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(12) **United States Design Patent** (10) **Patent No.:** **US D766,832 S**  
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(54) **ELECTRICAL CONNECTOR**

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(51) **LOC (10) Cl.** ..... **13-03**

(52) **U.S. Cl.**  
USPC ..... **D13/147**

(58) **Field of Classification Search**  
USPC ..... D13/146, 147, 154, 184, 199  
See application file for complete search history.

(56) **References Cited**

**U.S. PATENT DOCUMENTS**

318,186 A 5/1885 Hertzog  
741,052 A 10/1903 Mahon

(Continued)

**FOREIGN PATENT DOCUMENTS**

DE 1665181 4/1974  
DE 3529218 2/1986

(Continued)

**OTHER PUBLICATIONS**

U.S. Appl. No. 13/938,294, filed Jul. 10, 2013, Horchler.

(Continued)

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(57) **CLAIM**

The ornamental design for an electrical connector, as shown  
and described.

**DESCRIPTION**

This is related by subject matter to U.S. patent application  
Ser. No. 29/426,921 filed Jul. 11, 2012.

FIG. 1 is a top, left, front perspective view of an electrical  
connector showing our new design;

FIG. 2 is an enlarge view of area 2 of FIG. 1;

FIG. 3 is a top, right and rear perspective view thereof;

FIG. 4 is an enlarge view of area 4 of FIG. 3;

FIG. 5 is a bottom, right, rear perspective view thereof;

FIG. 6 is an enlarge view of area 6 of FIG. 5;

FIG. 7 is a top, left, rear perspective view thereof;

FIG. 8 is an enlarge view of area 8 of FIG. 7;

FIG. 9 is a bottom, left, front perspective view thereof;

FIG. 10 is an enlarge view of area 10 of FIG. 9;

FIG. 11 is a left side elevation view thereof;

FIG. 12 is a right side elevation view thereof;

FIG. 13 is a top plan view thereof;

FIG. 14 is a bottom plan view thereof;

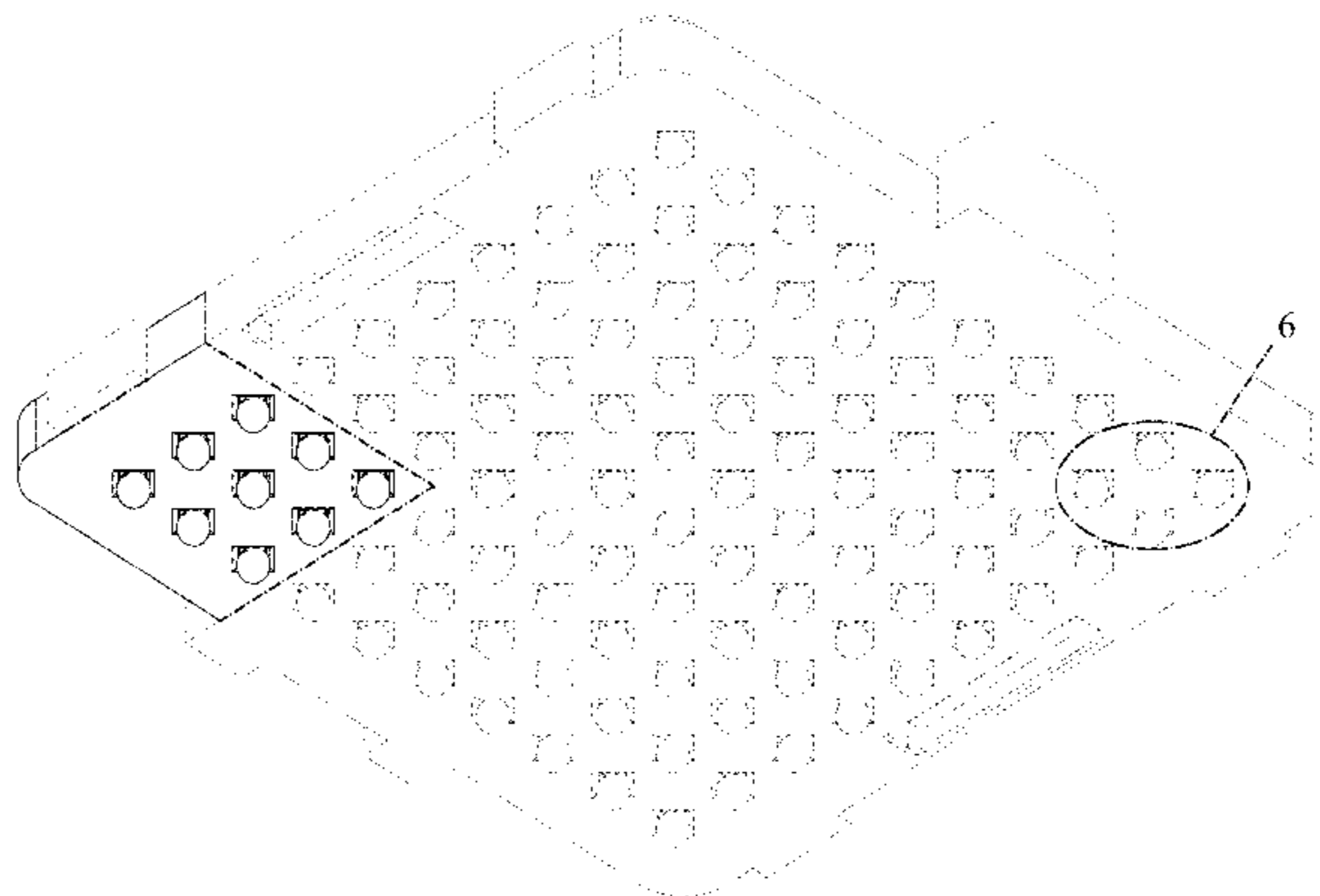
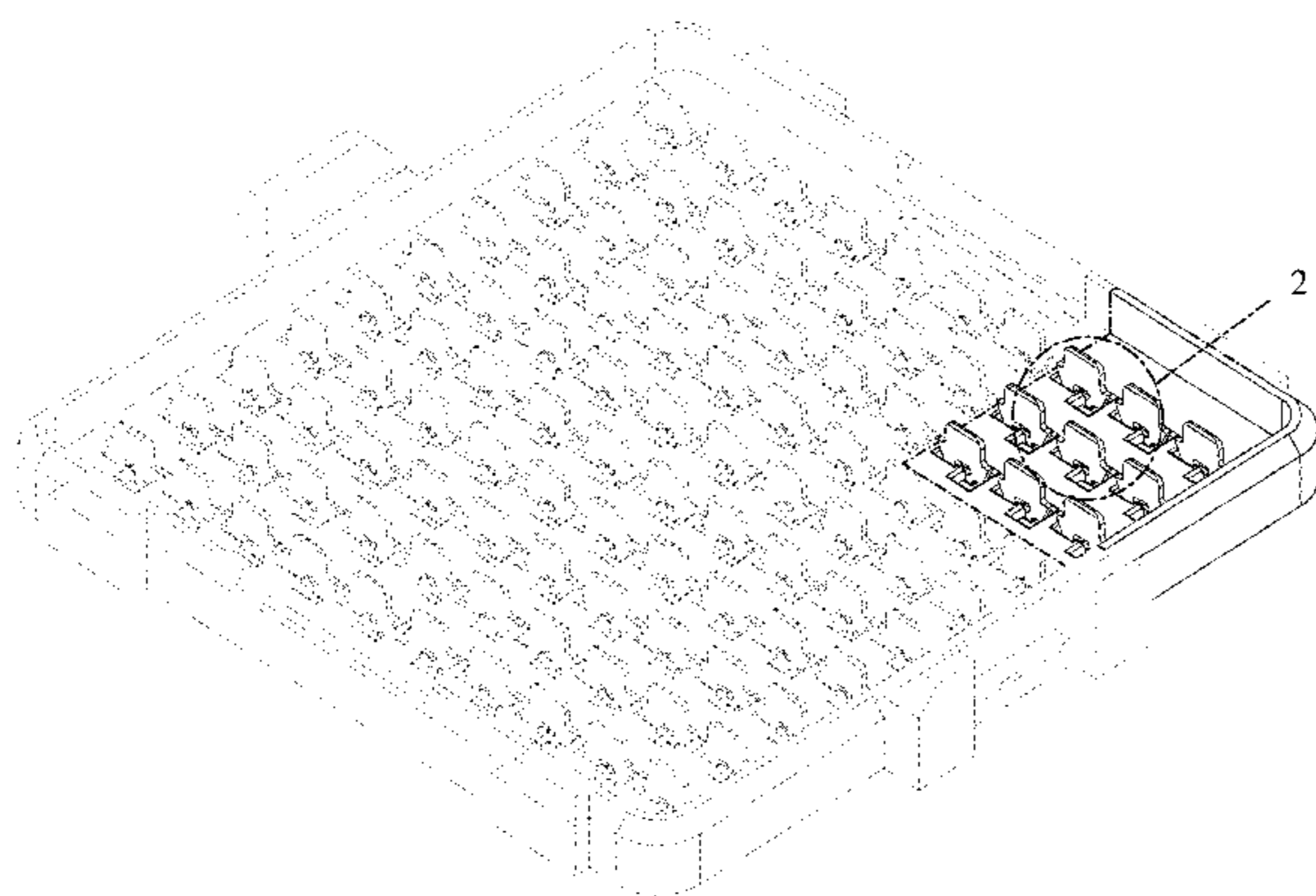
FIG. 15 is a rear elevation view thereof; and,

FIG. 16 is a front elevation view thereof.

In a preferred embodiment, the nature of this product is an  
electrical component that can take the form of an electrical  
connector, and a connector housing therefor.

The broken line portion of the figure drawings is included to  
show unclaimed subject matter only for the purpose of  
illustrating environment and forms no part of the claimed  
design. The dash-dot line in the drawing represents the  
boundary of the claimed design.

**1 Claim, 12 Drawing Sheets**



(56)

## References Cited

## U.S. PATENT DOCUMENTS

1,477,527 A	12/1923	Raettig	4,523,296 A	6/1985	Healy, Jr.
D86,515 S	3/1932	Cox	4,533,187 A	8/1985	Kirkman
2,231,347 A	2/1941	Reutter	4,536,955 A	8/1985	Gudgeon
2,248,675 A	7/1941	Huppert	4,545,610 A	10/1985	Lakritz et al.
2,430,011 A	11/1947	Gillentine	4,552,425 A	11/1985	Billman
2,664,552 A	12/1953	Ericsson et al.	4,560,222 A	12/1985	Dambach
2,759,163 A	8/1956	Ustin et al.	4,564,259 A	1/1986	Vandame
2,762,022 A	9/1956	Benander et al.	4,592,846 A	6/1986	Metzger et al.
2,849,700 A	4/1958	Perkin	4,596,428 A	6/1986	Tengler
2,844,644 A	7/1958	Soule, Jr.	4,596,433 A	6/1986	Oesterheld et al.
2,858,372 A	10/1958	Kaufman	4,624,604 A	11/1986	Wagner et al.
3,011,143 A	11/1961	Dean	4,632,476 A	12/1986	Schell
3,115,379 A	12/1963	McKee	4,641,426 A	2/1987	Hartman et al.
3,178,669 A	4/1965	Roberts	4,655,515 A	4/1987	Hamsher, Jr. et al.
3,179,738 A	4/1965	De Lyon	4,664,309 A	5/1987	Allen et al.
3,208,030 A	9/1965	Evans et al.	4,664,456 A	5/1987	Blair et al.
3,286,220 A	11/1966	Marley et al.	4,664,458 A	5/1987	Worth
3,320,658 A	5/1967	Bolda et al.	4,678,250 A	7/1987	Romine et al.
3,343,120 A	9/1967	Whiting	4,685,886 A	8/1987	Denlinger et al.
3,366,729 A	1/1968	Pauza	4,705,205 A	11/1987	Allen et al.
3,411,127 A	11/1968	Adams	4,705,332 A	11/1987	Sadigh-Behzadi
3,420,087 A	1/1969	Hatfield et al.	4,717,360 A	1/1988	Czaja
D213,697 S	4/1969	Oxley	4,722,470 A	2/1988	Johary
3,482,201 A	12/1969	Schneck	4,762,500 A	8/1988	Dola et al.
3,514,740 A	5/1970	Filson et al.	4,767,344 A	8/1988	Noschese
3,538,486 A	11/1970	Shlesinger, Jr.	4,776,803 A	10/1988	Pretchel et al.
3,560,908 A	2/1971	Dell et al.	4,782,893 A	11/1988	Thomas
3,591,834 A	7/1971	Kolias	4,790,763 A	12/1988	Weber et al.
3,634,811 A	1/1972	Teagno	4,806,107 A	2/1989	Arnold et al.
3,641,475 A	2/1972	Irish et al.	4,815,987 A	3/1989	Kawano et al.
3,663,925 A	5/1972	Proctor	4,818,237 A	4/1989	Weber
3,669,054 A	6/1972	Desso et al.	4,820,169 A	4/1989	Weber et al.
3,692,994 A	9/1972	Hirschman et al.	4,820,182 A	4/1989	Harwath et al.
3,701,076 A	10/1972	Irish	4,824,383 A	4/1989	Lemke
3,719,981 A	3/1973	Steitz	4,830,264 A	5/1989	Bitailou et al.
3,732,697 A	5/1973	Dickson	4,836,791 A	6/1989	Grabbe et al.
3,748,633 A	7/1973	Lundergan	4,844,813 A	7/1989	Helfgott et al.
3,827,005 A	7/1974	Friend	4,846,727 A	7/1989	Glover et al.
3,845,451 A	10/1974	Neidecker	4,850,887 A	7/1989	Sugawara
3,864,004 A	2/1975	Friend	4,854,899 A	8/1989	Matthews
3,865,462 A	2/1975	Cobaugh et al.	4,867,713 A	9/1989	Ozu et al.
3,867,008 A	2/1975	Gartland, Jr.	4,871,110 A	10/1989	Fukasawa et al.
3,871,015 A	3/1975	Lin et al.	4,878,611 A	11/1989	LoVasco et al.
3,889,364 A	6/1975	Krueger	4,881,905 A	11/1989	Demler et al.
3,942,856 A	3/1976	Mindheim et al.	4,882,554 A	11/1989	Akaba et al.
3,972,580 A	8/1976	Pemberton et al.	4,884,335 A	12/1989	McCoy et al.
4,030,792 A	6/1977	Fuerst	4,898,539 A	2/1990	Glover et al.
4,056,302 A	11/1977	Braun et al.	4,900,271 A	2/1990	Colleran et al.
4,070,088 A	1/1978	Vaden	4,904,212 A	2/1990	Durbin et al.
4,076,362 A	2/1978	Ichimura	4,907,990 A	3/1990	Bertho et al.
4,082,407 A	4/1978	Smorzaniuk et al.	4,908,129 A	3/1990	Finsterwalder et al.
4,097,266 A	6/1978	Takahashi et al.	4,913,664 A	4/1990	Dixon et al.
4,136,919 A	1/1979	Howard et al.	4,915,641 A	4/1990	Miskin et al.
4,140,361 A	2/1979	Sochor	4,917,616 A	4/1990	Demler, Jr. et al.
4,159,861 A	7/1979	Anhalt	4,952,172 A	8/1990	Barkus et al.
4,217,024 A	8/1980	Aldridge et al.	4,963,102 A	10/1990	Gettig et al.
4,232,924 A	11/1980	Kline et al.	4,965,699 A	10/1990	Jordan et al.
4,260,212 A	4/1981	Ritchie et al.	4,973,257 A	11/1990	Lhotak
4,274,700 A	6/1981	Keglewitsch et al.	4,973,271 A	11/1990	Ishizuka et al.
4,288,139 A	9/1981	Cobaugh et al.	4,974,119 A	11/1990	Martin
4,371,912 A	2/1983	Guzik	4,975,069 A	12/1990	Fedder et al.
4,380,518 A	4/1983	Wydro, Sr.	4,975,084 A	12/1990	Fedder et al.
4,383,724 A	5/1983	Verhoevan	4,979,074 A	12/1990	Morley et al.
4,395,086 A	7/1983	Marsh	4,997,390 A	3/1991	Scholz et al.
4,396,140 A	8/1983	Jaffe et al.	5,004,426 A	4/1991	Barnett
4,402,563 A	9/1983	Sinclair	5,016,968 A	5/1991	Hammond et al.
4,403,821 A	9/1983	Zimmerman et al.	5,024,372 A	6/1991	Altman et al.
4,448,467 A	5/1984	Weidler	5,024,610 A	6/1991	French et al.
4,462,534 A	7/1984	Bitailou et al.	5,035,631 A	7/1991	Piorunneck et al.
4,464,003 A	8/1984	Goodman et al.	5,035,639 A	7/1991	Kilpatrick et al.
4,473,113 A	9/1984	Whitfield et al.	5,046,960 A	9/1991	Fedder et al.
4,473,477 A	9/1984	Beall	5,052,953 A	10/1991	Weber
D275,849 S	10/1984	Sakurai	5,055,054 A	10/1991	Doutrich
4,482,937 A	11/1984	Berg	5,060,844 A	10/1991	Behun et al.
4,505,529 A	3/1985	Barkus	5,065,282 A	11/1991	Polonio
			5,066,236 A	11/1991	Broeksteeg
			5,077,893 A	1/1992	Mosquera et al.
			5,082,459 A	1/1992	Billman et al.
			5,083,238 A	1/1992	Bousman

