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Parsons et al.

(10) **Patent No.: US 9,630,070 B2**
(45) **Date of Patent: *Apr. 25, 2017**

(54) **GOLF CLUB HEADS AND METHODS TO MANUFACTURE GOLF CLUB HEADS**

(71) Applicant: **Parsons Xtreme Golf, LLC**, Scottsdale, AZ (US)

(72) Inventors: **Robert R. Parsons**, Scottsdale, AZ (US); **Bradley D. Schweigert**, Anthem, AZ (US); **Michael R. Nicolette**, Scottsdale, AZ (US)

(73) Assignee: **PARSONS XTREME GOLF, LLC**, Scottsdale, AZ (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **15/249,857**

(22) Filed: **Aug. 29, 2016**

(65) **Prior Publication Data**

US 2016/0361610 A1 Dec. 15, 2016

Related U.S. Application Data

(63) Continuation-in-part of application No. 15/040,892, filed on Feb. 10, 2016, which is a continuation-in-part of application No. 14/939,849, filed on Nov. 12, 2015, which is a continuation of application No. 14/615,606, filed on Feb. 6, 2015, now Pat. No. 9,199,140, application No. 15/249,857, which is a continuation-in-part of application No. 29/559,452,

(Continued)

(51) **Int. Cl.**

A63B 53/06	(2015.01)
A63B 53/04	(2015.01)
A63B 60/00	(2015.01)
A63B 60/54	(2015.01)

(52) **U.S. Cl.**

CPC ***A63B 53/0466*** (2013.01); ***A63B 53/04*** (2013.01); *A63B 53/0475* (2013.01); *A63B 53/06* (2013.01); *A63B 60/54* (2015.10); *A63B 2053/045* (2013.01); *A63B 2053/0433* (2013.01); *A63B 2053/0491* (2013.01); *A63B 2060/002* (2015.10); *A63B 2209/00* (2013.01)

(58) **Field of Classification Search**

CPC A63B 2053/045; A63B 2053/0433; A63B 2053/0491; A63B 53/06

USPC 473/334, 335, 338, 339, 345, 346, 349

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

1,133,129 A	3/1915	Govan
1,269,745 A	6/1918	Robertson

(Continued)

OTHER PUBLICATIONS

International Search Report and Written Opinion received in connection with corresponding application No. PCT/US2015/016666, on May 14, 2015 (8 pages).

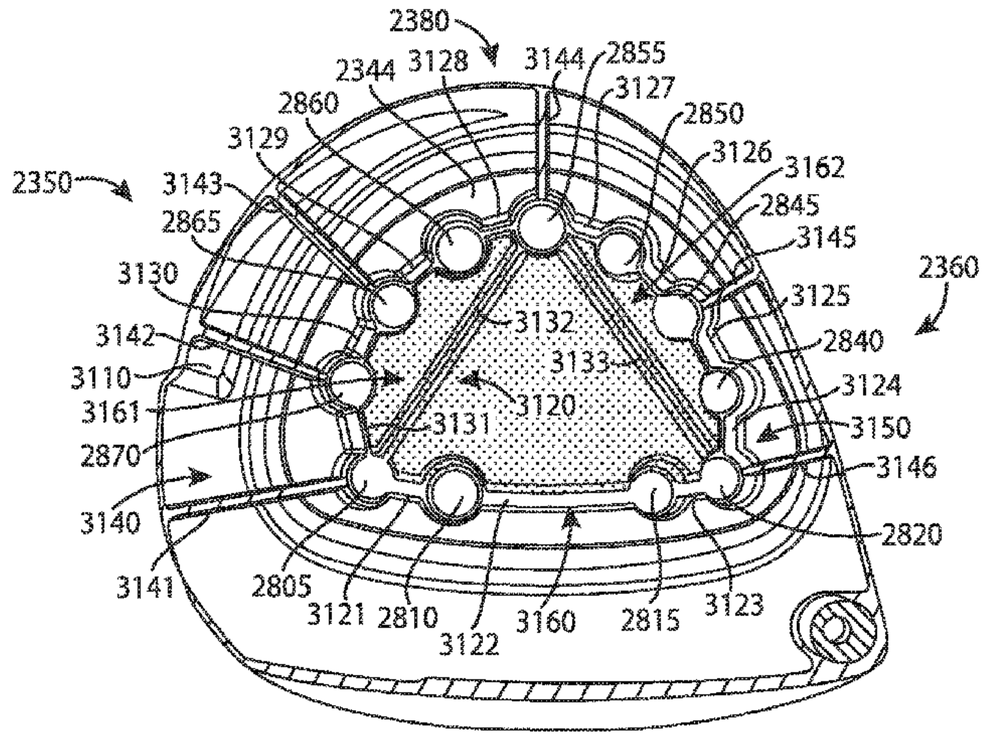
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Primary Examiner — Benjamin Layno

(57) **ABSTRACT**

Embodiments of golf club heads and methods to manufacture golf club heads are generally described herein. In one example, a golf club head may include a hollow body portion having a front portion, a rear portion, a toe portion, a heel portion, a bottom portion, a top portion, a plurality of ports on the bottom portion and a plurality of inner support portions in the hollow body portion. Other examples and embodiments may be described and claimed.

20 Claims, 25 Drawing Sheets



Related U.S. Application Data

filed on Mar. 28, 2016, now Pat. No. Des. 767,696, which is a continuation-in-part of application No. 29/552,228, filed on Jan. 21, 2016, now abandoned.

(60) Provisional application No. 62/281,639, filed on Jan. 21, 2016, provisional application No. 62/296,506, filed on Feb. 17, 2016, provisional application No. 62/301,756, filed on Mar. 1, 2016, provisional application No. 62/337,184, filed on May 16, 2016, provisional application No. 62/361,988, filed on Jul. 13, 2016, provisional application No. 62/362,491, filed on Jul. 14, 2016, provisional application No. 62/042,155, filed on Aug. 26, 2014, provisional application No. 62/048,693, filed on Sep. 10, 2014, provisional application No. 62/101,543, filed on Jan. 9, 2015, provisional application No. 62/105,123, filed on Jan. 19, 2015, provisional application No. 62/109,510, filed on Jan. 29, 2015.

