US00RE41283E

(19) **United States**

(12) **Reissued Patent**

Evans et al.

(10) **Patent Number: US RE41,283 E**

(45) **Date of Reissued Patent: Apr. 27, 2010**

(54) **POWER CONNECTOR WITH SAFETY FEATURE**

(75) Inventors: **Robert F. Evans**, Bedford, NH (US); **Jeffrey W. Allison**, Etters, PA (US); **Brian M. Rohrbaugh**, Glen Rock, PA (US)

(73) Assignee: **FCI Americas Technology, Inc.**, Carson City, NV (US)

(21) Appl. No.: **11/862,464**

(22) Filed: **Sep. 27, 2007**

Related U.S. Patent Documents

Reissue of:

(64) Patent No.: **7,037,142**
Issued: **May 2, 2006**
Appl. No.: **11/227,666**
Filed: **Sep. 15, 2005**

U.S. Applications:

(63) Continuation of application No. 10/352,531, filed on Jan. 28, 2003, now abandoned.

(51) **Int. Cl.**
H01R 13/64 (2006.01)

(52) **U.S. Cl.** **439/680**; 439/79; 439/633

(58) **Field of Classification Search** 439/680, 439/681, 682, 677, 633, 79
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,430,011	A	11/1947	Gillentine	173/361

(Continued)

FOREIGN PATENT DOCUMENTS

DE	23 50 834		4/1975
DE	34 41 416	A1	5/1986
DE	40 01 104	A1	7/1991
EP	0 465 013		1/1992
EP	0 724 313		7/1996
EP	0 951 102	A2	10/1999
EP	1091449		9/2004
FR	2 699 744		6/1994
GB	2 168 550		6/1986
JP	05344728		12/1993
JP	06068943		3/1994
JP	07169523		7/1995
JP	08096918		4/1996
JP	09 055 245		2/1997
JP	09199215		7/1997
JP	13135388		5/2001
JP	2003217785		7/2003
KR	100517561	B1	9/2005
WO	WO 200016445		3/2000
WO	WO 2002103847		12/2002
WO	WO 2005065254		7/2005
WO	WO 2007064632		6/2007

OTHER PUBLICATIONS

U.S. Appl. No. 12/317,366, filed Dec. 22, 2008, Minich.
Metral 1000 Series, PCB Mounted Receptacle Assembly, FCI Web Site page, 2001, 1 p.

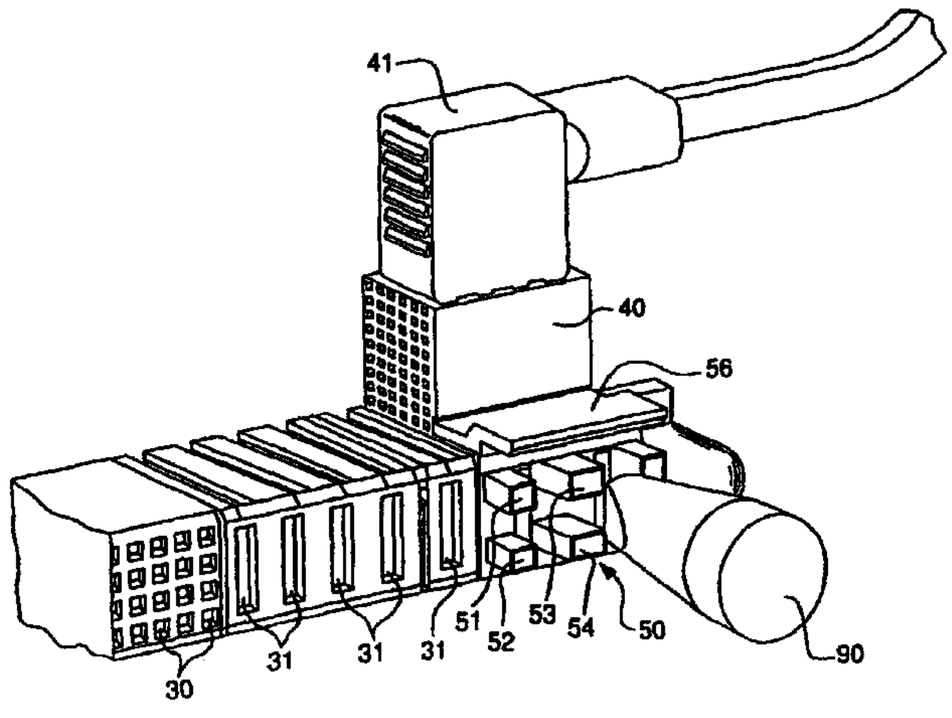
(Continued)

Primary Examiner—Briggitte R Hammond
(74) *Attorney, Agent, or Firm*—Woodcock Washburn LLP

(57) **ABSTRACT**

Electrical receptacle connectors are provided including an insulative housing and AC power contacts disposed therein that are configured for engaging an external power supply. The receptacle connectors are employed with a safety guard for restricting operator access to hot AC power contacts when disconnected from complementary header connectors. Preferred safety guards include projections extending along at least a portion of perimeter areas surrounding housing apertures that provide access to engaging portions of the AC power contacts. The projections define a safety gap between human digits directed toward the housing apertures and the AC power contacts.

