US00D806647S

(12) United States Design Patent

Lau et al.

(10) Patent No.: US D806,647 S
(45) Date of Patent: ** Jan. 2, 2018

(54) **BATTERY CHARGER**

(71) Applicant: **Delta-Q Technologies Corp.**, Burnaby (CA)

(72) Inventors: **Ngai Eric Lau**, Burnaby (CA); **Jeff Douglas Everett**, Vancouver (CA); **Jonathan Eric Stroud**, Surrey (CA); **James Lennox Fox**, Vancouver (CA)

(73) Assignee: **DELTA-Q TECHNOLOGIES CORP.**, Burnaby (CA)

(**) Term: **15 Years**

(21) Appl. No.: **29/535,892**

(22) Filed: **Aug. 11, 2015**

(51) **LOC (11) Cl.** **13-02**

(52) **U.S. Cl.**
USPC **D13/107**; D13/110

(58) **Field of Classification Search**
USPC D13/107–110, 118–119, 184; D14/251, D14/253, 432, 434
CPC Y02E 60/12; Y02T 90/14; Y02T 90/122; Y02T 90/128; Y02T 90/163; H02J 7/025; H02J 7/0042; H02J 7/0044; H02J 7/0045; H02J 7/0003; H01F 38/14; H01R 13/6675; H01M 2/1022; H01M 2/1055; H01M 10/44; H01M 10/46; H01M 10/425; B60L 11/182
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

D203,543	S *	1/1966	Coe	174/16.3
3,938,024	A	2/1976	Clarke	
4,412,277	A	10/1983	Mitchell	
4,559,590	A	12/1985	Davidson	
D305,115	S	12/1989	Kondo et al.	
4,885,675	A	12/1989	Henze et al.	
5,001,620	A	3/1991	Smith	
5,034,871	A	7/1991	Okamoto et al.	
5,065,278	A	11/1991	Schultz	

(Continued)

FOREIGN PATENT DOCUMENTS

CA	2 806 870	A1	4/2014
WO	2010/025596	A1	3/2010

OTHER PUBLICATIONS

Chen et al., "Digital Control for Improved Efficiency and Reduced Harmonic Distortion Over Wide Load Range in Boost PFC Rectifiers," *IEEE Transactions on Power Electronics 25*(10):2683-2692, Oct. 2010.

(Continued)

Primary Examiner — Rosemary K Tarcza
Assistant Examiner — Nathaniel D. Buckner
(74) *Attorney, Agent, or Firm* — Seed IP Law Group LLP

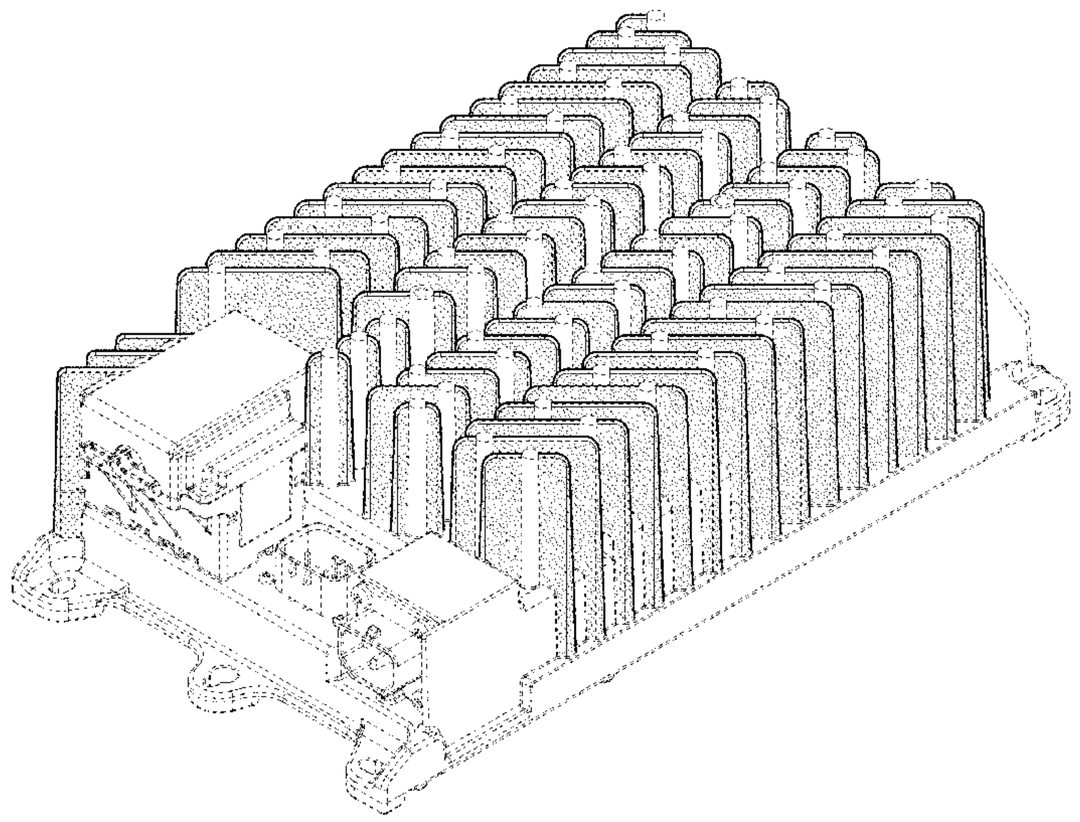
(57) **CLAIM**

The ornamental design for a battery charger, as shown and described.

DESCRIPTION

FIG. **1** is a top right-front isometric view of a battery charger showing an embodiment of our new design.
FIG. **2** is a bottom left-rear isometric view thereof.
FIG. **3** is a top left-rear isometric view thereof.
FIG. **4** is a bottom right-rear isometric view thereof.
FIG. **5** is a top left-front isometric view thereof.
FIG. **6** is a top right-rear isometric view thereof.
FIG. **7** is a top plan view thereof.
FIG. **8** is a bottom plan view thereof.
FIG. **9** is a front elevational view thereof.
FIG. **10** is a rear elevational view thereof.
FIG. **11** is a left side elevational view thereof; and,
FIG. **12** is a right side elevational view thereof.
The broken lines in the figures represent portions of the article which form no part of the claim.