(56) **References Cited**

U.S. PATENT DOCUMENTS

1,306,029	A	6/1919	Robertson
D55,867	S	7/1920	Mattern
1,534,600	A	4/1925	Mattern
1,538,312	A	5/1925	Beat
D138,437	S	8/1944	Link
D138,438	S	8/1944	Link
D138,442	S	8/1944	Link
3,652,094	A	3/1972	Glover
D240,748	S	7/1976	Bock
4,085,934	A	4/1978	Churchward
D253,778	S	12/1979	Madison
D307,783	S	5/1990	Linuma
D326,885	S	6/1992	Paul
D351,883	S	10/1994	Solheim et al.
5,518,243	A	5/1996	Redman
D378,111	S	2/1997	Parente et al.
D384,120	S	9/1997	De La Cruz et al.
5,788,584	A	8/1998	Parente et al.
D400,625	S	11/1998	Kubica et al.
D400,627	S	11/1998	Kubica et al.
D405,489	S	2/1999	Kubica et al.
D405,492	S	2/1999	Kubica et al.
5,997,415	A	12/1999	Wood
D444,830	S	7/2001	Kubica et al.
6,409,612	B1	6/2002	Evans et al.
D478,140	S	8/2003	Burrows
6,638,182	B2	10/2003	Kosmatka
6,773,360	B2	8/2004	Willett et al.
D508,969	S	8/2005	Hasebe
D513,051	S	12/2005	Barez et al.
D514,179	S	1/2006	Chen et al.
D514,185	S	1/2006	Barez et al.
D520,586	S	5/2006	Bingman
D522,077	S	5/2006	Schweigert et al.
D522,601	S	6/2006	Schweigert et al.
D523,498	S	6/2006	Chen et al.
D526,694	S	8/2006	Schweigert et al.
7,121,956	B2	10/2006	Lo
D534,599	S	1/2007	Barez et al.
7,166,040	B2	1/2007	Hoffman et al.
D536,401	S	2/2007	Kawami
D536,403	S	2/2007	Kawami
7,186,190	B1	3/2007	Beach et al.
7,223,180	B2	5/2007	Willett et al.
D563,498	S	3/2008	Jertson et al.
D564,054	S	3/2008	Jertson et al.
D564,055	S	3/2008	Jertson et al.
7,338,388	B2	3/2008	Schweigert et al.
7,347,794	B2	3/2008	Schweigert
D567,317	S	4/2008	Jertson et al.
D569,933	S	5/2008	Jertson et al.
D569,934	S	5/2008	Jertson et al.
D569,942	S	5/2008	Jertson et al.
D570,937	S	6/2008	Schweigert et al.
D570,938	S	6/2008	Jertson et al.
7,407,447	B2	8/2008	Beach et al.
7,410,425	B2	8/2008	Willett et al.
7,410,426	B2	8/2008	Willett et al.
7,419,441	B2	9/2008	Hoffman et al.
7,448,963	B2	11/2008	Beach et al.
7,448,964	B2	11/2008	Schweigert et al.
7,530,904	B2	5/2009	Beach et al.
D594,520	S	6/2009	Schweigert et al.
D594,521	S	6/2009	Jertson et al.
D594,919	S	6/2009	Schweigert et al.
7,540,811	B2	6/2009	Beach et al.
D597,620	S	8/2009	Taylor et al.
7,568,985	B2	8/2009	Beach et al.
7,578,753	B2	8/2009	Beach et al.
D600,297	S	9/2009	Jertson et al.
7,584,531	B2	9/2009	Schweigert et al.
7,588,502	B2	9/2009	Nishino
7,591,738	B2	9/2009	Beach et al.
D603,472	S	11/2009	Schweigert et al.
7,611,424	B2	11/2009	Nagai et al.
7,621,823	B2	11/2009	Beach et al.
D605,715	S	12/2009	Barez et al.
7,632,194	B2	12/2009	Beach et al.
7,658,686	B2	2/2010	Soracco
7,713,142	B2	5/2010	Hoffman et al.
7,717,804	B2	5/2010	Beach et al.
7,717,805	B2	5/2010	Beach et al.
D618,746	S	6/2010	Jertson et al.
D618,747	S	6/2010	Schweigert et al.
D618,753	S	6/2010	Jertson et al.
D618,754	S	6/2010	Schweigert et al.
7,744,484	B1	6/2010	Chao
7,798,203	B2	9/2010	Schweigert et al.
7,846,041	B2	12/2010	Beach et al.
D635,626	S	4/2011	Nicolette
7,927,229	B2	4/2011	Jertson et al.
D638,893	S	5/2011	Schweigert et al.
D638,896	S	5/2011	Schweigert et al.
7,963,861	B2	6/2011	Beach et al.
8,012,038	B1	9/2011	Beach et al.
D647,585	S	10/2011	Jertson et al.
D661,751	S	6/2012	Nicolette et al.
D661,756	S	6/2012	Nicolette et al.
8,257,196	B1	9/2012	Abbott et al.
8,257,197	B2	9/2012	Schweigert
8,262,506	B2	9/2012	Watson et al.
D673,630	S	1/2013	Schweigert
D673,632	S	1/2013	Schweigert et al.
8,371,957	B2	2/2013	Schweigert et al.
D680,179	S	4/2013	Solheim et al.
8,414,422	B2	4/2013	Peralta et al.
8,485,919	B2	7/2013	Rice et al.
D691,230	S	10/2013	Chen et al.
8,562,457	B2	10/2013	Beach et al.
8,608,587	B2	12/2013	Henrikson et al.
8,628,431	B2	1/2014	Schweigert et al.
8,663,026	B2	3/2014	Blowers et al.
8,777,778	B2	7/2014	Solheim et al.
8,784,232	B2	7/2014	Jertson et al.
8,790,196	B2	7/2014	Solheim et al.
8,808,108	B2	8/2014	Schweigert
D712,989	S	9/2014	Gillig
8,826,512	B2	9/2014	Schweigert
8,858,362	B1	10/2014	Leposky et al.
8,961,336	B1	2/2015	Parsons et al.
D724,164	S	3/2015	Schweigert et al.
D729,892	S	5/2015	Nicolette et al.
D733,234	S	6/2015	Nicolette
9,199,140	B1	12/2015	Schweigert et al.
9,199,143	B1	12/2015	Parsons et al.
D753,251	S	4/2016	Schweigert et al.
D756,471	S	5/2016	Nicolette et al.
9,352,197	B2	5/2016	Parsons et al.
D760,334	S	6/2016	Schweigert et al.
9,399,158	B2	7/2016	Parsons et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2006/0105856	A1	5/2006	Lo	
2006/0111200	A1	5/2006	Poynor	
2007/0238551	A1*	10/2007	Yokota	A63B 53/0466 473/349
2007/0293344	A1	12/2007	Davis	
2008/0004133	A1	1/2008	Schweigert	
2008/0188322	A1	8/2008	Anderson et al.	
2009/0029795	A1	1/2009	Schweigert et al.	
2010/0144461	A1	6/2010	Ban	
2010/0331102	A1	12/2010	Golden et al.	
2011/0143858	A1	6/2011	Peralta et al.	
2012/0202615	A1	8/2012	Beach et al.	
2013/0303304	A1	11/2013	Sato	
2015/0231454	A1	8/2015	Parsons et al.	