7 Claims, 5 Drawing Sheets



U.S. PATENT DOCUMENTS

3,208,030	A	9/1965	Evans et al.	
3,286,220	A	11/1966	Marley et al.	439/680
3,497,850	A	2/1970	Gallo, Sr.	337/197
3,538,486	A	11/1970	Shlesinger, Jr.	439/268
3,596,235	A	7/1971	Teurlings	439/907
3,669,054	A	6/1972	Desso et al.	113/119
3,748,633	A	7/1973	Lundergan	339/217
3,750,092	A	7/1973	Bury	339/192 RL
3,789,348	A	1/1974	Lenaerts et al.	339/198 R
3,871,015	A	3/1975	Lin et al.	357/67
3,910,671	A	10/1975	Townsend	339/97 R
3,942,856	A	3/1976	Mindheim et al.	339/74
3,944,312	A	3/1976	Koenig	339/59 R
4,005,923	A	2/1977	Davis, Jr.	339/157
4,073,564	A	2/1978	Davis, Jr.	339/157
4,076,362	A	2/1978	Ichimura	339/75
4,082,407	A	4/1978	Smorzaniuk et al.	
4,136,919	A	1/1979	Howard et al.	339/75
4,159,861	A	7/1979	Anhalt	339/75
4,224,486	A	9/1980	Zimmerman, Jr. et al.	200/51.1
4,227,762	A	10/1980	Scheiner	339/91 R
4,260,212	A	4/1981	Ritchie et al.	339/97
4,288,139	A	9/1981	Cobaugh et al.	339/74
4,322,120	A	3/1982	Rilling	439/907
4,371,912	A	2/1983	Guzik	361/417
4,383,724	A	5/1983	Verhoeven	439/510
4,402,563	A	9/1983	Sinclair	339/75
4,473,113	A	9/1984	Whitfield et al.	
4,500,160	A	2/1985	Bertsch	339/166
4,505,529	A	3/1985	Barkus	339/17
4,533,187	A	8/1985	Kirkman	
4,536,955	A	8/1985	Gudgeon	29/840
4,545,610	A	10/1985	Lakritz et al.	29/589
4,560,222	A	12/1985	Dambach	339/75
4,626,637	A	12/1986	Olsson et al.	200/284
4,659,158	A	4/1987	Sakamoto et al.	339/19
4,669,801	A	6/1987	Worth	439/404
4,685,886	A	8/1987	Denlinger et al.	439/55
4,709,976	A	12/1987	Nakama et al.	439/350
4,717,360	A	1/1988	Czaja	439/710
4,767,344	A	8/1988	Noschese	439/83
4,776,803	A	10/1988	Pretchel et al.	439/59
4,780,088	A	10/1988	Means	439/107
4,782,893	A	11/1988	Thomas	
4,790,763	A	12/1988	Weber et al.	
4,790,764	A	12/1988	Kawaguchi et al.	439/78
4,801,271	A	1/1989	Piper	439/148
4,815,987	A	3/1989	Kawano et al.	439/263
4,818,237	A	4/1989	Weber	
4,820,169	A	4/1989	Weber et al.	
4,820,175	A	4/1989	Hasegawa et al.	439/98
4,838,809	A	6/1989	Mouissie	439/155
4,845,592	A	7/1989	Himes, Jr. et al.	361/407
4,867,713	A	9/1989	Ozu et al.	439/833
4,875,865	A	10/1989	Demler, Jr. et al.	439/101
4,878,611	A	11/1989	LoVasco et al.	228/180.2
4,881,905	A	11/1989	Demler, Jr. et al.	439/79
4,900,271	A	2/1990	Colleran et al.	439/595
4,907,990	A	3/1990	Bertho et al.	439/851
4,915,641	A	4/1990	Miskin et al.	
4,917,625	A	4/1990	Haile	439/358
4,941,830	A	7/1990	Tkazyik et al.	439/59
4,950,186	A	8/1990	Kaley et al.	439/882
4,954,090	A	9/1990	Shimochi	439/76
4,963,102	A	10/1990	Gettig et al.	439/291
4,965,699	A	10/1990	Jorden et al.	
4,968,263	A	11/1990	Silbernagel et al.	439/246
4,973,271	A	11/1990	Ishizuka et al.	439/839
4,974,119	A	11/1990	Martin	
4,975,084	A	12/1990	Fedder et al.	
4,979,074	A	12/1990	Morley	
4,990,099	A	2/1991	Marin et al.	439/284
5,016,968	A	5/1991	Hammond et al.	
5,024,610	A	6/1991	French et al.	439/857
5,046,960	A	9/1991	Fedder et al.	
5,052,953	A	10/1991	Weber	439/857
5,066,236	A	11/1991	Broeksteeg	439/79
5,077,893	A	1/1992	Mosquera et al.	29/882
5,082,459	A	1/1992	Billman et al.	439/637
5,094,634	A	3/1992	Dixon et al.	431/751
5,107,328	A	4/1992	Kinsman	357/74
5,108,301	A	4/1992	Torok	439/263
5,137,959	A	8/1992	Block et al.	
5,139,426	A	8/1992	Barkus et al.	
5,151,056	A	9/1992	McClune	
5,152,700	A	10/1992	Bogursky et al.	
5,158,471	A	10/1992	Fedder et al.	439/80
5,173,063	A	12/1992	Barkus et al.	439/681
5,174,770	A	12/1992	Sasaki et al.	439/108
5,194,480	A	3/1993	Block et al.	
5,207,591	A	5/1993	Ozaki et al.	439/212
5,213,868	A	5/1993	Liberty et al.	
5,214,308	A	5/1993	Nishiguchi et al.	
5,238,414	A	8/1993	Yaegashi et al.	439/108
5,238,416	A	8/1993	Dickie	439/148
5,254,012	A	10/1993	Wang	439/263
5,274,918	A	1/1994	Reed	29/882
5,281,168	A	1/1994	Krehbiel et al.	435/595
5,286,212	A	2/1994	Broeksteeg	
5,295,843	A	3/1994	Davis et al.	
5,298,791	A	3/1994	Liberty et al.	
5,302,135	A	4/1994	Lee	439/263
5,321,582	A	6/1994	Casperson	
5,358,422	A	10/1994	Schaffer et al.	439/346
5,362,249	A	11/1994	Carter	439/357
5,376,012	A	12/1994	Clark	439/80
5,400,949	A	3/1995	Hirvonen et al.	228/180
5,403,206	A	4/1995	McNamara et al.	439/608
5,427,543	A	6/1995	Dynia	439/346
5,431,578	A	7/1995	Wayne	439/259
5,435,876	A	7/1995	Alfaro et al.	156/247
5,457,342	A	10/1995	Herbst, II	257/712
5,458,426	A	10/1995	Ito	
5,475,922	A	12/1995	Tamura et al.	29/881
5,481,442	A	1/1996	Dickie et al.	362/95
5,490,040	A	2/1996	Gaudenzi et al.	361/773
5,511,987	A	4/1996	Shinchi	
5,512,519	A	4/1996	Hwang	
5,533,915	A	7/1996	Deans	439/678
5,549,480	A	8/1996	Cheng	439/79
5,558,542	A	9/1996	O'Sullivan et al.	439/682
5,564,952	A	10/1996	Davis et al.	
5,582,519	A	12/1996	Buchter	
5,588,852	A	12/1996	Puerner	439/135
5,590,463	A	1/1997	Feldman et al.	29/844
5,605,489	A	2/1997	Gale et al.	451/28
5,609,502	A	3/1997	Thumma	439/747
5,618,187	A	4/1997	Goto	439/79
5,622,511	A	4/1997	Jarrett	439/248
5,637,008	A	6/1997	Kozel	439/342
5,643,013	A	7/1997	Weidler et al.	439/660
5,664,968	A	9/1997	Mickievicz	
5,667,392	A	9/1997	Kocher et al.	
5,691,041	A	11/1997	Frankeny et al.	
5,702,255	A	12/1997	Murphy et al.	
5,716,234	A	2/1998	Phillips	439/595
5,727,963	A	3/1998	LeMaster	
5,730,609	A	3/1998	Harwath	439/108
5,741,144	A	4/1998	Elco et al.	439/101
5,741,161	A	4/1998	Cahaly et al.	439/709
5,742,484	A	4/1998	Gillette et al.	