1 Claim, 10 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

5,077,486	A		12/1991	Marson et al.
D328,057	S		7/1992	Prager et al.
D336,074	S		6/1993	Friend et al.
D338,653	S		8/1993	Morgan et al.
D351,134	S		10/1994	Hunziker
5,355,300	A		10/1994	Zinn
D360,186	S	*	7/1995	Netz D13/124
5,490,057	A		2/1996	Vinciarelli et al.
5,602,462	A		2/1997	Stich et al.
D378,915	S	*	4/1997	Widmayer D13/179
D379,088	S		5/1997	Hopper
D379,799	S		6/1997	Widmayer et al.
D381,011	S	*	7/1997	Widmayer D13/179
D388,399	S		12/1997	Widmayer et al.
D401,216	S		11/1998	Person et al.
D409,139	S		5/1999	Cornell et al.
D410,652	S		6/1999	Jones et al.
D416,873	S		11/1999	Korsunsky et al.
D427,146	S		6/2000	Wei
D427,147	S		6/2000	Wei
D449,817	S		10/2001	Takeuchi et al.
6,320,772	B1		11/2001	Doyama et al.
D458,228	S		6/2002	Jacobson
6,462,966	B1		10/2002	Leung et al.
6,650,559	B1		11/2003	Okamoto et al.
D489,682	S		5/2004	Guillarme
6,736,195	B2		5/2004	Busch et al.
6,809,678	B2		10/2004	Vera et al.
6,841,979	B2		1/2005	Berson et al.
6,847,195	B2		1/2005	Chen
6,862,201	B2		3/2005	Hodge, Jr.
D505,915	S		6/2005	Hussaini et al.
7,116,090	B1		10/2006	Yang et al.
7,198,094	B2		4/2007	Barsun et al.
D541,743	S		5/2007	Virolainen et al.
D541,744	S		5/2007	Virolainen et al.
D541,745	S		5/2007	Virolainen et al.
D551,621	S	*	9/2007	Iacovelli D13/110
D562,765	S	*	2/2008	Tsuzuki D13/110
7,365,987	B2		4/2008	Jeong
D568,841	S		5/2008	Fischer et al.
D571,314	S		6/2008	Horng
7,535,716	B2		5/2009	Fischer et al.
D593,512	S		6/2009	Lin
7,616,455	B2		11/2009	Cameron et al.
D606,017	S		12/2009	Charlson et al.
D638,376	S		5/2011	Herrmann et al.
D651,200	S		12/2011	Sugime et al.
D652,156	S	*	1/2012	Li D26/2
D664,544	S	*	7/2012	Yi D14/436
D677,621	S		3/2013	Beroukas et al.
D678,852	S		3/2013	Marshall
D691,558	S		10/2013	Helosvouri et al.
8,546,974	B2		10/2013	Foxall et al.
8,552,695	B2		10/2013	Stracquadaini
8,598,737	B2		12/2013	Foxall et al.
D698,481	S	*	1/2014	Wasserman D26/120
D702,376	S	*	4/2014	Su D26/2
D703,132	S		4/2014	Pearson et al.
8,803,489	B2		8/2014	Li et al.
D713,336	S		9/2014	Perin
8,937,469	B2		1/2015	Clark et al.
D751,241	S	*	3/2016	Aldape D26/118
D751,751	S		3/2016	Lockart et al.
D755,740	S		5/2016	Chen et al.
D767,815	S	*	9/2016	Lee D26/113
2002/0149951	A1		10/2002	Leung et al.
2010/0110593	A1		5/2010	Kim et al.
2010/0165683	A1		7/2010	Sugawara
2010/0259240	A1		10/2010	Cuk
2011/0110127	A1		5/2011	Lee
2011/0211377	A1		9/2011	Uno
2011/0292703	A1		12/2011	Cuk
2012/0069615	A1		3/2012	Tomioka
2012/0249102	A1		10/2012	Cuk
2012/0256606	A1		10/2012	van den Broeke
2013/0235631	A1		9/2013	Pahlevaninezhad et al.
2015/0263605	A1		9/2015	Alam

OTHER PUBLICATIONS

Clark, "Digital Control Techniques for Power Quality Improvements in Power Factor Correction Applications," master's thesis, University of British Columbia, Jul. 2012, 114 pages.

De Gussemé et al., "Digitally Controlled Boost Power-Factor-Correction Converts Operating in Both Continuous and Discontinuous Conduction Mode," *IEEE Transactions on Industrial Electronics 52*(1):88-97, Feb. 2005.

De Gussemé et al., "Input-Current Distortion of CCM Boost PFC Converts Operated in DCM," *IEEE Transactions on Industrial Electronics 54*(2):858-865, Apr. 2007.

De Gussemé et al., "Sample Correction for Digitally Controlled Boost PFC Converters Operating in both CCM and DCM," *Eighteenth Annual IEEE Applied Power Electronics Conference and Exposition 1*:389-395, Feb. 9-13, 2003.

de Souza et al., "A New ZVS-PWM Unity Power Factor Rectifier with Reduced Conduction Losses," *IEEE Transactions on Power Electronics 10*(6):746-752, Nov. 1995.

de Souza et al., "High Power Factor Rectifier with Reduced Conduction and Commutation Losses," 21st International Telecommunication Energy Conference, Copenhagen, Jun. 6-9, 1999, 5 pages.

Dixon, "Average Current Mode Control of Switching Power Supplies," Unitrode Application Note U-140, pp. 3-356-3-369, 1990.

Dixon, "Average Current Mode Control of Switching Power Supplies—Topic 5," Unitrode Corporation, pp. 5-1-5-14, 2001, 16 pages.

Erickson et al., *Fundamentals of Power Electronics*, Second Edition, Kluwer Academic Publishers, Secaucus, NJ, 2001, 12 pages, Table of Contents.

Fairchild Semiconductor, "FAN7930: Critical Conduction Mode PFC Controller," Apr. 2010, 22 pages.

Huber et al., "Performance Evaluation of Bridgeless PFC Boost Rectifiers," *IEEE Transactions on Power Electronics 23*(3):1381-1390, May 2008.

Hwang et al., "Seamless Boost Converter Control in Critical Boundary Condition for Fuel Cell Power Conditioning System," IEEE Energy Conversion Congress and Exposition, Sep. 17-22, 2011, pp. 3641-3648.

Hwang et al., "Seamless Boost Converter Control Under the Critical Boundary Condition for a Fuel Cell Power Conditioning System," *IEEE Transactions on Power Electronics 27*(8):3616-3626, Aug. 2012.

Liou et al., "Design and Implementation of a Boost Power Factor Correction Stage Operated in Mixed-Condition Mode," International Conference of Electric Information and Control Engineering (ICEICE), Apr. 15-17, 2011, pp. 2069-2072.

Maksimović et al., "Impact of Digital Control in Power Electronics," *Proceedings of 2004 International Symposium on Power Semiconductor Devices & ICs, Kitakyushu*, pp. 13-22, 2004.

Martinez et al., "A High-Performance Single-Phase Rectifier with Input Power Factor Correction," *IEEE Transactions on Power Electronics 11*(2):311-317, Mar. 1996.

Marvi et al., "A Fully ZVS Critical Conduction Mode Boost PFC," *IEEE Transactions on Power Electronics 27*(4):1958-1965, Apr. 2012.

Moon et al., "Accurate Mode Boundary Detection in Digitally Controlled Boost Power Factor Correction Rectifiers," IEEE Energy Conversion Congress and Exposition (ECCE), Sep. 12-16, 2010, pp. 1212-1217.

Moon et al., "Autotuning of Digitally Controlled Boost Power Factor Correction Rectifiers," *IEEE Transactions on Power Electronics 26*(10):3006-3018, Oct. 2011.

Musavi et al., "A Phase-Shifted Gating Technique With Simplified Current Sensing for the Semi-Bridgeless AC-DC Converter," *IEEE Transactions on Vehicular Technology 62*(4):1568-1576, May 2013.

