned along the third column centerline, wherein one of the three differential signal pairs positioned along the second column centerline is a victim pair, and differential signals with rise times of forty picoseconds in six differential signal pairs positioned along the first, second, and third column centerlines that are closest to the victim pair produce no more than six percent worst-case, multi-active cross

talk on the victim pair. ~~29, wherein the edge of the first signal contact defines a first length, and the broadside of the first signal contact defines a second length that is at least twice the length defined by the edge thereof.~~

33. (Previously presented) The electrical connector of claim 28, wherein each of the electrical contacts terminates with a respective fusible mounting element

34. (Currently amended) The electrical connector of claim 28, wherein the system impedance is 100 Ohms. ~~33, wherein the connector is a ball grid array connector.~~

35 (Currently amended) The electrical connector of claim 28, wherein the first row of electrical contacts further comprises a fourth differential signal pair, the fourth differential signal pair comprising two broadside coupled electrical contacts positioned on opposite sides of the third column centerline. ~~34, wherein the connector is a right angle, ball grid array connector~~

36. (New) The electrical connector of claim 28, wherein the fixed gap distance is approximately 0.3mm to 0.4mm.

37. (New) The electrical connector of claim 36, wherein an air dielectric is present between the respective two broadside coupled electrical contacts that define the fixed gap distance.

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EXHIBIT D

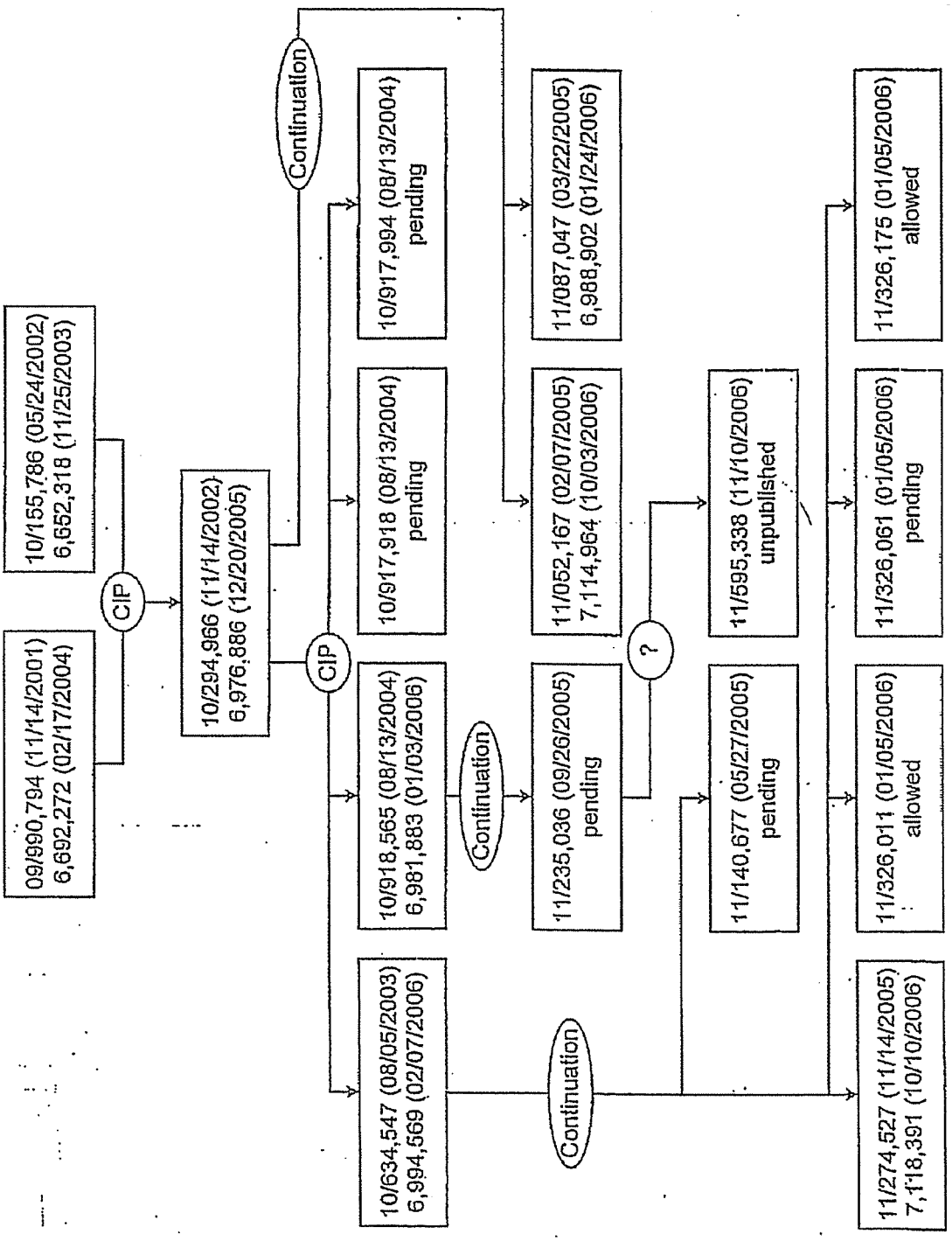

09/990,794 (11/14/2001) 6,692,272 (02/17/2004)
10/155,786 (05/24/2002) 6,652,318 (11/25/2003)
CIP
10/294,966 (11/14/2002) 6,976,886 (12/20/2005)
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CIP
10/634,547 (08/05/2003) 6,994,569 (02/07/2006)
10/918,565 (08/13/2004) 6,981,883 (01/03/2006)
10/917,918 (08/13/2004) pending
10/917,994 (08/13/2004) pending
Continuation
Continuation
11/235,036 (09/26/2005) pending
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11/087,047 (03/22/2005) 6,988,902 (01/24/2006)
?
11/140,677 (05/27/2005) pending
11/595,338 (11/10/2006) unpublished
11/274,527 (11/14/2005) 7,118,391 (10/10/2006)
11/326,011 (01/05/2006) allowed
11/326,061 (01/05/2006) pending
11/326,175 (01/05/2006) allowed