5,743,009	A	4/1998	Matsui et al.	6,220,895	B1	4/2001	Lin
5,745,349	A	4/1998	Lemke 361/818	6,220,896	B1	4/2001	Bertoncini et al. 439/608
5,746,608	A	5/1998	Taylor 439/70	6,238,225	B1	5/2001	Middlehurst et al.
5,749,746	A	5/1998	Tan et al.	6,257,478	B1	7/2001	Straub
5,755,595	A	5/1998	Davis et al. 439/607	6,259,039	B1	7/2001	Chroneos, Jr. et al.
5,772,452	A	6/1998	Aoyama 439/79	6,261,132	B1	7/2001	Koseki et al.
5,782,644	A	7/1998	Kiat	6,269,539	B1	8/2001	Takahashi et al. 29/883
5,785,557	A	7/1998	Davis 439/660	6,272,474	B1	8/2001	Garcia
5,787,971	A	8/1998	Dodson 165/121	6,280,230	B1	8/2001	Takase et al.
5,795,191	A	8/1998	Preputnick et al. 439/608	6,293,827	B1	9/2001	Stokoe 439/608
5,810,607	A	9/1998	Shih et al. 439/66	6,299,492	B1	10/2001	Pierini et al.
5,817,973	A	10/1998	Elco et al. 174/32	6,319,075	B1	11/2001	Clark et al. 439/825
5,827,094	A	10/1998	Aizawa et al.	6,322,377	B2	11/2001	Middlehurst et al.
5,831,314	A	11/1998	Wen 257/391	6,328,602	B1	12/2001	Yamasaki et al. 439/608
5,865,651	A	2/1999	Dague et al. 439/680	6,335,224	B1	1/2002	Peterson et al. 438/114
5,872,046	A	2/1999	Kaeriyama et al. 438/465	6,347,952	B1	2/2002	Hasegawa et al.
5,874,776	A	2/1999	Kresge et al. 257/747	6,350,134	B1	2/2002	Fogg et al. 439/79
5,876,219	A	3/1999	Taylor et al.	6,358,094	B1	3/2002	Belopolsky et al. 439/637
5,876,248	A	3/1999	Brunker	6,359,783	B1	3/2002	Noble
5,879,198	A	3/1999	Sekimori et al. 439/700	6,360,940	B1	3/2002	Bolde et al. 228/264
5,882,214	A	3/1999	Hillbish et al.	6,362,961	B1	3/2002	Chiou 361/704
5,883,782	A	3/1999	Thurston et al. 364/704	6,363,607	B1	4/2002	Chen et al. 29/883
5,888,884	A	3/1999	Wojnarowski 438/462	6,371,773	B1	4/2002	Crofoot et al. 439/79
5,904,594	A	5/1999	Longueville et al. 439/608	6,379,188	B1	4/2002	Cohen et al. 439/608
5,908,333	A	6/1999	Perino et al. 439/631	6,386,924	B2	5/2002	Long 439/701
5,919,050	A	7/1999	Kehley et al. 439/71	6,394,818	B1	5/2002	Smalley, Jr.
5,923,995	A	7/1999	Kao et al. 438/460	6,402,566	B1	6/2002	Middlehurst et al.
5,924,899	A	7/1999	Paagman 439/701	6,409,543	B1	6/2002	Astbury, Jr. et al. 439/608
5,930,114	A	7/1999	Kuzmin et al. 361/704	6,431,914	B1	8/2002	Billman 439/608
5,937,140	A	8/1999	Leonard et al. 392/392	6,435,914	B1	8/2002	Billman 439/608
5,955,888	A	9/1999	Frederickson et al. 324/761	6,450,029	B1	9/2002	Sakai et al.
5,961,355	A	10/1999	Morlion et al. 439/686	6,461,183	B1	10/2002	Ohkita et al.
5,971,817	A	10/1999	Longueville 439/857	6,461,202	B2	10/2002	Kline 439/701
5,975,921	A	11/1999	Shuey 439/83	6,471,523	B1	10/2002	Shuey 439/63
5,980,321	A	11/1999	Cohen et al. 439/608	6,471,548	B2	10/2002	Bertoncini et al. 439/608
5,984,726	A	11/1999	Wu 439/607	6,472,474	B2	10/2002	Burkhardt et al.
5,993,259	A	11/1999	Stokoe et al. 439/608	6,488,549	B1	12/2002	Weller et al.
6,012,948	A	1/2000	Wu 439/567	6,489,567	B2	12/2002	Zachrai
6,027,360	A	2/2000	Jenkins 439/364	6,506,081	B2	1/2003	Blanchfield et al. 439/682
6,036,549	A	3/2000	Wulff	6,511,329	B2	1/2003	Yi-Tsung 439/76.1
6,041,498	A	3/2000	Hillbish et al.	6,514,103	B2	2/2003	Pape et al.
6,050,862	A	4/2000	Ishii 439/843	6,537,111	B2	3/2003	Brammer et al. 439/857
6,059,170	A	5/2000	Jimarez et al. 228/119	6,551,112	B1	4/2003	Li et al. 439/66
6,062,911	A	5/2000	Davis et al. 439/630	6,554,046	B1	4/2003	Bryan et al. 156/584
6,063,696	A	5/2000	Brenner et al. 438/465	6,554,647	B1	4/2003	Cohen et al. 439/607
6,066,048	A	5/2000	Lees	6,572,410	B1	6/2003	Volstorf et al. 439/608
6,068,520	A	5/2000	Winings et al. 439/676	6,575,774	B2	6/2003	Ling et al.
6,071,152	A	6/2000	Achammer et al. 439/733.1	6,575,776	B1	6/2003	Conner et al.
6,089,878	A	7/2000	Meng 439/79	6,592,381	B2	7/2003	Cohen et al. 439/80
6,095,827	A	8/2000	Dutkowsky et al. 439/83	6,604,967	B2	8/2003	Middlehurst et al.
6,123,554	A	9/2000	Ortega et al. 439/79	6,629,854	B2	10/2003	Murakami
6,125,535	A	10/2000	Chiou et al. 29/883	6,652,318	B1	11/2003	Winings et al. 439/608
6,139,336	A	10/2000	Olson 439/83	6,663,426	B2	12/2003	Hasireoglu et al. 439/608
6,146,157	A	11/2000	Lenoir et al. 439/101	6,665,189	B1	12/2003	Lebo 361/730
6,146,202	A	11/2000	Ramey et al. 439/608	6,669,514	B2	12/2003	Wiebking et al. 439/701
6,146,203	A	11/2000	Elco et al. 439/608	6,672,884	B1	1/2004	Toh et al.
6,152,756	A	11/2000	Huang et al. 439/342	6,672,907	B2	1/2004	Azuma 439/682
6,174,198	B1	1/2001	Wu et al. 439/541.5	6,692,272	B2	2/2004	Lemke et al. 439/108
6,178,106	B1	1/2001	Umemoto et al. 363/146	6,702,594	B2	3/2004	Lee et al. 439/83
6,180,891	B1	1/2001	Murdeshwar 174/260	6,705,902	B1	3/2004	Yi et al. 439/678
6,183,301	B1	2/2001	Paagman 439/608	6,712,621	B2	3/2004	Li et al. 439/65
6,190,213	B1	2/2001	Reichart et al. 439/736	6,716,068	B2	4/2004	Wu 439/733.1
6,190,215	B1	2/2001	Pendleton et al. 439/853	6,740,820	B2	5/2004	Cheng 174/260
6,196,871	B1	3/2001	Szu 439/571	6,743,037	B2	6/2004	Kassa et al. 439/342
6,202,916	B1	3/2001	Updike et al.	6,746,278	B2	6/2004	Nelson et al. 439/608
6,206,722	B1	3/2001	Ko et al.	6,769,935	B2	8/2004	Stokoe et al.
6,210,197	B1	4/2001	Yu	6,776,635	B2	8/2004	Blanchfield et al. 439/181
6,212,755	B1	4/2001	Shimada et al. 29/527.1	6,776,649	B2	8/2004	Pape et al. 439/485
6,215,180	B1	4/2001	Chen et al.	6,780,027	B2	8/2004	Allison
6,219,913	B1	4/2001	Uchiyama 29/883	6,790,088	B2	9/2004	Ono et al. 439/607
6,220,884	B1	4/2001	Lin	6,796,831	B1	9/2004	Yasufuku et al. 439/485