(56)

## References Cited

## U.S. PATENT DOCUMENTS

5,093,986 A	3/1992	Mandai et al.	5,429,520 A	7/1995	Morlion et al.
5,094,623 A	3/1992	Scharf et al.	5,429,521 A	7/1995	Morlion et al.
5,094,634 A	3/1992	Dixon et al.	5,431,332 A	7/1995	Kirby et al.
5,098,311 A	3/1992	Roath et al.	5,431,578 A	7/1995	Wayne
5,104,332 A	4/1992	McCoy	5,433,617 A	7/1995	Morlion et al.
5,104,341 A	4/1992	Gilissen et al.	5,433,618 A	7/1995	Morlion et al.
5,111,991 A	5/1992	Clawson et al.	5,435,482 A	7/1995	Variot et al.
5,117,331 A	5/1992	Gebara	5,442,852 A	8/1995	Danner
5,118,027 A	6/1992	Braun et al.	5,445,313 A	8/1995	Boyd et al.
5,120,237 A	6/1992	Fussell	5,457,342 A	10/1995	Herbst, II
5,127,839 A	7/1992	Korsunsky et al.	5,458,426 A	10/1995	Ito
5,131,871 A	7/1992	Banakis et al.	5,462,456 A	10/1995	Howell
5,137,959 A	8/1992	Block et al.	5,467,913 A	11/1995	Namekawa et al.
5,139,426 A	8/1992	Barkus et al.	5,474,472 A	12/1995	Niwa et al.
5,145,104 A	9/1992	Apap et al.	5,475,922 A	12/1995	Tamura et al.
5,151,056 A	9/1992	McClune	5,477,933 A	12/1995	Nguyen
5,152,700 A	10/1992	Bogursky et al.	5,489,750 A	2/1996	Sakemi et al.
5,161,987 A	11/1992	Sinisi	5,490,040 A	2/1996	Gavdenzi et al.
5,163,337 A	11/1992	Herron et al.	5,491,303 A	2/1996	Weiss
5,163,849 A	11/1992	Fogg et al.	5,492,266 A	2/1996	Hoebener et al.
5,167,528 A	12/1992	Nishiyama et al.	5,495,668 A	3/1996	Furusawa et al.
5,169,337 A	12/1992	Ortega et al.	5,496,183 A	3/1996	Soes et al.
5,174,770 A	12/1992	Sasaki et al.	5,498,167 A	3/1996	Seto et al.
5,181,855 A	1/1993	Mosquera et al.	5,499,487 A	3/1996	McGill
5,194,480 A	3/1993	Block et al.	5,504,277 A	4/1996	Danner
5,199,885 A	4/1993	Korsunsky et al.	5,511,987 A	4/1996	Shinchi
5,203,075 A	4/1993	Angulas et al.	5,512,519 A	4/1996	Hwang
5,207,372 A	5/1993	Funari et al.	5,516,030 A	5/1996	Denton
5,213,868 A	5/1993	Liberty et al.	5,516,032 A	5/1996	Sakemi et al.
5,214,308 A	5/1993	Nishiguchi	5,518,410 A	5/1996	Masami
5,217,381 A	6/1993	Zell et al.	5,519,580 A	5/1996	Natarajan et al.
5,222,649 A	6/1993	Funari et al.	5,522,727 A	6/1996	Saito et al.
5,224,867 A	7/1993	Ohtsuki et al.	5,533,915 A	7/1996	Deans
5,228,864 A	7/1993	Fusselman et al.	5,534,127 A	7/1996	Sakai
5,229,016 A	7/1993	Hayes et al.	5,539,153 A	7/1996	Schwiebert et al.
5,238,414 A	8/1993	Yaegashi et al.	5,542,174 A	8/1996	Chiu
5,254,012 A	10/1993	Wang	5,558,542 A	9/1996	O' Sullivan et al.
5,255,839 A	10/1993	Da Costa Alves et al.	5,564,952 A	10/1996	Davis et al.
5,257,941 A	11/1993	Lwee et al.	5,575,688 A	11/1996	Crane, Jr.
5,261,155 A	11/1993	Angulas et al.	5,577,928 A	11/1996	Duclos
5,269,453 A	12/1993	Melton et al.	5,580,283 A	12/1996	O'Sullivan et al.
5,274,918 A	1/1994	Reed	5,586,908 A	12/1996	Lorrain
5,275,330 A	1/1994	Isaacs et al.	5,586,914 A	12/1996	Foster, Jr. et al.
5,276,964 A	1/1994	Anderson, Jr. et al.	5,588,859 A	12/1996	Maurice
5,277,624 A	1/1994	Champion et al.	5,590,463 A	1/1997	Feldman et al.
5,284,287 A	2/1994	Wilson et al.	5,591,118 A	1/1997	Bierck
5,285,163 A	2/1994	Liotta	5,591,941 A	1/1997	Acocella et al.
5,286,212 A	2/1994	Broeksteeg	5,593,322 A	1/1997	Swamy et al.
5,288,949 A	2/1994	Crafts	5,605,417 A	2/1997	Englert et al.
5,295,843 A	3/1994	Davis et al.	5,609,502 A	3/1997	Thumma
5,298,791 A	3/1994	Liberty et al.	5,613,882 A	3/1997	Hnatuck et al.
5,302,135 A	4/1994	Lee	5,618,187 A	4/1997	Goto
5,321,582 A	6/1994	Casperson	5,634,821 A	6/1997	Crane, Jr.
5,324,569 A	6/1994	Nagesh et al.	5,637,008 A	6/1997	Kozel
5,342,211 A	8/1994	Broeksteeg	5,637,019 A	6/1997	Crane, Jr. et al.
5,344,327 A	9/1994	Brunker et al.	5,643,009 A	7/1997	Dinkel et al.
5,346,118 A	9/1994	Degani et al.	5,664,968 A	9/1997	Micklevicz
5,354,219 A	10/1994	Wanjura	5,664,973 A	9/1997	Emmert et al.
5,355,283 A	10/1994	Marrs et al.	5,667,392 A	9/1997	Kocher et al.
5,356,300 A	10/1994	Costello et al.	5,672,064 A	9/1997	Provencher et al.
5,356,301 A	10/1994	Champion et al.	5,691,041 A	11/1997	Frankeny et al.
5,357,050 A	10/1994	Baran et al.	D387,733 S	12/1997	Lee
5,358,417 A	10/1994	Schmedding	5,697,799 A	12/1997	Consoli et al.
5,377,902 A	1/1995	Hayes	5,702,255 A	12/1997	Murphy et al.
5,381,314 A	1/1995	Rudy, Jr. et al.	5,713,746 A	2/1998	Olson et al.
5,382,168 A	1/1995	Azuma et al.	5,718,606 A	2/1998	Rigby et al.
D355,409 S	2/1995	Krokaugger	5,727,963 A	3/1998	LeMaster
5,387,111 A	2/1995	DeSantis et al.	5,730,609 A	3/1998	Harwath
5,387,139 A	2/1995	McKee et al.	5,733,453 A	3/1998	DeBusk
5,395,250 A	3/1995	Englert, Jr. et al.	5,741,144 A	4/1998	Elco et al.
5,400,949 A	3/1995	Hirvonen et al.	5,741,161 A	4/1998	Cahaly et al.
5,403,206 A	4/1995	McNamara et al.	5,742,484 A	4/1998	Gillette et al.
5,409,157 A	4/1995	Nagesh et al.	5,743,009 A	4/1998	Matsui et al.
5,410,807 A	5/1995	Bross et al.	5,743,765 A	4/1998	Andrews et al.
5,427,543 A	6/1995	Dynia	5,745,349 A	4/1998	Lemke
			5,746,608 A	5/1998	Taylor
			5,749,746 A	5/1998	Tan et al.
			5,755,595 A	5/1998	Davis et al.
			5,766,023 A	6/1998	Noschese et al.

(56)

## References Cited

## U.S. PATENT DOCUMENTS

5,772,451 A	6/1998	Dozier, II et al.	6,146,202 A	11/2000	Ramey et al.
5,782,644 A	7/1998	Kiat	6,146,203 A	11/2000	Elco et al.
5,787,971 A	8/1998	Dodson	6,152,747 A	11/2000	McNamara
5,795,191 A	8/1998	Preputnick et al.	6,152,756 A	11/2000	Huang et al.
5,810,607 A	9/1998	Shih et al.	6,154,742 A	11/2000	Herriot
5,817,973 A	10/1998	Elco et al.	6,171,115 B1	1/2001	Mickiewicz et al.
5,827,094 A	10/1998	Aizawa et al.	6,171,149 B1	1/2001	Van Zanten
5,831,314 A	11/1998	Wen	6,174,198 B1	1/2001	Wu et al.
5,833,475 A	11/1998	Mitra	6,179,663 B1	1/2001	Bradley et al.
5,846,024 A	12/1998	Mao et al.	6,180,891 B1	1/2001	Murdeshwar
5,851,121 A	12/1998	Thenaisie et al.	6,183,287 B1	2/2001	Po
5,853,797 A	12/1998	Fuchs et al.	6,183,301 B1	2/2001	Paagman
5,857,857 A	1/1999	Fukuda	6,190,213 B1	2/2001	Reichart et al.
5,860,816 A	1/1999	Provencher et al.	6,193,537 B1	2/2001	Harper, Jr. et al.
5,871,362 A	2/1999	Campbell et al.	6,196,871 B1	3/2001	Szu
5,874,776 A	2/1999	Kresge et al.	6,202,916 B1	3/2001	Updike et al.
5,876,219 A	3/1999	Taylor	6,206,722 B1	3/2001	Ko et al.
5,876,222 A	3/1999	Gardner et al.	6,206,735 B1	3/2001	Zanoli
5,876,248 A	3/1999	Brunker et al.	6,210,197 B1	4/2001	Yu
5,882,214 A	3/1999	Hillbish et al.	6,210,240 B1	4/2001	Comerci et al.
5,883,782 A	3/1999	Thurston et al.	6,212,755 B1	4/2001	Shimada et al.
5,887,158 A	3/1999	Sample et al.	6,215,180 B1	4/2001	Chen et al.
5,888,884 A	3/1999	Wojnarowski	6,219,913 B1	4/2001	Uchiyama
5,892,791 A	4/1999	Moon	6,220,884 B1	4/2001	Lin
5,893,761 A	4/1999	Longueville	6,220,895 B1	4/2001	Lin
5,902,136 A	5/1999	Lemke et al.	6,220,896 B1	4/2001	Bertoncini et al.
5,904,581 A	5/1999	Pope et al.	6,227,882 B1	5/2001	Ortega et al.
5,908,333 A	6/1999	Perino et al.	6,231,391 B1	5/2001	Ramey et al.
5,913,702 A	6/1999	Garcin	6,234,851 B1	5/2001	Phillips
5,919,050 A	7/1999	Kehley et al.	6,238,225 B1	5/2001	Middlehurst et al.
5,930,114 A	7/1999	Kuzmin et al.	6,241,535 B1	6/2001	Lemke et al.
5,938,479 A	8/1999	Paulson et al.	6,244,887 B1	6/2001	Commerci et al.
5,943,770 A	8/1999	Thenaisie et al.	6,257,478 B1	7/2001	Straub
5,955,888 A	9/1999	Frederickson et al.	6,259,039 B1	7/2001	Chronos, Jr. et al.
5,961,355 A	10/1999	Morlion et al.	6,261,132 B1	7/2001	Koseki et al.
5,967,844 A	10/1999	Doutrich et al.	6,267,604 B1	7/2001	Mickiewicz et al.
5,971,817 A	10/1999	Longueville	6,269,539 B1	8/2001	Takahashi et al.
5,975,921 A	11/1999	Shuey	6,274,474 B1	8/2001	Caletka et al.
5,980,270 A	11/1999	Fjelstad et al.	6,280,209 B1	8/2001	Bassler et al.
5,980,321 A	11/1999	Cohen et al.	6,280,230 B1	8/2001	Takase et al.
5,982,249 A	11/1999	Bruns	6,280,809 B1	8/2001	Wang
5,984,690 A	11/1999	Riechelmann et al.	6,290,552 B1	9/2001	Saito et al.
5,984,726 A	11/1999	Wu	6,293,827 B1	9/2001	Stokoe et al.
5,992,953 A	11/1999	Rabinovitz	6,299,483 B1	10/2001	Cohen et al.
5,993,259 A	11/1999	Stokoe et al.	6,299,484 B2	10/2001	Van Woensel et al.
6,012,948 A	1/2000	Wu	6,299,492 B1	10/2001	Pierini et al.
6,022,227 A	2/2000	Huang	6,302,711 B1	10/2001	Ito
6,024,584 A	2/2000	Lemke et al.	6,309,245 B1	10/2001	Sweeney
6,027,381 A	2/2000	Lok	6,319,075 B1	11/2001	Clark et al.
6,036,549 A	3/2000	Wulff	6,322,377 B2	11/2001	Middlehurst et al.
6,041,498 A	3/2000	Hillbish et al.	6,322,379 B1	11/2001	Ortega et al.
6,042,389 A	3/2000	Lemke et al.	6,322,393 B1	11/2001	Doutrich et al.
6,042,394 A	3/2000	Mitra et al.	6,328,602 B1	12/2001	Yamasaki et al.
6,042,427 A	3/2000	Adriaenssens et al.	6,338,635 B1	1/2002	Lee
6,050,842 A	4/2000	Ferrill et al.	6,343,955 B2	2/2002	Billman et al.
6,050,862 A	4/2000	Ishii	6,347,952 B1	2/2002	Hasegawa et al.
6,053,751 A	4/2000	Humphrey	6,347,962 B1	2/2002	Kline
6,059,170 A	5/2000	Jimarez et al.	6,350,134 B1	2/2002	Fogg et al.
6,066,048 A	5/2000	Lees	6,354,877 B1	3/2002	Shuey et al.
6,068,520 A	5/2000	Winings et al.	6,358,061 B1	3/2002	Regnier
6,071,152 A	6/2000	Achammer et al.	6,359,783 B1	3/2002	Noble
6,077,130 A	6/2000	Hughes et al.	6,360,940 B1	3/2002	Bolde et al.
6,083,047 A	7/2000	Paagman	6,361,366 B1	3/2002	Shuey et al.
6,086,386 A	7/2000	Fjelstad et al.	6,361,376 B1	3/2002	Onoda
6,089,878 A	7/2000	Meng	6,362,961 B1	3/2002	Chiou
6,095,827 A	8/2000	Dutkowsky et al.	6,363,607 B1	4/2002	Chen et al.
6,113,418 A	9/2000	Kjelhahl	6,364,710 B1	4/2002	Billman et al.
6,116,926 A	9/2000	Ortega et al.	6,371,773 B1	4/2002	Crofoot et al.
6,116,965 A	9/2000	Arnett et al.	6,371,813 B2	4/2002	Ramey et al.
6,123,554 A	9/2000	Ortega et al.	6,375,478 B1	4/2002	Kikuchi
6,125,535 A	10/2000	Chiou et al.	6,375,508 B1	4/2002	Pickles et al.
6,129,592 A	10/2000	Mickiewicz et al.	6,379,188 B1	4/2002	Cohen et al.
6,132,255 A	10/2000	Verhoeven	6,386,914 B1	5/2002	Collins et al.
6,139,336 A	10/2000	Olson	6,386,924 B2	5/2002	Long
6,146,157 A	11/2000	Lenoir et al.	6,390,826 B1	5/2002	Affolter et al.
			6,394,818 B1	5/2002	Smalley, Jr.
			6,402,566 B1	6/2002	Middlehurst et al.
			6,409,543 B1	6/2002	Astbury, Jr. et al.
			6,414,248 B1	7/2002	Sundstrom