EXHIBIT E

UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF DELAWARE

FCI USA INC., and FCI AMERICAS TECHNOLOGY INC., Plaintiffs, v. MOLEX INCORPORATED Defendant.	Case No. 1:07-cv-00049 (JJF)

DECLARATION OF CHARLES S. COHEN

I, Charles S. Cohen, hereby declare as follows:

1. I am the Intellectual Property counsel for Molex Incorporated ("Molex") and hold the title of Associate General Counsel.

2. Molex markets a high speed, shieldless electrical connector under the tradename I-Trac. Defendant FCI Americas Technology, Inc. ("FCI") is a direct competitor to Molex in the high speed shieldless backplane connector market.

3. At least as early as November 15, 2006, FCI and Molex engaged in business discussions for resolving disputes relating to various patents and a number of different products, one of which is Molex's I-Trac product that is at issue in this action.

4. From the outset of these discussions, Molex made it clear that Molex believed the I-Trac product did not infringe any claims of the patents-in-suit.

5. On December 14, 2006, representatives of FCI and Molex met in person to discuss the asserted infringement issues. Both parties expressed a desire to find a business solution. Throughout the discussions, FCI continued to assert its belief that Molex's I-Trac

product infringed the '883 and '964 patents, as well as claims of an allowed application which ultimately issued as the '643 patent. Molex continued to assert its belief that Molex's I-Trac product did not infringe the '883 and '964 patents, as well as the allowed claims which ultimately issued as the '643 patent.

6. Shortly after this meeting, on December 19, 2006, FCI offered a license to Molex containing terms and conditions that were not commercially viable. In particular, the scope of the license was narrower than Molex desired, the royalty rate presented was prohibitively high, and the offer did not provide for the second-source licensing freedom that Molex desired and which is an absolute necessity in this business. Molex believed that the license offered, if accepted, would prevent it from competing effectively in the marketplace with its I-Trac product.

7. On December 20, 2006, in response to FCI's offer, Molex stated that it stood by its positions of invalidity and non-infringement relative to these patents, but would remain willing to discuss a license on *reasonable* terms.

8. When no such reasonable terms were offered, on January 5, 2007 Molex asked FCI if it truly intended to seek such a high royalty rate under terms that made it so commercially unviable.

9. On January 8, 2007, FCI responded that they did not believe their terms were out of line with market realities and so maintained their original offer. This led Molex to believe that further discussions were unlikely to result in an acceptable business solution.

10. Throughout this November to January timeframe, license negotiations between the parties relating to other products and patents continued to move forward. Only the negotiation regarding the I-Trac product failed to move forward.

11. Prior to filing suit, Molex received various reports that FCI had asserted to Molex customers that Molex's I-Trac product infringed FCI's patents. Molex believed that such infringement assertions threatened its sales of the I-Trac product.

12. In view of the commercial unreasonableness of the terms of the license offered on December 19, 2006 and confirmed on January 8, 2007, Molex believed FCI was not interested in licensing the patents-in-suit on reasonable terms. This belief also was based, in part, on Molex's knowledge that FCI had already filed suit against a mutual competitor of FCI and Molex involving similar technology and patents from the same patent family being discussed with respect to the I-Trac product.

13. FCI never presented any acceptable changes to the terms and conditions of the license offered to Molex on December 19, 2006. In particular, FCI never made any reasonable offer for a license. In addition, Molex has never made a counteroffer to FCI.

14. Molex and FCI have continued to engage in negotiations regarding other unrelated patents and products. However, Molex has not been engaged in any ongoing negotiations with FCI regarding the proposed licensing terms for the I-Trac product since this action was filed.

I declare under penalty of perjury that the forgoing is true and correct.

Dated: April 11, 2007



Charles S. Cohen

EXHIBIT F

JURY, PATENT

U.S. District Court [LIVE]
Eastern District of TEXAS LIVE (Marshall)
CIVIL DOCKET FOR CASE #: 2:06-cv-00128-TJW

FCI USA Inc et al v. Tyco Electronics Corporation
Assigned to: Judge T. John Ward
Cause: 35:145 Patent Infringement

Date Filed: 03/29/2006
Jury Demand: None
Nature of Suit: 830 Patent
Jurisdiction: Federal Question

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Counter Claimant

Tyco Electronics Corporation

V.

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Counter Defendant

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Date Filed	#	Docket Text
03/29/2006	1	COMPLAINT against Tyco Electronics Corporation (Filing fee $ 250. receipt 6-4577) filed by FCI USA Inc, FCI Americas Technology Inc. (Attachments: # 1 Exhibit A-1# 2 Exhibit A-2# 3 Exhibit B-1# 4 Exhibit B-2# 5 Exhibit C-1# 6 Exhibit C-2# 7 Exhibit C-3# 8 Civil Cover Sheet)(rvw,) (Entered: 03/30/2006)
03/29/2006		Summons Issued as to Tyco Electronics Corporation. (rvw,) (Entered: 03/30/2006)
03/29/2006		Filing fee: $ 250.00, receipt number 6-1-4577 (ch,) (Entered: 03/31/2006)
03/31/2006	2	Form mailed to Commissioner of Patents and Trademarks. (ch,) (Entered: 03/31/2006)
04/05/2006	3	AMENDED COMPLAINT against Tyco Electronics Corporation, filed by FCI USA Inc, FCI Americas Technology Inc. (Attachments: # 1 Exhibit A# 2 Exhibit

