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(54) BATTERY CHARGER

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

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

(58) **Field of Classification Search**
USPC D13/103, 104, 105, 106, 107, 108, 109, D13/110, 112, 114, 118, 119, 122, 184, D13/199, 179
CPC .. H02J 50/00; H02J 50/10; H02J 50/12; H02J 50/80; H02J 7/25; H02J 7/005; H02J 7/02; H02J 7/0026; H02J 7/0042; H02J 7/0044; H02J 7/0045; H02J 7/0013; H02J 7/0003
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

D203,543 S	1/1966	Coe
3,938,024 A	2/1976	Clarke
4,412,277 A	10/1983	Mitchell
4,559,590 A	12/1985	Davidson
D287,718 S	1/1987	Moeller
D292,914 S	11/1987	Moeller
D305,115 S	12/1989	Kondo et al.

(Continued)

FOREIGN PATENT DOCUMENTS

CA 2 806 870 A1 4/2014
EM 015008516-0001 * 1/2023
(Continued)

OTHER PUBLICATIONS

“Delta-Q RQ Series: Compact and Efficient Battery Chargers”, first accessed Mar. 27, 2024. FullRiverBattery.com [https://fullriverbattery.com/charger-series/delta-q-rq-series-battery-chargers/] (Year: 2024).*
(Continued)

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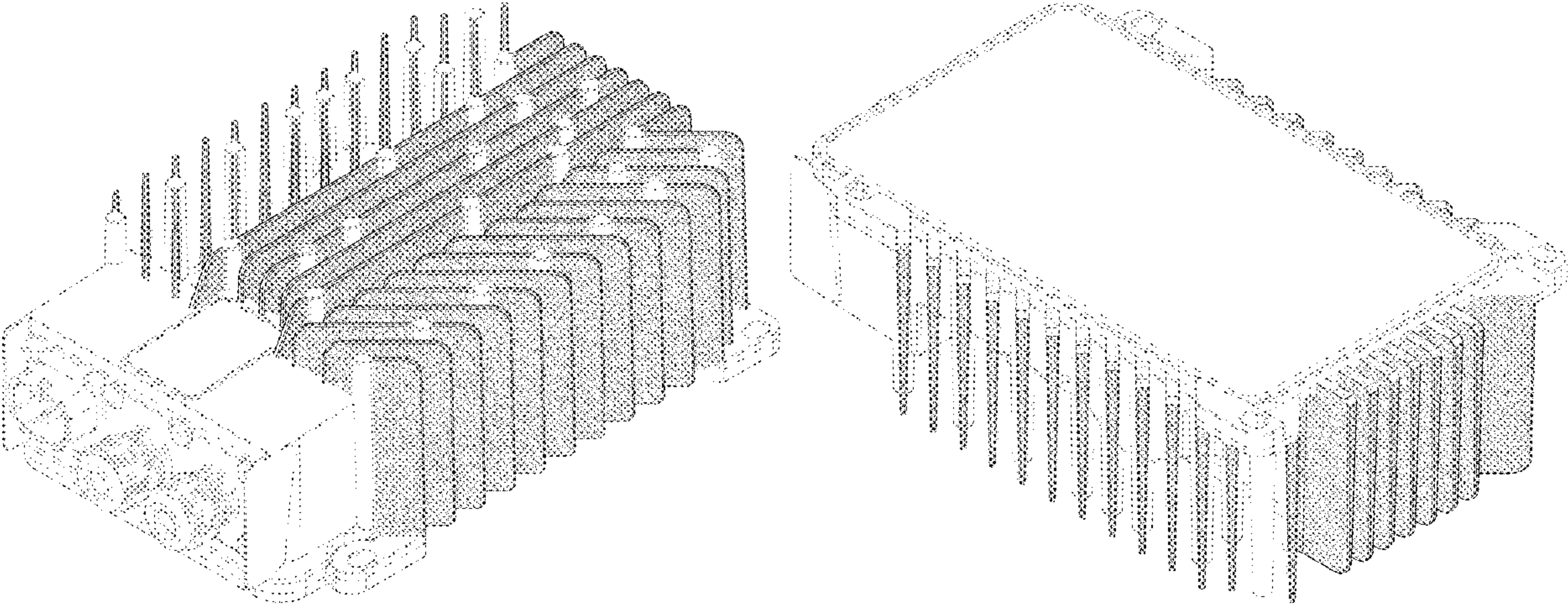
(57) **CLAIM**

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

DESCRIPTION

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

1 Claim, 12 Drawing Sheets



(56)