(56)

## References Cited

## U.S. PATENT DOCUMENTS

6,420,778 B1	7/2002	Sinyansky	6,716,045 B2	4/2004	Meredith
6,425,785 B1	7/2002	Azuma	6,716,068 B2	4/2004	Wu
6,428,328 B2	8/2002	Haba et al.	6,717,825 B2	4/2004	Volstorf
6,431,914 B1	8/2002	Billman	6,726,492 B1	4/2004	Yu
6,431,921 B2	8/2002	Saito et al.	6,736,664 B2	5/2004	Ueda et al.
6,435,914 B1	8/2002	Billman	6,739,910 B1	5/2004	Wu
6,450,829 B1	9/2002	Weisz-Margulescu	6,740,820 B2	5/2004	Cheng
6,457,983 B1	10/2002	Bassler et al.	D492,295 S	6/2004	Glatt
6,461,183 B1	10/2002	Ohkita et al.	6,743,037 B2	6/2004	Kassa et al.
6,461,202 B2	10/2002	Kline	6,743,059 B1	6/2004	Korsunsky et al.
6,464,529 B1	10/2002	Jensen et al.	6,746,278 B2	6/2004	Nelson et al.
6,471,523 B1	10/2002	Shuey	6,749,439 B1	6/2004	Potter et al.
6,471,548 B2	10/2002	Bertoncini et al.	6,762,067 B1	7/2004	Quinones et al.
6,472,474 B2	10/2002	Burkhardt et al.	6,764,341 B2	7/2004	Lappoehn
6,482,038 B2	11/2002	Olson	6,769,883 B2	8/2004	Brid et al.
6,485,330 B1	11/2002	Doutrich	6,769,935 B2	8/2004	Stokoe et al.
6,488,549 B1	12/2002	Weller et al.	6,776,635 B2	8/2004	Blanchfield et al.
6,489,567 B2	12/2002	Zachrai	6,776,649 B2	8/2004	Pape et al.
6,491,545 B1	12/2002	Spiegel et al.	6,780,027 B2	8/2004	Allison et al.
6,494,734 B1	12/2002	Shuey	6,786,771 B2	9/2004	Gailus
6,503,103 B1	1/2003	Cohen et al.	6,790,088 B2	9/2004	Ono et al.
6,506,076 B2	1/2003	Cohen et al.	6,796,831 B1	9/2004	Yasufuku et al.
6,506,081 B2	1/2003	Blanchfield et al.	6,797,215 B2	9/2004	Bonk et al.
6,514,103 B2	2/2003	Pape et al.	D497,343 S	10/2004	Busse et al.
6,517,360 B1	2/2003	Cohen	6,805,278 B1	10/2004	Olson et al.
6,520,803 B1	2/2003	Dunn	6,808,399 B2	10/2004	Rothermel et al.
6,526,519 B1	2/2003	Cuthbert	6,808,420 B2	10/2004	Whiteman, Jr. et al.
6,527,587 B1	3/2003	Ortega et al.	6,810,783 B1	11/2004	Larose
6,527,588 B2	3/2003	Paagman	6,811,440 B1	11/2004	Rothermel et al.
6,528,737 B1	3/2003	Kwong et al.	6,814,590 B2	11/2004	Minich et al.
6,530,134 B1	3/2003	Laphan et al.	6,814,619 B1	11/2004	Stokoe et al.
6,537,086 B1	3/2003	Mac Mullin	6,824,391 B2	11/2004	Mickiewicz et al.
6,537,111 B2	3/2003	Brammer et al.	6,829,143 B2	12/2004	Russell et al.
6,540,522 B2	4/2003	Sipe	6,835,072 B2	12/2004	Simons et al.
6,540,558 B1	4/2003	Paagman	6,835,103 B2	12/2004	Middlehurst et al.
6,540,559 B1	4/2003	Kemmick et al.	6,843,686 B2	1/2005	Ohnishi et al.
6,544,046 B1	4/2003	Hahn et al.	6,843,687 B2	1/2005	McGowan et al.
6,544,072 B2	4/2003	Olson	6,848,886 B2	2/2005	Schmaling et al.
6,547,066 B2	4/2003	Koch	6,848,944 B2	2/2005	Evans
6,551,112 B1	4/2003	Li et al.	6,848,950 B2	2/2005	Allison et al.
6,551,140 B2	4/2003	Billman et al.	6,848,953 B2	2/2005	Schell et al.
6,554,647 B1	4/2003	Cohen et al.	6,851,974 B2	2/2005	Doutrich
6,565,387 B2	5/2003	Cohen	6,851,980 B2	2/2005	Nelson et al.
6,565,388 B1	5/2003	Van Woensel et al.	6,852,567 B1	2/2005	Lee et al.
6,572,409 B2	6/2003	Nitta et al.	D502,919 S	3/2005	Studnick, III
6,572,410 B1	6/2003	Volstorf et al.	6,866,549 B2	3/2005	Kimura et al.
6,575,774 B2	6/2003	Ling et al.	6,869,292 B2	3/2005	Johnescu et al.
6,575,776 B1	6/2003	Conner et al.	6,869,294 B2	3/2005	Clark et al.
6,589,071 B1	7/2003	Lias et al.	6,872,082 B2	3/2005	Hsu et al.
6,592,381 B2	7/2003	Cohen et al.	6,872,085 B1	3/2005	Cohen et al.
6,602,095 B2	8/2003	Astbury, Jr. et al.	6,884,117 B2	4/2005	Korsunsky et al.
6,604,967 B2	8/2003	Middlehurst et al.	6,890,184 B2	5/2005	Doblar et al.
6,607,402 B2	8/2003	Cohen et al.	6,890,214 B2	5/2005	Brown et al.
6,623,310 B1	9/2003	Billman et al.	6,890,221 B2	5/2005	Wagner
6,629,854 B2	10/2003	Murakami	6,893,272 B2	5/2005	Yu
6,633,490 B2	10/2003	Centola et al.	6,893,300 B2	5/2005	Zhou et al.
6,641,410 B2	11/2003	Marvin et al.	6,893,686 B2	5/2005	Egan
6,641,411 B1	11/2003	Stoddard et al.	6,899,566 B2	5/2005	Kline et al.
6,641,825 B2	11/2003	Scholz et al.	6,902,411 B2	6/2005	Kubo
6,652,318 B1	11/2003	Winings et al.	6,905,367 B2	6/2005	Crane, Jr. et al.
6,663,426 B2	12/2003	Hasircoglu et al.	6,913,490 B2	7/2005	Whiteman, Jr. et al.
6,665,189 B1	12/2003	Lebo	6,918,776 B2	7/2005	Spink, Jr.
6,666,693 B2	12/2003	Belopolsky et al.	6,918,789 B2	7/2005	Lang et al.
6,669,514 B2	12/2003	Wiebking et al.	6,929,504 B2	8/2005	Ling et al.
6,672,884 B1	1/2004	Toh et al.	6,932,649 B1	8/2005	Rothermel et al.
6,672,907 B2	1/2004	Azuma	6,939,173 B1	9/2005	Elco et al.
6,679,709 B2	1/2004	Takeuchi	6,945,796 B2	9/2005	Bassler et al.
6,692,272 B2	2/2004	Lemke et al.	6,947,012 B2	9/2005	Aisenbrey
6,695,627 B2	2/2004	Ortega et al.	6,951,466 B2	10/2005	Sandoval et al.
6,702,590 B2	3/2004	Zaderej et al.	6,953,351 B2	10/2005	Fromm et al.
6,702,594 B2	3/2004	Lee et al.	6,969,268 B2	11/2005	Brunker
6,705,902 B1	3/2004	Yi et al.	6,969,280 B2	11/2005	Chien et al.
6,709,294 B1	3/2004	Cohen et al.	6,975,511 B1	12/2005	Lebo et al.
6,712,621 B2	3/2004	Li et al.	6,976,886 B2	12/2005	Winings et al.
6,712,646 B2	3/2004	Shindo	6,979,202 B2	12/2005	Benham et al.
			6,979,215 B2	12/2005	Avery et al.
			6,981,883 B2	1/2006	Raistrick et al.
			6,988,902 B2	1/2006	Winings et al.
			6,994,569 B2	2/2006	Minich et al.

(56)

References Cited

U.S. PATENT DOCUMENTS

7,001,189 B1	2/2006	McGowan et al.	7,500,871 B2	3/2009	Minich et al.
7,021,975 B2	4/2006	Lappohn	7,503,804 B2	3/2009	Minich
7,040,901 B2	5/2006	Benham et al.	7,541,135 B2	6/2009	Swain
7,044,794 B2	5/2006	Consoli et al.	7,549,897 B2	6/2009	Fedder et al.
7,059,892 B1	6/2006	Trout	7,553,182 B2	6/2009	Buck et al.
7,059,919 B2	6/2006	Clark et al.	7,588,463 B2	9/2009	Yamada et al.
7,065,871 B2	6/2006	Minich et al.	7,621,781 B2	11/2009	Rothermel et al.
7,070,464 B2	7/2006	Clark et al.	D607,822 S	1/2010	Dennes
7,074,096 B2	7/2006	Copper et al.	D611,908 S	3/2010	Takada et al.
7,086,147 B2	8/2006	Caletka et al.	7,708,569 B2	5/2010	Sercu et al.
7,090,501 B1	8/2006	Scherer et al.	D618,180 S	6/2010	Gross et al.
7,094,102 B2	8/2006	Cohen et al.	D618,181 S	6/2010	Gross et al.
7,097,465 B1	8/2006	Korsunsky et al.	7,753,731 B2	7/2010	Cohen et al.
7,097,506 B2	8/2006	Nakada	7,762,843 B2	7/2010	Minich et al.
7,101,191 B2	9/2006	Benham et al.	D626,075 S	10/2010	Truskett et al.
7,101,228 B2	9/2006	Hammer et al.	D628,963 S	12/2010	Sau et al.
7,104,812 B1	9/2006	Bogiel et al.	7,883,366 B2	2/2011	Davis et al.
7,108,556 B2	9/2006	Cohen et al.	7,976,326 B2	7/2011	Stoner
7,114,963 B2	10/2006	Shuey et al.	7,988,456 B2	8/2011	Davis et al.
7,114,964 B2	10/2006	Winings et al.	8,011,957 B2	9/2011	Pan
7,118,391 B2	10/2006	Minich et al.	D651,177 S	12/2011	Luo
RE39,380 E	11/2006	Davis	8,079,847 B2	12/2011	Davis et al.
7,131,870 B2	11/2006	Whiteman, Jr. et al.	D653,621 S	2/2012	Gross et al.
7,137,848 B1	11/2006	Trout et al.	8,109,770 B2	2/2012	Perugini et al.
7,153,162 B2	12/2006	Mizumura et al.	8,119,926 B2	2/2012	Murphy
7,160,151 B1	1/2007	Rigby et al.	8,231,415 B2	7/2012	Johnescu et al.
7,163,421 B1	1/2007	Cohen et al.	8,277,241 B2	10/2012	Horchler et al.
7,168,963 B2	1/2007	Minich et al.	8,323,038 B2	12/2012	Jin
7,172,461 B2	2/2007	Davis et al.	8,366,485 B2	2/2013	Johnescu
7,182,642 B2	2/2007	Ngo et al.	8,374,470 B2	2/2013	Ban et al.
7,182,643 B2	2/2007	Winings et al.	8,408,939 B2	4/2013	Davis et al.
D540,258 S	4/2007	Peng et al.	8,414,199 B2	4/2013	Ishigami
7,204,699 B2	4/2007	Stoner	8,465,213 B2	6/2013	Tamura et al.
7,207,807 B2	4/2007	Fogg	8,480,413 B2	7/2013	Minich et al.
D541,748 S	5/2007	Peng et al.	RE44,556 E	10/2013	Minich
D542,736 S	5/2007	Riku	8,632,263 B2	1/2014	Nekado et al.
7,220,141 B2	5/2007	Daily et al.	D712,843 S	9/2014	Buck et al.
7,239,526 B1	7/2007	Bibee	D713,799 S	9/2014	Buck et al.
7,241,168 B2	7/2007	Sakurai et al.	D745,852 S *	12/2015	Harper, Jr. .... D13/147
7,258,562 B2	8/2007	Daily et al.	2001/0003685 A1	6/2001	Aritani
D550,158 S	9/2007	Victor	2001/0008189 A1	7/2001	Reede
D550,628 S	9/2007	Whiteman et al.	2001/0012729 A1	8/2001	Van Woensel
7,267,515 B2	9/2007	Lappohn	2001/0041477 A1	11/2001	Billman et al.
7,270,574 B1	9/2007	Ngo	2001/0046810 A1	11/2001	Cohen et al.
7,273,382 B2	9/2007	Igarashi et al.	2001/0046816 A1	11/2001	Saito et al.
7,278,856 B2	10/2007	Minich	2002/0013101 A1	1/2002	Long
7,281,950 B2	10/2007	Belopolsky	2002/0039857 A1	4/2002	Naito et al.
D554,591 S	11/2007	Victor	2002/0084105 A1	7/2002	Geng et al.
7,292,055 B2	11/2007	Egitto	2002/0098727 A1	7/2002	McNamara et al.
7,303,427 B2	12/2007	Swain	2002/0106930 A1	8/2002	Pape et al.
7,309,239 B2	12/2007	Shuey et al.	2002/0106932 A1	8/2002	Holland et al.
7,316,585 B2	1/2008	Smith et al.	2002/0111068 A1	8/2002	Cohen et al.
7,322,855 B2	1/2008	Mongold et al.	2002/0127903 A1	9/2002	Billman et al.
7,331,802 B2	2/2008	Rothermel et al.	2002/0142629 A1	10/2002	Zaderej et al.
7,335,043 B2	2/2008	Ngo et al.	2002/0142676 A1	10/2002	Hosaka et al.
7,338,321 B2	3/2008	Laurx	2002/0159235 A1	10/2002	Miller et al.
7,344,383 B1	3/2008	Lu et al.	2002/0173177 A1	11/2002	Korsunsky
7,347,740 B2	3/2008	Minich	2002/0187688 A1	12/2002	Marvin et al.
7,351,071 B2	4/2008	Korsunsky et al.	2002/0193019 A1	12/2002	Blanchfield et al.
7,381,092 B2	6/2008	Nakada	2003/0116857 A1	6/2003	Taniguchi et al.
7,384,289 B2	6/2008	Minich	2003/0119378 A1	6/2003	Avery
7,384,311 B2	6/2008	Sharf et al.	2003/0143894 A1	7/2003	Kline et al.
7,402,064 B2	7/2008	Daily	2003/0171010 A1	9/2003	Winings et al.
7,407,387 B2	8/2008	Johnescu	2003/0203665 A1	10/2003	Ohnishi et al.
7,422,483 B2	9/2008	Avery et al.	2003/0219999 A1	11/2003	Minich et al.
7,425,145 B2	9/2008	Ngo et al.	2003/0220021 A1	11/2003	Whiteman, Jr. et al.
7,429,176 B2	9/2008	Johnescu	2003/0236035 A1	12/2003	Kuroda et al.
7,445,457 B1	11/2008	Frangioso, Jr. et al.	2004/0018757 A1	1/2004	Lang et al.
7,452,242 B2	11/2008	Poh et al.	2004/0038590 A1	2/2004	Lang et al.
7,452,249 B2	11/2008	Daily	2004/0072470 A1	4/2004	Lang et al.
7,458,839 B2	12/2008	Ngo	2004/0077224 A1	4/2004	Marchese
7,467,955 B2	12/2008	Raistrick et al.	2004/0087196 A1	5/2004	Lang et al.
7,476,108 B2	1/2009	Swain	2004/0102062 A1	5/2004	Liao et al.
7,497,735 B2	3/2009	Belopolsky	2004/0114866 A1	6/2004	Hiramatsu
7,497,736 B2	3/2009	Minich et al.	2004/0157477 A1	8/2004	Johnson et al.
			2004/0224559 A1	11/2004	Nelson et al.
			2004/0235316 A1	11/2004	Liao et al.
			2004/0235321 A1	11/2004	Mizumura et al.
			2004/0259420 A1	12/2004	Wu