		B# 3 Exhibit C# 4 Exhibit D# 5 Exhibit E# 6 Exhibit F)(Carroll, Otis) (Entered: 04/05/2006)
04/06/2006		Summons Issued as to Tyco Electronics Corporation. (ch,) (Entered: 04/06/2006)
04/12/2006	4	SUMMONS Returned Executed Process server by FCI USA Inc, FCI Americas Technology Inc. Tyco Electronics Corporation served on 4/3/2006, answer due 4/24/2006. (ch,) (Entered: 04/13/2006)
04/24/2006	5	MOTION for Extension of Time to File Answer re 3 Amended Complaint *[Unopposed]* by Tyco Electronics Corporation. (Attachments: # 1 Text of Proposed Order)(Jones, Michael) (Entered: 04/24/2006)
04/24/2006	6	SUMMONS Returned Executed Personal Service by FCI USA Inc, FCI Americas Technology Inc. Tyco Electronics Corporation served on 4/11/2006, answer due 5/1/2006. (ch,) (Entered: 04/27/2006)
05/02/2006	7	ORDER granting Tyco Electronics 5 Motion for Extension of Time to Answer. Deadline extended to 5/24/06 . Signed by Judge T. John Ward on 5/1/06. (ehs,) (Entered: 05/02/2006)
05/24/2006	8	SEALED PATENT MOTION *Motion to Dismiss FCI's Trade Secret Claims and Compel Contractually Required Arbitration or, in the Alternative, for a More Definite Statement of FCI's Trade Secret Claims* by Tyco Electronics Corporation. (Attachments: # (1) Exhibit A# (2) Exhibit B# (3) Text of Proposed Order)(Jones, Michael) (Entered: 05/24/2006)
05/24/2006	9	MOTION to Change Venue *to the Middle District of Pennsylvania* by Tyco Electronics Corporation. (Attachments: # 1 Exhibit A# 2 Text of Proposed Order)(Jones, Michael) (Entered: 05/24/2006)
05/25/2006	10	MOTION to Seal Document [8] SEALED PATENT MOTION *Motion to Dismiss FCI's Trade Secret Claims and Compel Contractually Required Arbitration or, in the Alternative, for a More Definite Statement of FCI's Trade Secret Claims* by Tyco Electronics Corporation. (Attachments: # 1 Text of Proposed Order)(Jones, Michael) (Entered: 05/25/2006)
05/26/2006	11	ORDER granting 10 Motion to Seal Document. Court orders that [8] be (and remain as) filed under seal. signed by Judge T. John Ward on 5/26/06. (ch,) Modified on 5/26/2006 (ch,). (Entered: 05/26/2006)
06/08/2006	12	RESPONSE in Opposition re 9 MOTION to Change Venue *to the Middle District of Pennsylvania* filed by FCI USA Inc, FCI Americas Technology Inc. (Attachments: # 1 Exhibit A# 2 Exhibit B# 3 Exhibit C# 4 Exhibit D# 5 Exhibit E# 6 Text of Proposed Order)(Carroll, Otis) (Entered: 06/08/2006)
06/08/2006	13	SEALED PATENT RESPONSE to SEALED PATENT MOTION re [8] SEALED PATENT MOTION *Motion to Dismiss FCI's Trade Secret Claims and Compel Contractually Required Arbitration or, in the Alternative, for a More Definite Statement of FCI's Trade Secret Claims* filed by FCI USA Inc, FCI Americas Technology Inc. (Attachments: # (1) Text of Proposed Order)(Carroll, Otis) (Entered: 06/08/2006)
06/09/2006	14	Consent MOTION to Seal Document [13] Sealed Patent Response to Sealed Patent Motion, by FCI USA Inc, FCI Americas Technology Inc. (Attachments: # 1 Text of Proposed Order)(Carroll, Otis) (Entered: 06/09/2006)