References Cited

U.S. PATENT DOCUMENTS

4,885,675	A	12/1989	Henze et al.		7,616,455	B2	11/2009	Cameron et al.
5,001,620	A	3/1991	Smith		D606,017	S	12/2009	Charlson et al.
5,034,871	A	7/1991	Okamoto et al.		D613,257	S	4/2010	Clifton
5,065,278	A	11/1991	Schultz		D613,258	S	4/2010	Walker et al.
5,077,486	A	12/1991	Marson et al.		D621,812	S	8/2010	Wayman
D328,057	S	7/1992	Prager et al.		D638,376	S	5/2011	Herrmann et al.
D336,074	S	6/1993	Friend et al.		7,983,043	B2	7/2011	Xu et al.
D338,653	S	8/1993	Morgan et al.		D642,721	S	8/2011	Li et al.
D348,869	S	7/1994	Egger et al.		D651,200	S	12/2011	Sugime et al.
D351,134	S	10/1994	Hunziker		D652,156	S	1/2012	Li et al.
5,355,300	A	10/1994	Zinn		D661,008	S	5/2012	Yuan
D358,753	S	5/1995	Yoshida et al.		D662,880	S	7/2012	Scott et al.
D360,186	S	7/1995	Netz et al.		D664,544	S	7/2012	Yi et al.
5,490,057	A	2/1996	Vinciarelli et al.		D667,789	S	9/2012	O'Neil
D375,725	S	11/1996	Dodson		D672,730	S	12/2012	Lin
5,602,462	A	2/1997	Stich et al.		D675,622	S	2/2013	Petrick et al.
D378,915	S	4/1997	Widmayer et al.		D677,621	S	3/2013	Beroukas et al.
D379,088	S	5/1997	Hopper		D678,852	S	3/2013	Marshall
D379,799	S	6/1997	Widmayer et al.		D682,207	S	5/2013	Nakahira et al.
D381,011	S	7/1997	Widmayer et al.		D682,459	S	5/2013	Gordin et al.
D388,399	S	12/1997	Widmayer et al.		D684,130	S	6/2013	Vincent et al.
D389,807	S	1/1998	Dodson		D691,558	S	10/2013	Helosvouri et al.
D398,589	S	9/1998	Dodson		8,546,974	B2	10/2013	Foxall et al.
D401,138	S	11/1998	Rosen et al.		8,552,695	B2	10/2013	Stracquadini
D401,216	S	11/1998	Person et al.		D696,764	S	12/2013	Sato et al.
D409,138	S	5/1999	Gammenthaler		8,598,737	B2	12/2013	Foxall et al.
D409,139	S	5/1999	Cornell et al.		D698,481	S	1/2014	Wasserman et al.
D410,652	S	6/1999	Jones et al.		D702,376	S	4/2014	Su
D416,873	S	11/1999	Korsunsky et al.		D703,132	S	4/2014	Pearson et al.
D426,814	S	* 6/2000	Lee	D13/179	D703,181	S	4/2014	Wilson
D427,146	S	6/2000	Wei		D705,728	S	5/2014	Choi
D427,147	S	6/2000	Wei		D706,216	S	6/2014	Perin
6,076,594	A	6/2000	Kuo		8,803,489	B2	8/2014	Li et al.
D441,724	S	5/2001	Chou et al.		D713,336	S	9/2014	Perin
D442,565	S	5/2001	Chou et al.		8,861,238	B2	10/2014	Huang et al.
D442,566	S	* 5/2001	Chou	D13/179	8,937,469	B2	1/2015	Clark et al.
D449,587	S	10/2001	Cronin		D722,576	S	2/2015	Zimmer
D449,817	S	10/2001	Takeuchi et al.		D722,958	S	2/2015	Kotaniemi et al.
6,307,747	B1	10/2001	Farnsworth et al.		D726,141	S	4/2015	Wilson
6,320,772	B1	11/2001	Doyama et al.		D730,333	S	5/2015	Matsumoto
D458,228	S	6/2002	Jacobson		9,028,096	B2	5/2015	Verdes et al.
D464,939	S	* 10/2002	Chuang	D13/179	D734,250	S	7/2015	Rennick
6,462,966	B1	10/2002	Leung et al.		D734,526	S	7/2015	Gordin et al.
D465,771	S	11/2002	Hsieh		D734,532	S	7/2015	Gordin et al.
D476,958	S	7/2003	Tsai		D739,347	S	9/2015	Huang et al.
D478,876	S	* 8/2003	Tan	D13/179	D751,241	S	3/2016	Aldape
6,650,559	B1	11/2003	Okamoto et al.		D751,751	S	3/2016	Lockart et al.
6,671,172	B2	12/2003	Carter et al.		D755,740	S	5/2016	Chen et al.
D489,682	S	5/2004	Guillarme		D761,472	S	7/2016	Zhu
D490,383	S	* 5/2004	Tan	D13/179	D761,729	S	7/2016	Leong
6,736,195	B2	5/2004	Busch et al.		D767,815	S	9/2016	Lee
D492,251	S	6/2004	Cameron et al.		D768,585	S	10/2016	Moore et al.
6,809,678	B2	10/2004	Vera et al.		D770,975	S	11/2016	Nada et al.
6,841,979	B2	1/2005	Berson et al.		9,490,694	B2	11/2016	Alam
6,847,195	B2	1/2005	Chen		D793,350	S	8/2017	Kenchappa
6,862,201	B2	3/2005	Hodge, Jr.		D796,431	S	9/2017	Lau et al.
D505,915	S	6/2005	Hussaini et al.		D801,921	S	11/2017	Vetu
D507,528	S	7/2005	Feldman et al.		D804,434	S	12/2017	Lu et al.
D510,320	S	10/2005	Tuomola et al.		D805,473	S	12/2017	Montgomery et al.
7,116,090	B1	10/2006	Yang et al.		D805,486	S	12/2017	Hochman et al.
7,198,094	B2	4/2007	Barsun et al.		D806,647	S	1/2018	Lau et al.
D541,743	S	5/2007	Virolainen et al.		D814,450	S	4/2018	Kumazawa et al.
D541,744	S	5/2007	Virolainen et al.		D815,592	S	4/2018	Lau et al.
D541,745	S	5/2007	Virolainen et al.		D817,876	S	5/2018	Meng
D546,282	S	7/2007	Wardenburg		D828,294	S	9/2018	Lau et al.
D551,621	S	9/2007	Iacovelli et al.		D829,649	S	10/2018	Lau et al.
D559,778	S	1/2008	Tsuzuki et al.		D849,566	S	5/2019	Klintworth
D561,711	S	* 2/2008	Lin	D13/179	D849,567	S	5/2019	Klintworth
D562,765	S	2/2008	Tsuzuki et al.		D853,956	S	7/2019	Lau et al.
7,365,987	B2	4/2008	Jeong		D854,497	S	7/2019	Lau et al.
D568,841	S	5/2008	Fischer et al.		D862,454	S	10/2019	Chun
D571,314	S	6/2008	Hornig		D872,019	S	1/2020	Chen
7,535,716	B2	5/2009	Fischer et al.		D872,020	S	1/2020	Chen
D593,512	S	6/2009	Lin		D875,681	S	2/2020	Xu
D602,577	S	* 10/2009	Miyazawa	D23/370	D879,715	S	3/2020	Brendel et al.
					D884,612	S	5/2020	Lau et al.
					D890,096	S	7/2020	Brendel et al.
					D891,369	S	7/2020	Wu et al.
					D913,233	S	3/2021	McGinley et al.

(56)

References Cited

U.S. PATENT DOCUMENTS

D913,916 S	3/2021	Zaremba et al.	
D914,595 S	3/2021	Rooyakkers et al.	
D931,807 S	9/2021	Wu et al.	
D943,529 S	2/2022	Carvalho et al.	
D949,788 S	4/2022	Sakamura et al.	
D962,879 S *	9/2022	Kuo	D13/179
D1,004,541 S *	11/2023	Bos	D13/107
2002/0149951 A1	10/2002	Leung et al.	
2004/0240182 A1	12/2004	Shah	
2005/0061480 A1	3/2005	Carter et al.	
2005/0105311 A1	5/2005	Soldano	
2007/0014089 A1	1/2007	Huang	
2007/0131387 A1	6/2007	Kawabata et al.	
2007/0133233 A1	6/2007	Cameron et al.	
2008/0002444 A1	1/2008	Shekhawat et al.	
2008/0295993 A1	12/2008	Chen 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	
2011/0286216 A1	11/2011	Araman	
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	
2013/0051102 A1	2/2013	Huang et al.	
2013/0235631 A1	9/2013	Pahlevaninezhad et al.	
2014/0056045 A1	2/2014	Yan et al.	
2014/0097808 A1	4/2014	Clark et al.	
2014/0268952 A1	9/2014	Tong	
2015/0171734 A1	6/2015	Yu et al.	
2015/0263605 A1	9/2015	Alam	
2016/0056730 A1	2/2016	Yan et al.	
2016/0099660 A1	4/2016	Khaligh et al.	

FOREIGN PATENT DOCUMENTS

GB	9008213565-0002	*	10/2020
WO	WO 2010025596 A1		3/2010

OTHER PUBLICATIONS

“Delta-Q Expands RQ Series With New High-Performance Charger”, posted Jul. 7, 2023. OEMOffHighway.com [https://www.oemoffhighway.com/electronics/power-systems/batteries-capacitors/product/22866590/deltaq-technologies-deltaq-expands-rq-series-with-new-highperformance-charger] (Year: 2023).*

“Delta-Q Technologies Launches Battery Compatibility Program”, posted May 24, 2021. OEMOffHighway.com [https://www.oemoffhighway.com/electronics/power-systems/batteries-capacitors/press-release/21440192/deltaq-technologies-deltaq-technologies-launches-battery-compatibility-program] (Year: 2021).*

Delta-Q Technologies’ RQ350 battery charger designed for electric vehicles. posted Jun. 12, 2020. TheFabricator.com [https://www.thefabricator.com/thefabricator/product/testingmeasuring/delta-q-technologies-rq350-battery-charger-designed-for-electric-vehicles] (Year: 2020).*

Jason’s Golf Carts, “Delta-Q IC1200 Battery Charger 36V 33A,” URL=https://jasonsgolfcarts.com/product/delta-q-ic1200-battery-charger-36v-33a/, download date Sep. 29, 2023. (6 pages).

Delta-Q Technologies, “The XV3300: A 3-in-1 Charging Solution,” 2023, URL=https://connect.delta-q.com/xv3300, download date Sep. 29, 2023. (11 pages).