(56)

## References Cited

## U.S. PATENT DOCUMENTS

2005/0009402 A1 1/2005 Chien et al.  
 2005/0026503 A1 2/2005 Trout et al.  
 2005/0032401 A1 2/2005 Kobayashi  
 2005/0048838 A1 3/2005 Korsunsky et al.  
 2005/0079763 A1 4/2005 Lemke et al.  
 2005/0101166 A1 5/2005 Kameyama  
 2005/0101188 A1 5/2005 Benham et al.  
 2005/0112952 A1 5/2005 Wang et al.  
 2005/0118869 A1 6/2005 Evans  
 2005/0170700 A1 8/2005 Shuey et al.  
 2005/0196987 A1 9/2005 Shuey et al.  
 2005/0202722 A1 9/2005 Regnier et al.  
 2005/0215121 A1 9/2005 Tokunaga  
 2005/0227552 A1 10/2005 Yamashita et al.  
 2005/0277315 A1 12/2005 Mongold et al.  
 2005/0287869 A1 12/2005 Kenny et al.  
 2006/0003620 A1 1/2006 Daily et al.  
 2006/0014433 A1 1/2006 Consoli et al.  
 2006/0024983 A1 2/2006 Cohen et al.  
 2006/0024984 A1 2/2006 Cohen et al.  
 2006/0040519 A1 2/2006 Arai et al.  
 2006/0046526 A1 3/2006 Minich  
 2006/0051987 A1 3/2006 Goodman et al.  
 2006/0068610 A1 3/2006 Belopolsky  
 2006/0068641 A1 3/2006 Hull et al.  
 2006/0073709 A1 4/2006 Reid  
 2006/0116857 A1 6/2006 Sevic et al.  
 2006/0121749 A1 6/2006 Fogg  
 2006/0128197 A1 6/2006 McGowan et al.  
 2006/0141818 A1 6/2006 Ngo  
 2006/0183377 A1 8/2006 Sinsheimer  
 2006/0192274 A1 8/2006 Lee et al.  
 2006/0216969 A1 9/2006 Bright et al.  
 2006/0228912 A1 10/2006 Morlion et al.  
 2006/0232301 A1 10/2006 Morlion et al.  
 2006/0281354 A1 12/2006 Ngo et al.  
 2007/0004287 A1 1/2007 Marshall  
 2007/0021002 A1 1/2007 Laurx et al.  
 2007/0042639 A1 2/2007 Manter et al.  
 2007/0071391 A1 3/2007 Mazotti et al.  
 2007/0099455 A1 5/2007 Rothermel et al.  
 2007/0099512 A1 5/2007 Sato  
 2007/0183707 A1 8/2007 Umezawa  
 2007/0183724 A1 8/2007 Sato  
 2007/0202715 A1 8/2007 Daily et al.  
 2007/0202747 A1 8/2007 Sharf et al.  
 2007/0205774 A1 9/2007 Minich  
 2007/0207641 A1 9/2007 Minich  
 2007/0293084 A1 12/2007 Ngo  
 2008/0032524 A1 2/2008 Lemke et al.  
 2008/0045079 A1 2/2008 Minich et al.  
 2008/0176453 A1 7/2008 Minich et al.  
 2008/0232737 A1 9/2008 Ishigami et al.  
 2008/0246555 A1 10/2008 Kirk et al.  
 2008/0248670 A1 10/2008 Daily et al.  
 2008/0316729 A1 12/2008 Rothermel et al.  
 2009/0011643 A1 1/2009 Amlleshi et al.  
 2010/0055983 A1 3/2010 Wu  
 2010/0093209 A1 4/2010 Liu et al.  
 2010/0216342 A1 8/2010 Lin  
 2010/0240233 A1 9/2010 Johnescu et al.  
 2010/0291803 A1 11/2010 Kirk  
 2011/0159744 A1 6/2011 Buck  
 2011/0195593 A1 8/2011 McGrath et al.  
 2012/0202363 A1 8/2012 McNamara et al.  
 2012/0214343 A1 8/2012 Buck et al.  
 2012/0289095 A1 11/2012 Kirk  
 2013/0005160 A1 1/2013 Minich  
 2013/0090025 A1 4/2013 Trout et al.  
 2013/0122744 A1 5/2013 Morgan et al.  
 2013/0149881 A1 6/2013 Johnescu et al.  
 2013/0149890 A1 6/2013 Schroll et al.  
 2013/0195408 A1 8/2013 Hermeline et al.  
 2013/0210246 A1 8/2013 Davis et al.

2013/0273756 A1 10/2013 Stoner et al.  
 2013/0273781 A1 10/2013 Buck et al.  
 2014/0227911 A1 8/2014 Lim et al.

## FOREIGN PATENT DOCUMENTS

DE 3605316 8/1987  
 DE 4040551 4/1993  
 DE 10226279 11/2003  
 DE 102010005001 8/2010  
 EP 0212764 3/1987  
 EP 0273683 7/1988  
 EP 0337634 10/1989  
 EP 0442785 8/1991  
 EP 0486298 5/1992  
 EP 0321257 4/1993  
 EP 0560550 9/1993  
 EP 0562691 9/1993  
 EP 0591772 4/1994  
 EP 0623248 11/1995  
 EP 0706240 4/1996  
 EP 0782220 7/1997  
 EP 0789422 8/1997  
 EP 0843383 5/1998  
 EP 0635910 6/2000  
 EP 1024556 8/2000  
 EP 1111730 6/2001  
 EP 0891016 10/2002  
 EP 1091449 9/2004  
 EP 1148587 4/2005  
 GB 1162705 8/1969  
 JP 57/058115 4/1982  
 JP 60/072663 4/1985  
 JP 02/278893 11/1990  
 JP 0521119 1/1993  
 JP 05344728 12/1993  
 JP 0668943 3/1994  
 JP 06236788 8/1994  
 JP 07114958 5/1995  
 JP 07169523 7/1995  
 JP 0896918 4/1996  
 JP 08125379 5/1996  
 JP 09199215 7/1997  
 JP 11185886 7/1999  
 JP 2000/003743 1/2000  
 JP 2000/003744 1/2000  
 JP 2000/003745 1/2000  
 JP 2000/003746 1/2000  
 JP 2000/228243 8/2000  
 JP 2001/135388 5/2001  
 JP 2001/305182 10/2001  
 JP 2002/008790 1/2002  
 JP 2003/217785 7/2003  
 JP 2007/128706 5/2007  
 KR 100517561 9/2005  
 TW 576555 8/1990  
 TW 546872 8/2003  
 WO WO 90/16093 12/1990  
 WO WO 96/38889 12/1996  
 WO WO 96/42123 12/1996  
 WO WO 97/20454 6/1997  
 WO WO 97/43885 11/1997  
 WO WO 97/44859 11/1997  
 WO WO 97/45896 12/1997  
 WO WO 98/15989 4/1998  
 WO WO 00/16445 3/2000  
 WO WO 01/29931 4/2001  
 WO WO 01/39332 5/2001  
 WO WO 02/058191 7/2002  
 WO WO 02/101882 12/2002  
 WO WO 02/103847 12/2002  
 WO WO 2005/065254 7/2005  
 WO WO 2006/031296 3/2006  
 WO WO 2006/105535 10/2006  
 WO WO 2007/064632 6/2007  
 WO WO 2008/082548 7/2008

(56)

## References Cited

## FOREIGN PATENT DOCUMENTS

WO	WO 2008/117180	10/2008
WO	WO 2012/047619	4/2012
WO	WO 2012/174120	12/2012

## OTHER PUBLICATIONS

U.S. Appl. No. 29/426,921, filed Jul. 11, 2012, Horchler.  
 U.S. Appl. No. 29/418,299, filed Apr. 13, 2012, Buck et al.  
 U.S. Appl. No. 29/418,310, filed Apr. 13, 2012, Buck et al.  
 U.S. Appl. No. 29/418,313, filed Apr. 13, 2012, Zerebilov et al.  
 U.S. Appl. No. 29/449,794, filed Mar. 15, 2013, Zerebilov et al.  
 U.S. Appl. No. 29/504,773, filed Oct. 9, 2014, Horchler.  
 U.S. Appl. No. 29/529,797, filed Jun. 1, 2015, Harper et al.  
 "Backplane Connectors", <http://www.amphenol-tcs.com/products/connectors/backplane/index.html>, Amphenol TCS (ATCS), Jun. 19, 2008, 1-3.  
 "Champ Z-Dok Connector System", Tyco Electronics, Jan. 2002, 3 pages.  
 "Daughtercard Hole Pattern: Signal Modules (10 & 25 positions) Connector Assembly", Customer No. C-163-5101-500, Teradyne Connection Systems, Inc., 2001, 1 page.  
 "FCI's Airmax VS Connector System Honored at DesignCon 2005", <http://www.heilind.com-products-fci-airmax-vs-design.asp> Heilind Electronics, Inc., 2005, 1 page.  
 "Framatome Connector Specification", May 10, 1999, 1 page.  
 "GbXI-Trac Backplane Connector System", [www.molex.com/cgi-bin](http://www.molex.com/cgi-bin), Molex, 2007, 1-3.  
 "Gig-Array Connector System, Board to Board Connectors", 2005, 4 pages.  
 "Gig-Array High Speed Mezzanine Connectors 15-40 mm Board to Board", FCI Corporation, Jun. 5, 2006, 1 page.  
 "HDM Separable Interface Detail", Molex, Feb. 17, 1993, 3 pages.  
 "HDM Stacker Signal Integrity", [http://www.teradyne.com/prods/tcs/products/connectors/mezzanine/hdm\\_stack/signintegrity.html](http://www.teradyne.com/prods/tcs/products/connectors/mezzanine/hdm_stack/signintegrity.html), Amphenol TCS (ATCS), Feb. 2, 2006, 3 pages.  
 "HDM, HDM Plus Connectors", <http://www.teradyne.com-prods-tcs-products-connectors-backplane-hdm-index.html>, Amphenol TCS, 2006, 1 page.  
 "HDM/HDM Plus, 2mm, Backplane Interconnection System", Teradyne Connection Systems, 1993, 22 pages.  
 "High Definition Multimedia Interface (HDMI)", [www.molex.com](http://www.molex.com), Molex, Jun. 19, 2008, 2 pages.  
 "High Speed Backplane Interconnect Solutions", Tyco Electronics, 2007, 6 pages.  
 "High Speed Characterization Report, SEAM-30-02.0-S-10-2", [www.samtec.com](http://www.samtec.com), SAMTEC, 2005, 55 pages.  
 "Honda High-Speed Backplane Connector NSP Series", Honda Connectors, Feb. 7, 2003, 25 pages.  
 "Impact 3 Pair 10 Column Signal Module", Tyco Electronics, Mar. 25, 2008, 1 page.  
 "Impact 3 Pair Header Unguided Open Assembly", Tyco Electronics, Apr. 11, 2008, 1 page.  
 "Impact Connector Offered by Tyco Electronic, High Speed Backplane Connector System", Tyco Electronics, Apr. 15, 2008, 12 pages.  
 "Lucent Technologies' Bell Labs and FCI Demonstrate 25gb-S Data Transmission Over Electrical Backplane Connectors", <http://www.lucent.com-press-0205-050201.bla.html>, Lucent Tech Bell Labs, Feb. 1, 2005, 1-4.  
 "Metral 1000 Series, 5 Row Receptacle, Right Angle, Press Fit, PCB Mounted Receptacle Assembly", FCI 2001, 1 page.  
 "Metral 2mm High-Speed Connectors, 1000, 2000, 3000 Series, Electrical Performance Data for Differential Applications", FCI Framatome Group, 2000, 2 pages.  
 "Metral Speed & Density Extensions", FCI, Jun. 3, 1999, 1-25.  
 "Mezzanine High Speed High-Density Connectors Gig-Array and Meg-Array Electrical Performance Data", FCI Corporation, 10 pages.  
 "Micro Electronic Interconnects", Alphametals, 1990, 4 pages.