06/13/2006	15	ORDER granting 14 Motion to Seal Document. Pla's Opposition to Dft Tyco Electronics Corp. After considering such motion the court orders that the motion [13] be (and remain as) filed under seal . Signed by Judge T. John Ward on 6/13/06. (ch,) (Entered: 06/14/2006)
06/14/2006	20	APPLICATION to Appear Pro Hac Vice by Attorney Stephanie J Felicetty for Tyco Electronics Corporation. (ch,) (Entered: 06/23/2006)
06/14/2006		Pro Hac Vice Filing fee paid by Felicetty; Fee: $25, receipt number: 6-1-5566 (ch,) (Entered: 06/23/2006)
06/14/2006	21	APPLICATION to Appear Pro Hac Vice by Attorney Mark H Remus for Tyco Electronics Corporation. (ch,) (Entered: 06/23/2006)
06/14/2006		Pro Hac Vice Filing fee paid by Remus; Fee: $25, receipt number: 6-1-5565 (ch,) (Entered: 06/23/2006)
06/14/2006	22	APPLICATION to Appear Pro Hac Vice by Attorney Rodney A Daniel for Tyco Electronics Corporation. (ch,) (Entered: 06/23/2006)
06/14/2006		Pro Hac Vice Filing fee paid by Daniel; Fee: $25, receipt number: 6-1-5566 (ch,) (Entered: 06/23/2006)
06/16/2006	16	MOTION to Seal *its Reply in Support of its Motion to Compel Arbitration or a More Definite Statement* by Tyco Electronics Corporation. (Attachments: # 1 Text of Proposed Order)(Jones, Michael) (Entered: 06/16/2006)
06/16/2006	27	APPLICATION to Appear Pro Hac Vice by Attorney Jack C Berenzweig for Tyco Electronics Corporation. (ch,) (Entered: 07/11/2006)
06/16/2006		Pro Hac Vice Filing fee paid by Berenzweig; Fee: $25, receipt number: 6-1-5609 (ch,) (Entered: 07/11/2006)
06/19/2006	17	REPLY in Support to Response re 9 MOTION to Change Venue *to the Middle District of Pennsylvania* filed by Tyco Electronics Corporation. (Jones, Michael) Modified on 6/19/2006 (sm,). (Entered: 06/19/2006)
06/19/2006	18	SEALED PATENT REPLY to Response to PATENT Motion re [8] SEALED PATENT MOTION *Motion to Dismiss FCI's Trade Secret Claims and Compel Contractually Required Arbitration or, in the Alternative, for a More Definite Statement of FCI's Trade Secret Claims [Reply in Support of its Motion to Compel Arbitration]* filed by Tyco Electronics Corporation. (Jones, Michael) (Entered: 06/19/2006)
06/21/2006	19	ORDER granting 16 Motion to Seal Dft's Reply in support of its Motion to Compel Arbitration or a More Definite Statement. Signed by Judge T. John Ward on 6/231/06. (poa,) (Entered: 06/21/2006)
06/21/2006	28	APPLICATION to Appear Pro Hac Vice by Attorney Albert Breneisen for FCI USA Inc and FCI Americas Technology Inc. (ch,) (Entered: 07/11/2006)
06/21/2006		Pro Hac Vice Filing fee paid by Breneisen; Fee: $25, receipt number: 6-1-5673 (ch,) (Entered: 07/11/2006)
06/21/2006	29	APPLICATION to Appear Pro Hac Vice by Attorney Michael Shen for FCI USA Inc and FCI Americas Technology Inc. (ch,) (Entered: 07/11/2006)
06/21/2006		Pro Hac Vice Filing fee paid by Shen; Fee: $25, receipt number: 6-1-5673 (ch,)

		(Entered: 07/11/2006)
06/21/2006	30	APPLICATION to Appear Pro Hac Vice by Attorney Sheila Mortazavi for FCI USA Inc and FCI Americas Technology Inc. (ch,) (Entered: 07/11/2006)
06/21/2006		Pro Hac Vice Filing fee paid by Mortazavi; Fee: $25, receipt number: 6-1-5673 (ch,) (Entered: 07/11/2006)
06/21/2006	31	APPLICATION to Appear Pro Hac Vice by Attorney Yariv Waks for FCI USA Inc and FCI Americas Technology Inc. (ch,) (Entered: 07/11/2006)
06/21/2006		Pro Hac Vice Filing fee paid by Waks; Fee: $25, receipt number: 6-1-5673 (ch,) (Entered: 07/11/2006)
06/21/2006	32	APPLICATION to Appear Pro Hac Vice by Attorney Nicholas Aaron Gillard-Byers for FCI USA Inc and FCI Americas Technology Inc. (ch,) (Entered: 07/11/2006)
06/21/2006		Pro Hac Vice Filing fee paid by Gillard-Byers; Fee: $25, receipt number: 6-1-5673 (ch,) (Entered: 07/11/2006)
06/29/2006	23	REPLY to Response to Motion re 9 MOTION to Change Venue *to the Middle District of Pennsylvania* filed by FCI USA Inc, FCI Americas Technology Inc. (Carroll, Otis) (Entered: 06/29/2006)
06/29/2006	24	Consent MOTION for Leave to File *Under Seal Its Sur-Reply In Support of Its Opposition to Defendant's Motion to Compel Arbitration Or A More Definite Statement* by FCI USA Inc, FCI Americas Technology Inc. (Attachments: # 1 Text of Proposed Order)(Carroll, Otis) (Entered: 06/29/2006)
07/05/2006	35	APPLICATION to Appear Pro Hac Vice by Attorney John W Bateman for FCI USA Inc and FCI Americas Technology Inc. (ch,) (Entered: 07/18/2006)
07/05/2006		Pro Hac Vice Filing fee paid by Bateman; Fee: $25, receipt number: 6-1-5870 (ch,) (Entered: 07/18/2006)
07/07/2006	25	ORDER granting 24 FCI USA, Inc's and FCI Americas Technology, Inc's Motion for Leave to File, Under Seal, its Sur-Reply in Support of its Opposition to Defendant Tyco Electronics Corporation's Motion to Compel Arbitration or a More Definite Statement. Signed by Judge T. John Ward on 7/7/06. (kjr,) (Entered: 07/10/2006)
07/11/2006	26	SEALED PATENT REPLY to Response to PATENT Motion re [8] SEALED PATENT MOTION *Motion to Dismiss FCI's Trade Secret Claims and Compel Contractually Required Arbitration or, in the Alternative, for a More Definite Statement of FCI's Trade Secret Claims* filed by FCI USA Inc, FCI Americas Technology Inc. (Carroll, Otis) (Entered: 07/11/2006)
07/14/2006	33	VACATED PER ORDER FILED 9/12/06 MEMORANDUM OPINION and ORDER granting in part with respect to compelling arbitration, denying in part denying with respect to dismissing claims and motion for a more definite statement. Signed by Judge T. John Ward on 7/14/06. (ehs,) Modified on 9/12/2006 (poa,). (Entered: 07/14/2006)
07/18/2006	34	MEMORANDUM OPINION and ORDER - granting in part FCI's motion to compel arbitration, staying the claims, denying with respect to dismissing the claims. All claims other than the misappropriation of trade secrets claim in the