OTHER PUBLICATIONS

International Search Report and Written Opinion received in connection with PCT/US15/42484 on Oct. 19, 2015 (12 pages).
International Search Report and Written Opinion received in connection with PCT Application PCTUS2015042282 on Oct. 13, 2015 (12 pages).
U.S. Appl. No. 29/512,313, Nicolette, "Golf Club Head," filed Dec. 18, 2014.
U.S. Appl. No. 14/618,501, Parsons et al., "Golf Club Heads and Methods to Manufacture Golf Club Heads,"filed Feb. 10, 2015.
Wall, Jonathan, "Details: Phil's Prototype Mack Daddy PM-Grind Wedge," (http://www.pgatour.com/equipmentreport/2015/01/21/callaway-wedge.html), www.pgatour.com, PGA Tour, Inc., published Jan. 21, 2015.

* cited by examiner

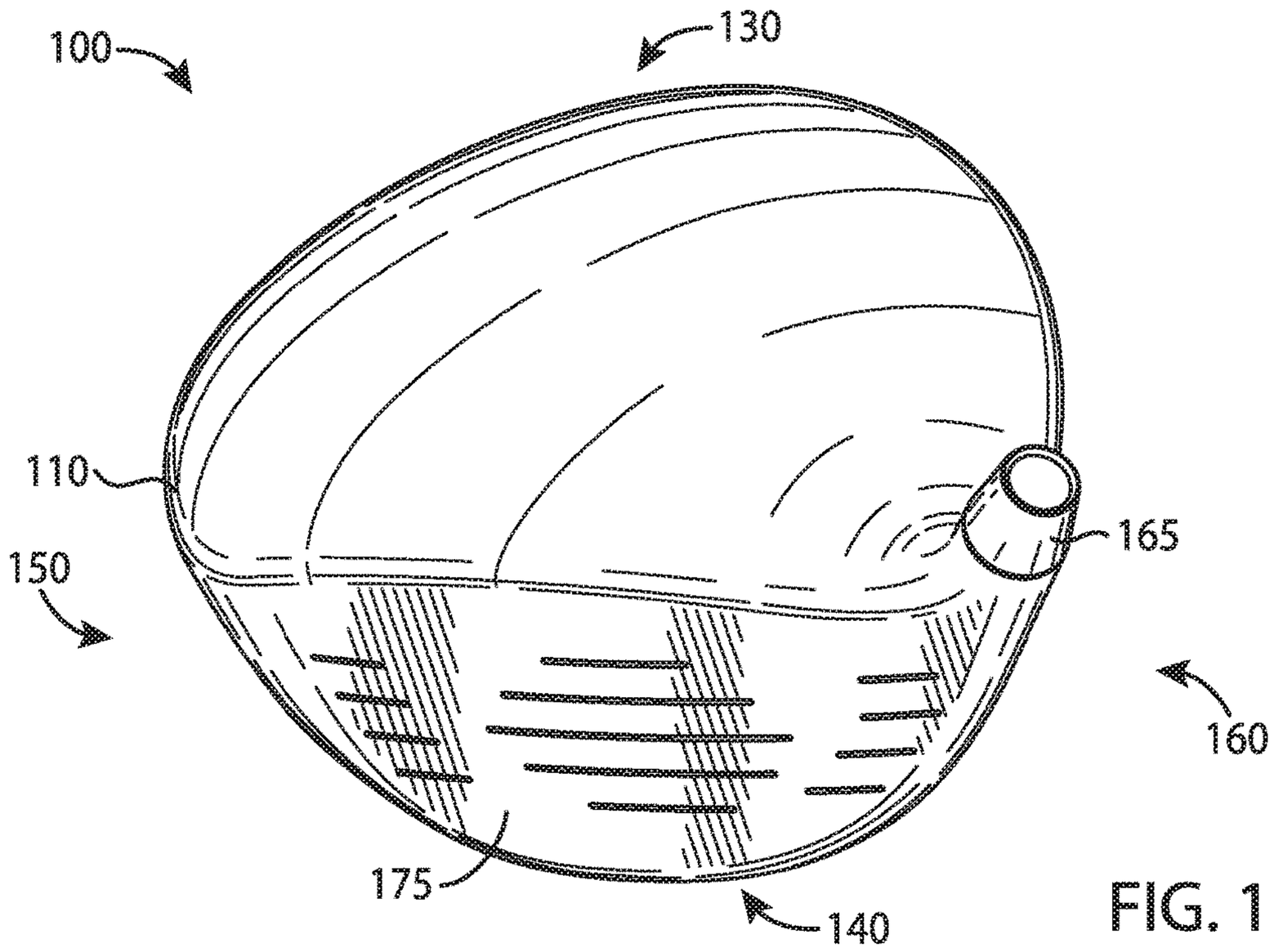

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FIG. 1

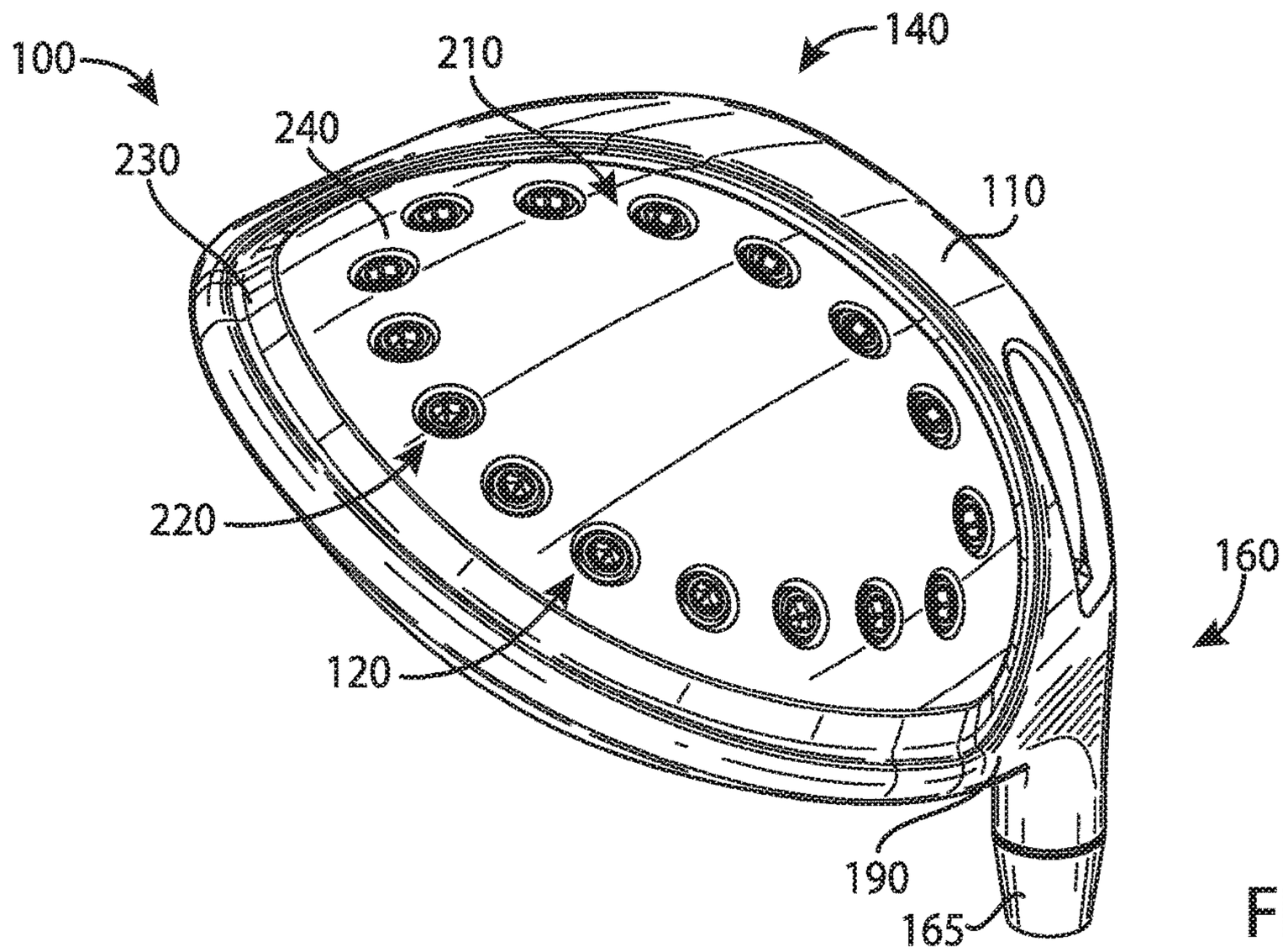

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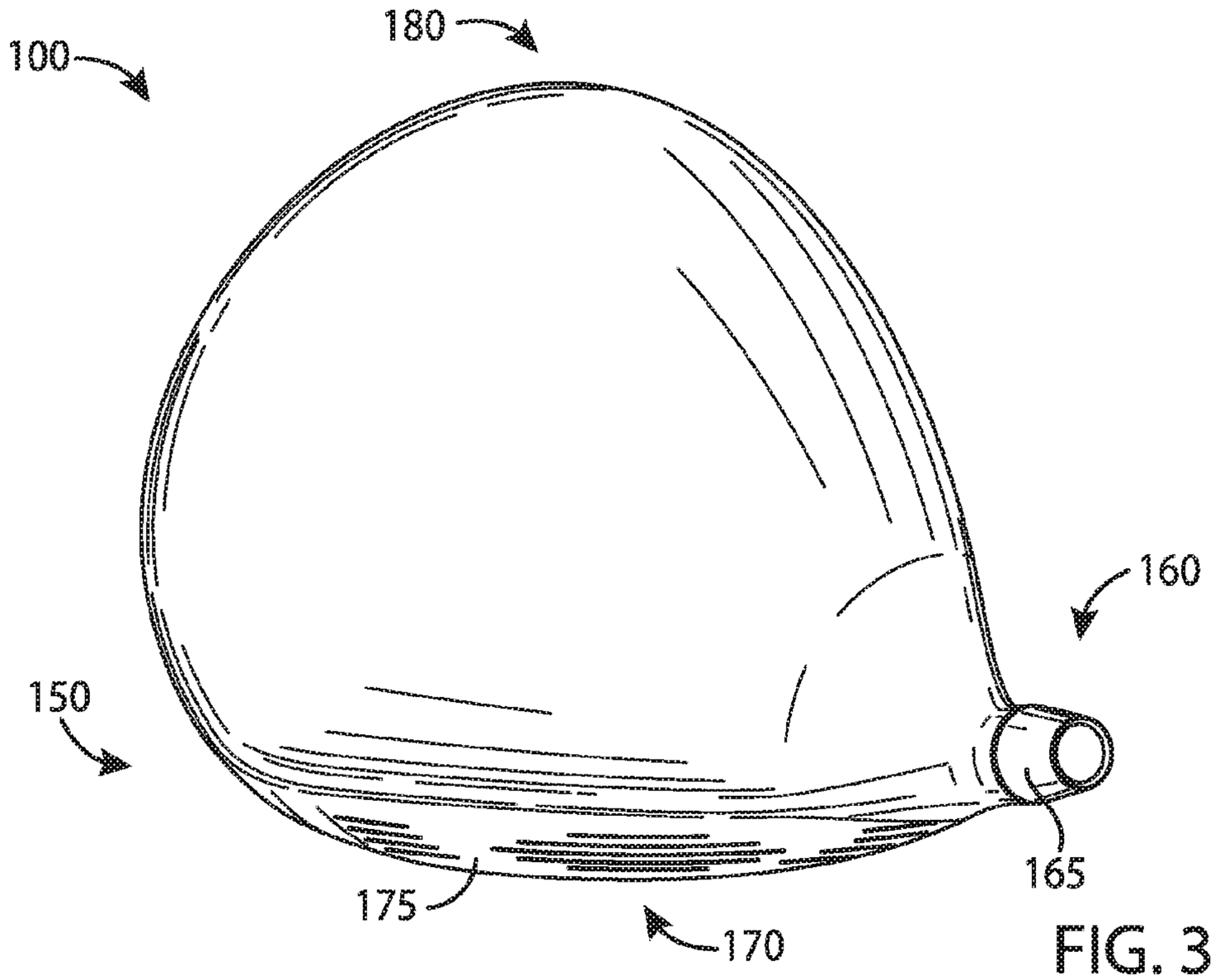