6,810,783	B1	11/2004	Larose	
6,811,440	B1	11/2004	Rothermel et al.	439/608
6,814,590	B2	11/2004	Minich et al.	
6,829,143	B2	12/2004	Russell et al.	361/704
6,835,103	B2	12/2004	Middlehurst et al.	439/699.1
6,843,687	B2	1/2005	McGowan et al.	439/608
6,848,886	B2	2/2005	Schmaling et al.	416/134
6,848,950	B2	2/2005	Allison et al.	439/682
6,869,294	B2	3/2005	Clark et al.	
6,884,117	B2	4/2005	Korsunsky et al.	439/607
6,890,221	B2	5/2005	Wagner	439/855
6,905,367	B2	6/2005	Crane, Jr. et al.	439/608
6,947,012	B2	9/2005	Aisenbrey	343/906
6,975,511	B1	12/2005	Lebo et al.	361/703
6,994,569	B2	2/2006	Minich et al.	439/79
7,001,189	B1	2/2006	McGowan et al.	439/79
7,059,892	B1	6/2006	Trout	
7,059,919	B2	6/2006	Clark et al.	
7,065,871	B2	6/2006	Minich et al.	
7,070,464	B2	7/2006	Clark et al.	
7,097,465	B1	8/2006	Korsunsky et al.	
7,101,228	B2	9/2006	Hamner et al.	439/637
7,104,812	B1	9/2006	Bogiel et al.	439/79
7,114,963	B2	10/2006	Shuey et al.	439/79
RE39,380	E	11/2006	Davis	
7,137,848	B1	11/2006	Trout et al.	
7,168,963	B2	1/2007	Minich et al.	439/79
7,182,642	B2	2/2007	Ngo et al.	439/608
7,204,699	B2	4/2007	Stoner	
D542,736	S	5/2007	Rico	D13/147
7,220,141	B2	5/2007	Daily et al.	
7,258,562	B2	8/2007	Daily et al.	
7,273,382	B2	9/2007	Igarashi et al.	
7,303,427	B2	12/2007	Swain	
7,335,043	B2	2/2008	Hgo et al.	
7,384,289	B2	6/2008	Minich	
7,425,145	B2	9/2008	Ngo	
7,458,839	B2	12/2008	Ngo	
7,476,108	B2	5/2009	Swain et al.	
2001/0000498	A1	4/2001	Watanabe et al.	439/507
2001/0003685	A1	6/2001	Aritani	439/485
2001/0049229	A1	12/2001	Pape et al.	
2002/0106930	A1	8/2002	Pape et al.	439/485
2002/0142676	A1	10/2002	Hosaka et al.	439/874
2002/0159235	A1	10/2002	Miller et al.	361/704
2002/0193019	A1	12/2002	Blanchfield et al.	439/857
2003/0013330	A1	1/2003	Takeuchi	439/83
2003/0119378	A1	6/2003	Avery	
2003/0143894	A1	7/2003	Kline et al.	439/608
2003/0219999	A1	11/2003	Minich et al.	439/79
2003/0220021	A1	11/2003	Whiteman, Jr. et al.	439/608
2003/0236035	A1	12/2003	Kuroda et al.	439/857
2004/0147177	A1	7/2004	Wagner	
2004/0183094	A1	9/2004	Caletka et al.	257/178
2005/0112952	A1	5/2005	Wang et al.	439/660
2006/0003620	A1	1/2006	Daily et al.	439/295
2006/0128197	A1	6/2006	McGowan et al.	
2006/0228927	A1	10/2006	Daily	
2006/0228948	A1	10/2006	Swain	
2006/0281354	A1	12/2006	Ngo et al.	439/290
2007/0197063	A1	8/2007	Ngo	
2007/0202748	A1	8/2007	Daily	
2007/0275586	A1	11/2007	Hgo	
2007/0293084	A1	12/2007	Ngo	
2008/0038956	A1	2/2008	Swain	
2008/0248670	A1	10/2008	Daily et al.	

OTHER PUBLICATIONS

Power TwinBlade™ I/O Cable Connector RA–North–South, No. GS–20_072, Aug. 6, 2007, 11 pages.

Product Datasheets, 10 Bgit/s XENPAK 850 nm Transponder (TRP10GVP2045), Copyright 2005, MergeOptics GmbH, 13 pages.

Product Datasheets, Welome to XENPAK.org., Copyright 2001, http://www.xenpak.org., 1 page.

FCI, "PwrBlade® Power Distribution Connector System," 2003, www.fciconnect.com, 2 pages.

FCI, "PwrBlade® Power Distribution Connector System," *Technology Innovation Service,* 2003, 2–3.

FCI, "PwrBlade™, new Power Distribution connector for electronic applications," *Product News,* 2003, www.fciconnect.com, 1 page.

FCI, "Act Connectors in action," *Panorama,* 2003, 1 page.

In the United States Patent and Trademark Office, Notice of Allowance and Fee(s) Due in re: U.S. Appl. No. 10/352,584, filed Jan. 28, 2003, 4 pages.

In the United States Patent and Trademark Office, Office Action Final Rejection in re: U.S. Appl. No. 10/352,584, filed Jan. 28, 2003, 7 pages.

In the United States Patent and Trademark Office, Non Final Office Action in re: U.S. Appl. No. 10/352,584, filed Jan. 28, 2003, 14 pages.

Finan, J.M., "Thermally Conductive Thermoplastics", LNP Engineering Plastics, Inc., Plastics Engineering 2000, www.4spe.org, 4 pages.

Sherman, L.M., "Plastics that Conduct Heat", Plastics Technology Online, Jun. 2001, http://www.plasticstechnology.com, 4 pages.

Ogando, J., "And now—An Injection–Molded Heat Exchanger", Sure, plastics are thermal insulators, but additive packages allow them to conduct heat instead, Global Design News, Nov. 1, 2000, 4 pages.

U.S. Appl. No. 09/944,266, filed Aug. 31, 2001, Schell.

