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(54) **SOLAR PANEL**

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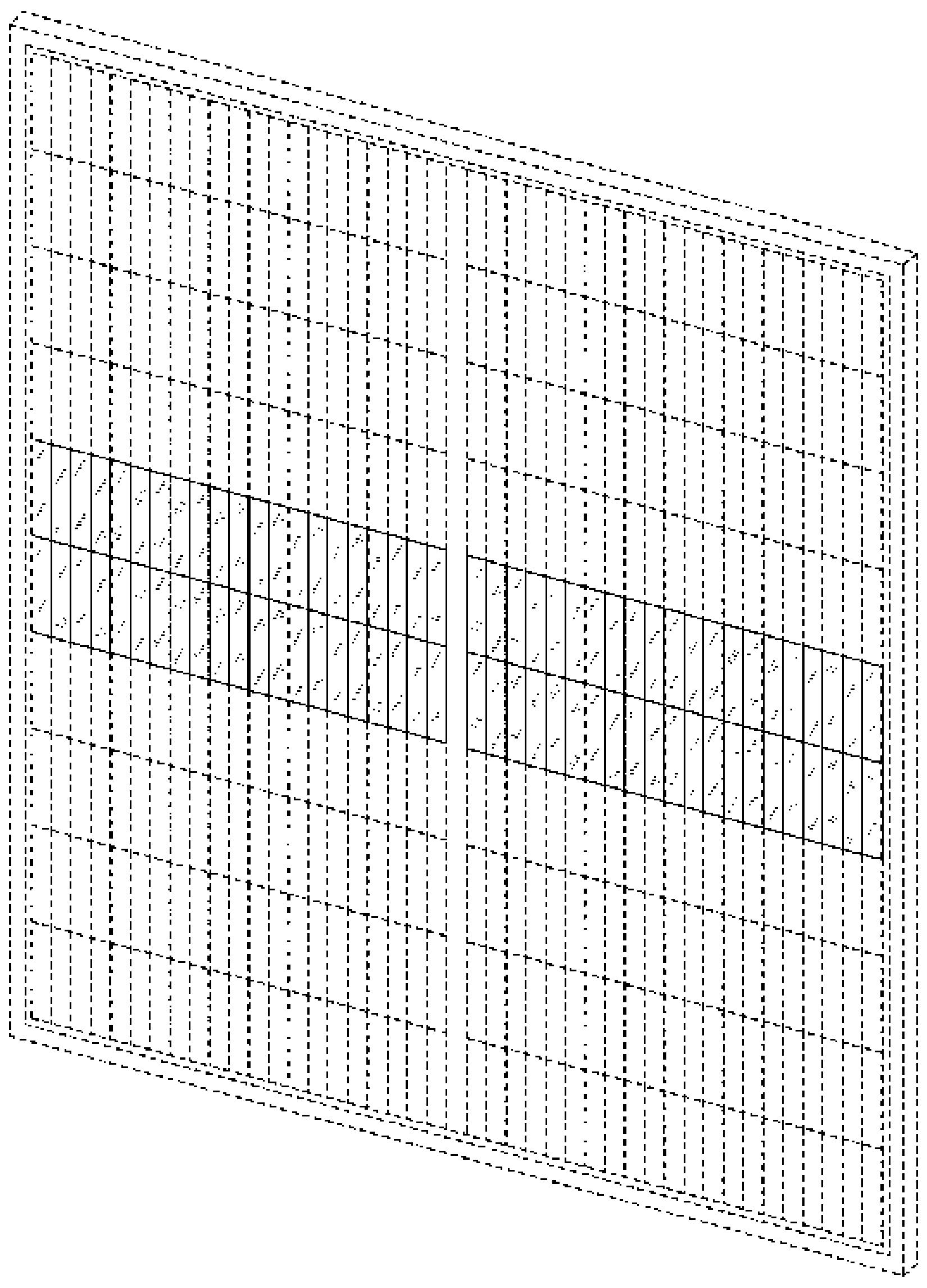