		lawsuit may proceed. Motion for more definite statement of the misappropriation of trade secrets claim is denied as moot. Signed by Judge T. John Ward on 7/17/06. (ehs,) (Entered: 07/18/2006)
07/24/2006	36	MEMORANDUM OPINION and ORDER denying Tyco's motion to transfer venue. Signed by Judge T. John Ward on 7/24/06. (ehs,) (Entered: 07/24/2006)
07/28/2006	37	ANSWER to Amended Complaint , *Affirmative Defenses and*, COUNTERCLAIM against FCI USA Inc, FCI Americas Technology Inc by Tyco Electronics Corporation.(Jones, Michael) (Entered: 07/28/2006)
08/04/2006	38	ANSWER to Counterclaim *and Affirmative Defenses* by FCI USA Inc, FCI Americas Technology Inc.(Carroll, Otis) (Entered: 08/04/2006)
09/12/2006	39	ORDER SUBSTITUTING re 34 Memorandum & Opinion issued on July 17, 2006 and VACATING 33 Memorandum & Opinion issued on July 14, 2006. Signed by Judge T. John Ward on 9/11/06. (poa,) (Entered: 09/12/2006)
10/04/2006	40	NOTICE of Attorney Appearance by Allen Franklin Gardner on behalf of Tyco Electronics Corporation (Gardner, Allen) (Entered: 10/04/2006)

PACER Service Center			
Transaction Receipt			
04/04/2007 13:39:32			
PACER Login:	lv0531	**Client Code:**	701287
Description:	Docket Report	**Search Criteria:**	2:06-cv-00128-TJW
Billable Pages:	5	**Cost:**	0.40

EXHIBIT G

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U.S. DISTRICT COURT
2006 MAR 29 PM 4:21
TEXAS EASTERN
BY_____

IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

FCI USA, INC. and
FCI AMERICAS TECHNOLOGY, INC.,

Plaintiff,

v.

TYCO ELECTRONICS CORPORATION,

Defendant.

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Civil Action No. 2:06cv128

JURY

COMPLAINT

Plaintiffs FCI USA, Inc. ("FCI USA") and FCI Americas Technology, Inc. ("FCI Americas") (collectively, "FCI"), through their attorneys, complain of Defendant Tyco Electronics Corporation ("Defendant") and allege as follows, upon knowledge with respect to themselves and their own acts, and upon information and belief as to the circumstances and facts of others:

NATURE OF THE ACTION

1. This is an action for infringement of United States Patent Nos. 6,976,886 B2, 6,988,902 B2 and 6,994,569 B2, and arises under the patent laws of the United States, 35 U.S.C. § 1, *et seq.*

2. This is also an action to remedy acts of unfair competition under the Lanham Act, 15 U.S.C. § 1125(a); and unfair competition by trade secret misappropriation, common law misappropriation, and palming off under the laws of the State of Texas.

THE PARTIES

3. Plaintiff FCI USA, Inc. is a corporation organized under the laws of the State of New York, having its principal place of business at 825 Old Trail Road, Etters, PA 17319-9769.

4. Plaintiff FCI Americas Technology, Inc., a wholly-owned subsidiary of Plaintiff FCI USA, Inc., is a corporation organized under the laws of the State of Nevada, having its principal place of business at 825 Old Trail Road, Etters, PA 17319-9769.

5. Upon information and belief, Defendant is a corporation organized under the laws of Pennsylvania with a principal place of business at 2901 Fulling Mill Road, Middletown, Pennsylvania. Defendant is registered to do business in the State of Texas and has a registered agent, CT Corporation System, located at 350 N. St. Paul Street, Dallas, Texas 75201. On information and belief, Defendant sells and offers for sale high speed electrical connectors throughout the United States, including within the State of Texas and this judicial district.

SUBJECT MATTER JURISDICTION

6. This Court has original jurisdiction over the subject matter of the causes of action set forth as Counts I-III pursuant to 28 U.S.C. §§ 1331 and 1338(a) because those causes of action arise under the patent laws of the United States, 35 U.S.C. § 1, *et seq.*

7. This Court has supplemental jurisdiction over the subject matter of the causes of action set forth as Counts V through VII pursuant to 28 U.S.C. § 1367 because those causes of action are based on state law and are substantially related to and arise from the same operative facts as those causes of action over which the Court has original jurisdiction.

8. This Court has original jurisdiction over the subject matter of the cause of action set forth as Count IV pursuant to 28 U.S.C. §§ 1331 and 1338(a) because those causes of action arise under the Lanham Act, 15 U.S.C. § 1125a.

PERSONAL JURISDICTION

9. This Court has personal jurisdiction over Defendant because Defendant, on information and belief, does business throughout the United States, including within the State of Texas and this judicial district.

VENUE

10. Venue in this judicial district is proper pursuant to 28 U.S.C. §§ 1391 and 1400(b) because, on information and belief, Defendant resides in this judicial district for purposes of jurisdiction.

FCI'S PATENT RIGHTS AND DEFENDANT'S VIOLATION THEREOF

11. On December 20, 2005, U.S. Patent No. 6,976,886 B2 (the "'886 Patent") was duly and legally issued to Clifford L. Winings, Joseph B. Shuey, Timothy A. Lemke, Gregory A. Hull, Stephen B. Smith, Stefaan Hendrik Josef Sercu and Timothy W. Houtz for an invention entitled "Cross-Talk Reduction in High Speed Electrical Connectors." A true and correct copy of the '886 Patent is attached to this Complaint as Exhibit A.