Anderson, “Delta-Q launches XV3300 battery charger,” Jun. 15, 2021, URL=https://www.accesslifthandlers.com/news/delta-q-launches-xv3300-battery-charger/8012935.article, download date Sep. 29, 2023. (4 pages).

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.

Cheng et al., “A Novel Single-Stage High-Power-Factor LED Street-Lighting Driver with Coupled Inductors,” IEEE Power Electronics Lab. Dept. of Electrical Engineering, I-Shou University, Taiwan, R.O.C. 2013.

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.

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-technologies-introduces-new-lithium-specific-battery-charger-at-promat-2017-617167523.htm> on Jun. 1, 2017, 3 pages.

Deng et al., “Design Methodology of LLC Resonant Converters for Electric Vehicle Battery Chargers,” *IEEE Transactions on Vehicular Technology* 63(4):1581-1592, May 2014.

Dixon, “Average Current Mode Control of Switching Power Supplies,” Unitrode Application Note U-140, pp. 3-356-3-369, 1990. (14 pages).

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.

Hu et al., “Single-Stage, Universal-Input AC/DC LED Driver With Current-Controlled Variable PFC Boost Inductor,” *IEEE Transactions on Power Electronics* 27(3):1579-1588, Mar. 2012.

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.

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. 29/535,892, filed Aug. 11, 2015, 22 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.

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.

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

(56)

References Cited

OTHER PUBLICATIONS

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.

Park et al., "Design on Topologies for High Efficiency Two-Stage AC-DC Converter," *IEEE 7th International Power Electronics and Motion Control Conference—ECCE Asia* Jun. 2-5, 2012, Harbin, China.

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," 10th 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.

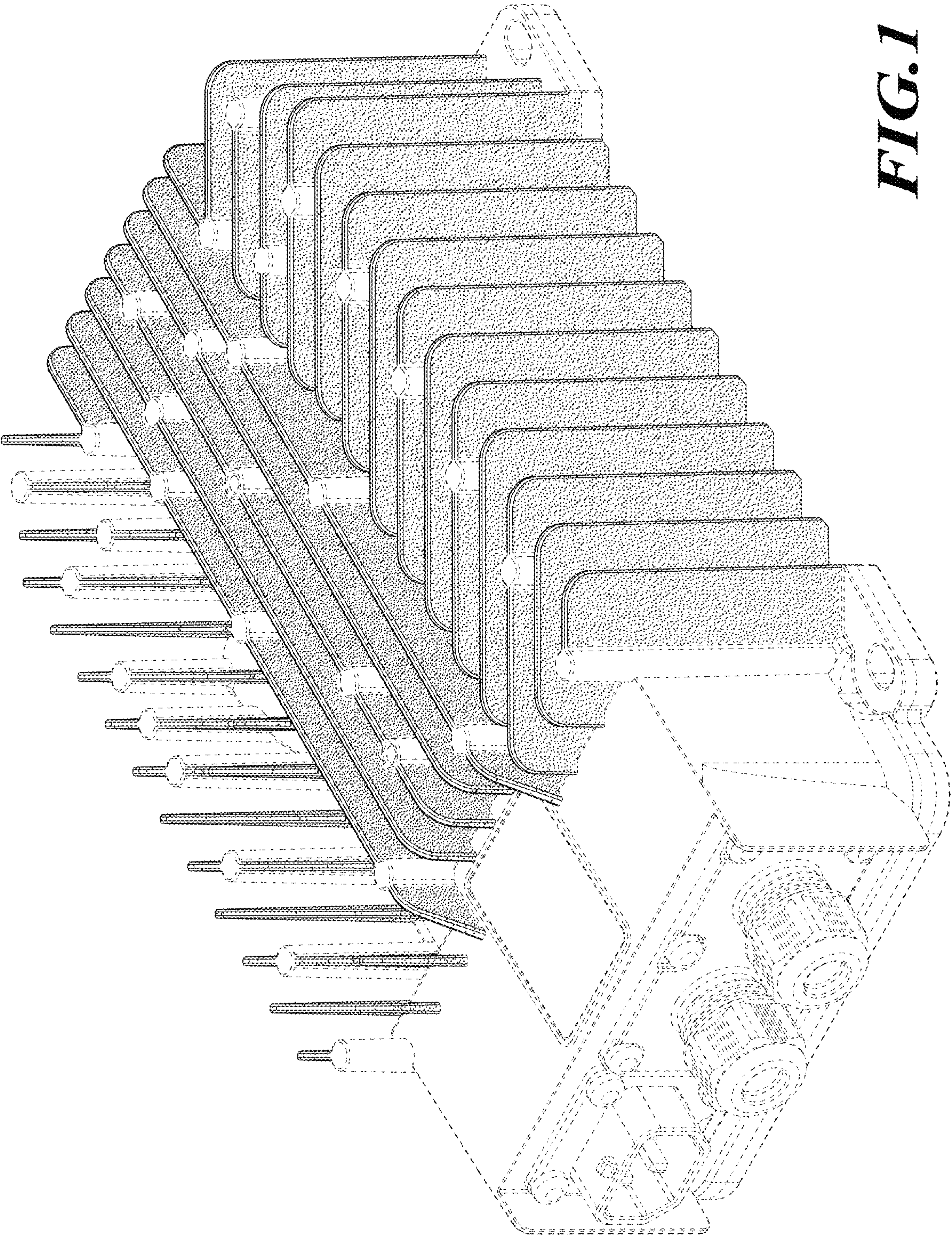
Tollik et al., "Comparative Analysis of 1-Phase Active Power Factor Correction Topologies," 14th International Telecommunications Energy Conference, Washington, DC, Oct. 4-8, 1992, pp. 517-523.

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.