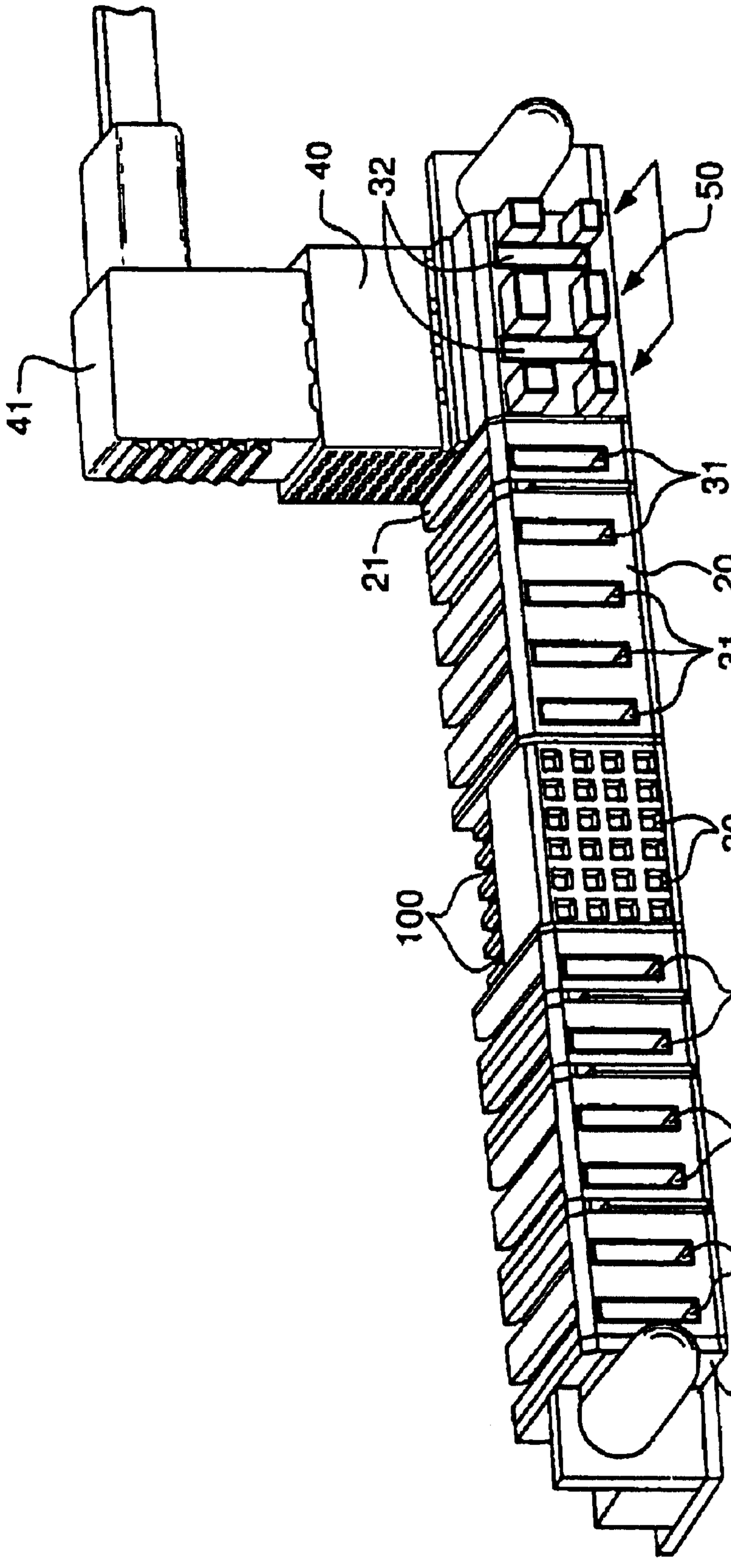


FIG. 1

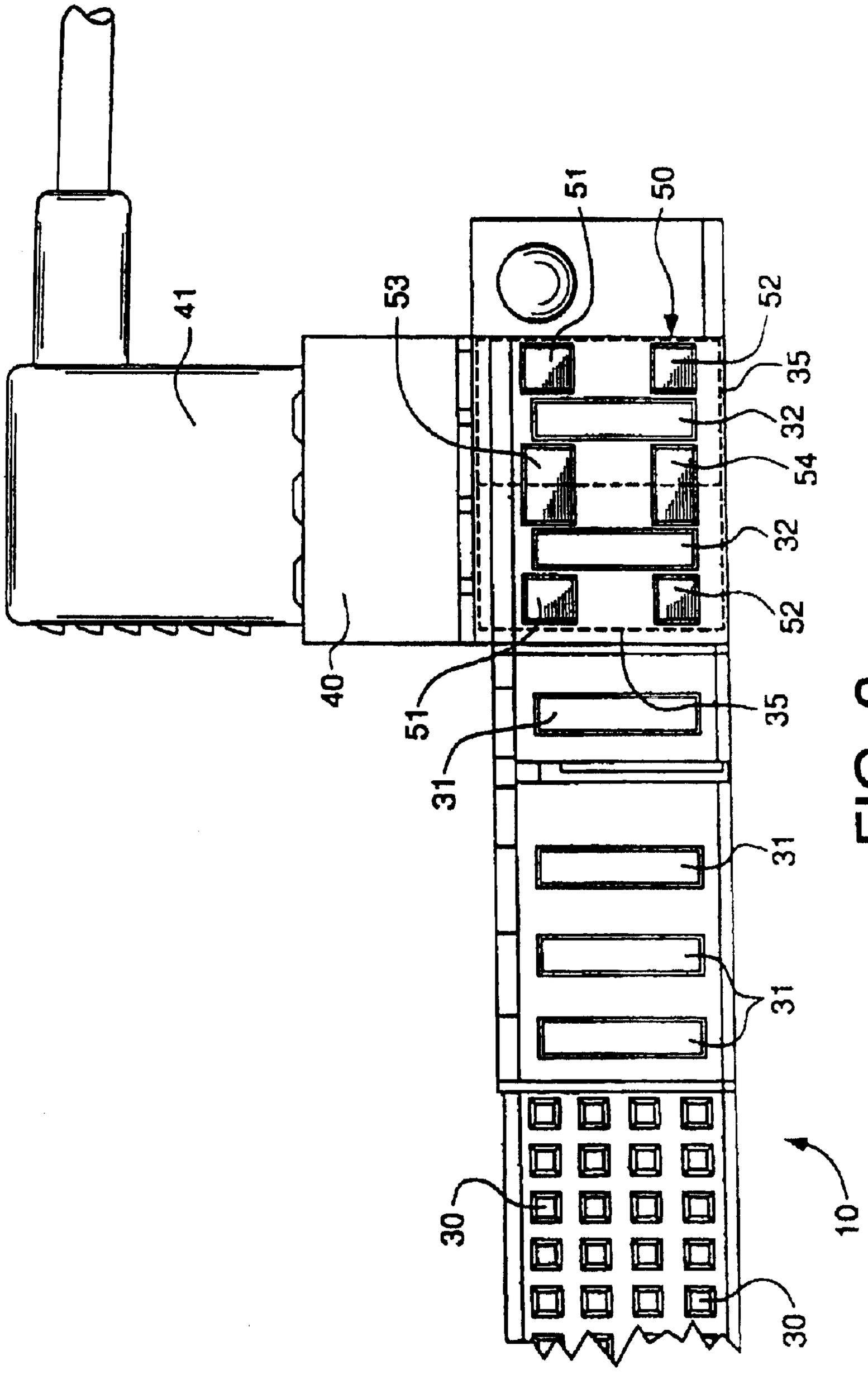


FIG. 2

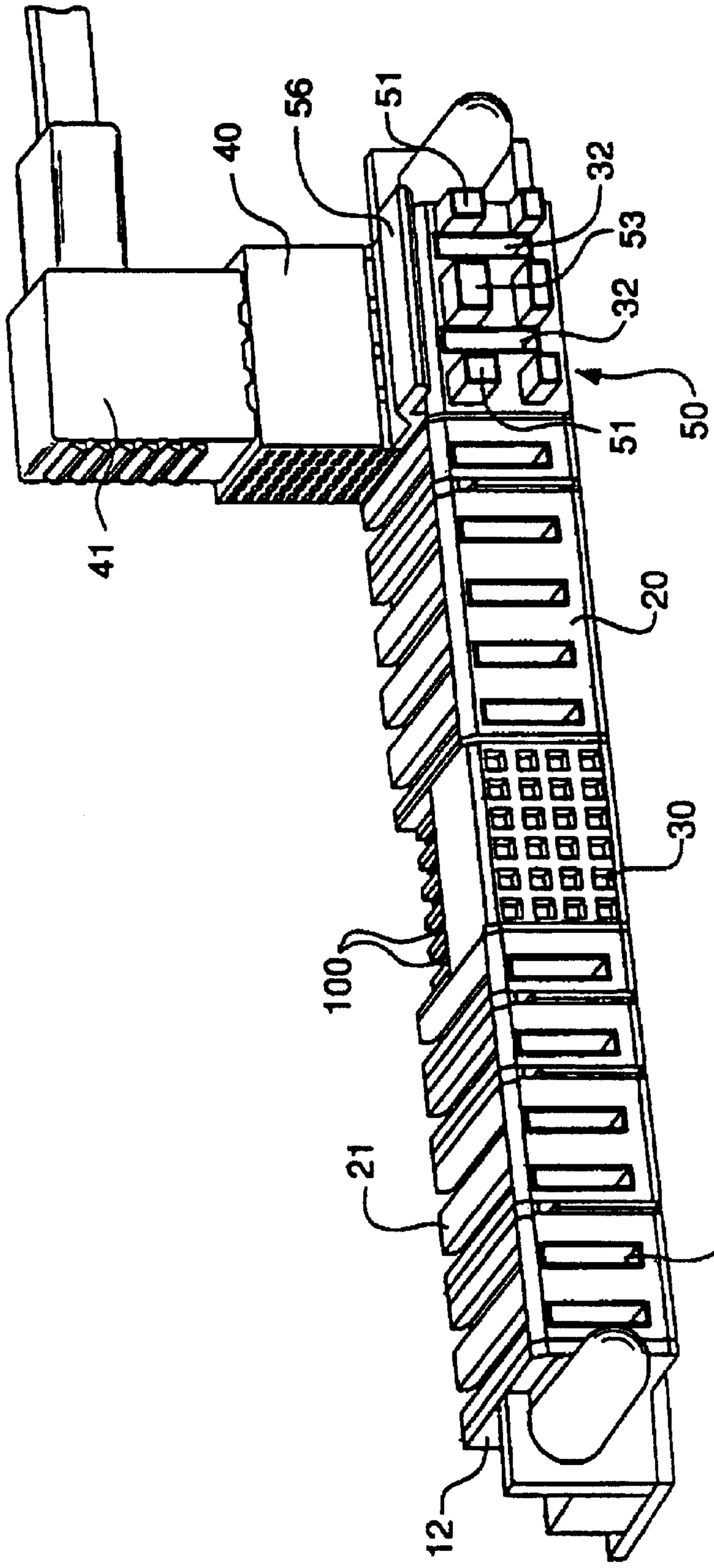


FIG. 3

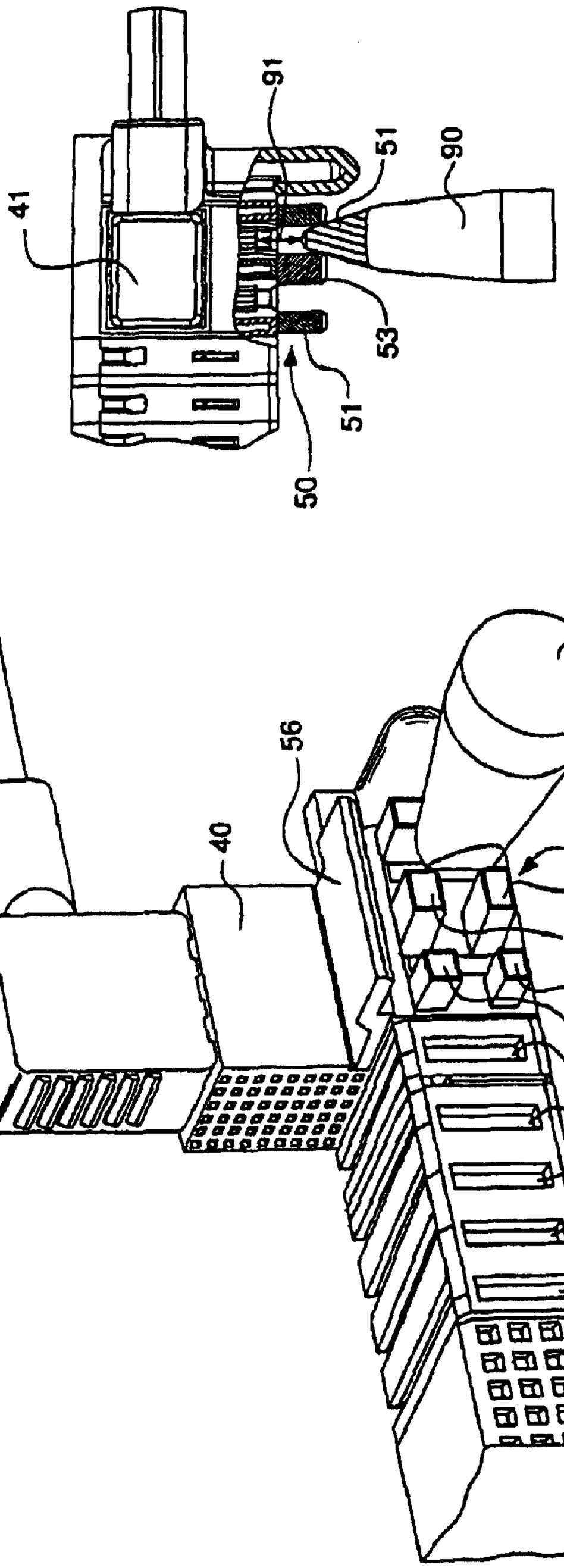


FIG. 5

FIG. 4

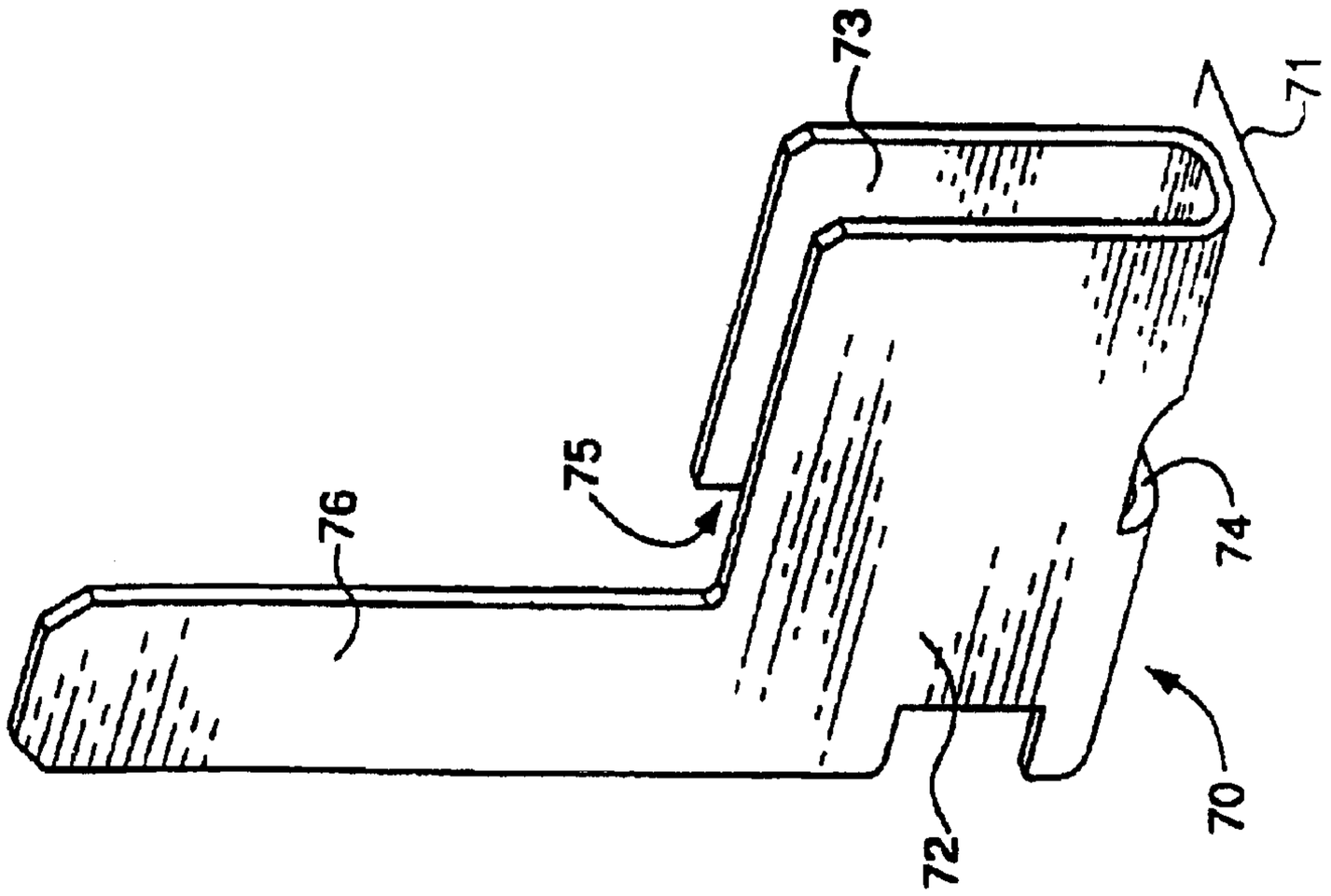


FIG. 6

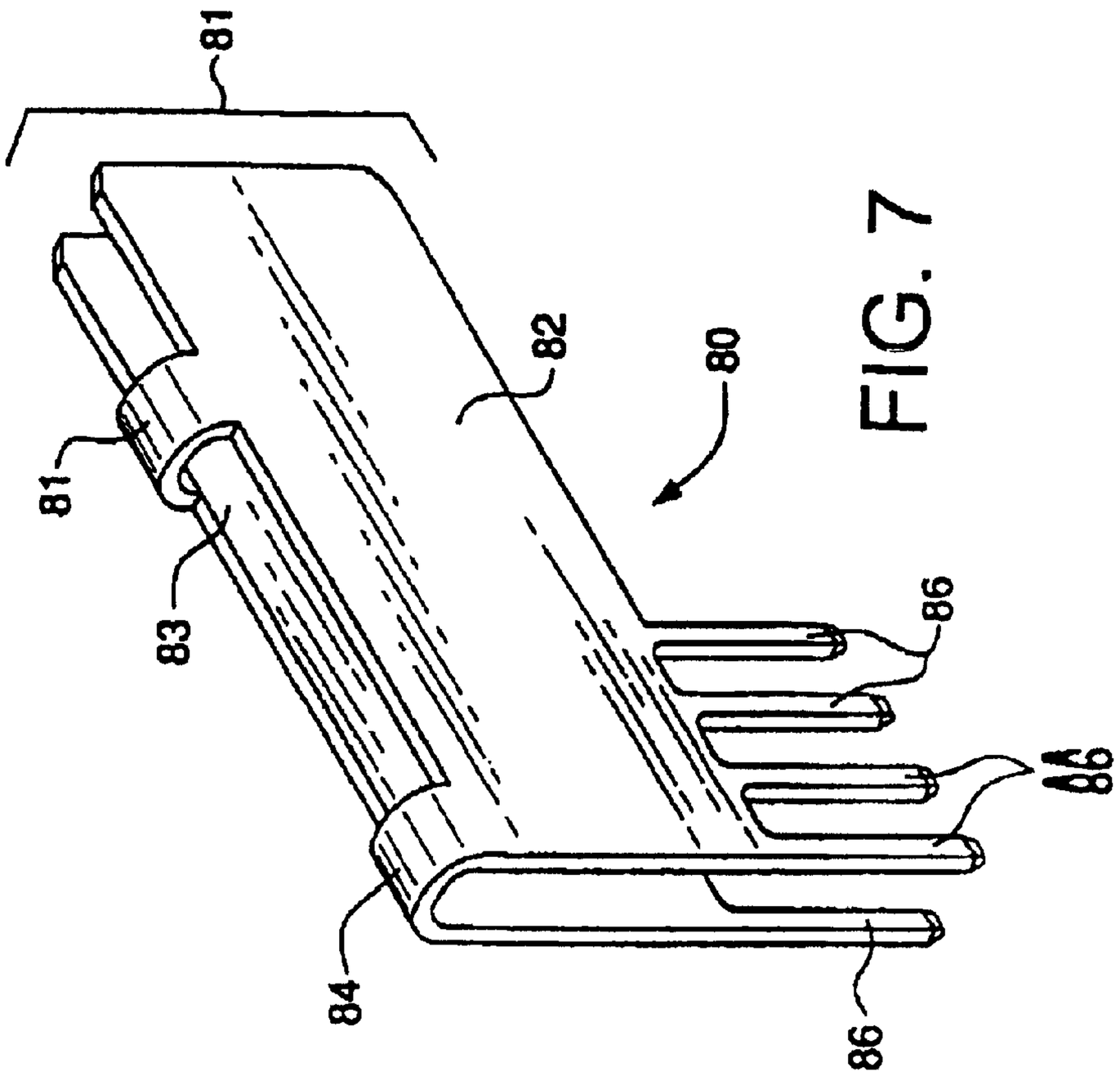


FIG. 7

POWER CONNECTOR WITH SAFETY FEATURE

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

CROSS-REFERENCE TO RELATED APPLICATION

This is a continuation of U.S. patent application Ser. No. 10/352,531 filed Jan. 28, 2003, now abandoned the contents of which is incorporated by reference herein in its entirety.

FIELD OF THE INVENTION

The present invention relates to electrical power connectors that are useful in circuit board or backplane interconnection systems. Connectors of the present invention include a safety feature that restricts access to hot AC power contacts housed within the connectors.

BACKGROUND OF THE INVENTION

There has been significant evolution in the area of electrical connectors, with improvements including multi-function consolidation within a single connector housing, and employment of features for effective heat dissipation generated from electrical power transmission. For example, Clark et al., in U.S. Pat. No. 6,319,075, discloses an electrical connector including both power and signal contacts within a single insulative housing, thereby eliminating the need for two separate connectors. Preferred power contacts disclosed in the '075 patent employ a "dual-mass" principle that provides a greater surface area available for heat dissipation, as compared to "single-mass" designed contacts, such as, for example, those having a circular or pin-like cross section.

Electrical connectors similar to those above may further comprise an AC power cable port and AC power contacts for direct connection with an external power supply. Examples of such connectors are commercially available from FCI Electronics, Inc. FCI's PWRBLADE brand connector series includes a receptacle connector that consists of AC power contacts, DC power contacts, signal contacts, and a shrouded AC cable port. Each of the power contacts includes two contact walls with a space therebetween to facilitate heat dissipation. Two patent applications owned by the assignee of the instant application and generally related to power distribution connectors, U.S. patent application Ser. No. 09/160,900 filed Sep. 25, 1998 and Ser. No. 09/944,266 filed Aug. 31, 2001, are currently pending in the U.S. Patent & Trademark Office, and are incorporated by reference herein.