12. On January 24, 2006, U.S. Patent No. 6,988,902 B2 (the "'902 Patent") was duly and legally issued to Clifford L. Winings, Joseph B. Shuey, Timothy A. Lemke, Gregory A. Hull, Stephen B. Smith, Stefaan Hendrik Josef Sercu and Timothy W. Houtz for an invention entitled

"Cross-Talk Reduction in High Speed Electrical Connectors." A true and correct copy of the '902 Patent is attached to this Complaint as Exhibit B.

13. On February 7, 2006 U.S. Patent No. 6,994,569 B2 (the "'569 Patent") was duly and legally issued to Steven E. Minich, Joseph B. Shuey, Gregory A. Hull and Stephen Smith for an invention entitled "Electrical Connectors Having Contacts That May Be Selectively Designated As Either Signal Or Ground Contacts." A true and correct copy of the '569 Patent is attached to this Complaint as Exhibit C.

14. FCI owns by assignment all right, title, and interest in and to the '886 Patent, the '902 Patent, and the '569 Patent (collectively, "FCI's Patents").

15. Without authority or license from FCI, Defendant has acted and is acting to infringe FCI's Patents by way of its activities involving backplane connectors, including those marketed under the Z-PACK MAX name. On information and belief, these connectors have been and are being used, sold and/or offered for sale in Texas, including within this judicial district.

FCI'S TRADE SECRETS

16. FCI has invested significant amounts of money, time and research into the development of high speed, shieldless electrical connector technology, which has resulted in valuable proprietary technology. This proprietary technology is inherently valuable to FCI because they are the basis of many of its commercial products. This proprietary technology would also be valuable to FCI's competitors because it represents significant improvements over the products and technology previously available.

17. FCI has undertaken the requisite precautions to protect and preserve its proprietary technology with regard to high speed, shieldless electrical connectors as trade secrets.

18. FCI's trade secrets have been used to develop products sold under the AIRMAX family of marks.

19. Starting in October, 2002, as part of a joint development proposal, FCI confidentially disclosed to Defendant its proprietary technology with respect to developing a high speed, shieldless electrical connector and provided samples of its AIRMAX connector. On information and belief, Defendant subsequently used the proprietary technology confidentially disclosed by FCI to develop their own line of high speed, shieldless electrical connectors.

20. FCI launched a family of commercial high speed, shieldless electrical connectors under the AIRMAX family of marks in September 2003. FCI's AIRMAX connectors have been a commercial success. About a year later, sometime in the fall of 2004, Defendant began to offer a competing high speed, shieldless electrical connector. On information and belief, Defendant would not have been able to develop and bring to market a competing product as soon as it did without the benefit of FCI's proprietary technology.

FCI'S TRADEMARK RIGHTS AND DEFENDANT'S VIOLATION THEREOF

21. FCI is a leading manufacturer and seller of high speed, shieldless electrical connectors.

22. Since at least as early as July 2003, FCI has continuously manufactured, marketed and/or sold high speed, shieldless electrical connectors in interstate commerce under its family of AIRMAX trademarks, which include the AIRMAX, AIRMAX HP, AIRMAX VS and AIRMAX NEO marks (collectively "FCI's AIRMAX Marks").

23. FCI's AIRMAX Marks are inherently distinctive. Further, as a result of FCI's continuous use of these marks, the commercial success of high speed, shieldless electrical

connectors under these marks, and the substantial advertising and promotional efforts made in connection therewith, FCI's AIRMAX Marks have acquired secondary meaning within the relevant market.

24. Notwithstanding the foregoing, in December of 2005, Defendant adopted a substantially similar mark, Z-PACK MAX, for directly competing products, specifically, high speed, shieldless electrical connectors.

25. Defendant's website (http://www.tycoelectronics.com) advertises for sale high speed, shieldless electrical connectors under the Z-PACK MAX mark.

26. Defendant's Z-PACK MAX mark is highly similar to FCI's AIRMAX Marks in terms of sound and commercial meaning.

27. The high speed, shieldless electrical connectors that FCI markets and sells under FCI's AIRMAX Marks and the high speed, shieldless electrical connectors that Defendant markets and sells under the Z-PACK MAX mark travel in the same channels of distribution. Given the nationwide recognition of the high speed, shieldless electrical connectors marketed and sold under FCI's AIRMAX Marks, the relevant consumer encountering Defendant's Z-PACK MAX high speed, shieldless electrical connectors would likely believe that they are in the same product line as or related to FCI's AIRMAX high speed, shieldless electrical connectors.

28. In light of the confusing similarity between Defendant's Z-PACK MAX mark and FCI's AIRMAX Marks, purchasers familiar with FCI's high speed, shieldless electrical connectors sold under FCI's AIRMAX Marks would likely assume that Defendant's high speed, shieldless electrical connectors sold under the Z-PACK MAX mark originated with FCI, or that there is some affiliation between the parties, or that FCI has sponsored, endorsed, or approved Defendant's high speed, shieldless electrical connectors sold under the Z-PACK MAX mark.

Count I

PATENT INFRINGEMENT – '886 PATENT

(Federal)

29. FCI repeats and realleges each and every allegation contained in paragraphs 1-28 of this Complaint as though fully set forth herein.

30. Defendant is infringing the '886 Patent by making, using, importing, offering to sell, and/or selling high speed, shieldless electrical connectors, including those marketed under the Z-PACK MAX name, in violation of 35 U.S.C. § 271(a).

31. Defendant's activities also have induced, are inducing, and/or will induce others to infringe the '886 Patent in violation of 35 U.S.C. § 271(b).

32. Defendant is also liable for contributory infringement of the '886 Patent in violation of 35 U.S.C. § 271(c).

33. Upon information and belief, the infringing acts of Defendant have been and are willful and deliberate, with knowledge of FCI's rights in and to the '886 Patent.