* cited by examiner



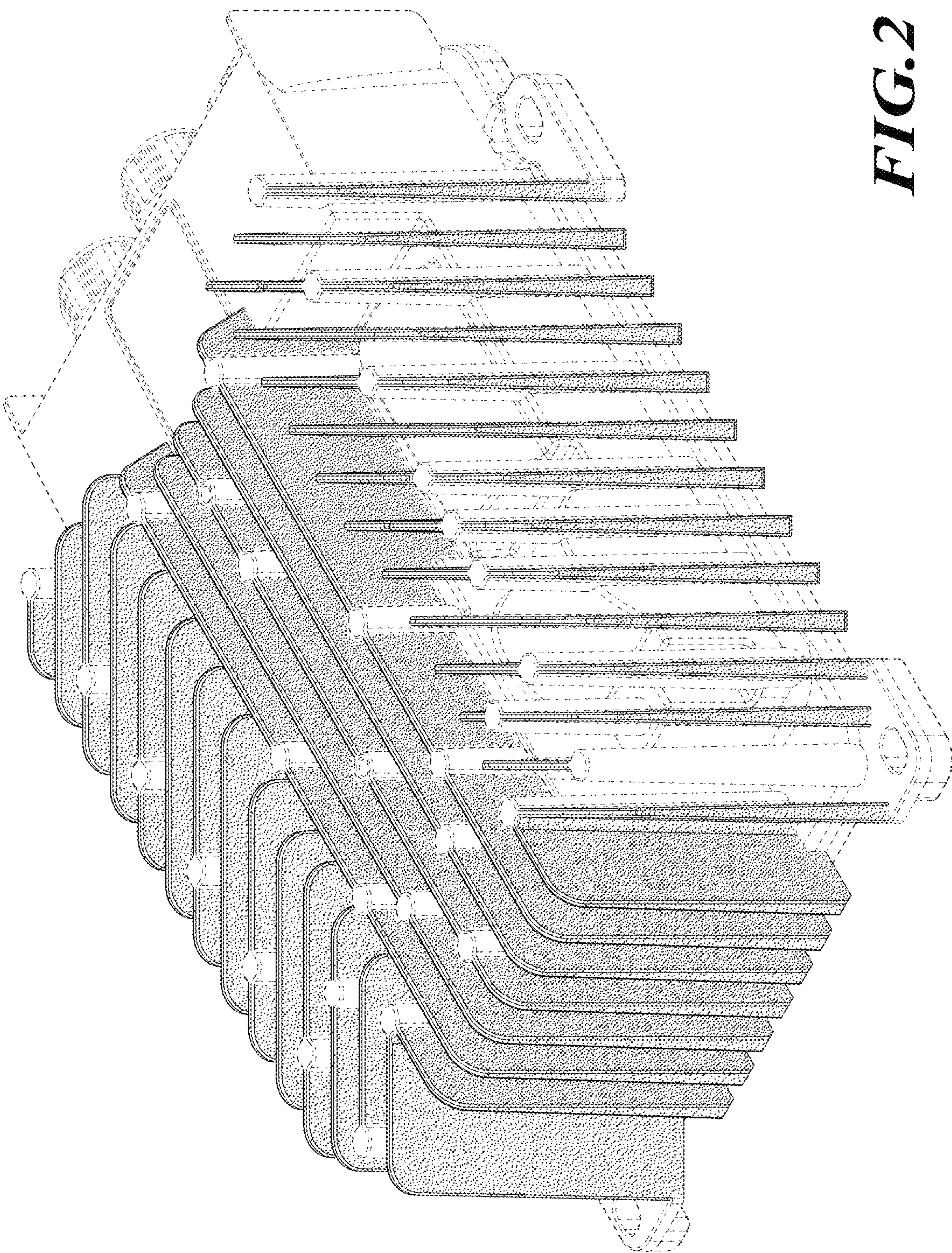
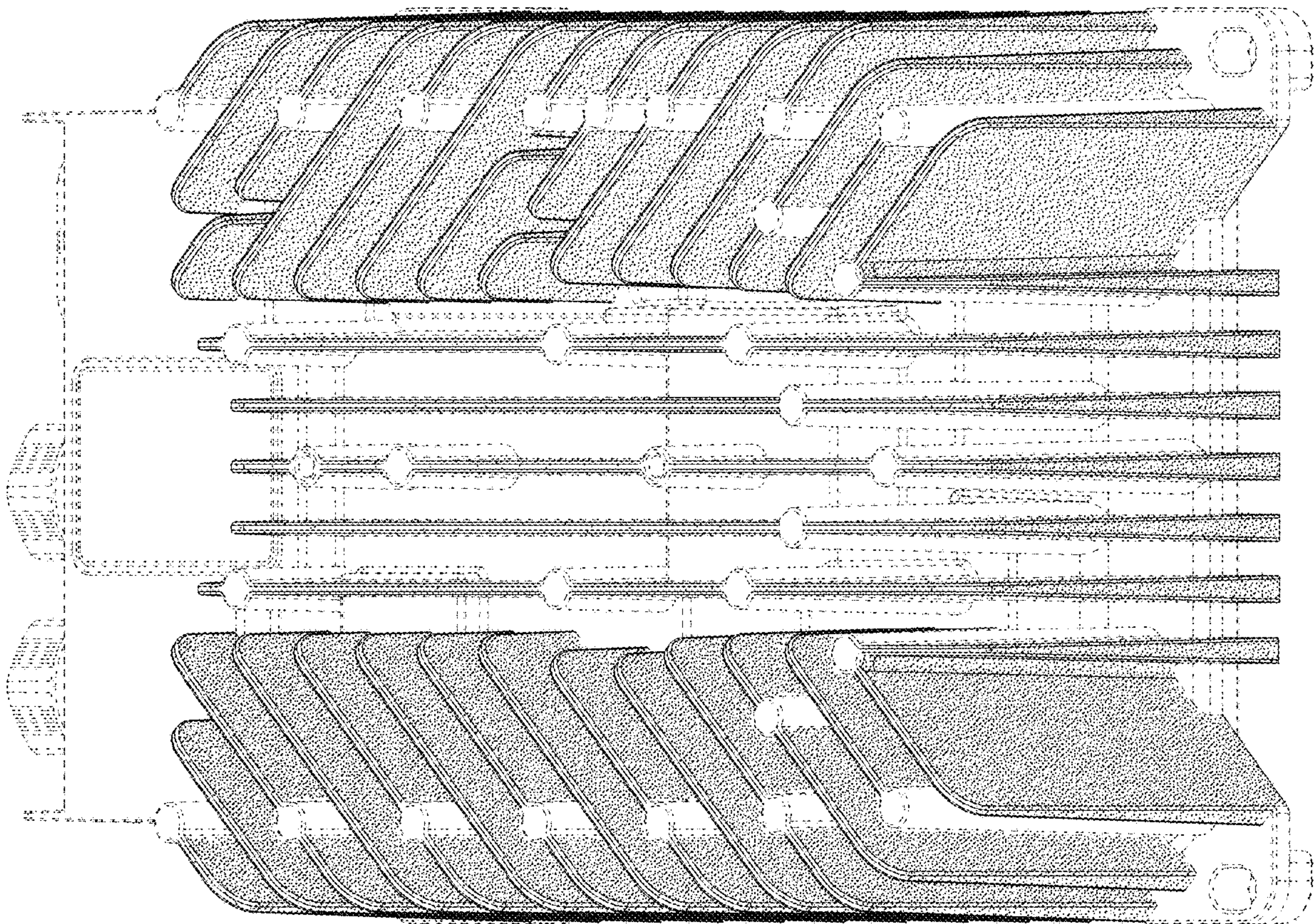