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See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,938,938	A		5/1960	Dickson, Jr.	
3,116,171	A		12/1963	Neilsen et al.	
3,340,096	A		9/1967	Mann et al.	
3,459,597	A		8/1969	Baron	
3,769,091	A		10/1973	Leinkram et al.	
3,811,181	A		5/1974	Leinkram et al.	
3,837,924	A		9/1974	Baron	
4,097,310	A		6/1978	Lindmayer	
4,189,881	A	*	2/1980	Hawley	H02S 20/23 52/509
4,257,821	A		3/1981	Kelly et al.	
4,321,416	A	*	3/1982	Tennant	H01L 31/05 52/173.3
4,362,128	A		12/1982	Downey	
4,449,514	A		5/1984	Selcuk	
4,617,420	A		10/1986	Dilts et al.	
4,617,421	A		10/1986	Nath et al.	
4,652,693	A		3/1987	Baron	
4,805,006	A		2/1989	Yamaguchi et al.	
4,836,861	A		6/1989	Peltzer et al.	
4,877,460	A		10/1989	Flodl	
5,171,717	A		12/1992	Broom et al.	
D332,509	S		1/1993	Kovatch	
D353,129	S		12/1994	Ricaud et al.	
5,590,495	A		1/1997	Bressler et al.	
5,610,919	A		3/1997	Willard et al.	
5,616,185	A		4/1997	Kukula	
D389,817	S		1/1998	Umetsu	
D391,921	S		3/1998	Zimmer et al.	
D397,990	S		9/1998	Fukuhara et al.	
6,017,123	A		1/2000	Bleha et al.	
6,018,123	A		1/2000	Takada et al.	
6,034,322	A		3/2000	Pollard	
6,180,868	B1		1/2001	Yoshino et al.	
6,218,605	B1		4/2001	Dally et al.	
D442,915	S		5/2001	Sasaoka	
6,232,545	B1		5/2001	Samaras et al.	
6,288,323	B1		9/2001	Hayashi et al.	
6,303,853	B1		10/2001	Fraas et al.	
6,315,575	B1		11/2001	Kajimoto	
6,353,175	B1		3/2002	Fraas	
6,414,235	B1		7/2002	Luch	
6,441,297	B1		8/2002	Keller et al.	
6,489,553	B1		12/2002	Fraas et al.	
D469,057	S	*	1/2003	Shugar	D13/102
6,525,262	B1		2/2003	Makita et al.	
6,538,193	B1		3/2003	Fraas	
6,563,289	B1		5/2003	Cross	
6,573,445	B1		6/2003	Burgers	
6,583,522	B1		6/2003	McNulty et al.	
D479,191	S		9/2003	Peress et al.	
6,653,550	B2		11/2003	Hayashi et al.	
6,670,787	B2		12/2003	Tachibana	
D487,884	S		3/2004	Peress et al.	
6,770,544	B2		8/2004	Sawada	
6,803,513	B2		10/2004	Beemink et al.	
D501,563	S		2/2005	Miller et al.	
D543,502	S		5/2007	Yamashita et al.	
7,238,872	B1		7/2007	Gonsiorawski	
7,271,333	B2		9/2007	Fabick et al.	
7,334,451	B1		2/2008	Fauveau	
7,388,146	B2		6/2008	Fraas et al.	
7,390,961	B2		6/2008	Aschenbrenner et al.	
D582,842	S		12/2008	Wei	
D588,534	S		3/2009	Sharma et al.	
7,507,903	B2		3/2009	Luch	
7,534,699	B2		5/2009	Wong et al.	
7,635,810	B2		12/2009	Luch	
7,772,484	B2		8/2010	Li et al.	
7,777,128	B2		8/2010	Montello et al.	
7,781,672	B2		8/2010	Gaudiana et al.	
7,825,329	B2		11/2010	Basol	
7,829,781	B2		11/2010	Montello et al.	
7,829,785	B2		11/2010	Basol	
7,851,700	B2		12/2010	Luch	
7,868,249	B2		1/2011	Luch	