34. As a direct and proximate consequence of Defendant's acts and practices, FCI has suffered, is suffering, and, unless such acts and practices are enjoined, will continue to suffer injury and damages for which it is entitled to relief under 35 U.S.C. § 284.

35. By reason of its acts and practices, Defendant has also caused, is causing and, unless such acts and practices are enjoined, will continue to cause immediate and irreparable harm to FCI for which there is no adequate remedy at law, and for which FCI is entitled to injunctive relief under 35 U.S.C. § 283.

Count II

PATENT INFRINGEMENT – '902 PATENT

(Federal)

36. FCI repeats and realleges each and every allegation contained in paragraphs 1-35 of this Complaint as though fully set forth herein.

37. Defendant is infringing the '902 Patent by making, using, importing, offering to sell, and/or selling high speed, shieldless electrical connectors, including those marketed under the Z-PACK MAX name, in violation of 35 U.S.C. § 271(a).

38. Defendant's activities also have induced, are inducing, and/or will induce others to infringe the '902 Patent in violation of 35 U.S.C. § 271(b).

39. Defendant is also liable for contributory infringement of the '902 Patent in violation of 35 U.S.C. § 271(c).

40. Upon information and belief, the infringing acts of Defendant have been and are willful and deliberate, with knowledge of FCI's rights in and to the '902 Patent.

41. As a direct and proximate consequence of Defendant's acts and practices, FCI has suffered, is suffering, and, unless such acts and practices are enjoined, will continue to suffer injury and damages for which it is entitled to relief under 35 U.S.C. § 284.

42. By reason of its acts and practices, Defendant also has caused, is causing and, unless such acts and practices are enjoined, will continue to cause immediate and irreparable harm to FCI for which there is no adequate remedy at law, and for which FCI is entitled to injunctive relief under 35 U.S.C. § 283.

Count III

PATENT INFRINGEMENT – '569 PATENT

(Federal)

43. FCI repeats and realleges each and every allegation contained in paragraphs 1-42 of this Complaint as though fully set forth herein.

44. Defendant is infringing the '569 Patent by making, using, importing, offering to sell, and/or selling high speed, shieldless electrical connectors, including those marketed under the Z-PACK MAX name, in violation of 35 U.S.C. § 271(a).

45. Defendant's activities also have induced, are inducing, and/or will induce others to infringe the '569 Patent in violation of 35 U.S.C. § 271(b).

46. Defendant is also liable for contributory infringement of the '569 Patent in violation of 35 U.S.C. § 271(c).

47. Upon information and belief, the infringing acts of Defendant have been and are willful and deliberate, with knowledge of FCI's rights in and to the '569 Patent.

48. As a direct and proximate consequence of Defendant's acts and practices, FCI has suffered, is suffering, and, unless such acts and practices are enjoined, will continue to suffer injury and damages for which it is entitled to relief under 35 U.S.C. § 284.

49. By reason of its acts and practices, Defendant has also caused, is causing and, unless such acts and practices are enjoined, will continue to cause immediate and irreparable harm to FCI for which there is no adequate remedy at law, and for which FCI is entitled to injunctive relief under 35 U.S.C. § 283.

Count IV

UNFAIR COMPETITION

(Federal)

50. FCI repeats and realleges each and every allegation contained in paragraphs 1-49 of this Complaint as though fully set forth herein.

51. This cause of action arises under Section 43(a) of the Lanham Act, 15 U.S.C. § 1125(a).

52. FCI's AIRMAX Marks enjoy goodwill and a favorable reputation among the trade and purchasing public.

53. Defendant's use of the highly similar Z-PACK MAX mark is likely to cause confusion, mistake, or deception as to the affiliation, connection, or association of Defendant with FCI or as to the origin, sponsorship, or approval of Defendant's products by FCI, and misrepresents the nature, characteristics, and qualities of these products, in violation of Section 43(a) of the Lanham Act, 15 U.S.C. § 1125(a).

54. FCI is without an adequate remedy at law because Defendant's acts set forth herein are causing irreparable harm to FCI and will continue to damage FCI unless restrained by this Court.

55. Defendant's acts of trademark infringement have further caused FCI to sustain monetary damages, loss, and injury in an amount to be determined at the trial of this action.

Count V

UNFAIR COMPETITION BY TRADE SECRET MISAPPROPRIATION

(State Law)

56. FCI repeats and realleges each and every allegation contained in paragraphs 1-55 of this Complaint as though fully set forth herein.

57. This cause of action is to remedy unfair competition by trade secret misappropriation under the common law of the State of Texas.

58. FCI's AIRMAX connectors were developed using its proprietary technology. This proprietary technology is not generally known to parties outside of FCI, and, due to their valuable nature, FCI has taken the necessary measures to guard the secrecy of these technologies and to maintain them as trade secrets. These trade secrets were developed at great expense to FCI, and it would not be possible for other parties to acquire the same technology without significant investment and effort.

59. Starting in October, 2002, FCI confidentially disclosed its proprietary technology with respect to developing a high speed, shieldless electrical connector. FCI also provided samples of its high speed, shieldless electrical connectors to Defendant. On information and belief, Defendant used the proprietary technology disclosed by FCI to develop their own line of high speed, shieldless electrical connectors.

60. Defendant's use of FCI's trade secrets without authorization constitutes unfair competition by misappropriation of trade secrets under the common law of the State of Texas.

61. Defendant's acts of unfair competition by misappropriation of trade secrets have caused FCI to sustain monetary damage, loss and injury, in an amount to be determined at the time of trial.

62. Defendant has engaged and continues to engage in this activity knowingly and willfully, so as to justify the assessment of increased and punitive damages against it, in an amount to be determined at the time of trial.