(56) **References Cited**

OTHER PUBLICATIONS

Roggia et al., "Digital Control System Applied to a PFC Boost Converter Operating in Mixed Conduction Mode," Brazilian Power Electronics Conference (COBEP), Sep. 2-Oct. 1, 2009, pp. 698-704.
Salmon, "Circuit topologies for pwm boost rectifiers operated from 1-phase and 3-phase ac supplies and using either single or split dc rail voltage outputs," 10*th* Annual Applied Power Electronics Conference and Exposition, Dallas, TX, Mar. 5-9, 1995, vol. 1, pp. 473-479.
Salmon, "Circuit Topologies for Single-Phase Voltage-Doubler Boost Rectifiers," *IEEE Transactions on Power Electronics* 8(4):521-529, Oct. 1993.
Sebastián et al., "The Determination of the Boundaries Between Continuous and Discontinuous Conduction Modes in PWM DC-to-DC Converters Used as Power Factor Preregulators," *IEEE Transactions on Power Electronics 10*(5):574-582, Sep. 1995.
Su et al., "An Interleaved Totem-Pole Boost Bridgeless Rectifier With Reduced Reverse-Recovery Problems for Power Factor Correction," *IEEE Transactions on Power Electronics 25*(6):1406-1415, Jun. 2010.
Tollik et al., "Comparative Analysis of 1-Phase Active Power Factor Correction Topologies," 14*th* International Telecommunications Energy Conference, Washington, DC, Oct. 4-8, 1992, pp. 517-523.
Tsai et al., "A Family of Zero-Voltage-Transition-Bridgeless Power-Factor-Correction Circuits With a Zero-Current-Switching Auxiliary Switch," *IEEE Transactions on Industrial Electronics* 58(5):1848-1855, May 2011.
Van de Sype et al., "Duty-Ratio Feedforward for Digitally Controlled Boost PFC Converters," *IEEE Transactions on Industrial Electronics 52*(1):108-115, Feb. 2005.
Wang, "A New Single-Phase ZCS-PWM Boost Rectifier With High Power Factor and Low Conduction Losses," *IEEE Transactions on Industrial Electronics 53*(2):500-510, Apr. 2006.
Lau et al., "Battery Charger," U.S. Appl. No. 29/530,060, filed Jun. 12, 2015, 18 pages.
Lau et al., "Battery Charger," U.S. Appl. No. 29/565,135, filed May 18, 2016, 26 pages.
Lau et al., "Battery Charger," U.S. Appl. No. 29/586,567, filed Dec. 5, 2016, 18 pages.
Delta-Q Technologies Corp., "Delta-Q Technologies Introduces New Lithium-Specific Battery Charger at ProMAT 2017," published Mar. 27, 2017, retrieved from http://www.prnewswire.com/news-releases/delta-q-technologoes-introduces-new-lithium-specific-battery-charger-at-promat-2017-617167523.htm on Jun. 1, 2017, 3 pages.