"Millipacs Connector, Type A Specification", Dec. 14, 2004, 1 page.  
 "NSP Series, Backplane High-Speed Data Transmission Cable Connectors", <http://www.honda-connectors.co.jp>, Honda Connectors, 2006, 6 pages, English Translation attached.  
 "Open Pin Field Array Seaf Series", [www.samtec.com](http://www.samtec.com), SAMTEC, 2005, 1 page.  
 "Overview for High Density Backplane Connector (Z-Pack TinMan)", Tyco Electronics, 2008, 1 page.  
 "Overview for High Density Backplane Connectors (Impact) Offered by Tyco Electronics", [www.tycoelectronics.com/catalog](http://www.tycoelectronics.com/catalog), Tyco Electronics, 2007, 1-2.  
 "Overview: Backplane Products", [http://www.molex.com/cgi-bin/bv-molex-super\\_family-super\\_family.jsp?BV\\_SessionID=@](http://www.molex.com/cgi-bin/bv-molex-super_family-super_family.jsp?BV_SessionID=@), Molex, Feb. 8, 2006, 4 pages.  
 "PCB-Mounted Receptacle Assemblies, 2.00 mm (0.079 In) Centerlines, Right-Angle Solder-to-Board Signal Receptacle", Metral, Berg Electronics, 2 pages.  
 "Product Datasheets, 10 Bgit/s XENPAK 850 nm Transponder (TRP10GVP2045)", MergeOptics GmbH, 2005, 13 pages.  
 "Product Datasheets, Welcome to XENPAK.org.", <http://www.xenpak.org>, 2001, 1 page.  
 "Two-Piece, High-Speed Connectors", [www.tycoelectronics.com/catalog](http://www.tycoelectronics.com/catalog), Tyco Electronics, 2007, 1-3.  
 "Tyco Unveils Z-Pack TinMan Orthogonal Connector System", <http://www.epn-online.com/page/new59327/tyco-unveils-z-pack-orthogonal-conn>, Oct. 13, 2009, 4 pages.  
 "Ventura High Performance, Highest Density Available", <http://www.amphenol-tcs.com/products/connectors/backplane/ventura/index.html>, Amphenol TCS (ATCS), Jun. 19, 2008, 1-2.  
 "VHDM Connector", <http://www.teradyne.com/prods/tcs/products/connectors/backplan/vhdm/index.html>, Amphenol TCS (ATCS), Jan. 31, 2006, 2 pages.  
 "VHDM Daughterboard Connectors Feature Press-Fit Terminations and a Non-Stubbing Separable Interface", Teradyne, Inc. Connections Sys Div, Oct. 8, 1997, 46 pages.  
 "VHDM High-Speed Differential (VHDM HSD)", <http://www.teradyne.com/prods/bps/vhdm/hsd.html>, Teradyne, Jan. 24, 2000, 6 pages.  
 "VHDM L-Series Connector", [http://www.teradyne.com/prods/tcs/products/connectors/backplane/vhdm\\_1-series/index.html](http://www.teradyne.com/prods/tcs/products/connectors/backplane/vhdm_1-series/index.html), Amphenol TCS(ATCS), 2006, 4 pages.  
 "XCede® Connector", <http://www.amphenol-tcs.com/products/connectors/backplane/xcede/index.html>, Amphenol TCS (ATCS), Jun. 19, 2008, 1-5.  
 "Z-Dok and Connector", <http://2dok.tyco.electronics.com>, Tyco Electronics, May 23, 2003, 1-15.  
 "Z-Pack Slim UHD", <http://www.zpackuhd.com>, Tyco Electronics, 2007, 8 pages.  
 "Z-Pack TinMan High Speed Orthogonal Connector Product Feature Selector", Tyco Electronics, 2009, 2 pages.  
 "Z-Pack TinMan Product Portfolio Expanded to Include 6-Pair Module", Tyco Electronics, Jun. 19, 2008, 1 page.  
 Berg Electronics Catalog, p. 13-96, Solder Washers, 1996, 1 page.  
 Chen et al., "Characteristics of Coplanar Transmission Lines on Multilayer Substrates: Modeling and Experiments", IEEE Transactions on Microwave Theory and Techniques, Jun. 1997, 45(6), 939-945.  
 Cheng et al., "Terahertz-Bandwidth Characteristics of Coplanar Transmission Lines on Low Permittivity Substrates", IEEE Transactions on Microwave Theory and Techniques, 1994, 42(12), 2399-2406.  
 Chua et al., "Broadband Characterisation of CPW Transition and Transmission Line Parameters for Small Reflection Up to 100 GHz", RF and Microwave Conference, 2004, 269-271.  
 Derman "Speed, Density Push Design Complexities," Electronic Engineering Times, May 1998, 2 pages.  
 European Patent Application No. 10753953.8: Extended European Search Report dated Nov. 7, 2013, 6 pages.  
 European Patent Application No. 12305119.5: European Search Report dated Jul. 11, 2012, 5 pages.  
 Finan, "Thermally Conductive Thermoplastics", LNP Engineering Plastics, Inc., Plastics Engineering 2000, [www.4spe.org](http://www.4spe.org), 4 pages.



(56)

**References Cited**

## OTHER PUBLICATIONS

Fusi et al., "Differential Signal Transmission through Backplanes and Connectors", *Electronic Packaging and Production*, Mar. 1996, 27-31.

Goel et al., "AMP Z-Pack Interconnect System", AMP Incorporated, 1990, 9 pages.

Hettak et al., "Simultaneous Realization of Millimeter Wave Uniplanar Shunt Stubs and DC Block", *IEEE MTT-S Digest*, 1998, 809-812.

Hult, "FCI's Problem Solving Approach Changes Market, The FCI Electronics AirMax VS", [http://www.connectorsupplier.com-tech\\_updates\\_FCI\\_Airmax\\_archive.htm](http://www.connectorsupplier.com-tech_updates_FCI_Airmax_archive.htm), ConnectorSupplier.com, 2006, 1-4.

Hunsaker, "Ventura Application Design", TB-2127, Amphenol, Aug. 25, 2005, 13 pages.

IBM Technical Disclosure Bulletin, 1972, 14(8), 2 pages.

IBM Technical Disclosure Bulletin, 1977, 20(2), 2 pages.

IBM Technical Disclosure Bulletin, 1990, 32(11), 2 pages.

International Application No. PCT/US2003/014370, International Search Report dated Aug. 6, 2003, 2 pages.

International Application No. PCT/US2010/040899, International Search Report dated Jan. 25, 2011, 2 pages.

International Patent Application No. PCT/US2013/035775: International Search Report dated Jul. 18, 2013, 3 pages.

International Patent Application No. PCT/US2013/035915: International Search Report and Written Opinion dated Jul. 25, 2013, 17 pages.

International Patent Application No. PCT/US2013/049995: International Search Report dated Oct. 28, 2013, 18 pages.

Kazmierowicz, "Profiling Your Solder Reflow Oven in Three Passes or Less", *KIC Oven Profiling, Surface Mount Technology*, 1990, 2 pages.

Kazmierowicz, "The Science Behind Conveyor Oven Thermal Profiling", *KIC Oven Profiling, Surface Mount Technology*, 1990, 9 pages.

Lee et al., "Characteristic of the Coplanar Waveguide to Microstrip Right-Angled Transition", Department of Electronics Engineering, 1998, 3 pages.

Leung et al., "Low-Loss Coplanar Waveguides Interconnects on Low-Resistivity Silicon Substrate", *IEEE Transactions on Components and Packaging Technologies*, 2004, 27(3), 507-512.

Lim et al., "A Spiral-Shaped Defected Ground Structure for Coplanar Waveguide", *IEEE Microwave and Wireless Components Letters*, 2002, 12(9), 330-332.

Machac et al., "Space Leakage of Power from Uniplanar Transmission Lines", *Czech Technical University*, 565-568.

Mao et al., "Characterization of Coplanar Waveguide Open End Capacitance-Theory and Experiment", *IEEE Transactions on Microwave Theory and Techniques*, 1994, 42(6), 1016-1024.

Mottonen et al., "Novel Wide-Band Coplanar Waveguide-to-Rectangular Waveguide Transition", *IEEE Transactions on Microwave Theory and Techniques*, 2004, 52(8), 1836-1842.

Nadolny et al., "Optimizing Connector Selection for Gigabit Signal Speeds", <http://www.ecnimage.com-article-CA45245>, ECN, Sep. 1, 2000, 6 pages.

Ogando, "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.

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

Research Disclosure, Kenneth Mason Publications Ltd., England, Aug. 1990, No. 316, 1 page.

Research Disclosure, Kenneth Mason Publications Ltd., England, Oct. 1992, No. 342, 1 page.

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

Siemens, "SpeedPac: A New Concept for the Next Generation of Transmission Speed," *Backplane Interconnection*, Jan. 1996.

Soliman. et al., "Multimodel Characterization of Planar Microwave Structures", *IEEE Transactions on Microwave Theory and Techniques*, 2004, 52(1), 175-182.

Son et al., "Picosecond Pulse Propagation on Coplanar Striplines Fabricated on Lossy Semiconductor Substrates: Modeling and Experiments", *IEEE Transactions on Microwave Theory and Techniques*, 1993, 41(9), 1574-1580.

Straus, "Shielded In-Line Electrical Multiconnector", *IBM Technical Disclosure Bulletin*, Aug. 3, 1967, 10(3), 3 pages.

Suh et al., "Coplanar Strip line Resonators Modeling and Applications to Filters", *IEEE Transactions on Microwave Theory and Techniques*, 2002, 50(5), 1289-1296.

Tzuang et al., "Leaky Mode Perspective on Printed Antenna", *Proc. Natl. Sci. Council. ROC(A)*, 1999, 23(4), 544-549.

Weller et al., "High Performance Microshield Line Components", *IEEE Transactions on Microwave Theory and Techniques*, 1995, 43(3), 534-543.

Williams et al., "Accurate Transmission Line Characterization", *IEEE Microwave and Guided Wave Letters*, 1993, 3(8), 247-249.

Wu et al., "Full-Wave Characterization of the Mode Conversion in a Coplanar Waveguide Right-Angled Bend", *IEEE Transactions on Microwave Theory and Techniques*, 1995, 43(11), 2532-2538.

Ya et al., "Microstrip and Slotline Two-Pole Microwave Filters with Additional Transmission Zeros", *Int. Crimean Conference, Microwave & Telecommunication Technology*, 2004, 405-407 (English Abstract provided).

Samtec Ultra Fine Pitch Socket, [http://suddendocs.samtec.com/catalog\\_english/ss4.pdf](http://suddendocs.samtec.com/catalog_english/ss4.pdf) dated Apr. 23, 2009, 1 page.