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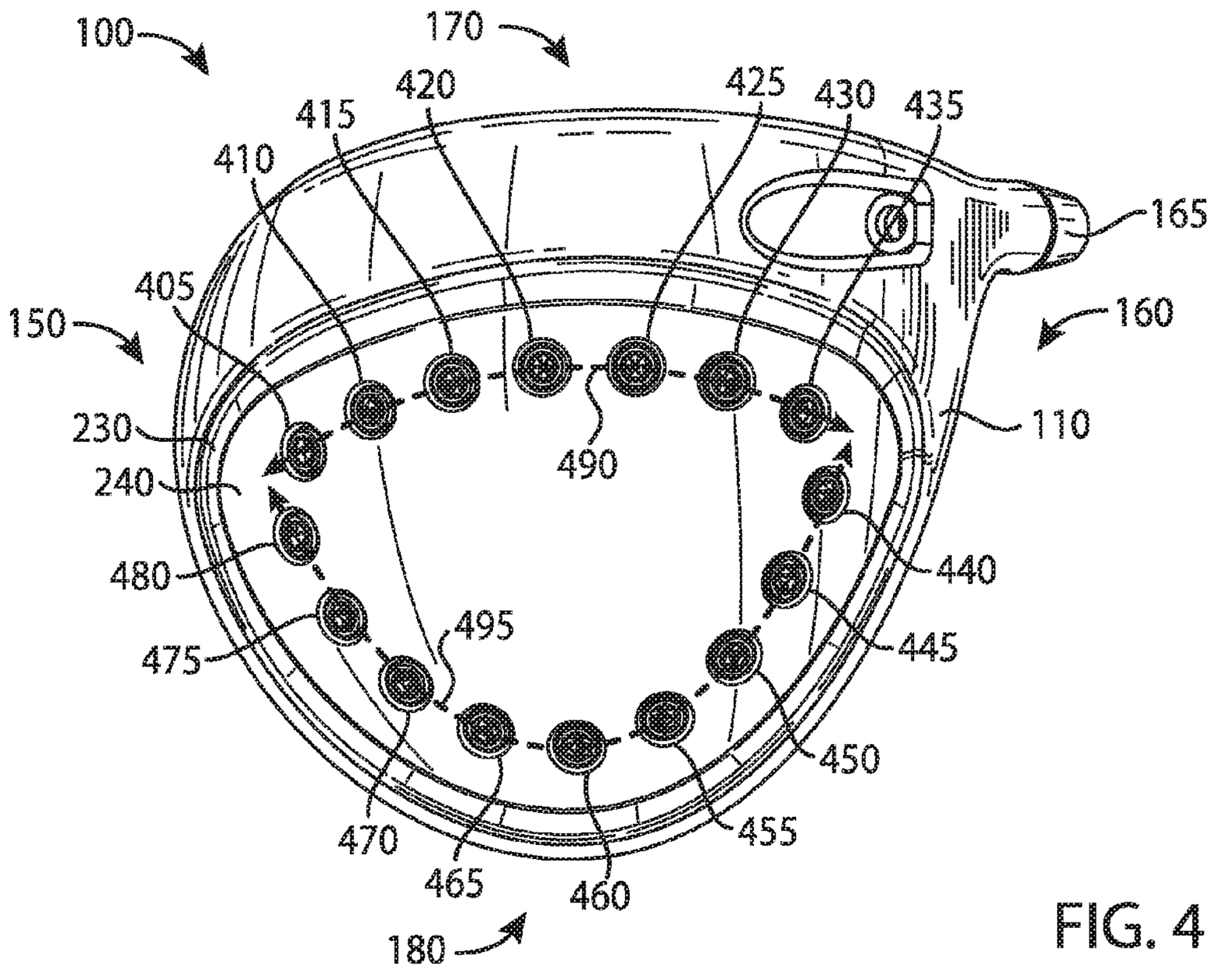

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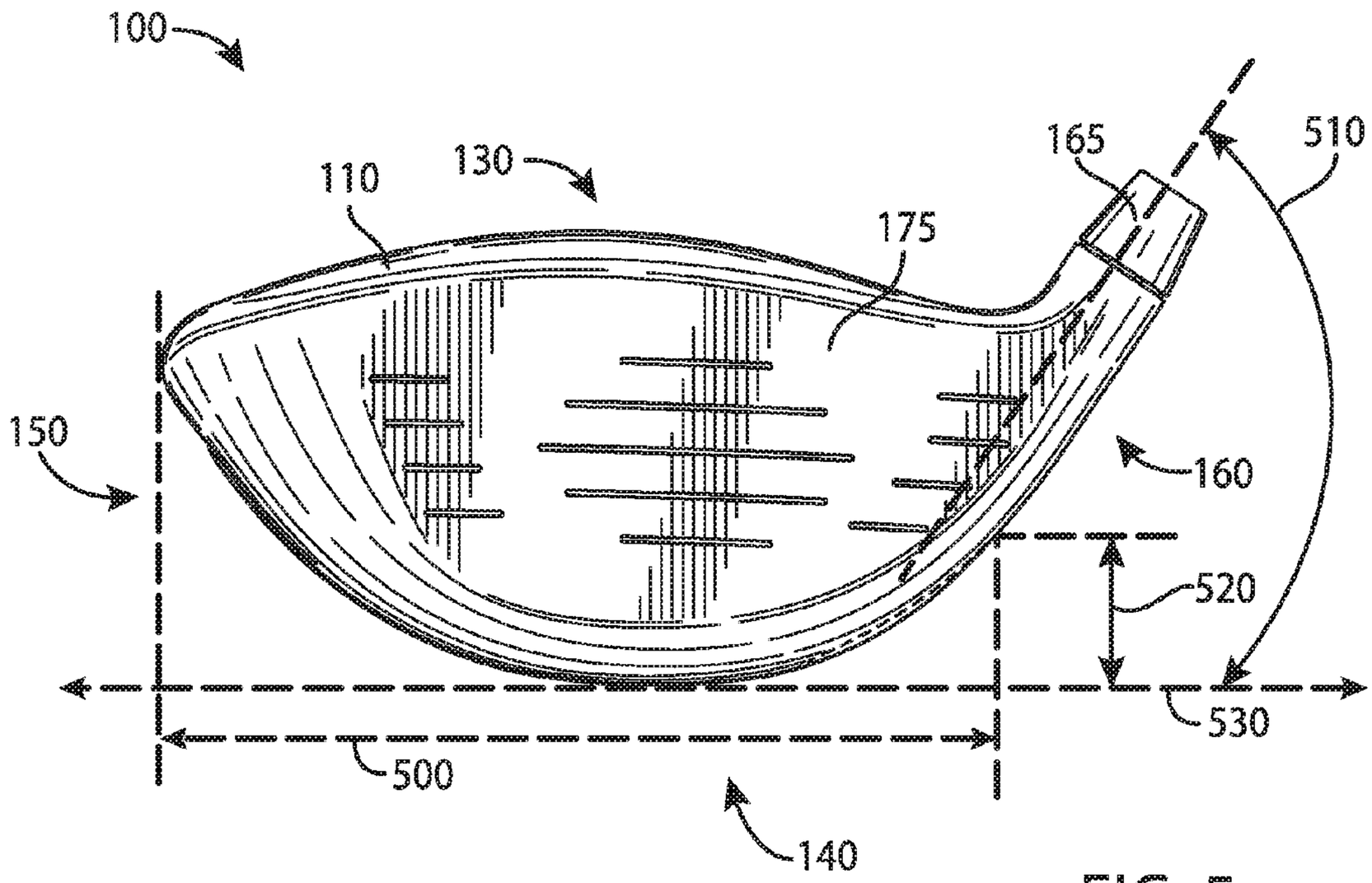