FIG. 2

FIG. 3



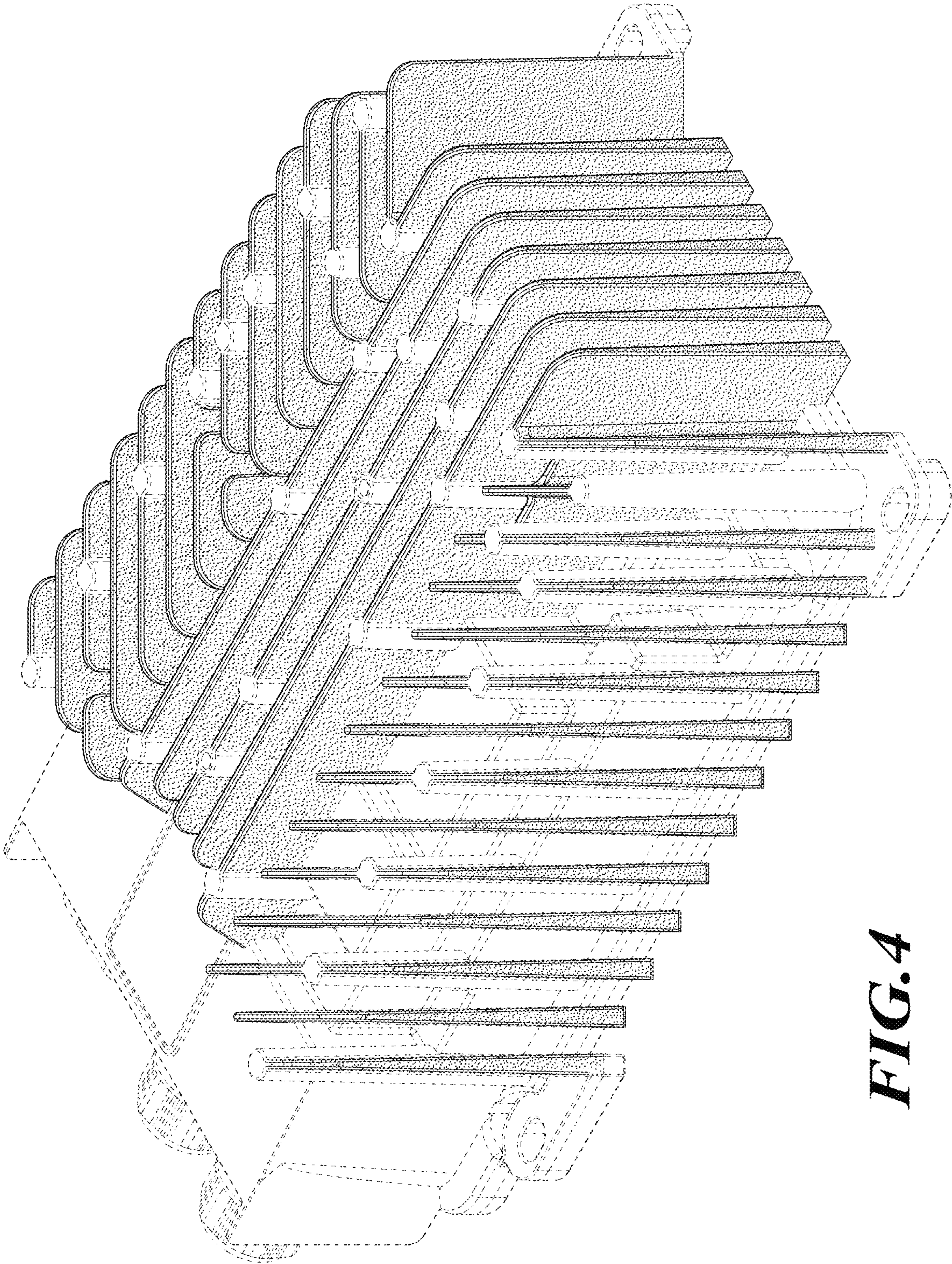


FIG. 4

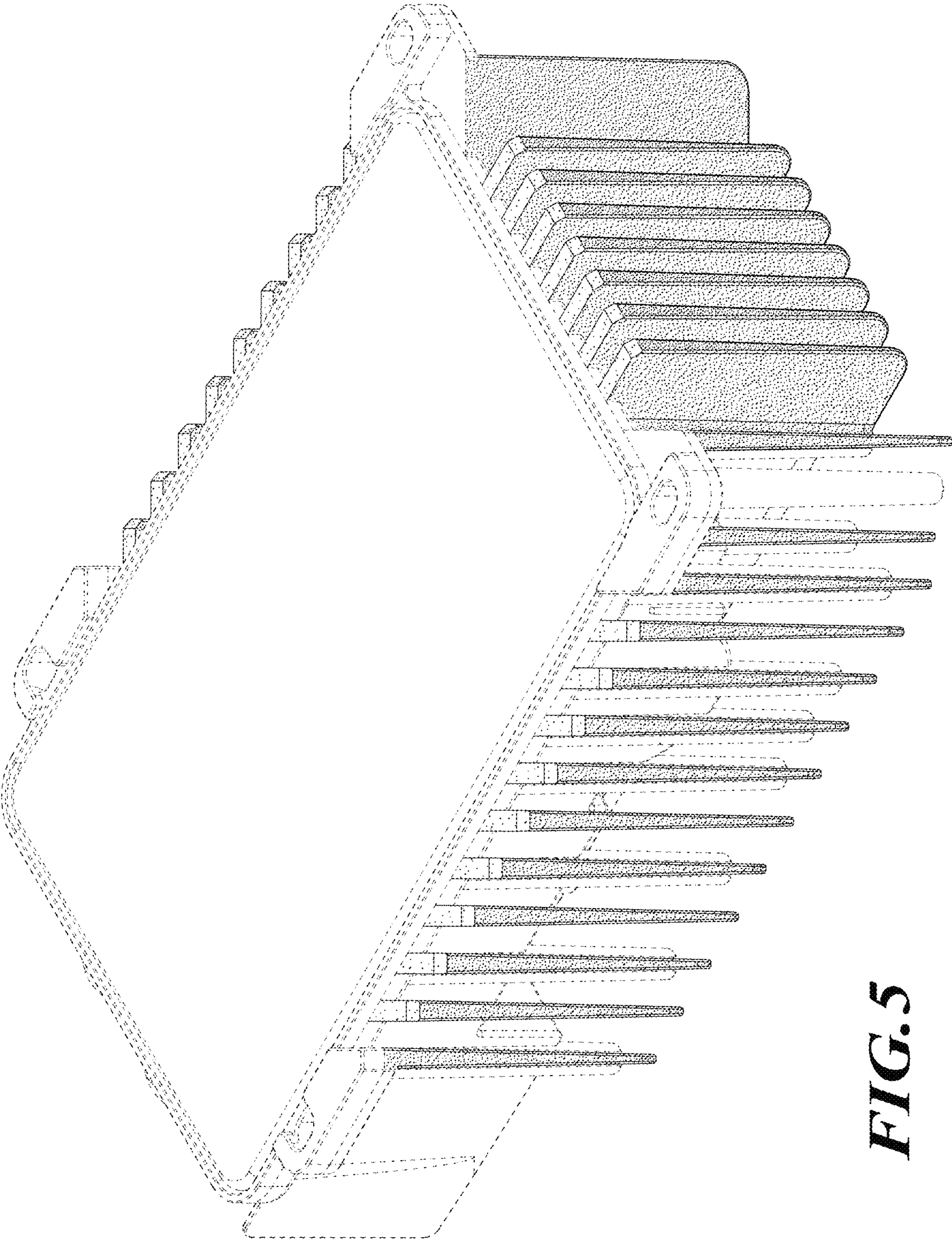


FIG. 5