* cited by examiner

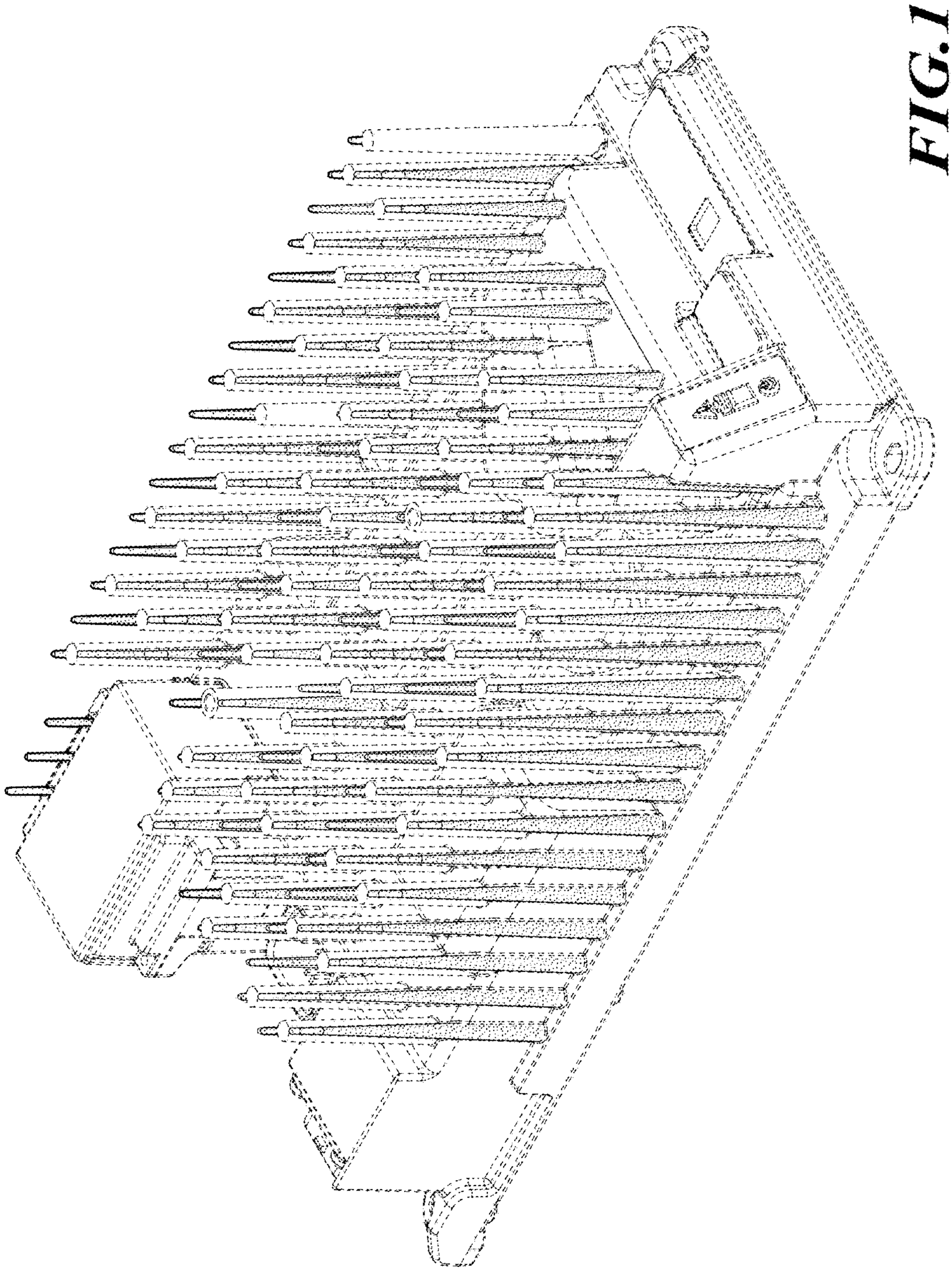


FIG. 1

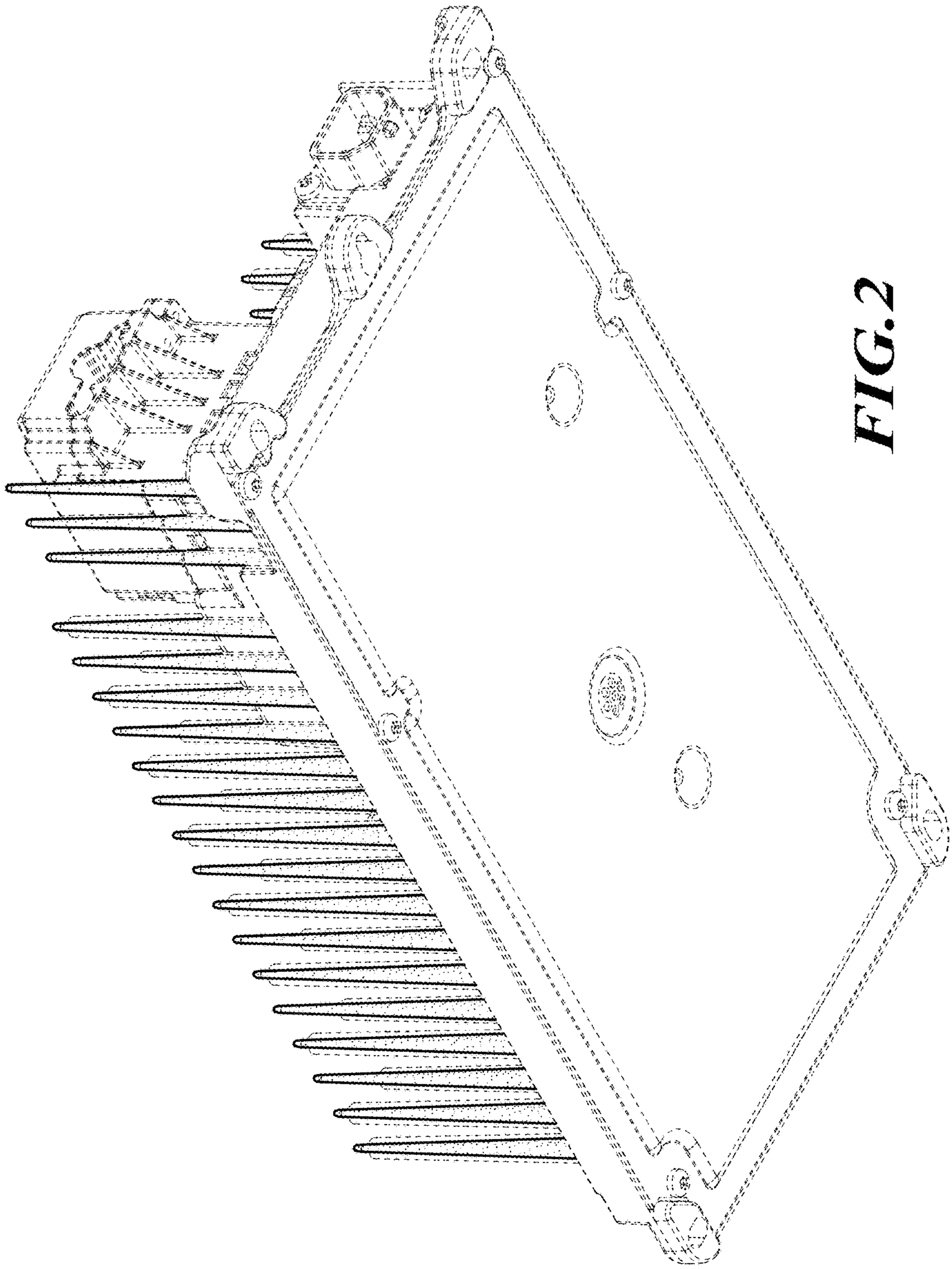
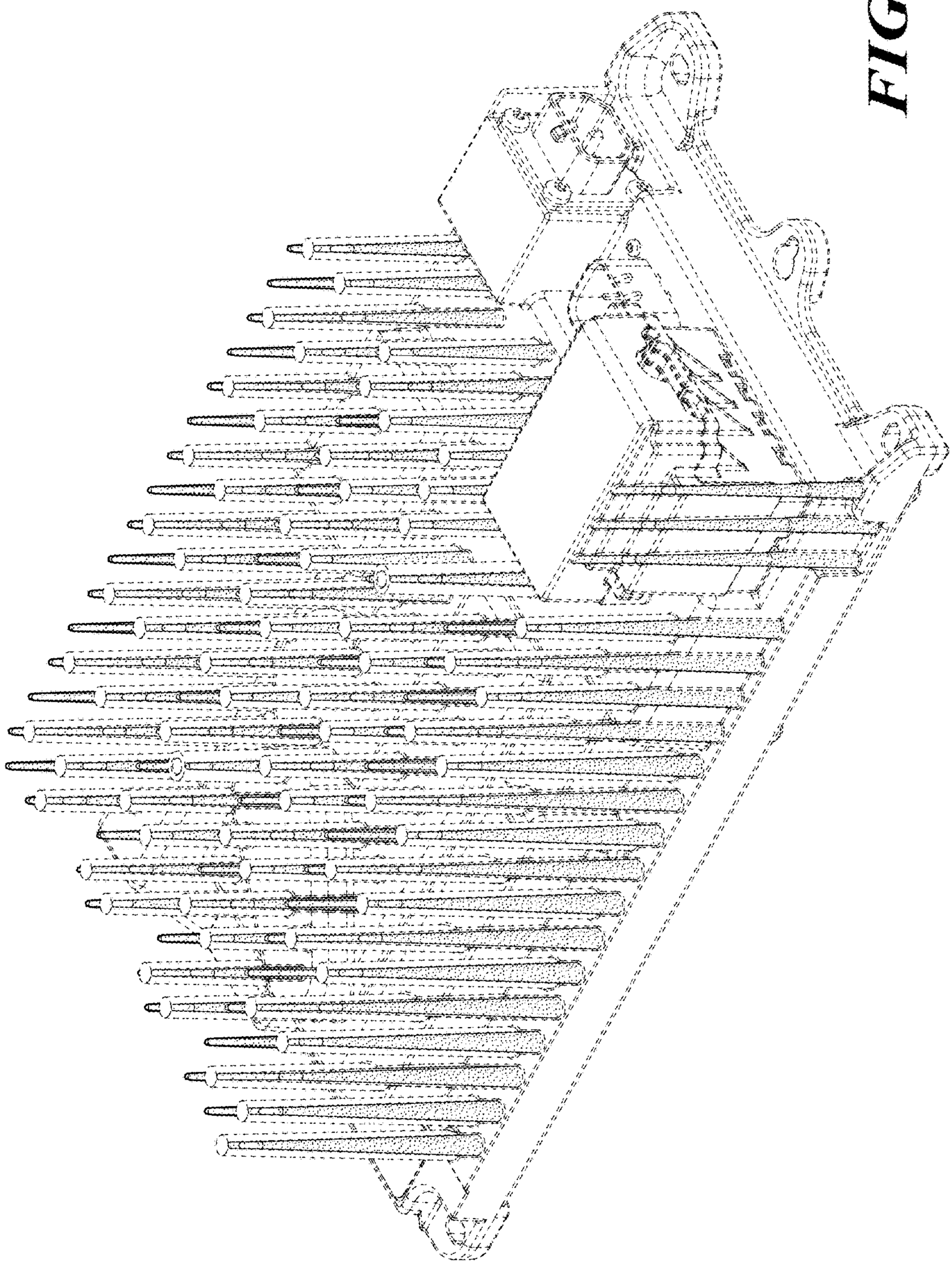