Power distribution connectors that are engaged with an AC power cable plug when the mating face is unconnected to a complementary connector, may provide access of foreign objects to engaging portions of the hot AC power contacts. Accordingly, there is room for improvement in the art.

SUMMARY OF THE PRESENT INVENTION

The present invention is related to electrical connectors having contacts for transmitting electrical power and electrical signals in a single connector. In accordance with a preferred embodiment of the present invention, there has now been provided an electrical connector comprising an insulative housing including a connector mating face, and an AC power contact disposed in the insulative housing. The connector mating face comprises an aperture to provide access

to an engaging portion of the AC power contact, and a guard for preventing direct human touching of the engaging portion.

In accordance with another preferred embodiment of the present invention, there has now been provided an electrical connector comprising an insulative housing, and an AC power contact disposed in the insulative housing. The power contact includes an engaging portion comprising two spaced apart contact walls. The insulative housing includes a mating face having an aperture therein to provide access to the AC power contact, and a guard proximate a perimeter of the aperture to define an electrical shock safety gap of at least about 5 mm between a human digit that is directed towards the aperture and the engaging portion of the AC power contact.

In accordance with yet another preferred embodiment of the present invention, there has now been provided an electrical connector comprising an insulative housing having a mating face, a plurality of AC power contacts, a plurality of DC power contacts, and a plurality of signal contacts. The mating face comprises a plurality of spaced apart apertures to provide access to a mating portion of a power or signal contact, and at least one outwardly directed projection extending along at least a portion of a perimeter defined by each of the apertures corresponding to the plurality of AC power contacts.