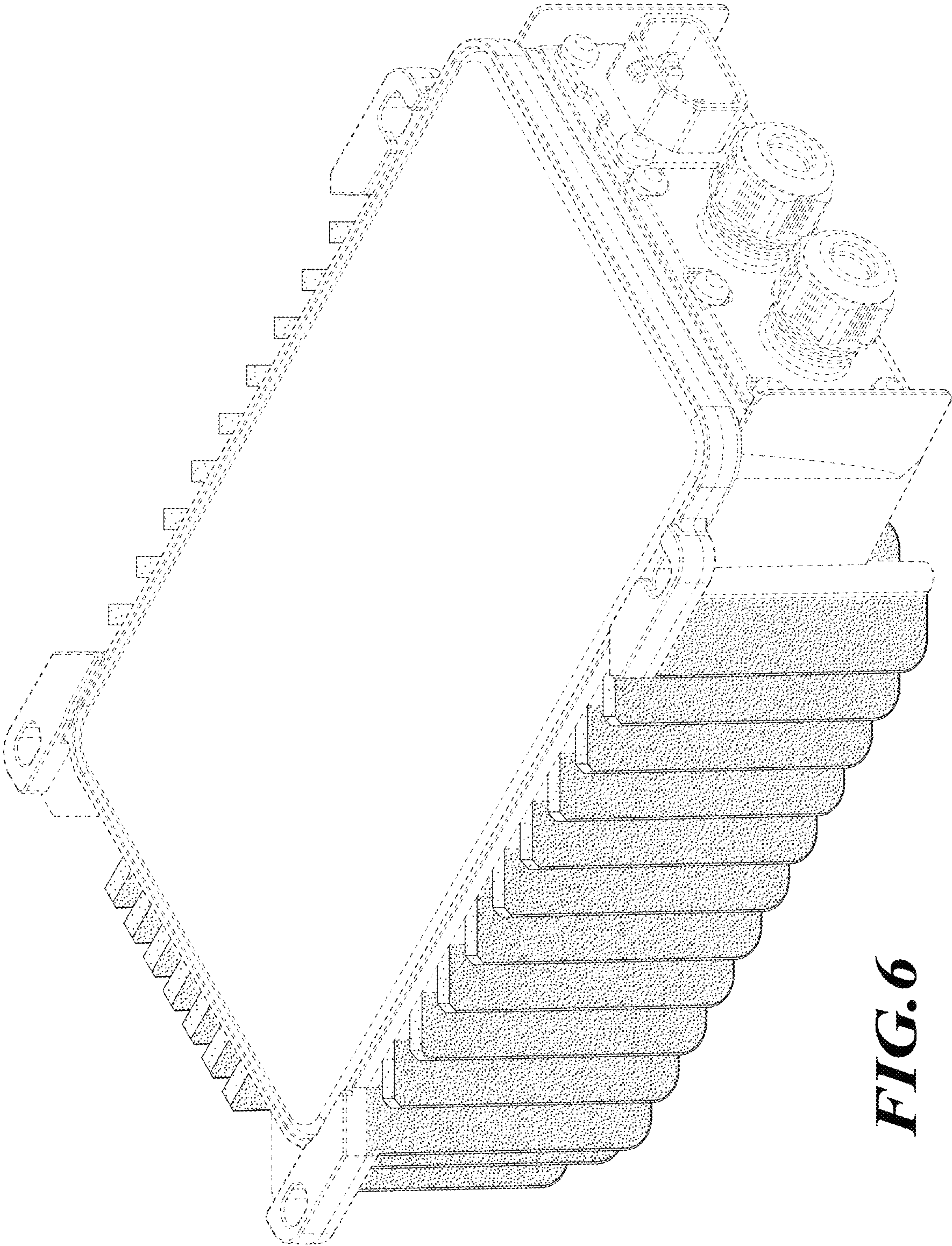


FIG. 6

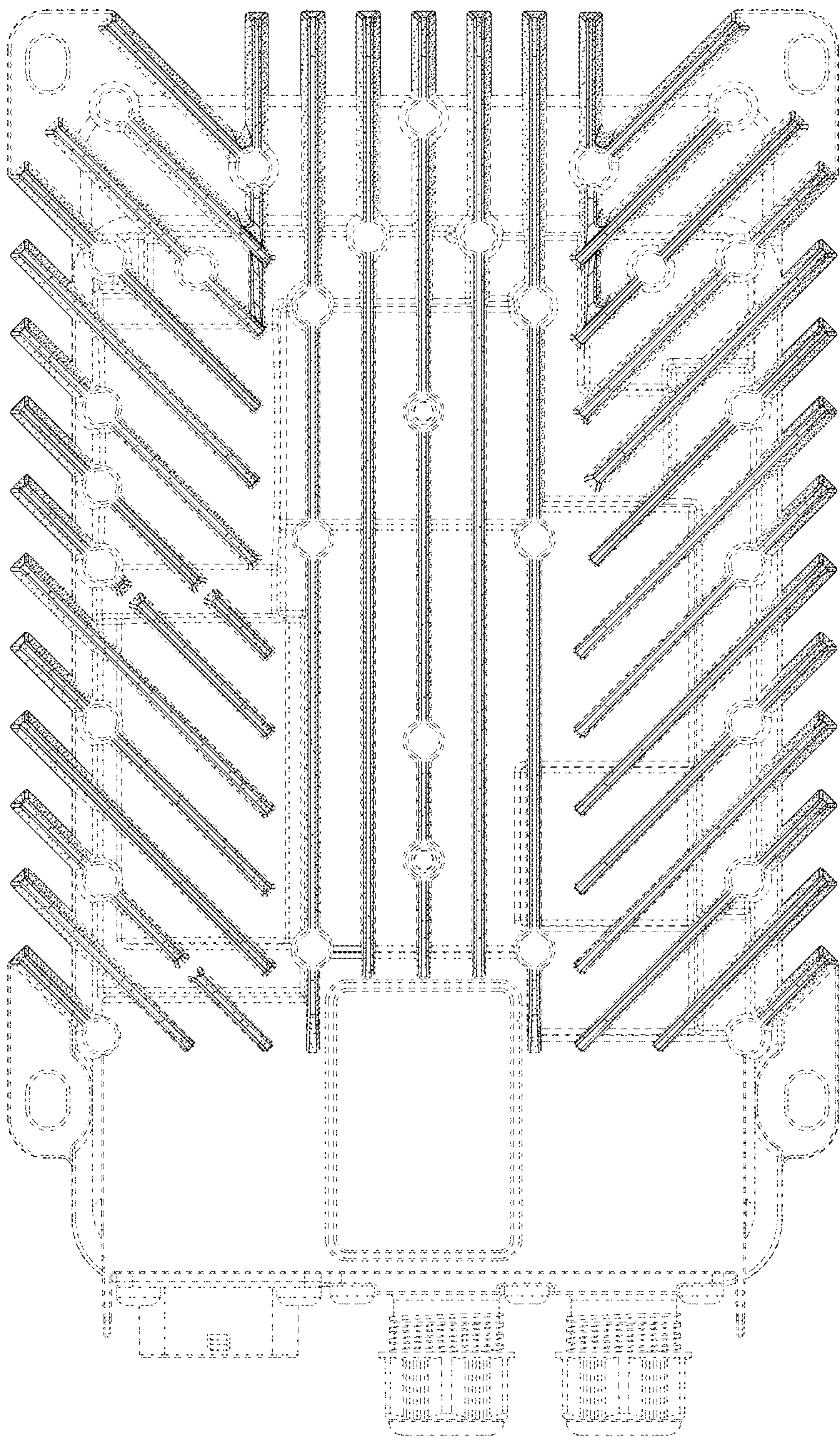


FIG. 7