FIG.2

FIG.3



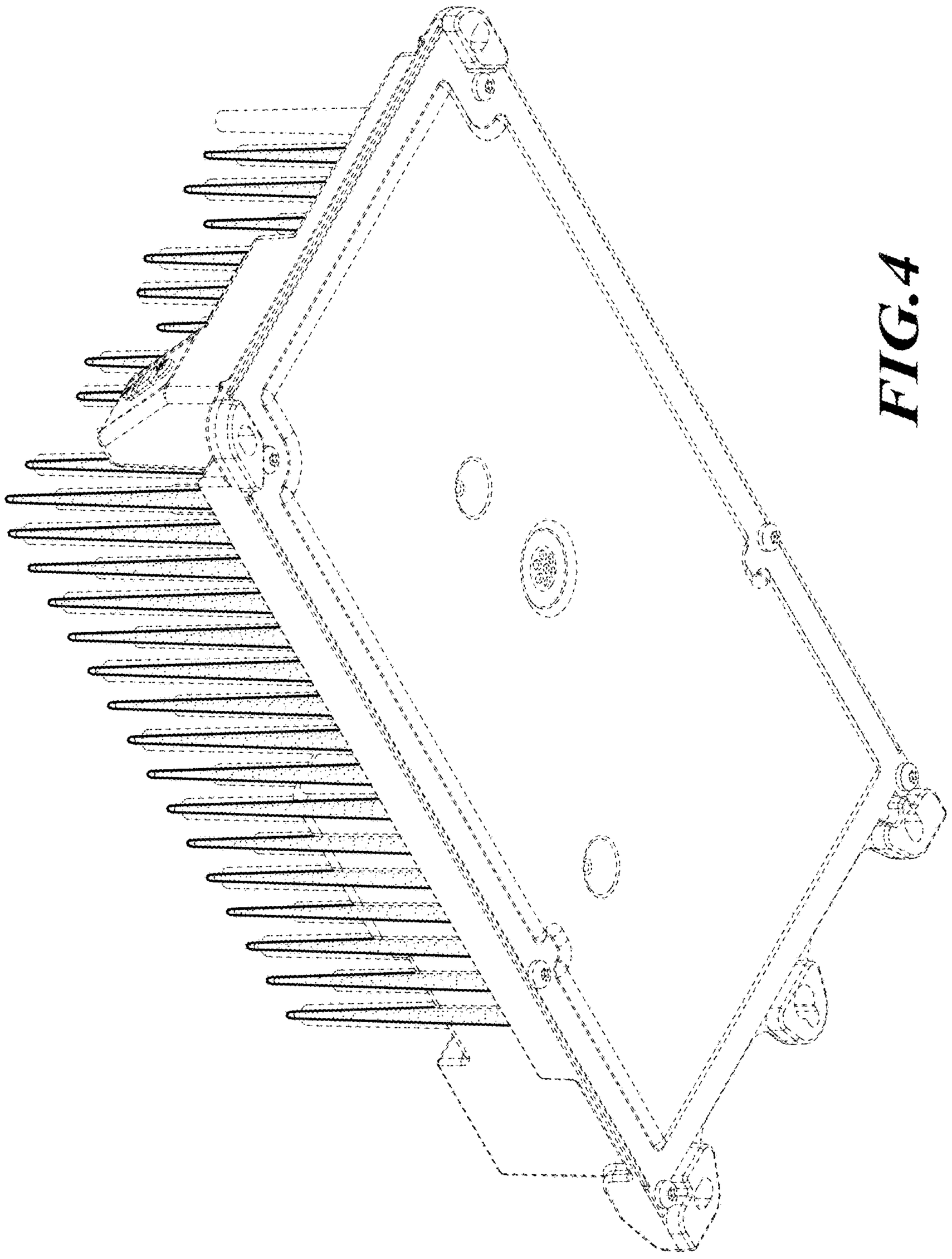


FIG.4

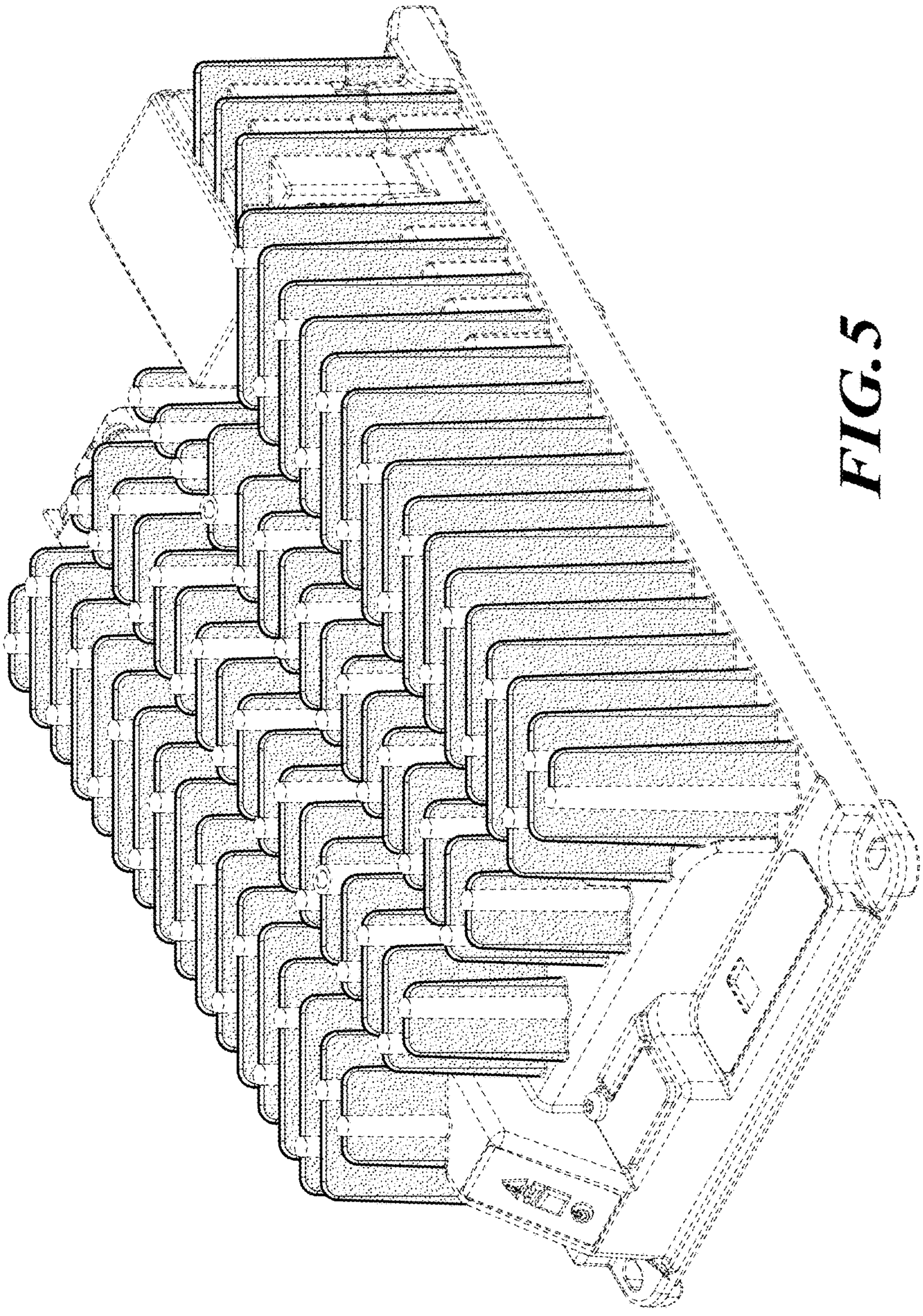


FIG.5