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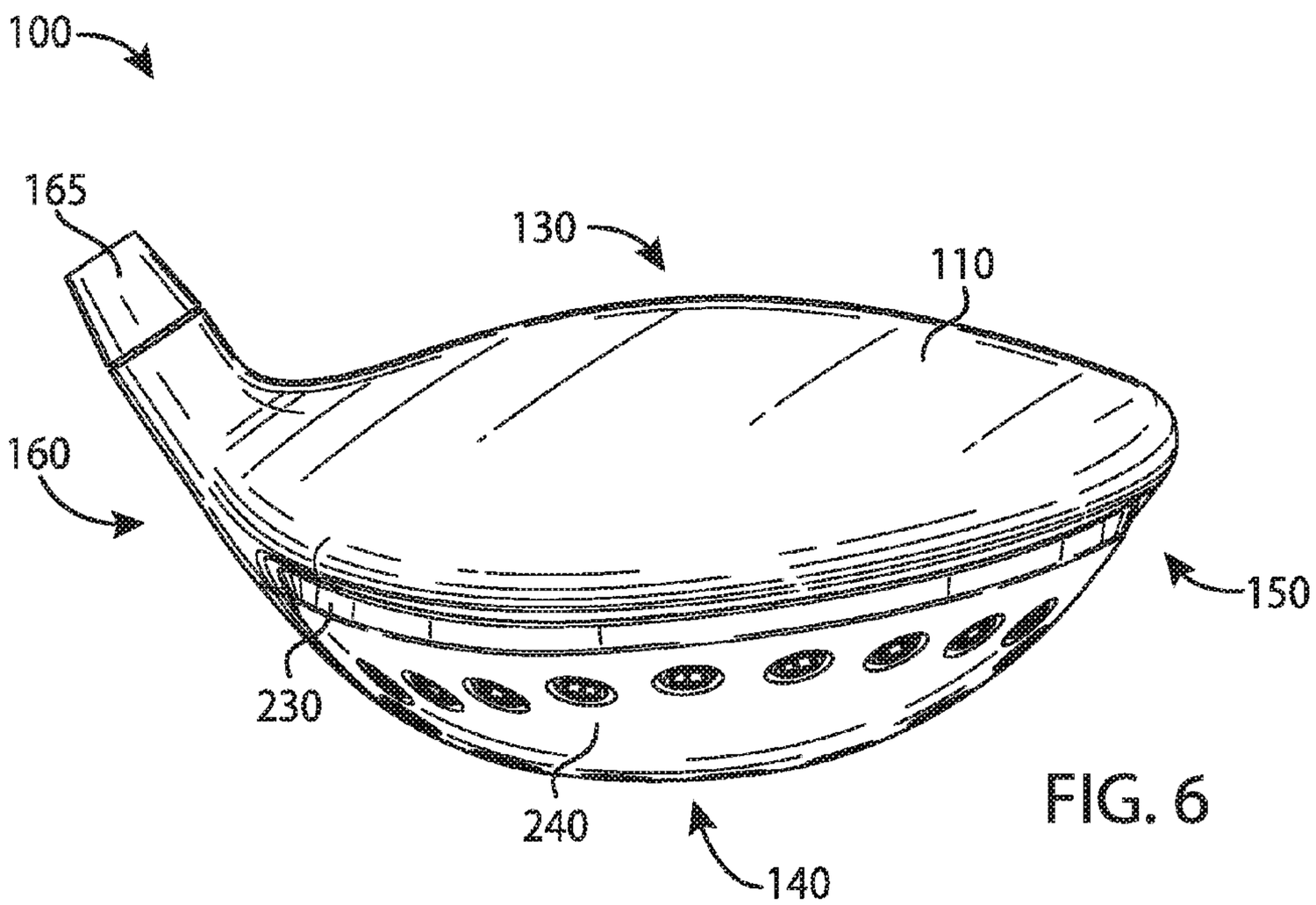

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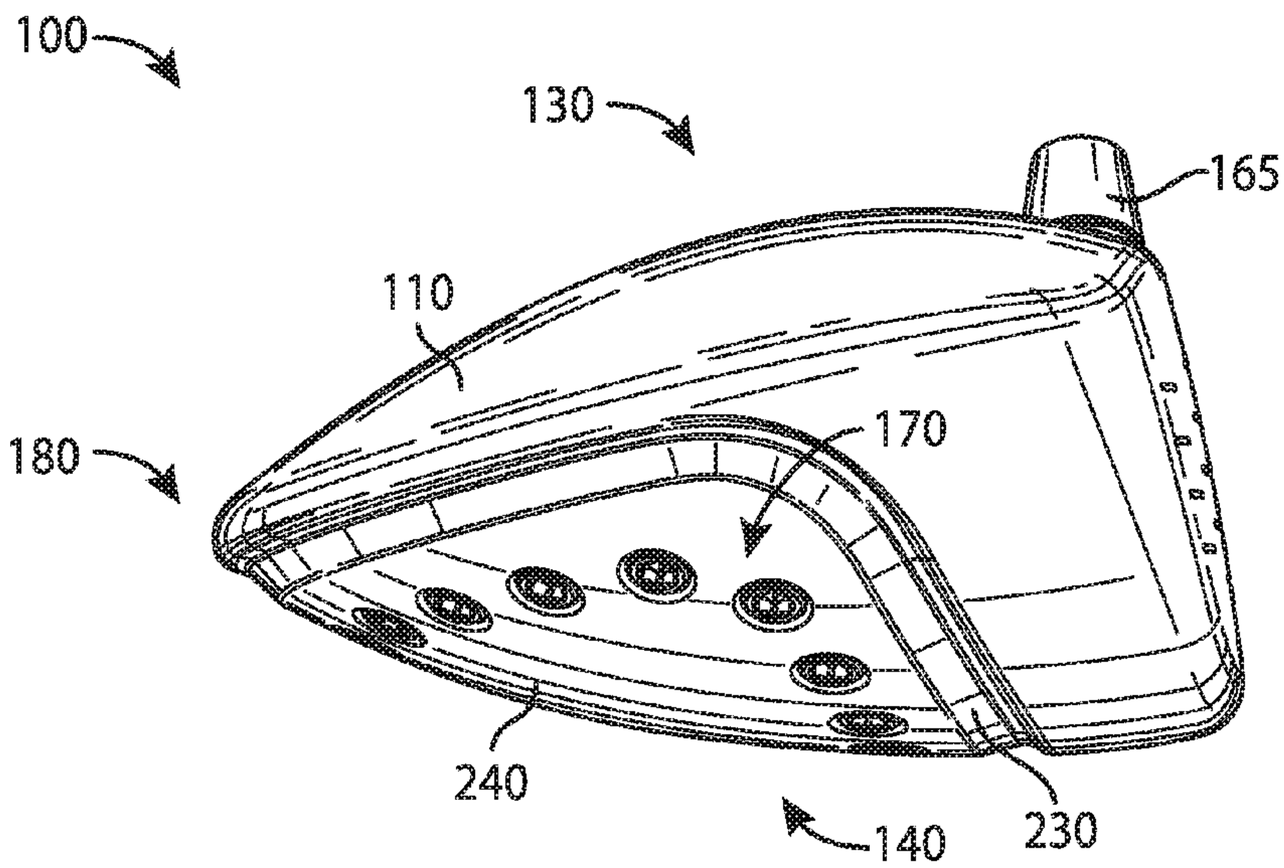