\* cited by examiner

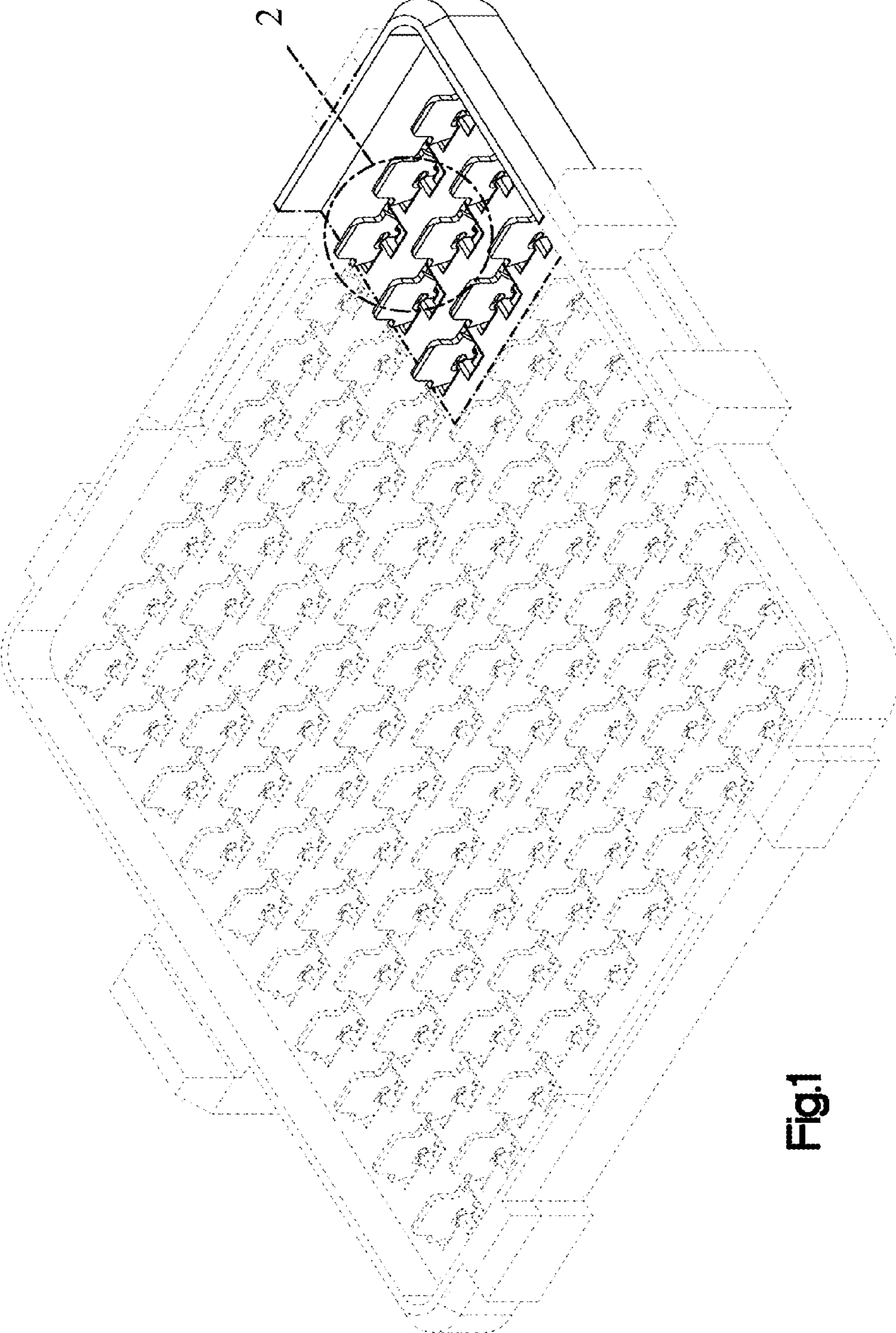


Fig.1

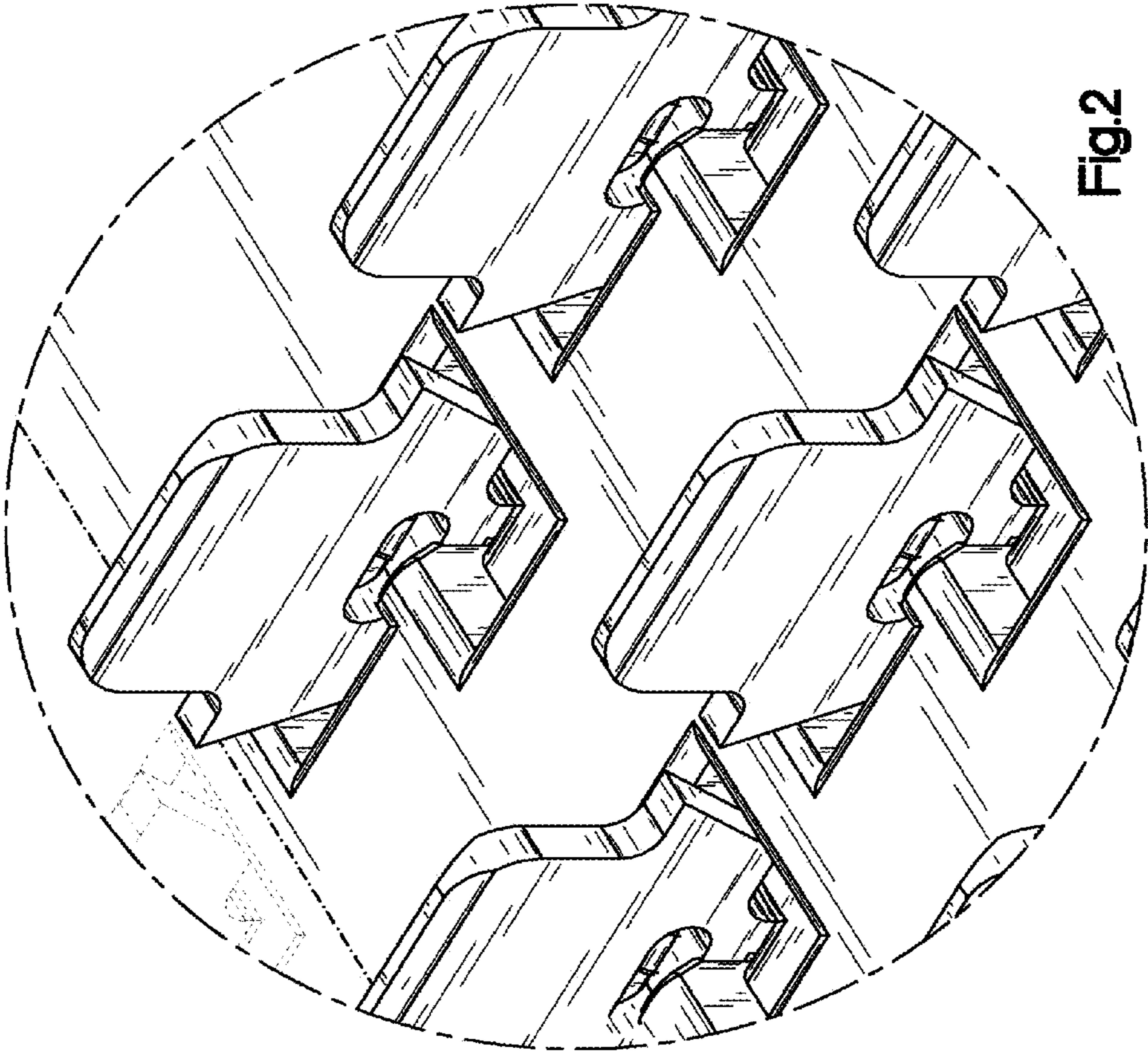


Fig.2

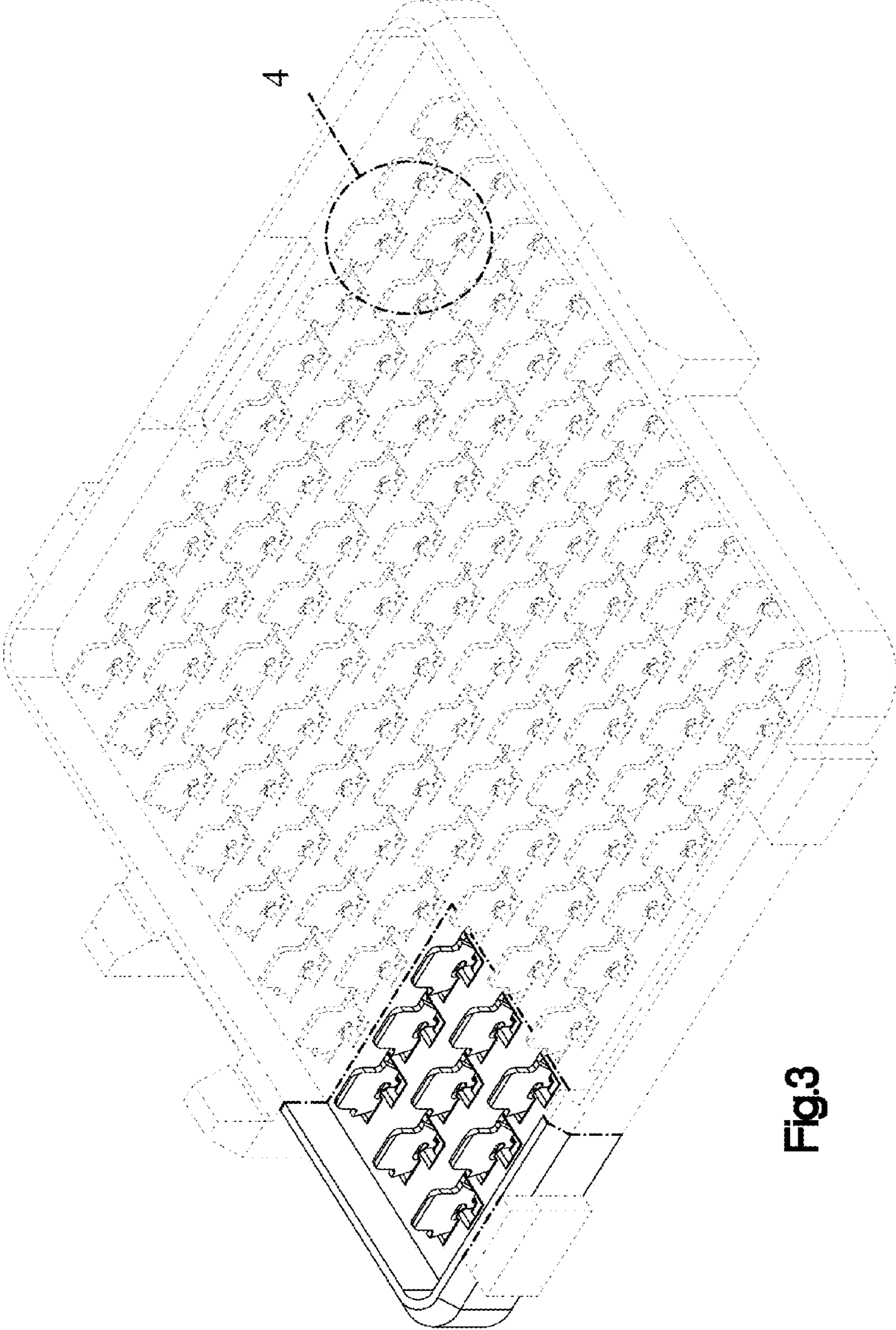


Fig.3

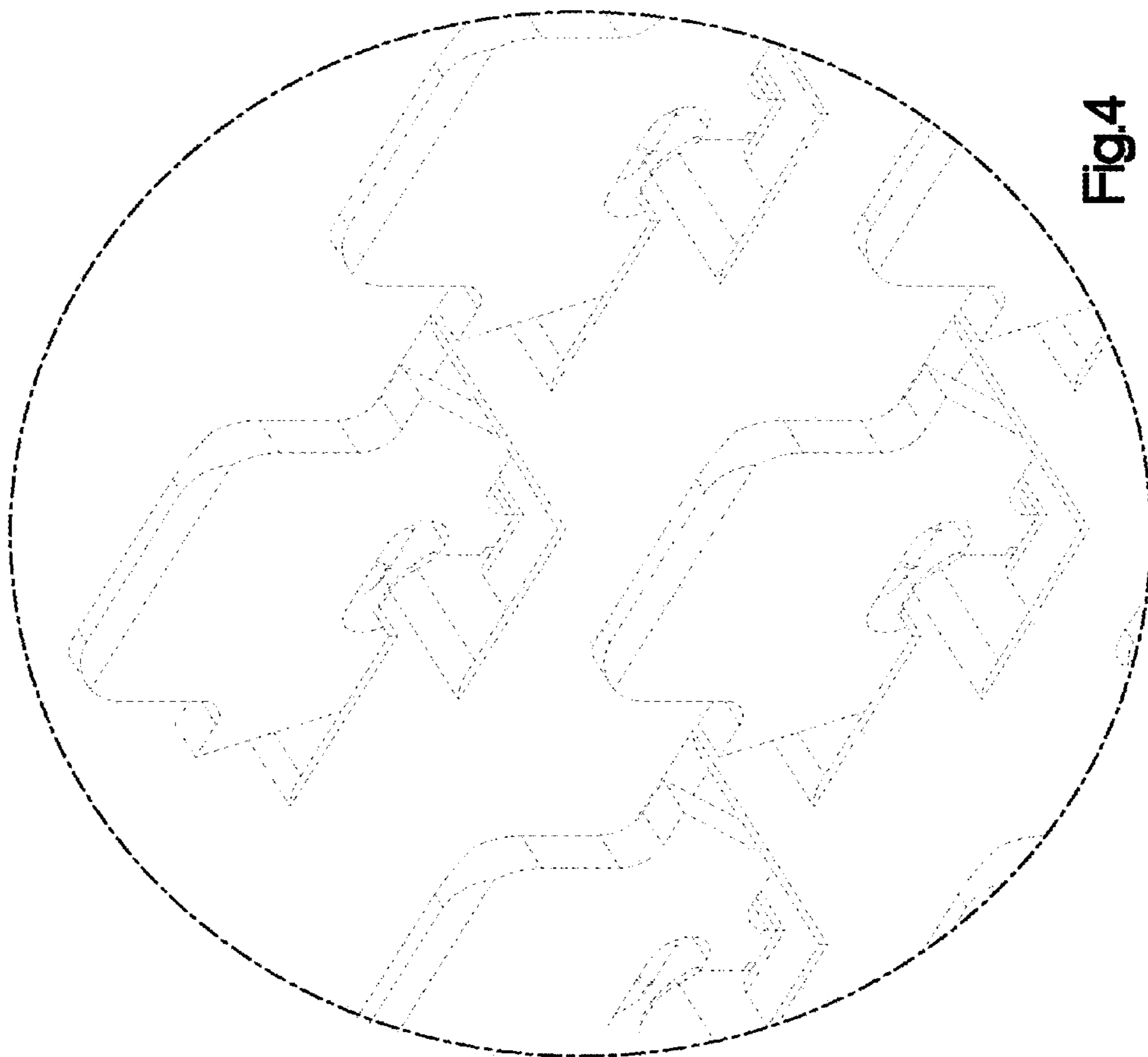


Fig.4

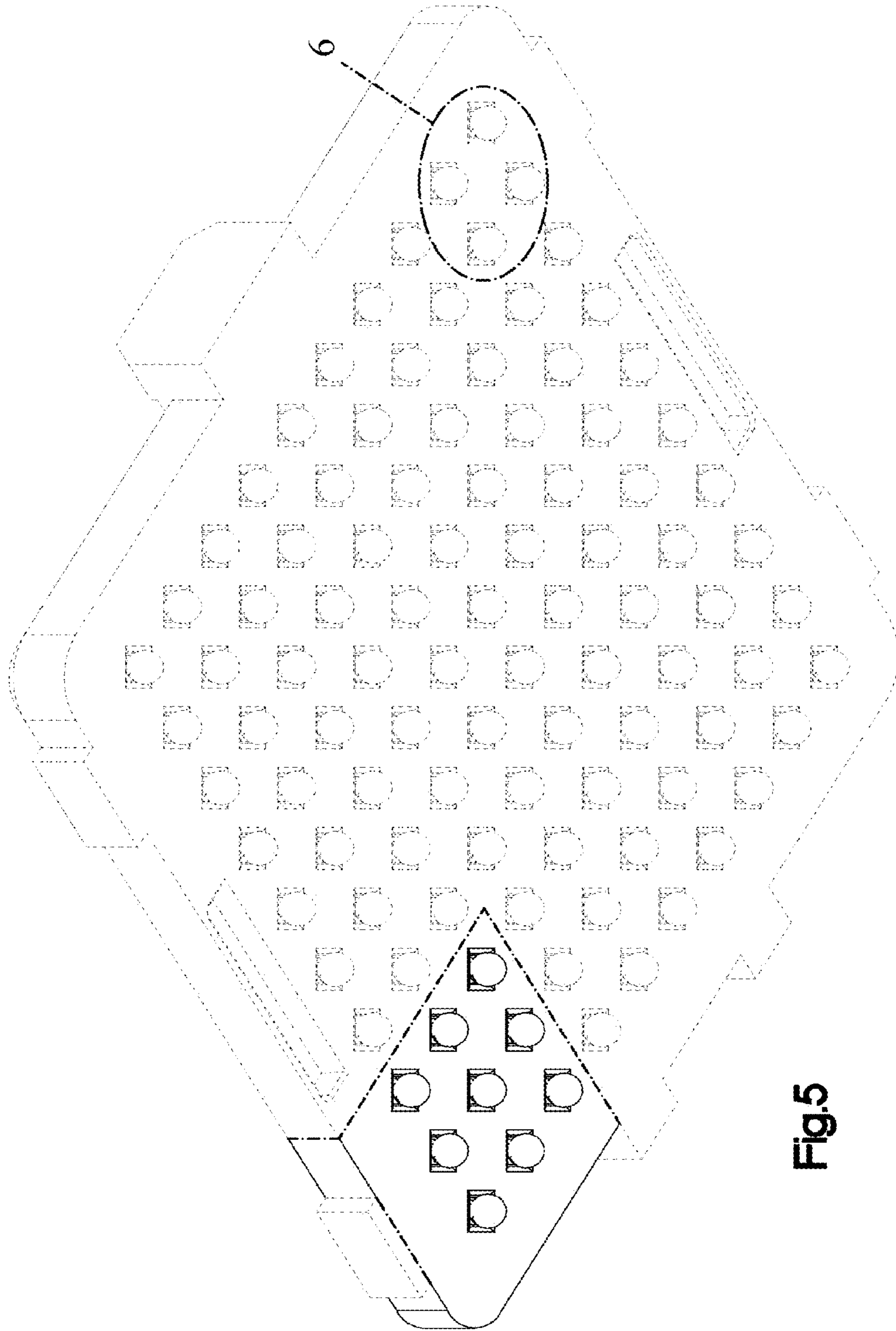


Fig.5