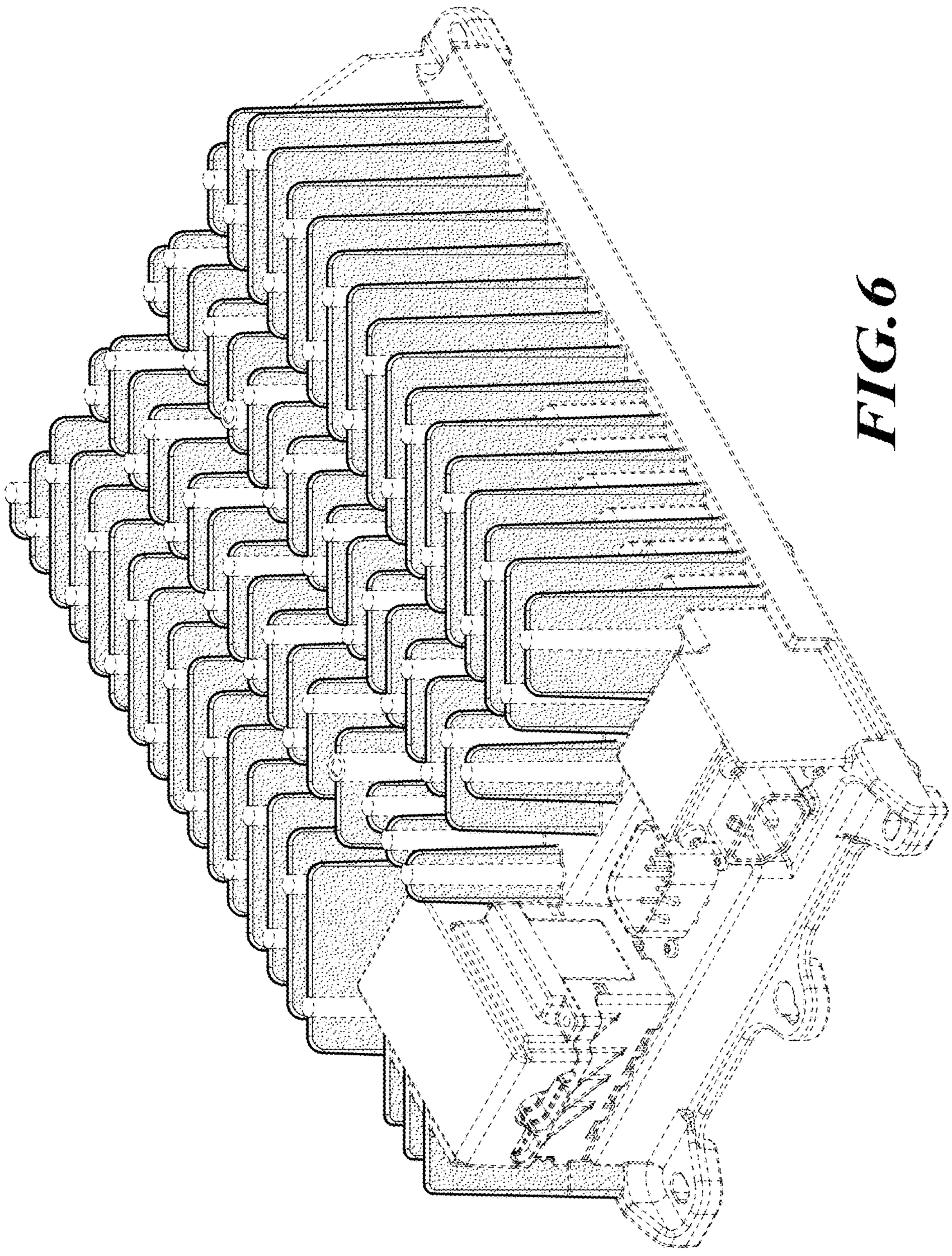


FIG. 6

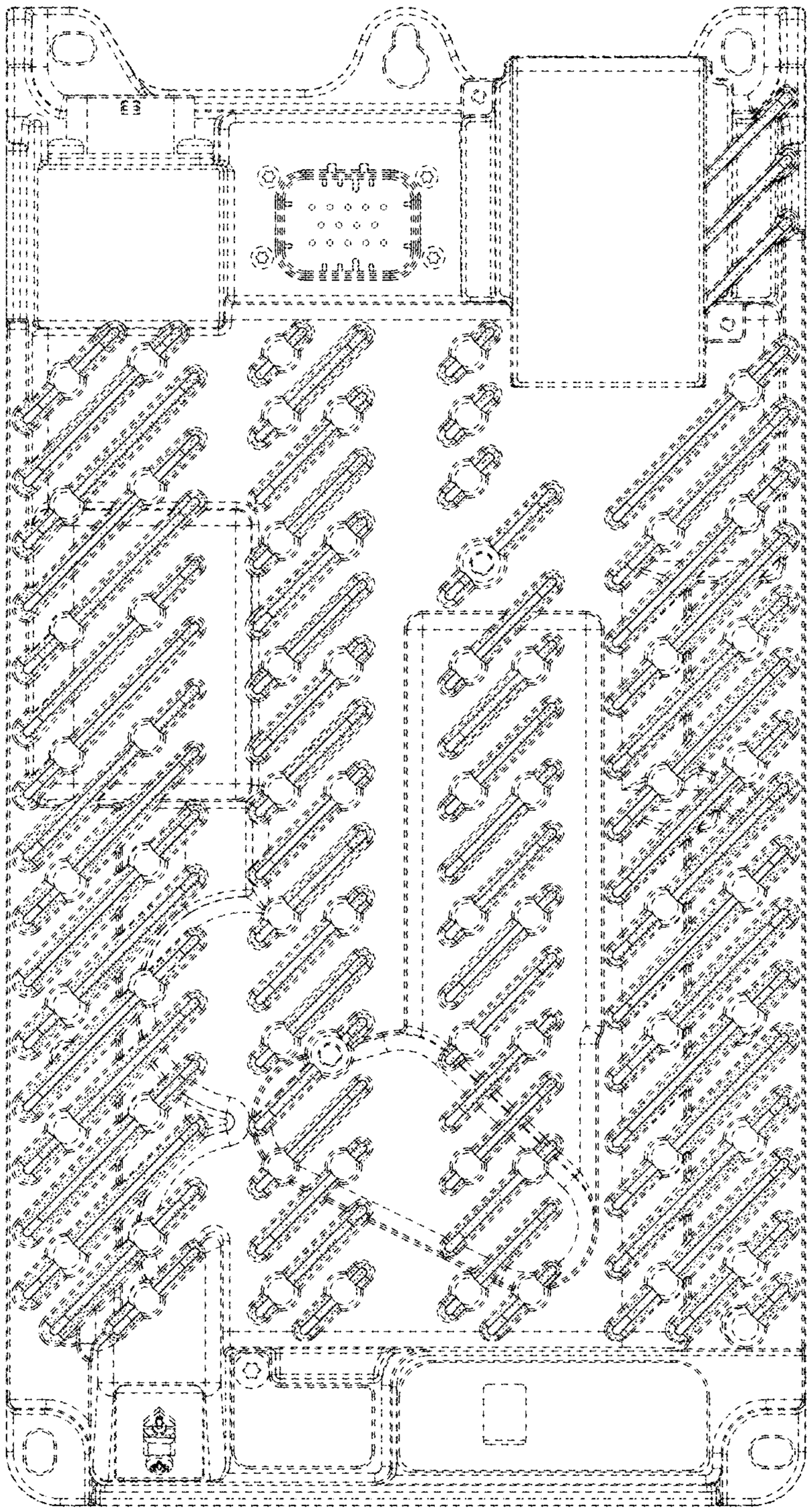


FIG. 7