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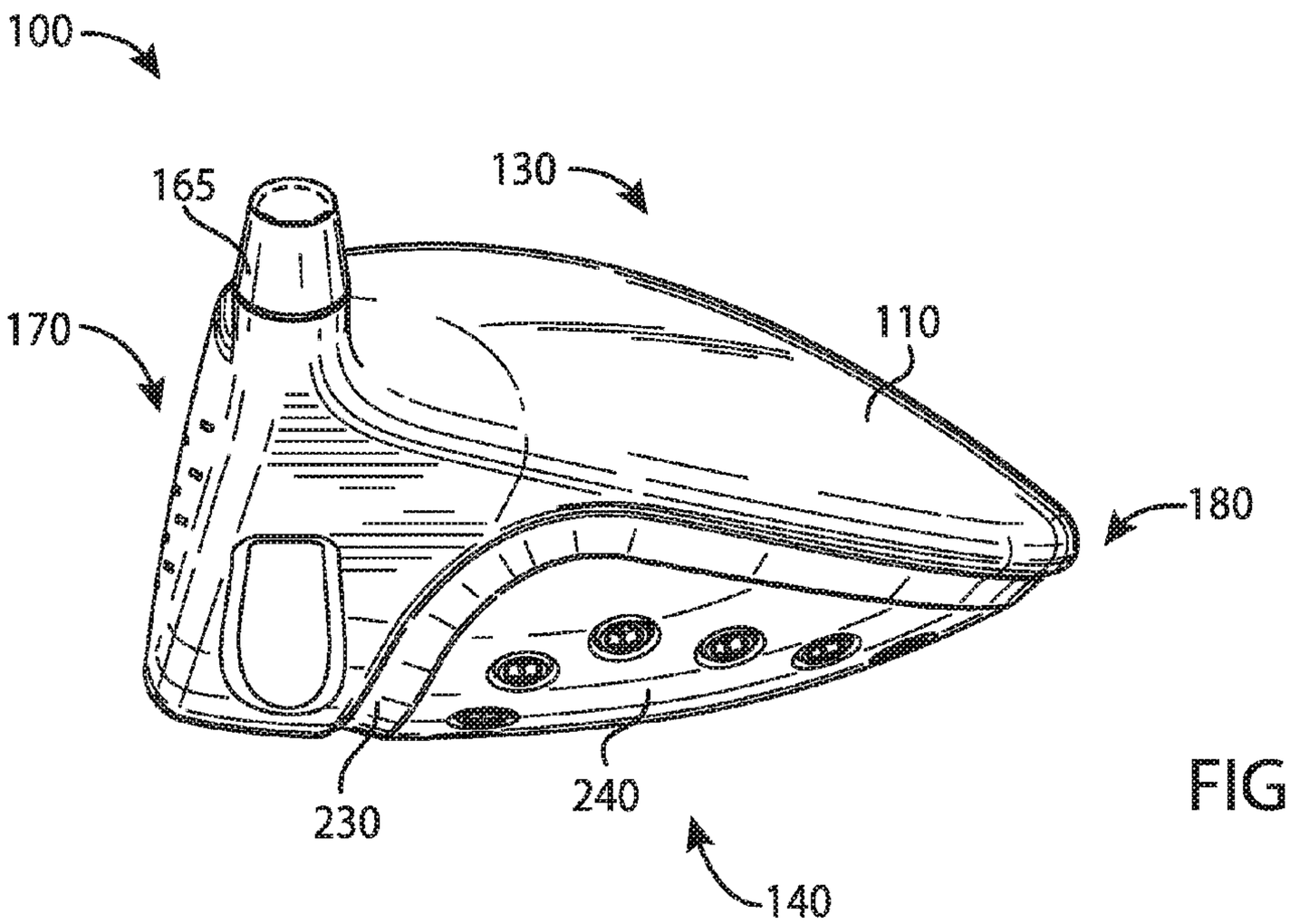

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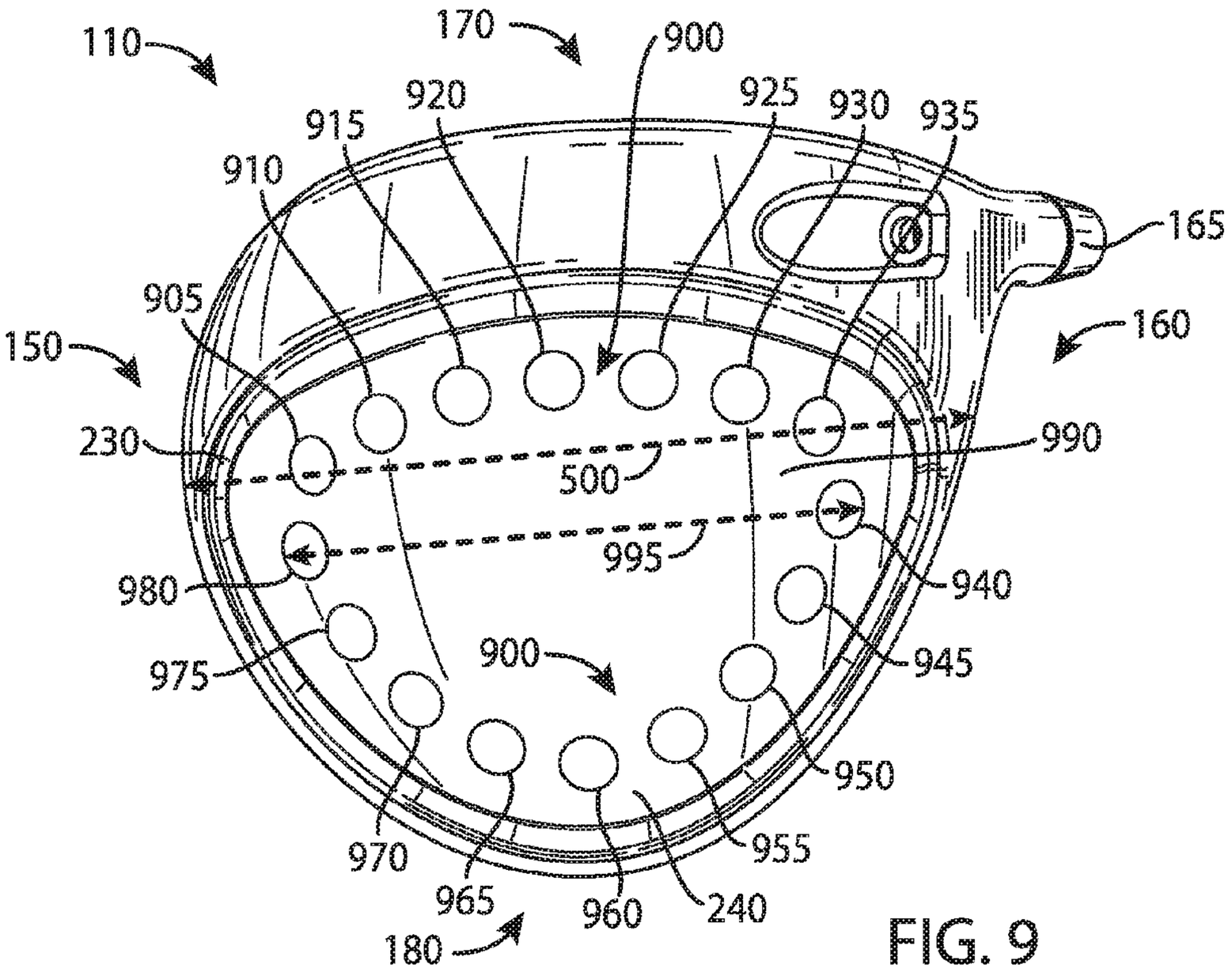