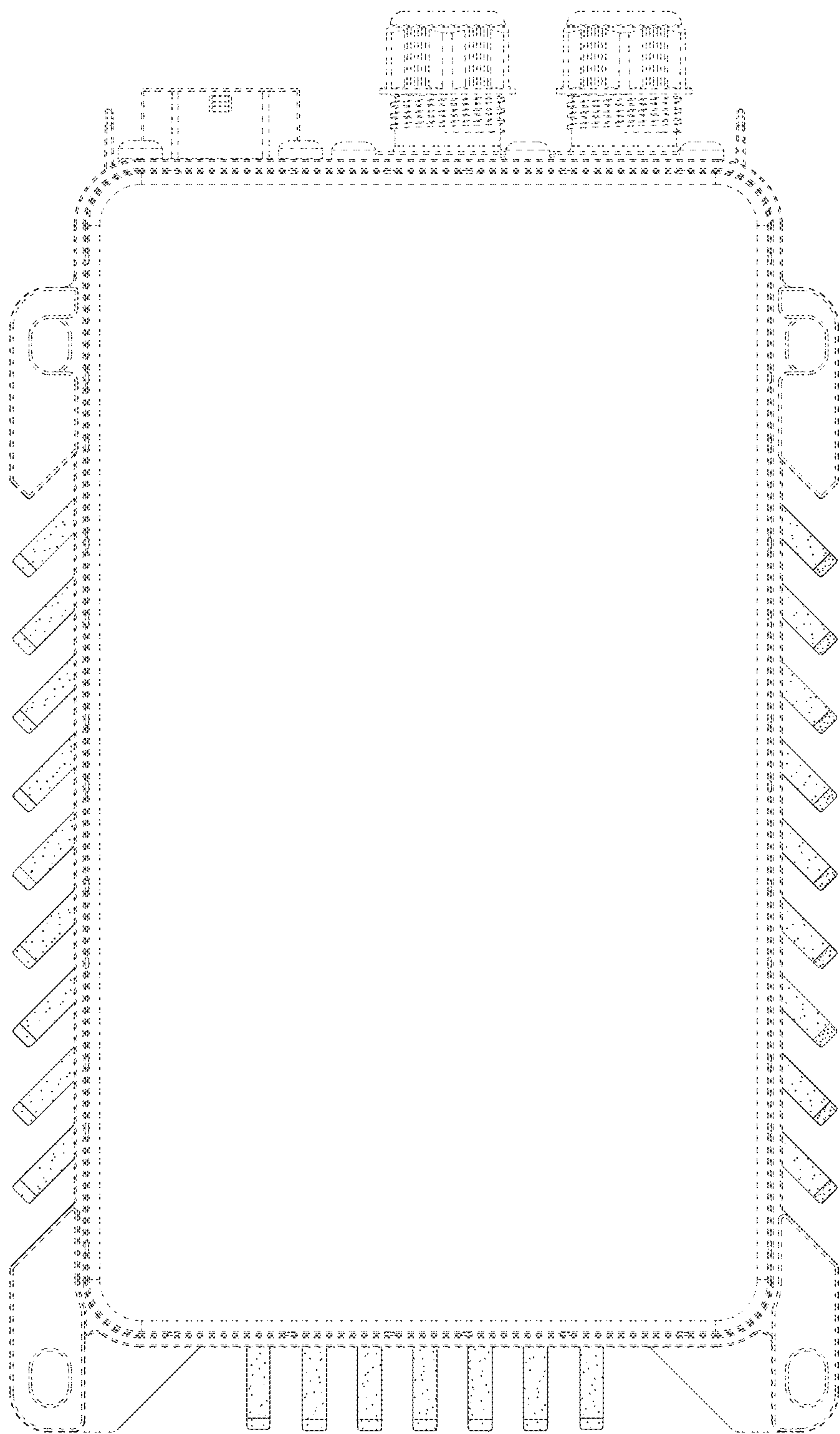


FIG. 8

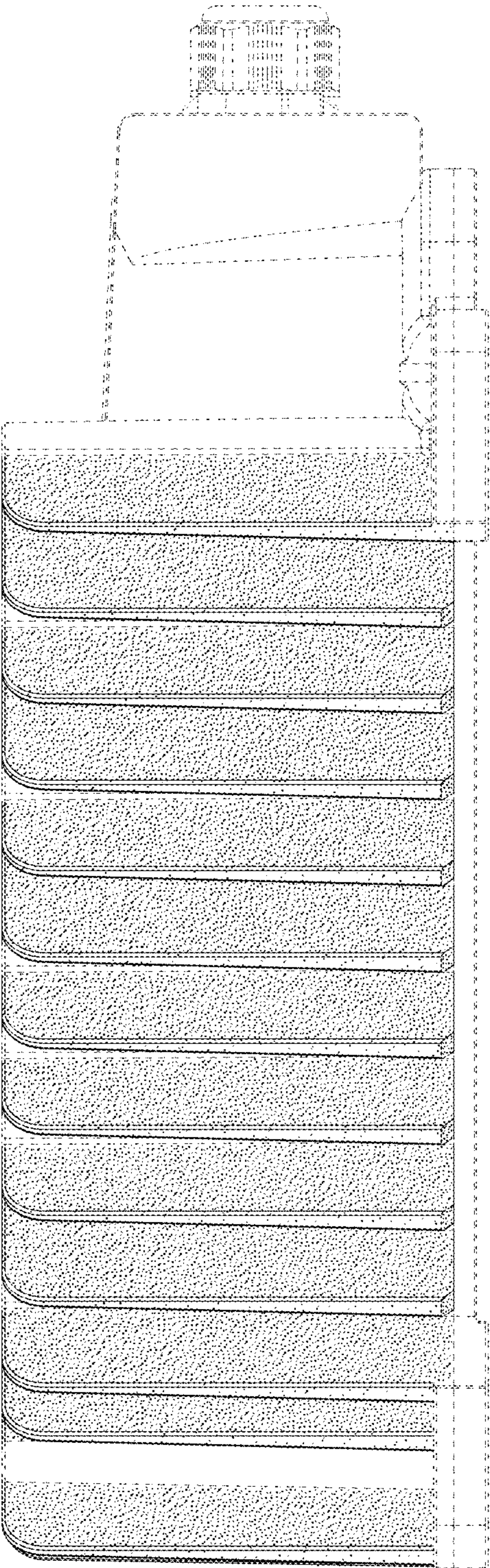


FIG. 9

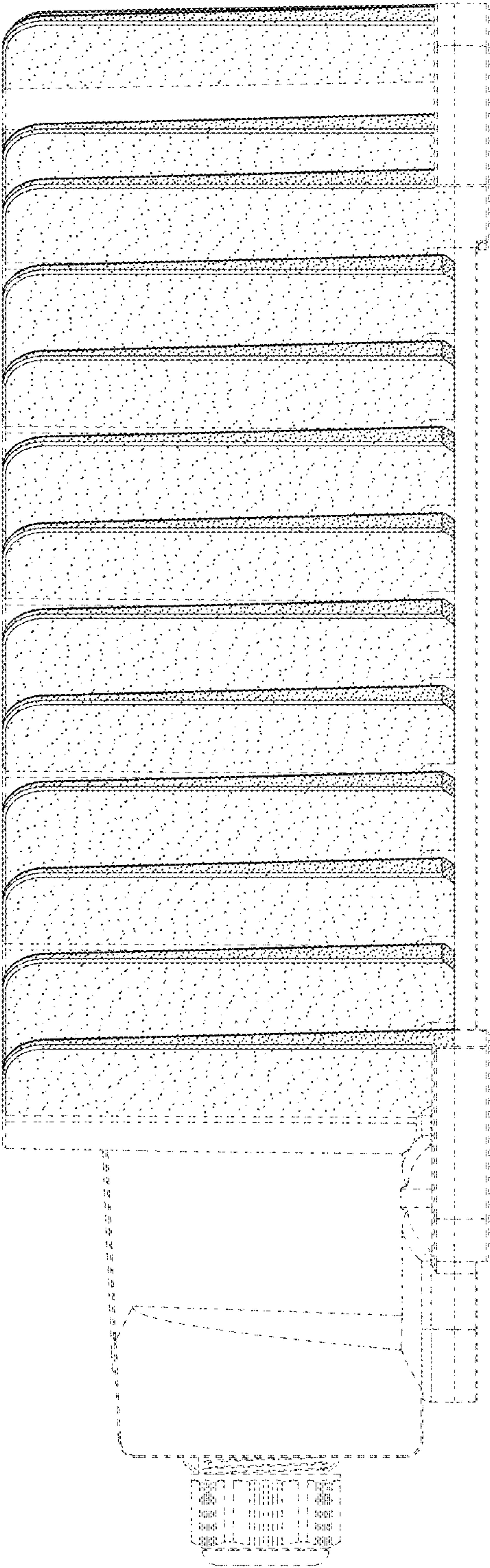