These and various other features of novelty, and their respective advantages, are pointed out with particularity in the claims annexed hereto and forming a part hereof. However, for a better understanding of aspects of the invention, reference should be made to the drawings which form a further part hereof, and to the accompanying descriptive matter, in which there is illustrated preferred embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of an electrical connector embodiment provided by the present invention including anti-shock guard projections extending from its mating face.

FIG. **2** is a partial front view of the electrical connector embodiment shown in FIG. **1**.

FIG. **3** is a perspective view of another electrical connector embodiment provided by the present invention including beam and hood projections extending from its mating face.

FIG. **4** is a partial perspective view of the electrical connector embodiment shown in FIG. **3**, and including a simulated human digit directed towards an aperture providing access to an AC power contact.

FIG. **5** is a partial cutaway view of the electrical connector embodiment shown in FIG. **3**, illustrating a safety gap between a simulated human digit and a power contact housed with the connector.

FIG. **6** is a perspective view of an AC power contact embodiment comprising two spaced apart contact walls and a tab extending from one of the contact walls.

FIG. **7** is a perspective view of a DC power contact embodiment comprising two spaced apart contact walls and a plurality of terminals extending from each of the contact walls.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention is believed to be best understood through the following detailed description of preferred embodiments and the accompanying drawings wherein like

reference numbers indicate like features. Referring to FIG. **1**, an electrical receptacle connector **10** is shown including an insulative housing **12** having a mating face **20** for receiving a complimentary header connector (not shown). Mating face **20** contains a plurality of apertures that provide access to electrical contacts disposed in insulative housing **12**. Apertures **30** provide access to engaging portions of signal contacts **100**, apertures **31** provide access to engaging portions of DC power contacts **80** (shown in FIG. **7**), and apertures **32** provide access to engaging portions of AC power contacts **70** (shown in FIG. **6**). Although the number and arrangement of the various apertures is identical in all of the figures herein, connectors covered by the appended claims may have any number of contacts and corresponding apertures that are arranged in various configurations.