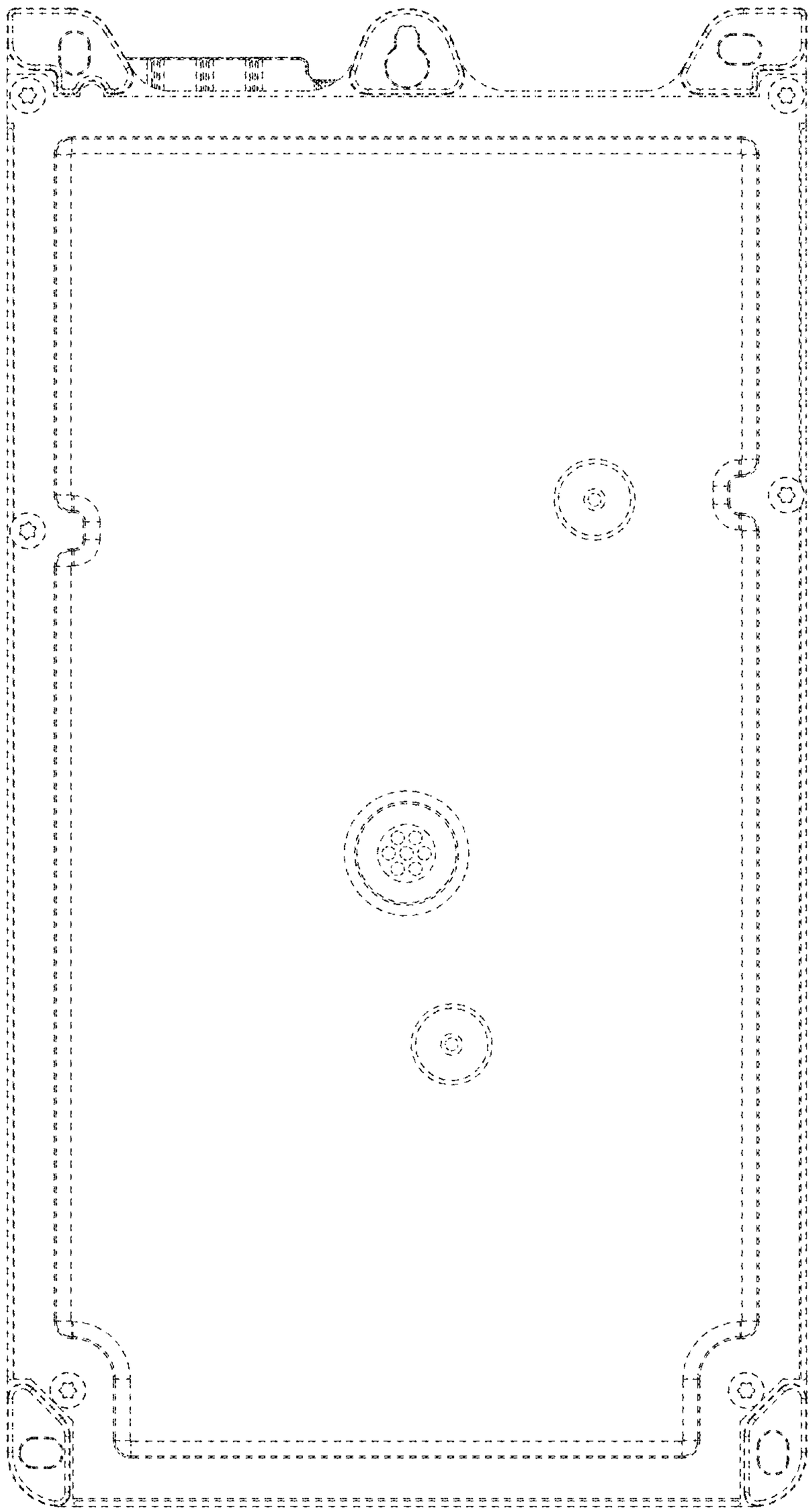


FIG.8

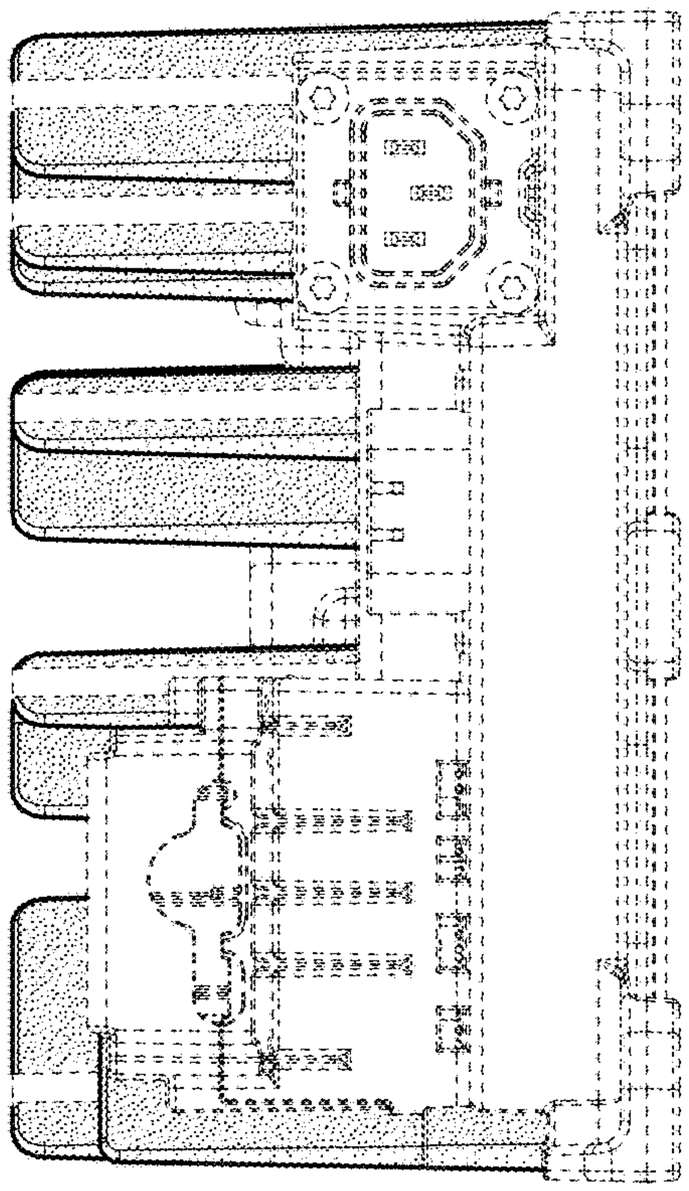


FIG. 10

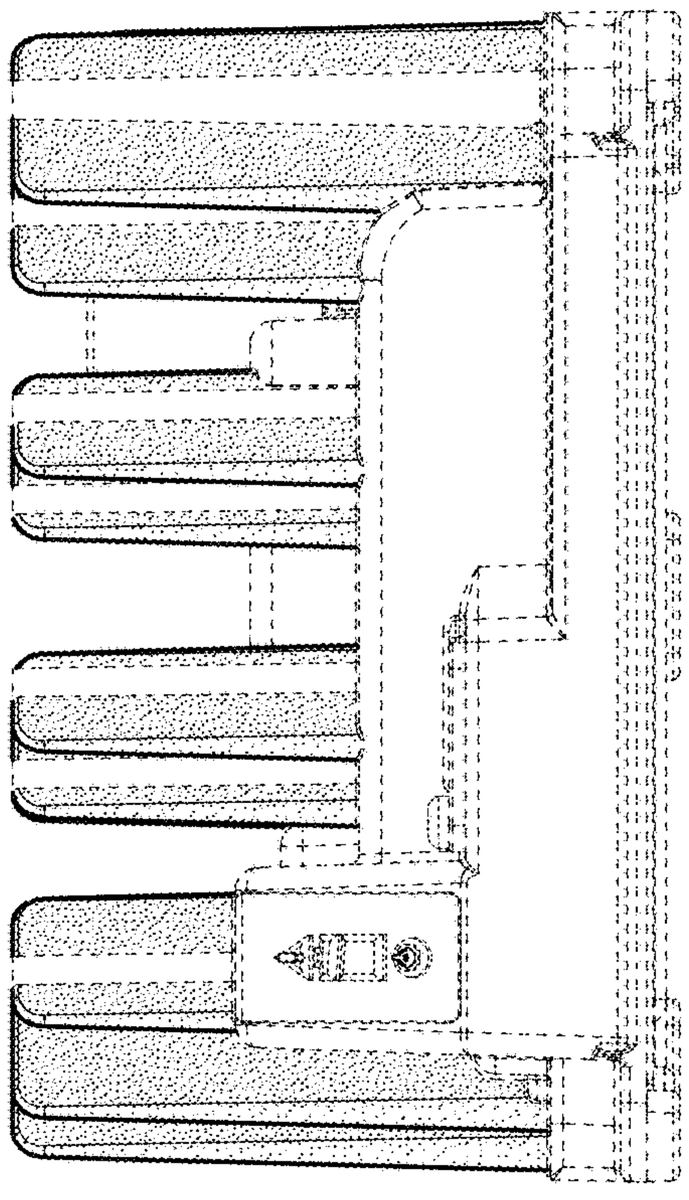