63. Defendant's acts of unfair competition by misappropriation of trade secrets, unless enjoined by this Court, will continue to cause FCI to sustain irreparable harm, loss and injury, for which FCI has no adequate remedy at law.

Count VI

UNFAIR COMPETITION BY COMMON LAW MISAPPROPRIATION

(State Law)

64. FCI repeats and realleges each and every allegation contained in paragraphs 1-63 of this Complaint as though fully set forth herein.

65. This cause of action is to remedy unfair competition by common law misappropriation under the common law of the State of Texas.

66. FCI's AIRMAX line of connectors were developed through extensive investments of time, skilled labor and money, which has resulted in technology and knowledge that is proprietary to FCI.

67. Upon information and belief, Defendant has made, used, sold and/or offered for sale products containing FCI's proprietary technology while avoiding the investment required for development and shortening the development time, thereby obtaining a competitive advantage over FCI.

68. Defendant's sale and/or offer for sale of their competing products, in conjunction with their improper competitive advantage, has caused significant commercial harm to FCI.

69. Defendant's use of FCI's proprietary technology in competition with FCI constitutes unfair competition by common law misappropriation under the common law of the State of Texas.

70. Defendant's acts of unfair competition by common law misappropriation have caused FCI to sustain monetary damage, loss and injury, in an amount to be determined at the time of trial.

71. Upon information and belief, Defendant has engaged and continues to engage in this activity knowingly and willfully, so as to justify the assessment of increased and punitive damages against it, in an amount to be determined at the time of trial.

72. Defendant's acts of unfair competition by common law misappropriation, unless enjoined by this Court, will continue to cause FCI to sustain irreparable harm, loss and injury, for which FCI has no adequate remedy at law.

Count VII

UNFAIR COMPETITION BY PALMING OFF

(State Law)

73. FCI repeats and realleges each and every allegation contained in paragraphs 1-72 of this Complaint as though fully set forth herein.

74. This cause of action is to remedy unfair competition by palming off under the common law of the State of Texas.

75. FCI has used the AIRMAX family of marks to identify its high speed, shieldless connector since July 2003. During that time FCI's AIRMAX Marks have acquired a secondary meaning with customers, indicating the source of the goods. Upon information and belief,

Defendant's adoption of the Z-PACK MAX mark is based on its similarity to FCI's AIRMAX Marks and is likely to cause confusion as to whether there is some affiliation between the parties or that FCI has sponsored, endorsed or approved Defendant's product.

76. Defendant sells high speed, shieldless electrical connectors under the Z-PACK MAX name nationwide that compete directly with FCI's AIRMAX connectors.

77. Defendant's use of the Z-PACK MAX mark in conjunction with high speed, shieldless electrical connectors constitutes unfair competition by passing or palming off under the common law of the State of Texas.

78. FCI is without an adequate remedy at law because Defendant's acts set forth herein are causing irreparable harm to FCI and will continue to damage FCI unless restrained by this Court.

79. Defendant's acts of unfair competition by passing or palming off have further caused FCI to sustain monetary damages, loss, and injury in an amount to be determined at the trial of this action.

DEMAND FOR JURY TRIAL

80. FCI hereby requests a trial by jury for all issues so triable.

PRAYER FOR RELIEF

WHEREFORE, FCI prays that this Court enter judgment as follows, that:

A. Defendant be held liable under each claim for relief set forth in this Complaint;

B. Defendant has infringed and is infringing one or more claims of U.S. Patent Nos. 6,976,886 B2, 6,988,902 B2 and 6,994,569 B2;

C. Defendant's infringement of U.S. Patent Nos. 6,976,886 B2, 6,988,902 B2 and 6,994,569 B2 has been and is willful;

D. U.S. Patent Nos. 6,976,886 B2, 6,988,902 B2 and 6,994,569 B2 are valid and enforceable;

E. Defendant, its agents, servants, employees, and all other persons in active concert or participation with them be enjoined from further infringement of U.S. Patent Nos. 6,976,886 B2, 6,988,902 B2 and 6,994,569 B2;

F. Defendant be required to account for damages sustained by FCI as a result of its patent infringement, together with interest, and that such damages will be increased by three times the amount found or assessed pursuant to 35 U.S.C. § 284;

G. Defendant, its agents, servants, employees, and attorneys, and all other persons in active concert or participation with them, be enjoined from unfairly competing and using Z-PACK MAX (however spelled or punctuated, whether capitalized, abbreviated, singular or plural, printed or stylized, whether as one word or two, whether used alone or in combination with any word(s), punctuation or symbol(s), and whether used in caption, text, orally or otherwise), or any other reproduction, counterfeit, copy, colorable imitation or confusingly similar variation of FCI's AIRMAX Marks, as a trademark or service mark, trade name or domain name, or in the advertising, distribution, sale, or offering for sale of Defendant's products and/or services;

H. Defendant be required to pay to FCI all damages FCI has suffered by reason of Defendant's unlawful acts set forth herein in Counts IV through VII, together with legal interest from the date of accrual thereof;

I. Defendant be required to account for and pay to FCI all profits wrongfully derived by Defendant through their unlawful acts set forth herein in Counts IV through VII, together with legal interest from the date of accrual thereof;

J. Defendant be required to pay to FCI exemplary damages in an amount to be determined by this Court for Defendant's unfair competition with malice;

K. Defendant be required to pay to FCI its reasonable attorneys' fees and disbursements incurred herein, pursuant to 35 U.S.C. § 285, 15 U.S.C. § 1117, and the equity powers of this Court;

L. Defendant be required to pay to FCI the costs of this action; and

M. This Court award FCI such other and further relief as this Court deems just and equitable.

Respectfully submitted,

Dated: March 29, 2006

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