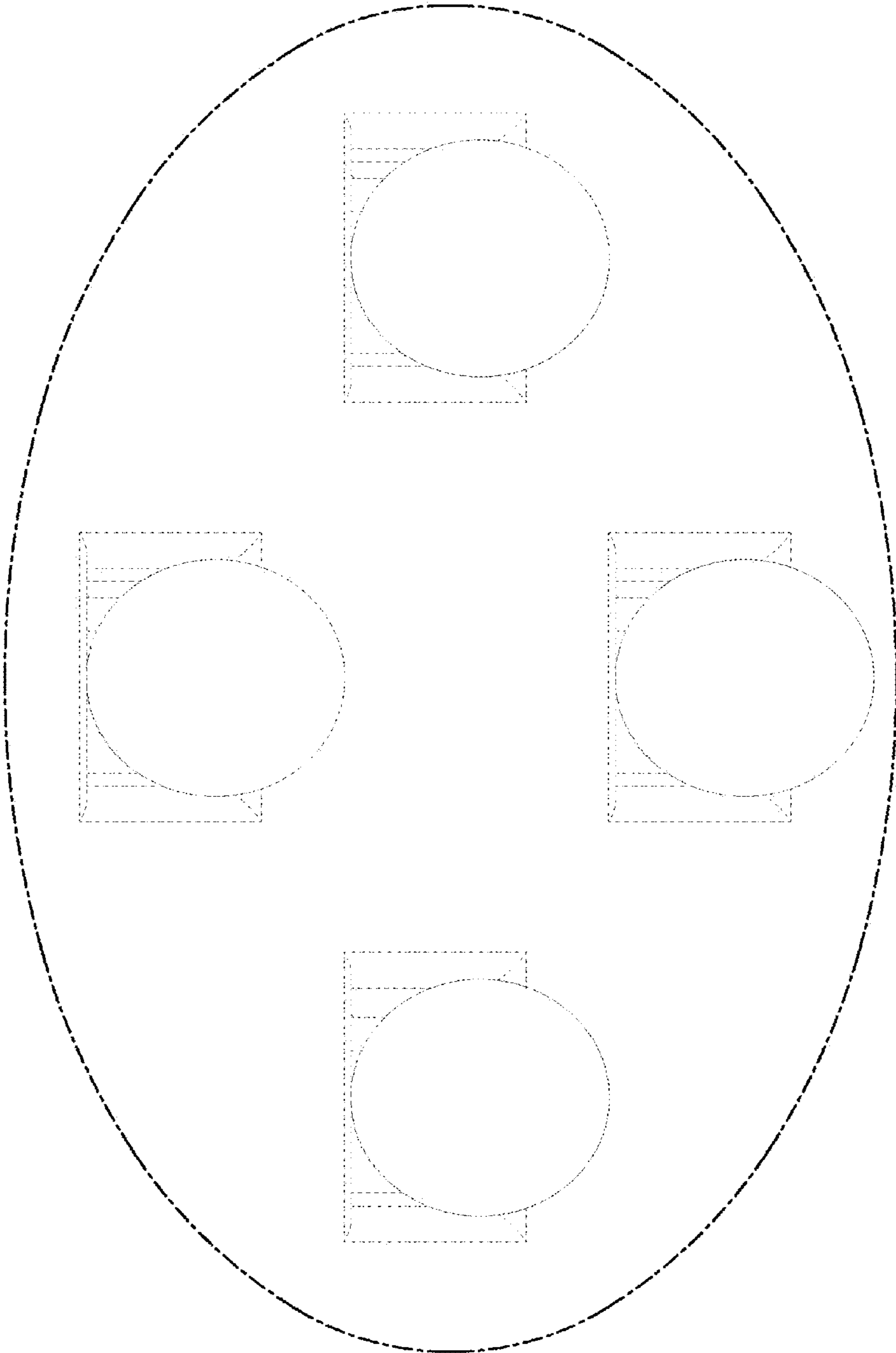


Fig.6

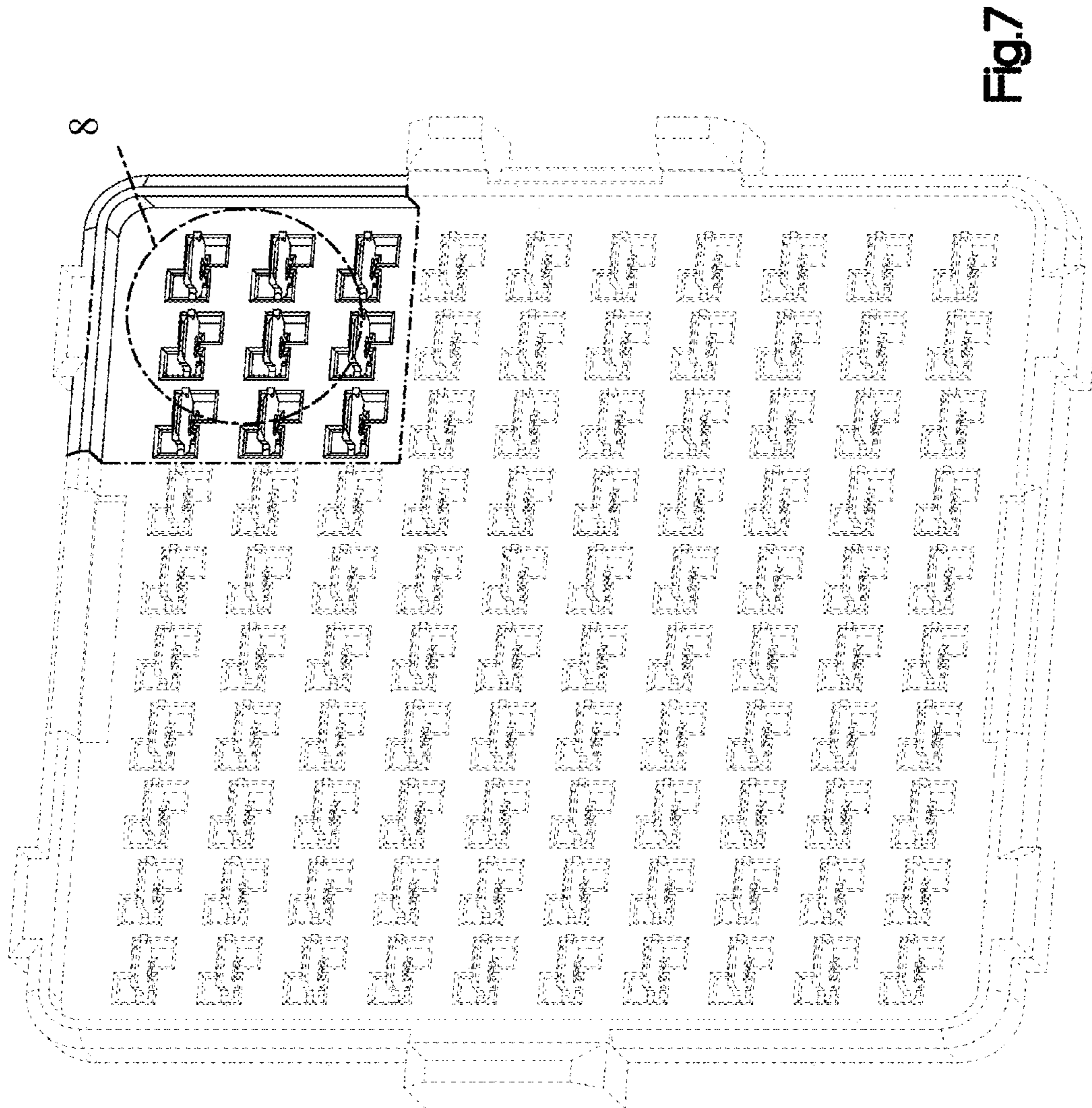


Fig.7



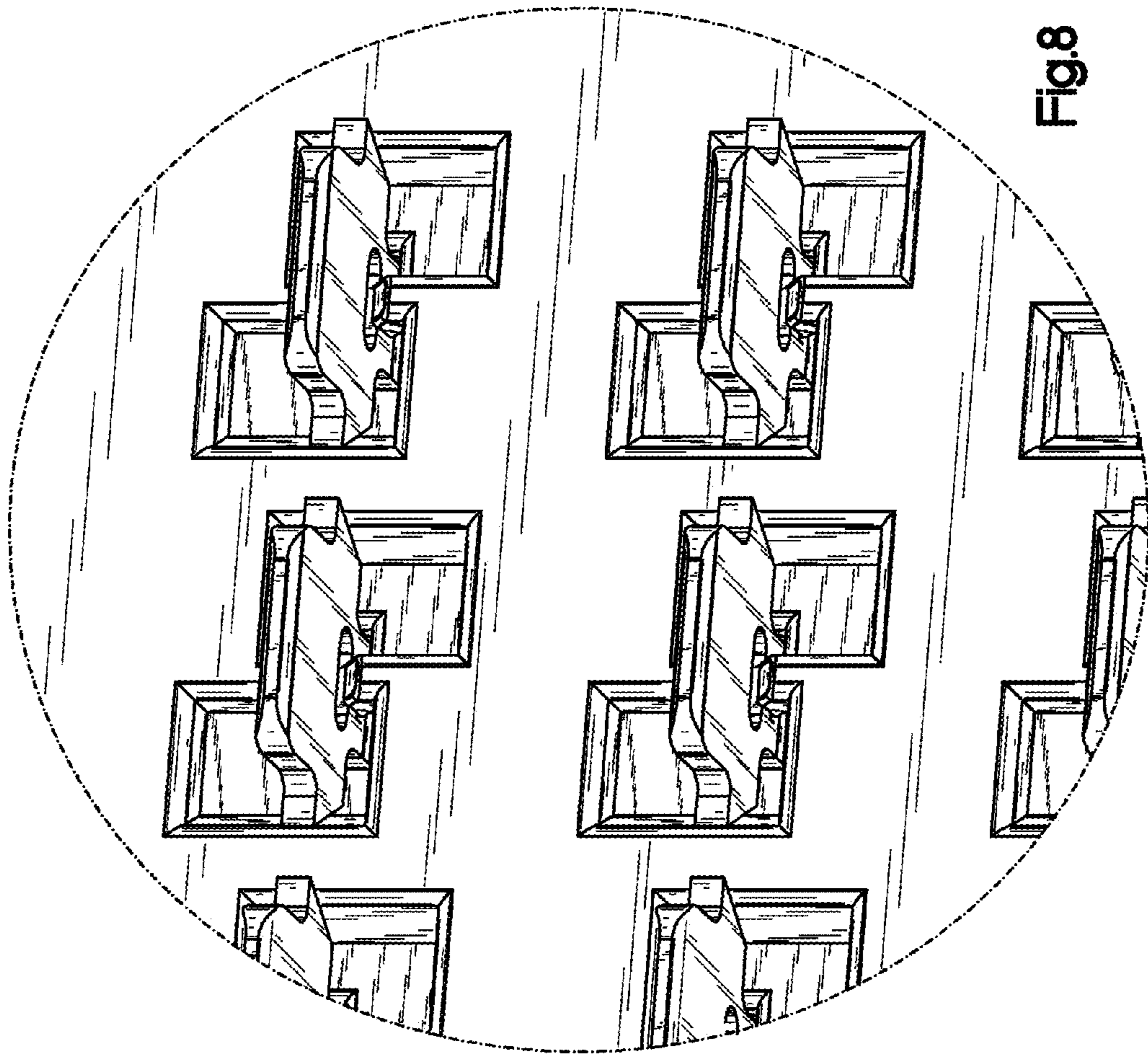


Fig.8

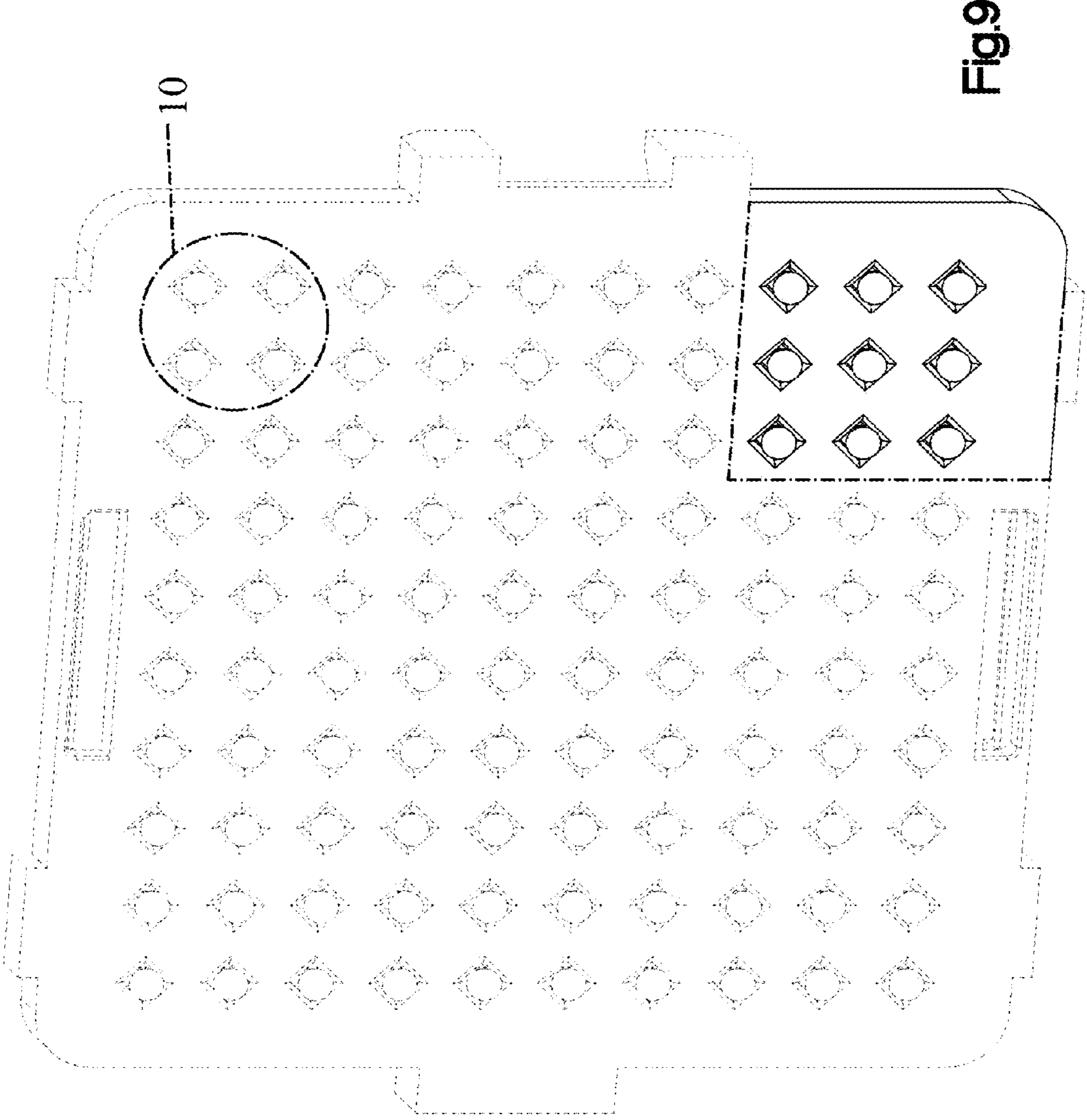


Fig. 9

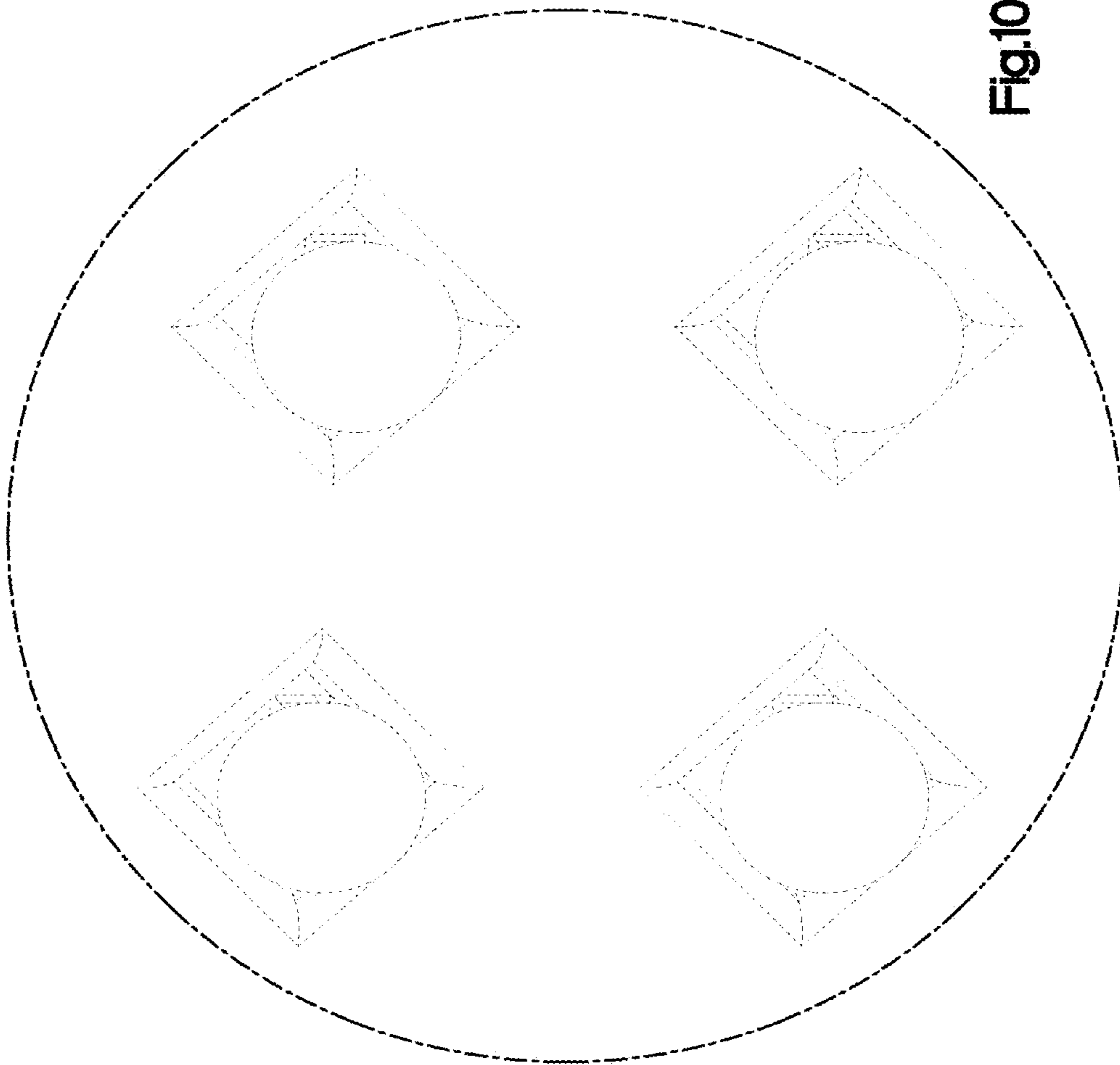
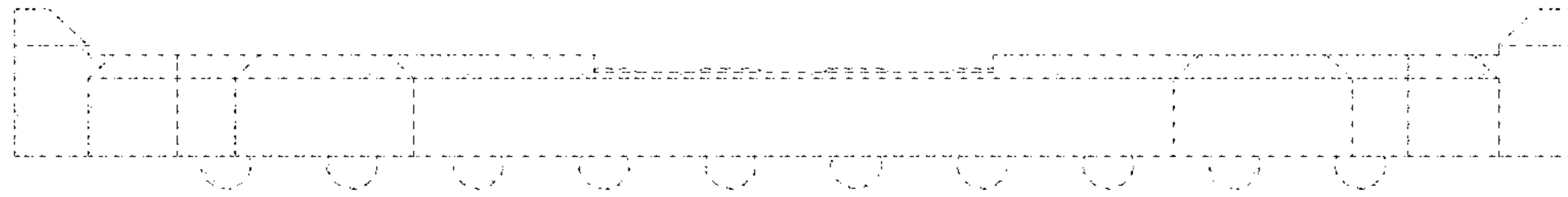