A shrouded AC cable port **40** extends from a top portion **21** of housing **12**. An external power supply is provided by way of an AC power cable plug **41**, which is shown partially inserted within AC cable port **40**. Preferred connectors may alternatively be configured so that AC cable port **40** extends from a bottom portion or rear portion of housing **12**. AC power cable plug **41** engages vertically-oriented AC power contacts **70** (shown in FIG. **6**). An anti-shock guard **50** is employed to restrict direct operator access (that is, direct human touching without the aid of a tool) to the hot AC power contacts **70** during times when AC power cable plug **41** is engaged and receptacle connector **10** is disconnected from a complementary header connector.

Preferred exemplary embodiments of anti-shock guard **50** will be described with reference to FIGS. **2**–**5**. Mating face **20** includes a perimeter area **35** associated with each of apertures **32** that provide access to AC power contacts **70**. Perimeter area **35** is shown as a dotted line in FIG. **2**; however, the perimeter area as included in the preferred embodiments and appended claims should not be construed as a fixed area limited to contact with or within a certain distance of apertures **32**, but rather is the area generally surrounding apertures **32**. Anti-shock guard **50** may comprise one or more projections extending outwardly along at least a portion of perimeter area **35**. By way of example and as shown in FIGS. **2**–**4**, two spaced apart beams **51** and **52** are disposed on one side of perimeter area **35** and two additional spaced apart beams **53** and **54** are disposed on the opposing side. A space exists between each pair of beams **51**, **52** and **53**, **54** to provide room for structural features employed on a complementary header connector. The space may for example, support and insulate electrical contacts extending from the header connector, or provide a latching feature. Alternative embodiments (not shown) contemplated and covered by the appended claims include, but are not limited to, a single projection disposed on opposing sides of perimeter area **35**, and a single projection extending along a sufficient portion of perimeter area **35** to encompass opposing sides thereof. Connector **10** is shown having two apertures **32**, with beams **53** and **54** serving as joint anti-shock guard projections on one side of the adjacent perimeter areas **35** of the two apertures. Individual, side-by-side beams could alternatively be employed that extend from the adjacent perimeter areas. Since beams **53** and **54** collectively restrict operator access to two adjacent apertures, they are preferably slightly larger than beams **51** and **52**.

Now referring to FIG. **3**, another projection in the form of a hood **56** preferably extends from a top position of perimeter area **35** and in between opposing beams **51** and **53**. Hood **56** restricts operator access to apertures **32** from a position above connector **10**. Hood **56** is shown as a single projection extending over two adjacent apertures **32**; however, hood **56** could alternatively comprise multiple individual projections associated with the individual apertures. As illustrated by comparing FIGS. **1** and **3**, preferred connectors may include an anti-shock guard **50** having one type of projection discussed above (beam and hood) and not the other.

As can be seen in FIGS. **4** and **5**, a simulated human digit **90** directed towards an aperture **32** is restricted from touching the hot AC power contact **70** accessible via aperture **32**. A safety gap **91** of at least 5 mm is provided between simulated human digit **90** and an engaging portion of the AC power contact.

Housing **12**, AC cable port **40**, and anti-shock guard **50** are preferably molded or formed from a glass-filled high temperature nylon or other materials known to one having ordinary skill in the art. AC cable port **40** and anti-shock guard **50** may be integrally molded with housing **12**, or alternatively, be manufactured separately and then coupled to housing **12**.

Power circuits can undergo changes in electrical properties because of the relatively high current flows, for example, on the order of 30 amps or more in certain electronic equipment. Preferred power contacts are designed to dissipate heat generated from power transmission so that changes in circuit characteristics are minimized. A preferred AC power contact **70** is shown in FIG. **6**, comprising an engaging portion **71** having two spaced apart contact walls **72** and **73** connected by a bridging element **74**. Employing two contact walls increases the electrical integrity of the connector. Also, the two contact walls in conjunction with intermediate space **75** increases the ability and rate of heat dissipation. A tab **76** extends from contact wall **72** for engaging AC power cable plug **41**. Although not shown, both contact walls **72** and **73** may include a tab for engaging an external power supply.

Referring now to FIG. **7**, a preferred DC power contact **80** is shown, similar to the preferred AC power contact **70**, comprising an engaging portion **81** having two spaced apart contact walls **82** and **83** connected by a bridging element **84**. One or both, as shown in FIG. **7**, of contact walls **82** and **83** have terminals **86** for connection with a circuit board (not shown).

Power contacts **70** and **80** are preferably loaded into housing **12** from the rear. The contact walls and/or bridging element of the AC and DC power contacts **70**, **80** may contain notches or other female elements, and/or tangs or other male elements for retaining the power contacts in housing **12**. Preferred power contacts **70** and **80** are stamped or otherwise formed as single piece from suitable materials such as phosphor bronze alloys or beryllium copper alloys. Signal contacts **100** (shown in FIG. **1** disposed in housing **12**) are preferably "pin-type" contacts that include tail portions for connection with a circuit board, and are made from suitable materials, such as, for example, copper alloys. The power and signal contacts may be plated with gold, or a combination of gold and nickel.

It is to be understood that even though numerous characteristics and advantages of the present invention have been set forth in the foregoing description, together with details of the structure and function of the invention, the disclosure is illustrative only. Accordingly, changes may be made in detail, especially in matters of shape, size and arrangement of features within the principles of the invention to the full extent indicated by the broad general meaning of the terms in which the appended claims are expressed.

What is claimed is:

1. An electrical connector, comprising:

an insulative housing including a connector mating face;

a DC power contact disposed in said insulative housing, said DC power contact comprising a pair of opposed and spaced apart contact walls, and one or more terminals extending from one of the contact walls for engaging a circuit board;

an AC power contact disposed in said insulative housing; and

a shrouded AC cable port extending from said insulative housing at a location that is different from that of said connector mating face;

wherein said connector mating face comprises:

an aperture therein to provide access to a engaging portion of said AC power contact;

a perimeter area adjacent said aperture; and

a guard proximate said perimeter area for preventing direct human touching of said engaging portion of said AC power contact.

2. The electrical connector according to claim **1**, wherein said AC power contact comprises a pair of opposed and spaced apart contact walls, and a tab extending from at least one of the contact walls.

3. The electrical connector according to claim **1**, further comprising a plurality of signal contacts disposed in said insulative housing.

4. The electrical connector according to claim **1**, wherein said guard comprises at least one projection extending outwardly from opposing sides of said perimeter area.

5. The electrical connector according to claim **4**, wherein said guard comprises two spaced apart projections extending outwardly from each of the opposing sides of said perimeter area.

6. The electrical connector according to claim **[3]** *5*, wherein said two spaced apart projections are dissimilar.

7. An electrical connector, comprising:

an insulative housing including a connector mating face including first and second apertures formed therein;

a first type of power contact disposed in said insulative housing and accessible through said first aperture;

a second type of power contact disposed in said insulative housing, said second type of power contact being accessible through said second aperture and having a different configuration than that of said first type of power contact; and

at least one projection extending outwardly from said connector mating face and along at least a portion of a perimeter of said first aperture to inhibit entry of a human digit into said first aperture,

wherein said first type of power contact comprises a pair of opposed and spaced apart walls, at least one of which includes a tab for engaging an AC power cable plug; and wherein said second type of power contact comprises a second pair of opposed and spaced apart walls including a plurality of terminals extending therefrom for engaging a printed circuit board.

* * * * *