FIG. 10

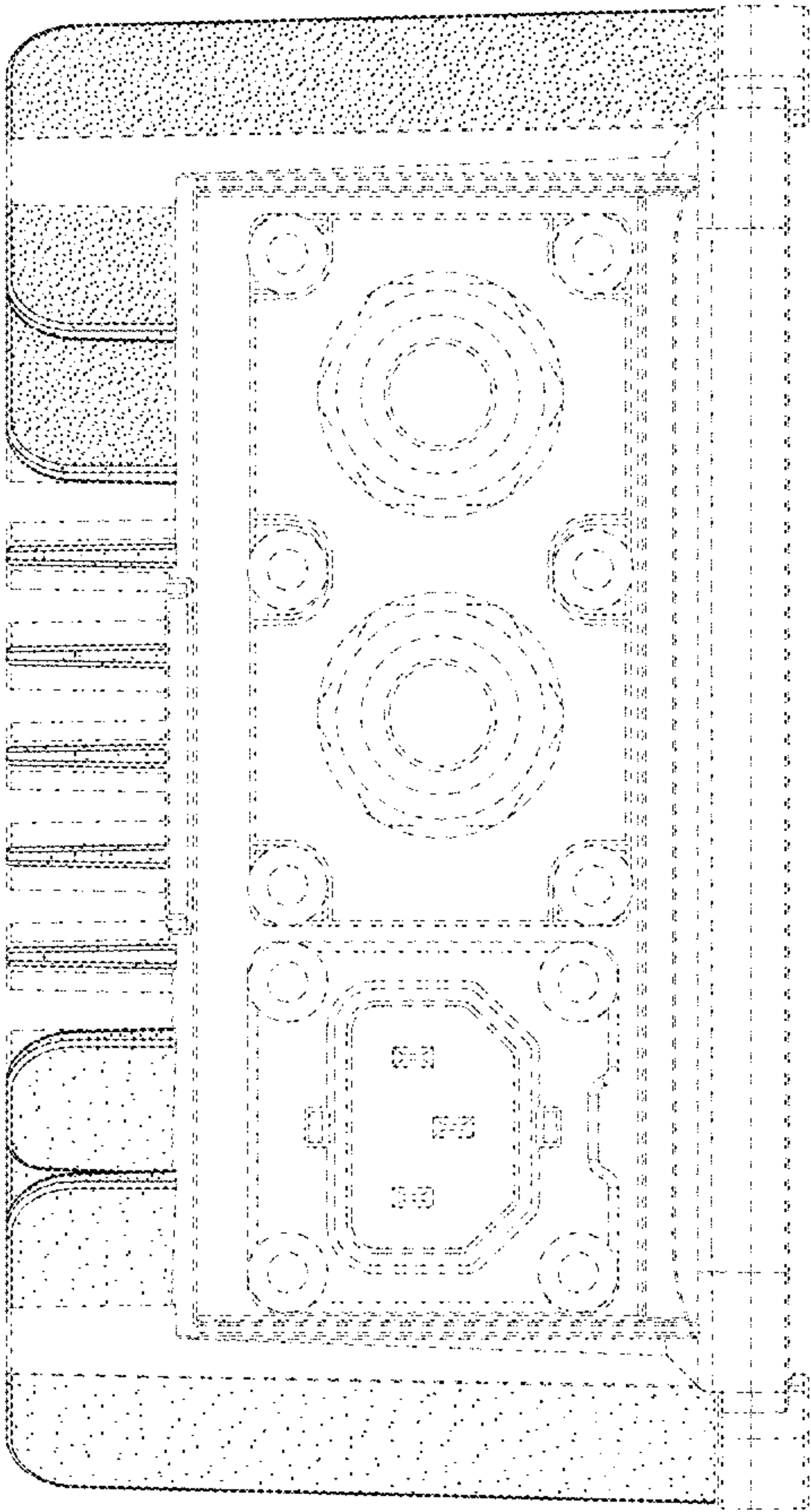


FIG. 11

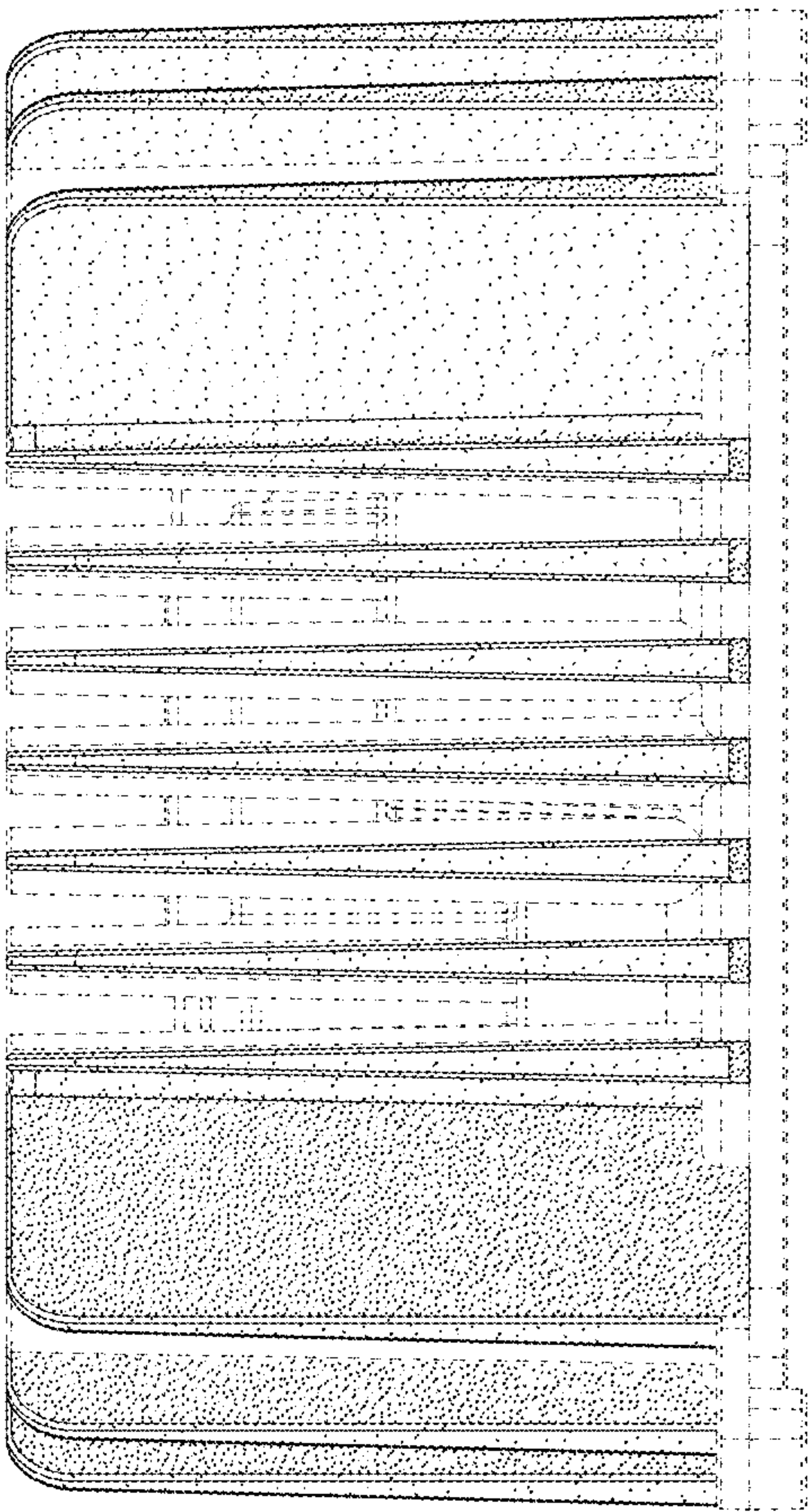


FIG. 12