7,872,192	B1		1/2011	Fraas et al.	
7,910,822	B1		3/2011	Funcell	
7,989,692	B2		8/2011	Luch	
7,989,693	B2		8/2011	Luch	
D652,376	S		1/2012	Nomi et al.	
8,110,737	B2		2/2012	Luch	
8,138,413	B2		3/2012	Luch et al.	
D658,119	S		4/2012	Bamberg et al.	
8,207,440	B2		6/2012	Basol	
8,222,513	B2		7/2012	Loch	
8,304,646	B2		11/2012	Luch	
8,319,097	B2		11/2012	Luch	
8,378,209	B2		2/2013	Masson et al.	
8,513,095	B1		8/2013	Funcell et al.	
D694,175	S		11/2013	Kannou et al.	
8,574,943	B2		11/2013	Murray et al.	
8,586,875	B2		11/2013	Morita et al.	
D696,186	S		12/2013	Kannou et al.	
8,729,385	B2		5/2014	Loch	
8,766,090	B2		7/2014	Sewell et al.	
8,829,330	B2		9/2014	Meyer et al.	
8,835,745	B2	*	9/2014	Intrieri	H01L 31/0521 136/246
8,907,203	B2		12/2014	Nasuno et al.	
D724,012	S		3/2015	Zhan	
9,006,559	B2		4/2015	Kobamoto et al.	
9,099,588	B2		8/2015	Letocart et al.	
9,100,868	B2		8/2015	Pedersen et al.	
9,147,788	B2		9/2015	Degroot et al.	
D741,793	S		10/2015	Lim et al.	
9,216,607	B2		12/2015	Endo et al.	
D750,556	S		3/2016	Morad et al.	
9,343,595	B2		5/2016	Fu et al.	
D762,163	S		7/2016	Parilla et al.	
9,397,252	B2		7/2016	Morad et al.	
D767,484	S		9/2016	Morad et al.	
9,484,484	B2		11/2016	Morad et al.	
2001/0050101	A1		12/2001	Makita et al.	
2001/0054262	A1		12/2001	Nath et al.	
2003/0029494	A1		2/2003	Ohkubo	
2003/0121228	A1		7/2003	Stoehr et al.	
2004/0097012	A1		5/2004	Weber et al.	
2004/0123895	A1		7/2004	Kardauskas et al.	
2004/0261836	A1		12/2004	Kataoka et al.	
2005/0126619	A1		6/2005	Abe et al.	
2005/0133079	A1		6/2005	Boulanger et al.	
2005/0217717	A1		10/2005	Faris	
2005/0263178	A1		12/2005	Montello et al.	
2006/0042682	A1		3/2006	Wolfe et al.	
2006/0276420	A1		12/2006	Keller et al.	
2007/0045831	A1		3/2007	Wong et al.	
2007/0107766	A1		5/2007	Langley, II et al.	
2007/0181175	A1		8/2007	Landis	
2007/0281355	A1		12/2007	Dalton et al.	
2007/0283996	A1		12/2007	Hachtmann et al.	
2007/0283997	A1		12/2007	Hachtmann et al.	
2007/0295381	A1		12/2007	Fujii et al.	
2008/0156365	A1		7/2008	Scholz et al.	
2008/0216887	A1		9/2008	Hacke et al.	
2009/0000221	A1		1/2009	Jacobs et al.	
2009/0014058	A1		1/2009	Croft et al.	
2009/0014505	A1		1/2009	Croft et al.	
2009/0038671	A1		2/2009	Yamaguchi	
2009/0114279	A1		5/2009	Zhao et al.	
2009/0229596	A1		9/2009	Shin et al.	
2009/0229663	A1		9/2009	Appadurai	
2009/0277491	A1		11/2009	Nakamura et al.	
2010/0001587	A1		1/2010	Casey et al.	
2010/0012172	A1		1/2010	Meakin et al.	
2010/0043863	A1		2/2010	Wudu et al.	
2010/0071752	A1		3/2010	Vellore et al.	
2010/0075151	A1		3/2010	Weingord et al.	