FIG. 9

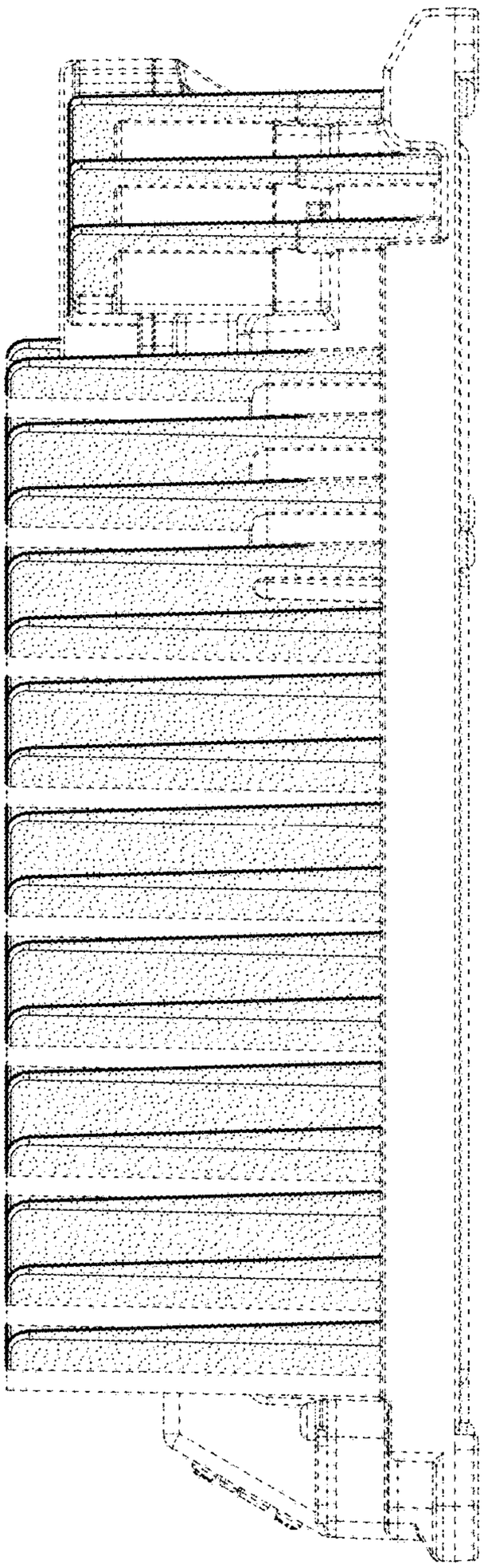


FIG.11

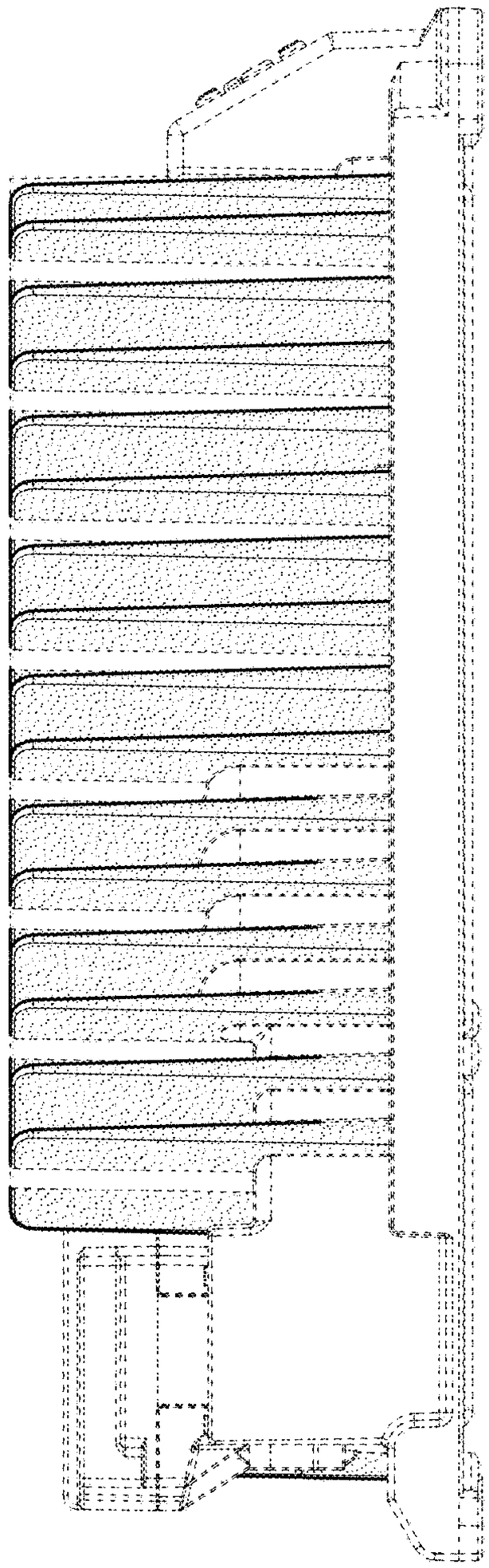


FIG.12