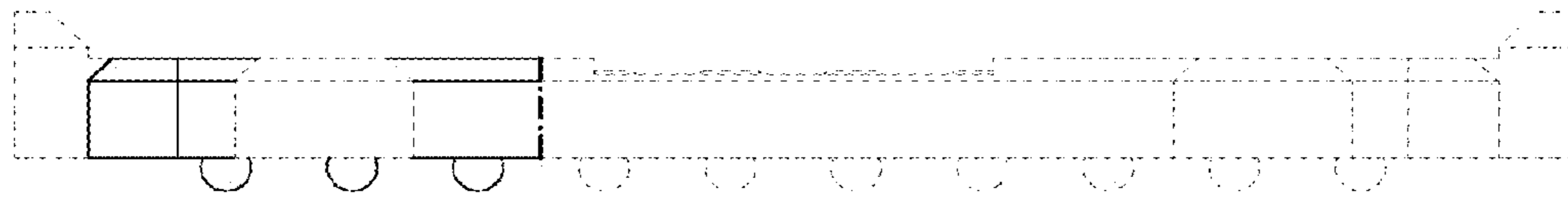


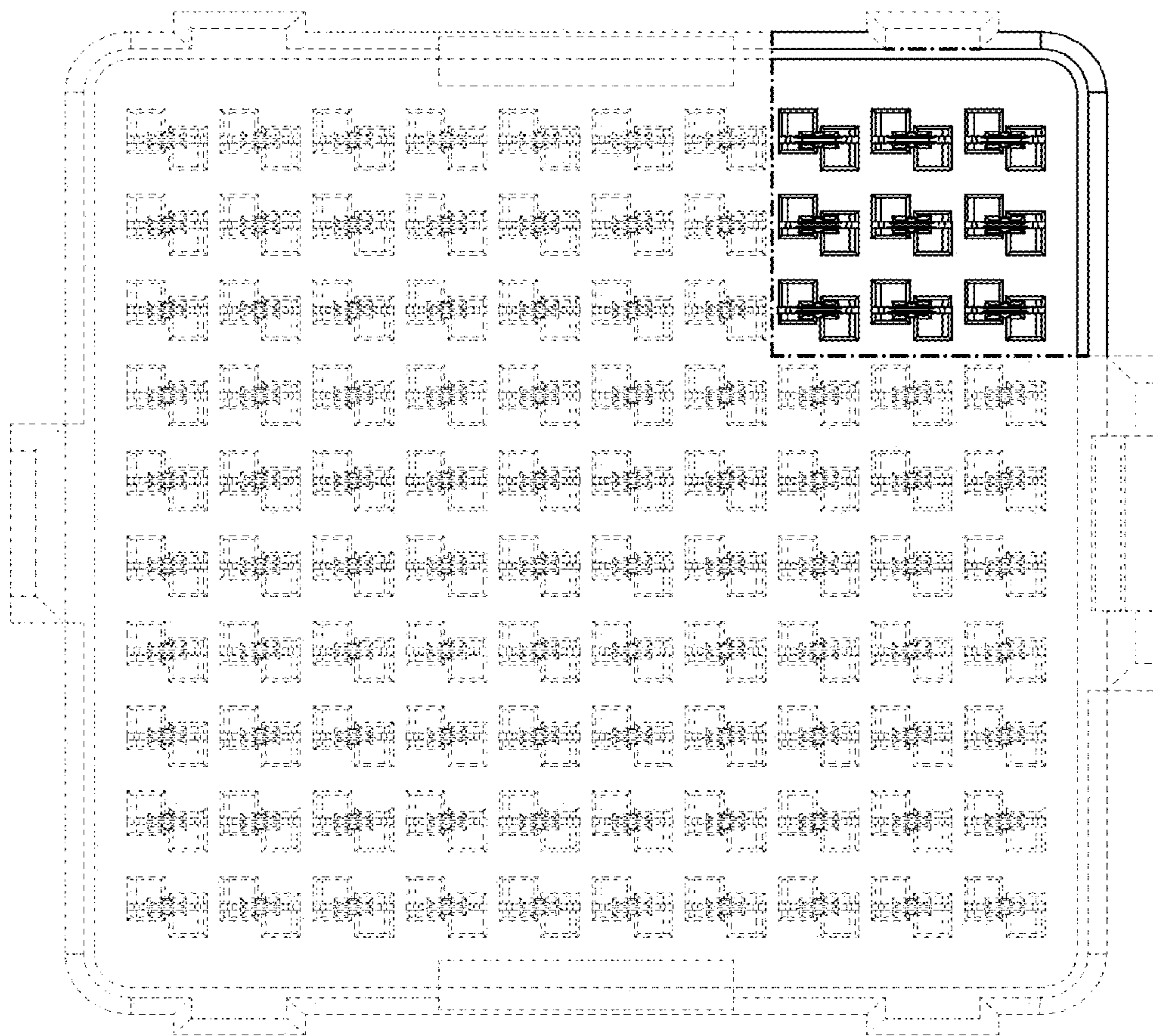
Fig.10



**Fig.11**



**Fig.12**



**Fig.13**

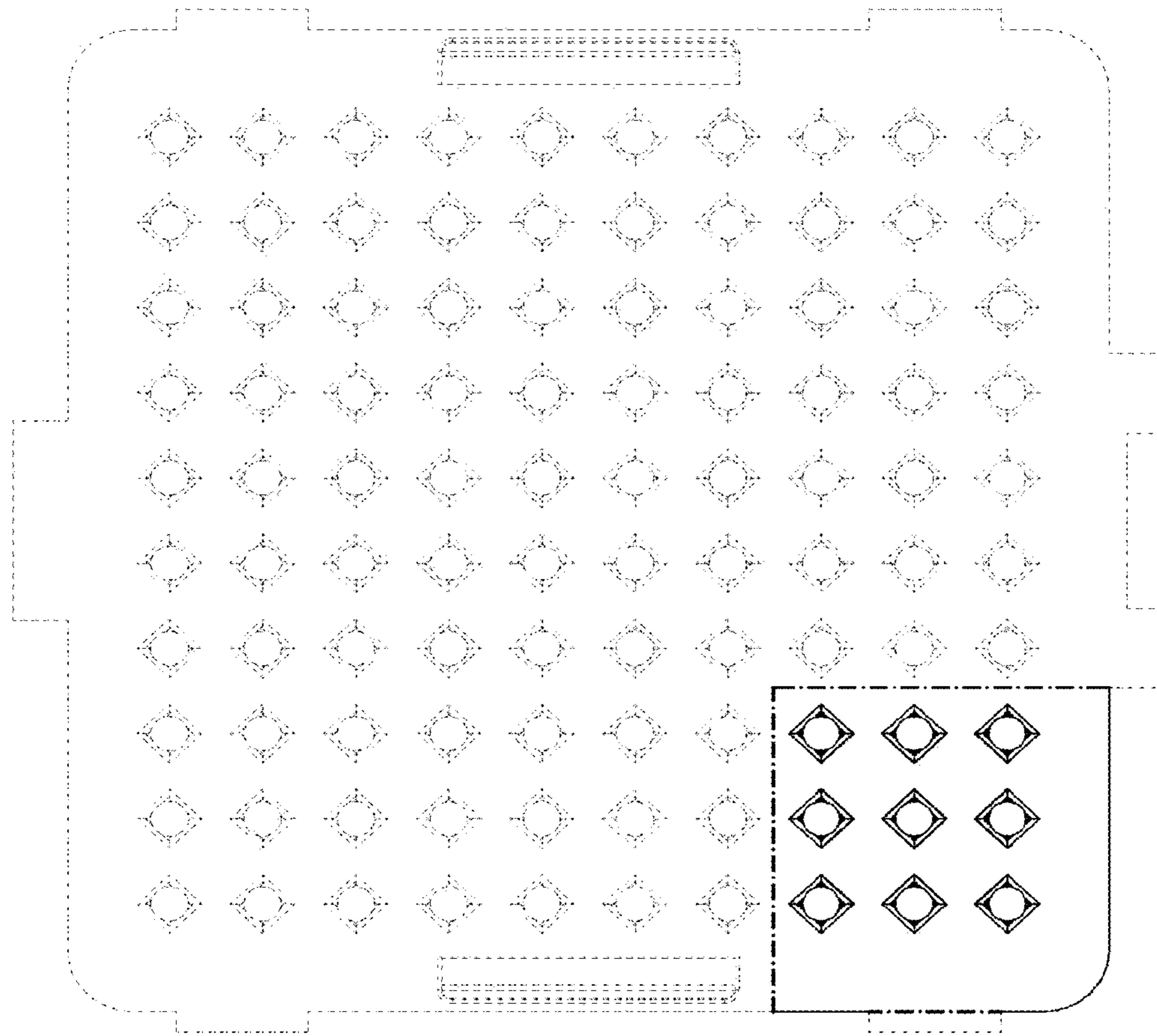


Fig.14

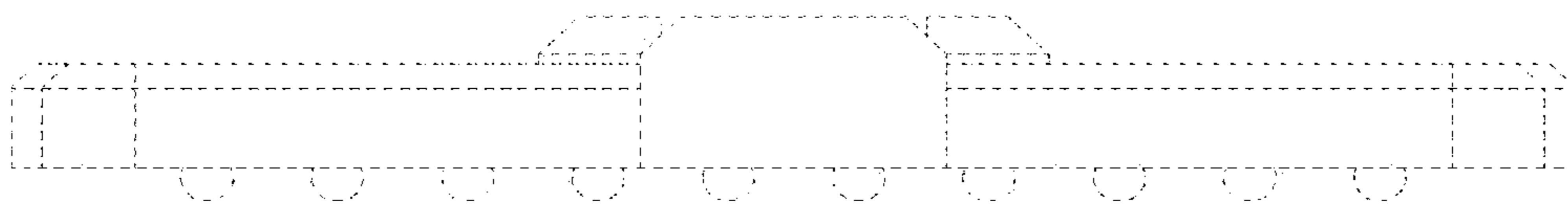


Fig.15

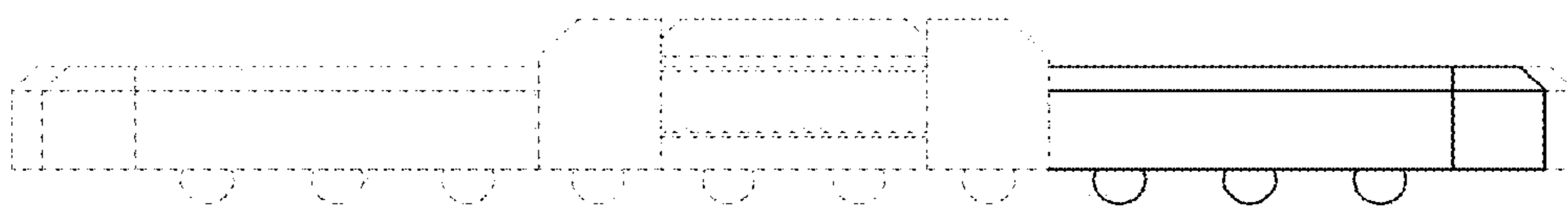


Fig.16