2010/0078057	A1	4/2010	Karg et al.
2010/0078064	A1	4/2010	Coakly
2010/0084004	A1	4/2010	Ortabasi
2010/0126554	A1	5/2010	Morgan et al.
2010/0131108	A1	5/2010	Meyer
2010/0136748	A1	6/2010	Autry
2010/0139734	A1	6/2010	Hadar et al.
2010/0144033	A1	6/2010	Mandalam et al.
2010/0147364	A1	6/2010	Gonzalez et al.
2010/0175743	A1	7/2010	Gonzalez et al.
2010/0218799	A1	9/2010	Stefani
2010/0218824	A1	9/2010	Luch
2010/0224230	A1	9/2010	Luch et al.
2010/0243024	A1	9/2010	Hashimoto et al.
2010/0308662	A1	12/2010	Schatz et al.
2011/0005572	A1	1/2011	Shimizu
2011/0017257	A1	1/2011	Lee et al.
2011/0036390	A1	2/2011	Nelson et al.
2011/0048501	A1	3/2011	Jaus et al.
2011/0079263	A1	4/2011	Avrutsky
2011/0114157	A1	5/2011	Meissner
2011/0114158	A1	5/2011	Lenox
2011/0114165	A1	5/2011	Chang
2011/0146750	A1	6/2011	Nasuno et al.
2011/0151561	A1	6/2011	Davis et al.
2011/0155209	A1	6/2011	Tober et al.
2011/0168237	A1	7/2011	Takeda et al.
2011/0168238	A1	7/2011	Metin et al.
2011/0192448	A1	8/2011	Croft et al.
2011/0214714	A1	9/2011	Aberle et al.
2011/0240337	A1	10/2011	Motello et al.
2011/0259417	A1	10/2011	Toyokawa et al.
2011/0271999	A1	11/2011	Almogy et al.
2011/0272004	A1	11/2011	Davis et al.
2011/0275175	A1	11/2011	Minsek et al.
2011/0315184	A1	12/2011	Kabade
2012/0000502	A1	1/2012	Wiedeman et al.
2012/0031457	A1	2/2012	Taira et al.
2012/0031470	A1	2/2012	Dimov et al.
2012/0037206	A1	2/2012	Norman et al.
2012/0048349	A1	3/2012	Metin et al.
2012/0118355	A1	5/2012	Rudolfs
2012/0125391	A1	5/2012	Pinarbasi et al.
2012/0149110	A1	6/2012	Kitamura et al.
2012/0152327	A1	6/2012	Pinarbasi et al.
2012/0152349	A1	6/2012	Cao et al.
2012/0204935	A1	8/2012	Meyer et al.
2012/0211049	A1	8/2012	Kobamoto et al.
2012/0234388	A1	9/2012	Stancel et al.
2012/0244656	A1	9/2012	Kim et al.
2012/0268087	A1	10/2012	Kemahan
2012/0279548	A1	11/2012	Munch et al.
2012/0298166	A1	11/2012	Chen et al.
2012/0318318	A1	12/2012	Metin et al.
2012/0318319	A1	12/2012	Pinarbasi et al.
2012/0325282	A1	12/2012	Snow et al.
2013/0048046	A1	2/2013	Domsic et al.
2013/0068279	A1	3/2013	Buller et al.
2013/0096710	A1	4/2013	Pinarbasi et al.
2013/0133743	A1	5/2013	Grah
2013/0152996	A1	6/2013	Degroot et al.
2013/0156743	A1	6/2013	Vallier et al.
2013/0160823	A1	6/2013	Khouri et al.
2013/0160824	A1	6/2013	Khouri et al.
2013/0164266	A1	6/2013	Jensen
2013/0203206	A1	8/2013	Umeda et al.
2013/0206203	A1	8/2013	Lommasson et al.
2013/0206206	A1	8/2013	Bjorneklett et al.
2013/0206210	A1	8/2013	Niinobe et al.
2013/0206213	A1	8/2013	He et al.
2013/0206221	A1	8/2013	Gannon et al.
2013/0213469	A1	8/2013	Kramer et al.
2013/0269748	A1	10/2013	Wiedeman et al.
2014/0060610	A1	3/2014	Moslehi et al.
2014/0060638	A1	3/2014	Oh et al.
2014/0102519	A1	4/2014	Rodrigues et al.
2014/0102537	A1	4/2014	Malik, Jr.
2014/0116495	A1	5/2014	Kim et al.
2014/0124014	A1	5/2014	Morad et al.
2014/0124027	A1	5/2014	Teshima et al.
2014/0158201	A1	6/2014	Aitken et al.
2014/0213013	A1	7/2014	Britt et al.
2014/0271566	A1	9/2014	Agulnick
2014/0318613	A1	10/2014	Von Campe et al.
2014/0326295	A1	11/2014	Moslehi
2014/0329321	A1	11/2014	Rajesh et al.
2014/0352765	A1	12/2014	Nakamura
2014/0352773	A1	12/2014	Chuang et al.
2014/0367887	A1	12/2014	Sachs et al.
2015/0007883	A1	1/2015	Ikenaga et al.
2015/0027513	A1	1/2015	Ring et al.
2015/0068592	A1	3/2015	Kommera et al.
2015/0136221	A1	5/2015	Miyazaki et al.
2015/0171239	A1	6/2015	Tanaka et al.
2015/0243534	A1	8/2015	Osenbach
2015/0349162	A1	12/2015	Morad et al.
2016/0158890	A1	6/2016	Gonzalez et al.
2016/0163888	A1	6/2016	Reddy
2016/0163903	A1	6/2016	Yang et al.
2016/0163907	A1	6/2016	Gonzalez et al.
2016/0163908	A1	6/2016	Gonzalez et al.
2016/0163909	A1	6/2016	Gonzalez et al.
2016/0163910	A1	6/2016	Gonzalez et al.
2016/0163912	A1	6/2016	Gonzalez et al.
2016/0163913	A1	6/2016	Gonzalez et al.
2016/0163914	A1	6/2016	Gonzalez et al.

FOREIGN PATENT DOCUMENTS

EM	000034350-0001	4/2003
EM	001955030-0002	11/2011
EM	002032581-0005	4/2012
EM	001386056-0001	10/2013
WO	2015/183827 A2	12/2015

OTHER PUBLICATIONS

Office Action dated Feb. 1, 2016, corresponding to U.S. Appl. No. 14/565,820, 62 pages.

R.A. Matula, "Electrical Resistivity of Copper, Gold, Palladium, and Silver" J. Phys. Chem. Ref. Data, vol. 8, No. 4, 1979.

3M TM Thermally Conductive Heat Spreading Tape 98768-05 98768-08 9876-10 9876-15, pp. 1-4.

D.W.K. Eikelboom, "Conductive Adhesives for Low-Stress Interconnection of Thin Back-Contact Solar Cells", 29th IEEE Photovoltaic Specialists Conference, May 20-24, 2002, New Orleans, USA.

Geoffrey R. Walker, "Cascaded DC-DC Converter Connection of Photovoltaic Modules", IEEE Transactions On Dower Electronics, vol. 19, No. 4, Jul. 2004.

F.C. Nix, Phys. Rev. 57, 744 (1940).

"ST Microelectronics, How to choose a bypass diode for a silicon panel junction box", AN3432, 24 pages.

F.C. Nix et al., "The Thermal Expansion of Pure Metals: Copper, Gold, Aluminum, Nickel, and iron", Oct. 15, 2914, vol. 60, 9 pages.

Goldberg, Lee H., "Active Bypass Diodes Improve Solar Panel Efficiency and Performance", Digi-Key Corporation, ittp://www.digikey.com/en/articles/techzone/2012/dec/ctivebypassdiodesimprovesolarpanelefficiencyandperformance, Dec. 12, 2012, 8 pages.

Herrmann, W et al., "Operational Behaviour of Commercial Solar Cells Under Reverse Biased Conditins", TON./Rheinland Sicherheit und Umweltschutz GmbH, 3 pages.

Creative Materials, "Product Announcement: Flexible Electrically Conductive Adhesive Family As Solder Replacements In Solar Cells", hffp://www.creativematerials.com/news/pr-conductive-3dhesive-for-solar-cells.php, Feb. 9, 2015, 2 pages.

Creative Materials, "124-08 NB Electrically Conductive Epoxy Adhesive", www. creativematerials.com, Apr. 22, 2010, Revision: E, 1 page.

Herrmann, W. et al. "Hot Spot Investigations on PV Modules—New Concepts for a Test Standard and Consequences for Module Design with Respect to Bypass Diodes", TUV Rheinland Sicherheit und Umweltschutz GmbH, 4 pages.

Yang, et al., "investigation of the Relationship between Reverse Current of Crystalline Silicon Solar Celis and Conduction of Bypass

Diode", Hindawi Publishing Corporation International Journal of Photoenergy, vol. 2012, Article ID 357218, 6 pages.
Breitenstein, 0. et al., "Shunts due to laser scribing of solar cells evaluated by highly sensitive lock-in hermography", 11th International Photovoltaic Science and Engineering Conference (PVSEC-11), Sep. 20-24, 1999 Sapporo, Japan, 9 pages.
Kyocera, News Releases 2009, "KYOCERA, Explains innovations Used in Solar Panel for New Toyota Prius", http://global.kyocera.com/new/2009/0902/fpri.htnnl, Dec. 21, 2014, 2 pages.
Herrmann, W. et al., "Hot Spot Investigations on PV Modules—New Concepts for a Test Standard and consequences for Module Design with Respect to Bypass Diodes," TUV Rheinland Sicherheit and Umweltschutz GmbH, http://ieeexplore.ieee.org, Dec. 20, 2014, 6 pages.
Viaki, et al., "Power Losses in Long String and Parallel-Connected Short Strings of Series-Connected Silicon-Based Photovoltaic Modules Due to Partial Shading Conditions", IEEE Transactions on Energy Conversion, vol. 27, No. 1, Mar. 2012, pp. 173-183.
Halavani, et al., "Results of Pressue-Only Cell Interconnections in High Voltage PV-Modules", 29th European Photovoltaic Solar Energy Conference and Exhibition, Vienna University of Technology, pp. 64-68.
Heimann, M., et al., "Ultrasonic Bonding of Aluminum Ribbons to Interconnect High-Efficiency Crystalline-Silicon Solar Cells", Energy Procedia 27 (2012) pp. 670-675.
Silvestre S., et al., "Study of bypass diodes configuration on PV modules", Applied Energy 86 (2009) pp. 1632-1640.
Scholten, "Silicone Encapsulation of c-Si Photovoltaic Modules", Solar Nevus Today, Feb. 10, 2014, 5 pages, lttp://www.solarnovus.com.
3Mtm "Thermally Conductive Heat Spreading Tape, 9876B-05, 9876B-08, 9876-10, 9876-15", Nov. 2012, pp. 1-4.
STMicroelectronics, "How to choose a bypass diode for a silicon panel junction box", Sep. 2011, pp. 1-24.
Kray, D., et al., "Reducing AG Cost and Increasing Efficiency. Multicrystalline Silicon Solar Cells With Direct Plated Contacts Exceeding 17% Efficiency", 26th EU PVSEC Proceedings, pp. 1199-1202.
Viatula, J. Phys. Chem. Ref. Daa, vol. 8, No. 4, 1979.

* cited by examiner

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(57) CLAIM

The ornamental design for a solar panel, as shown and described.

DESCRIPTION

FIG. **1** is a front, top, and right side perspective view of a solar panel.
FIG. **2** is a front elevational view thereof, the rear elevational view forming no part of the claimed design.
FIG. **3** is a top plan view thereof, the bottom plan view being a mirror image of the top plan view shown.
FIG. **4** is a left side elevational view thereof, the right side elevational view being a mirror image of the left side elevational view shown.
FIG. **5** is a detail view of the callout box **5** in FIG. **2**; and,
FIG. **6** is a detail view along line **6**-**6** in FIG. **5**.
The broken lines show portions of the solar panel that form no part of the claimed design.

1 Claim, 3 Drawing Sheets

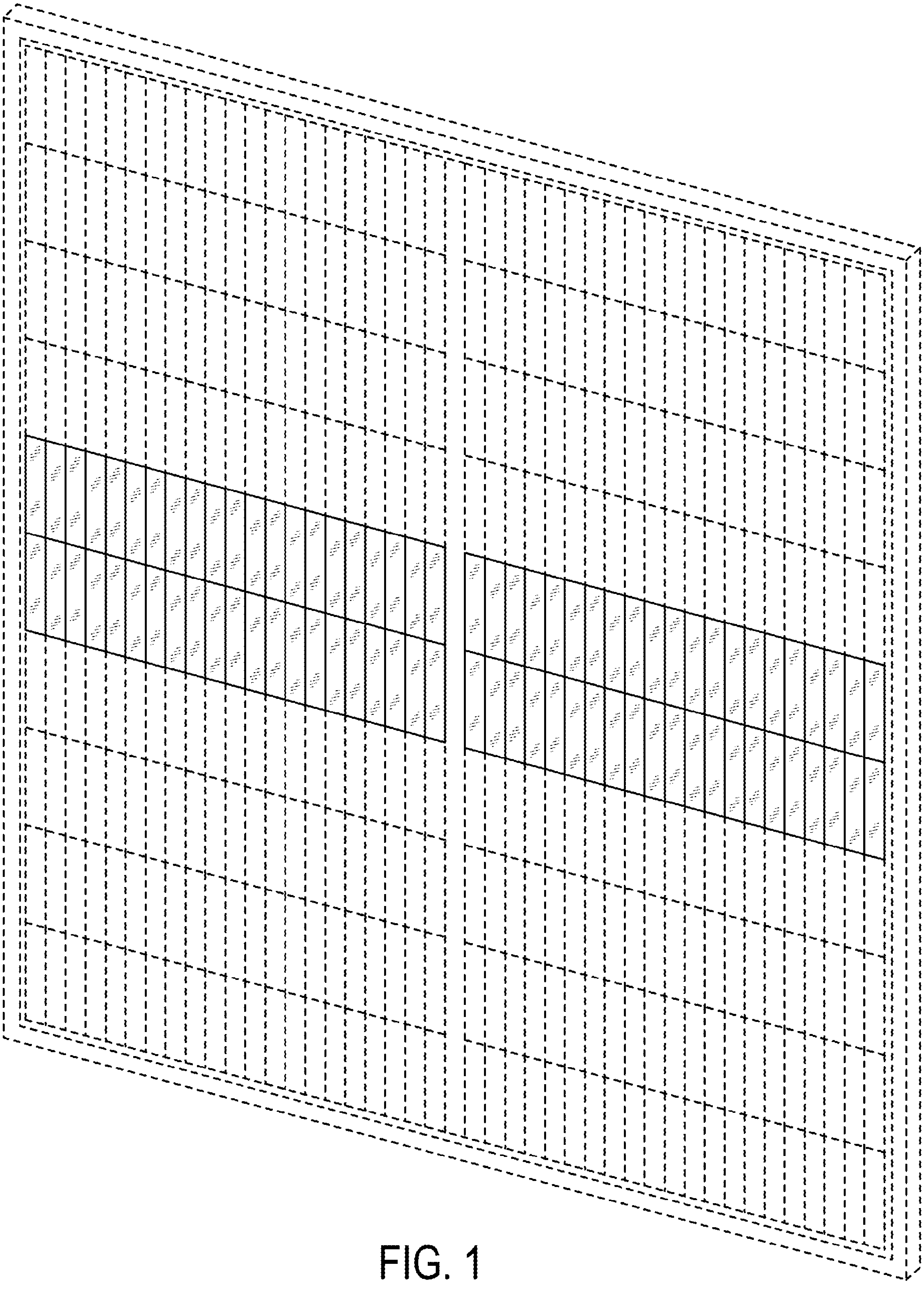

FIG. 1

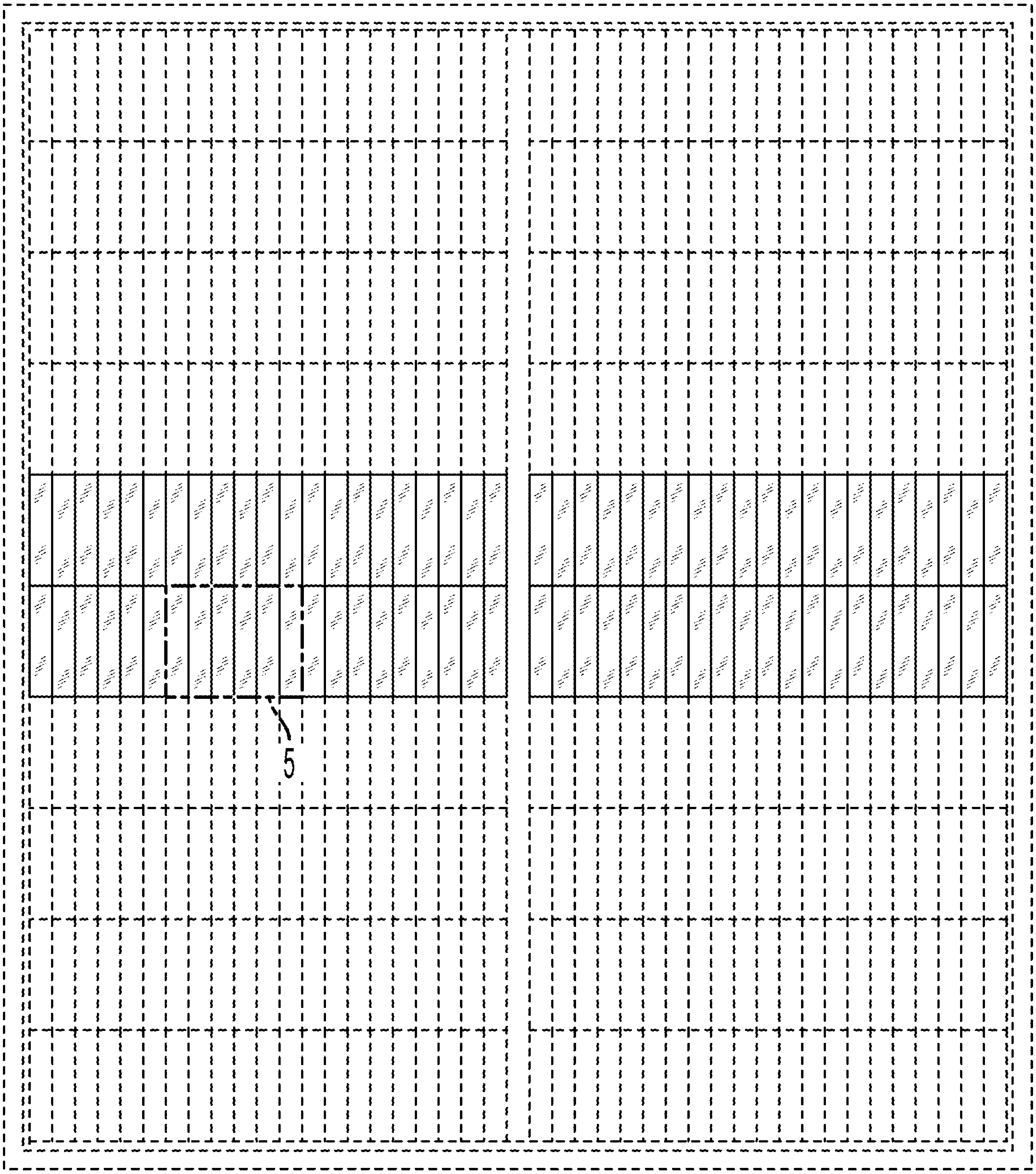

FIG. 2

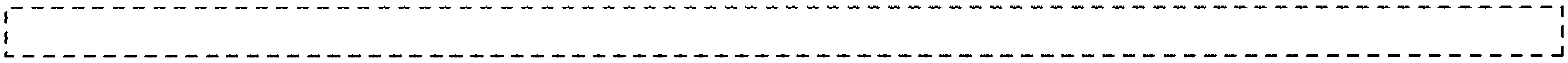

FIG. 3

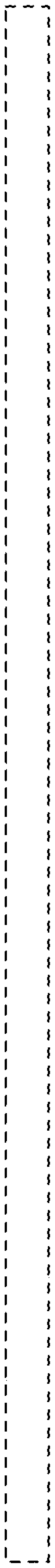

FIG. 4

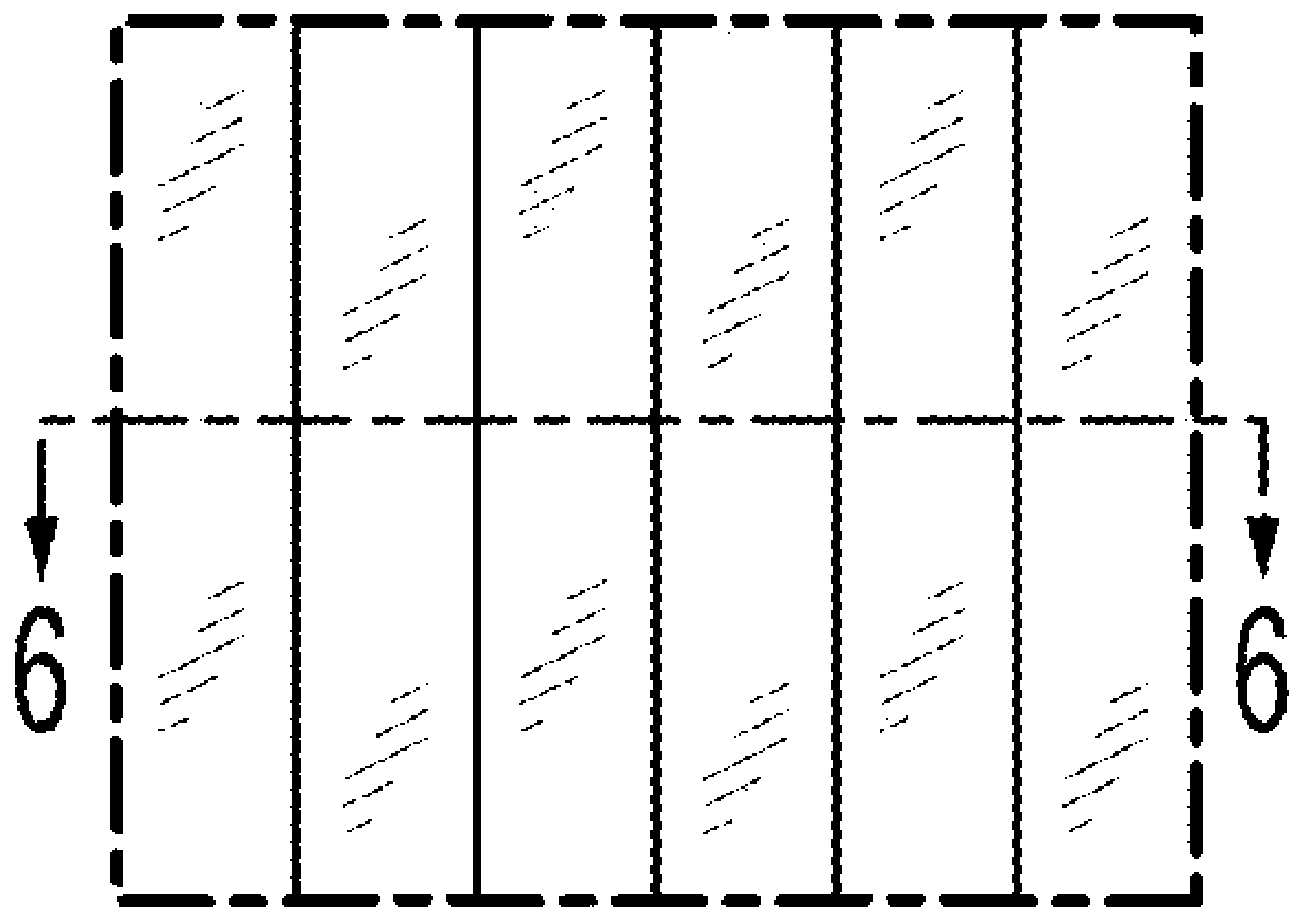

FIG. 5

FIG. 6