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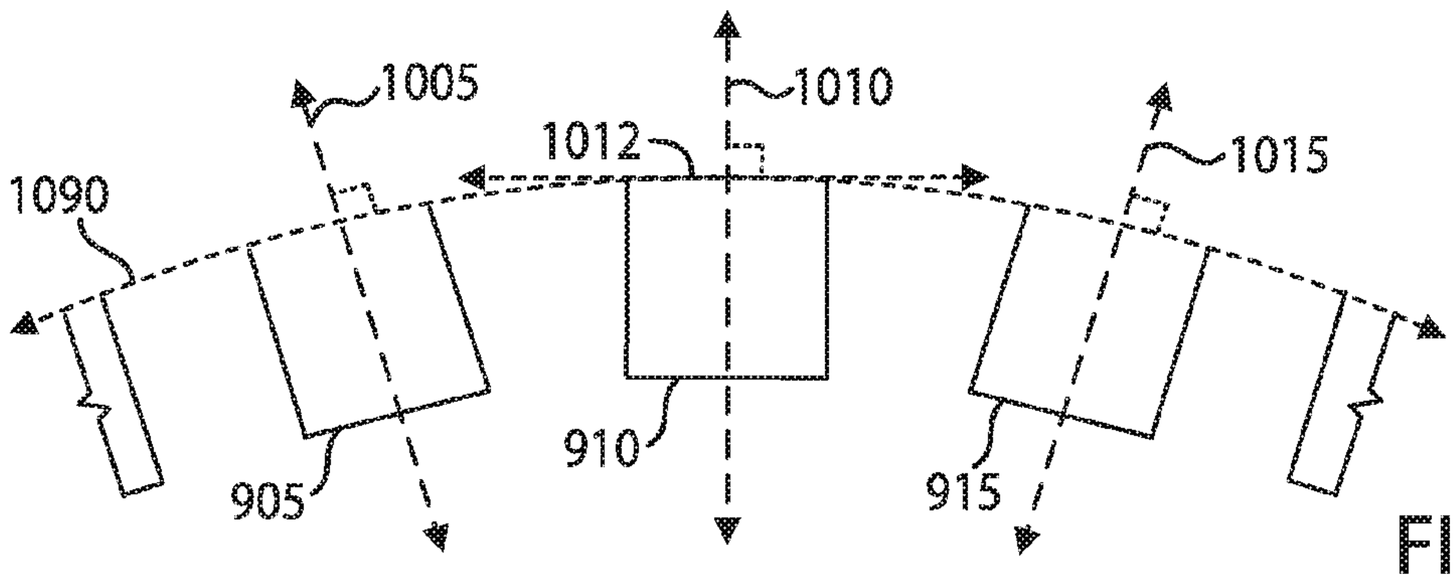


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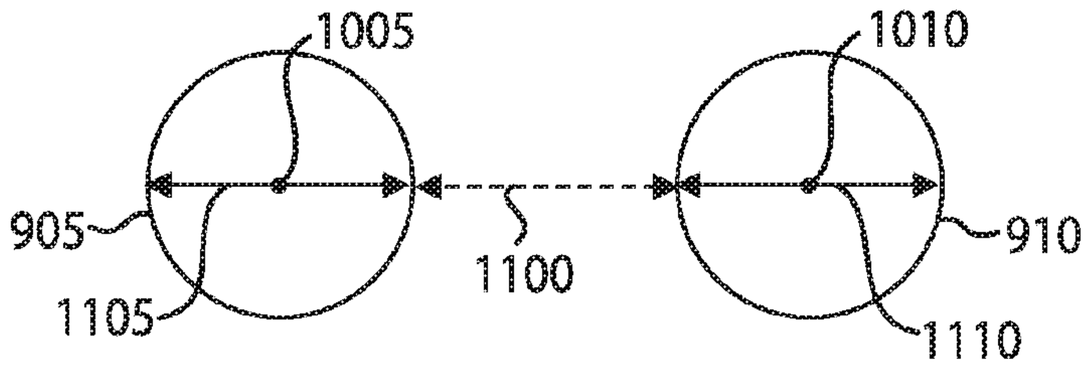


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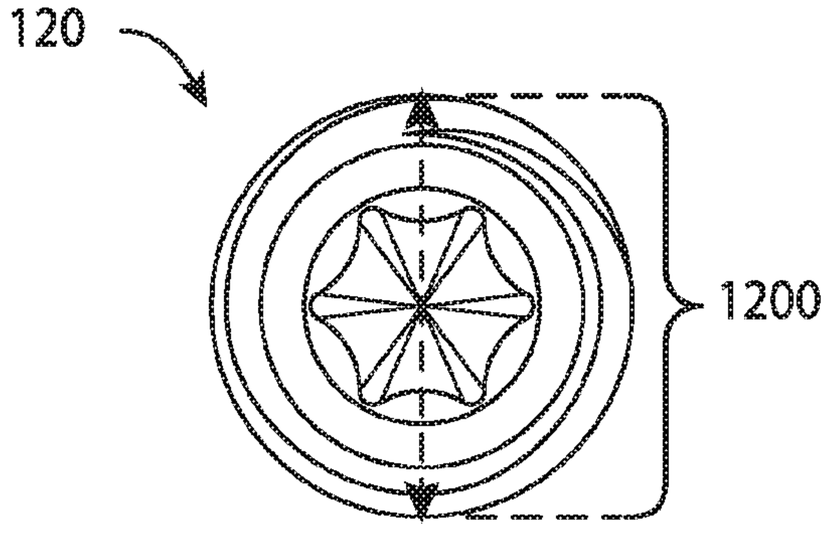


FIG. 12

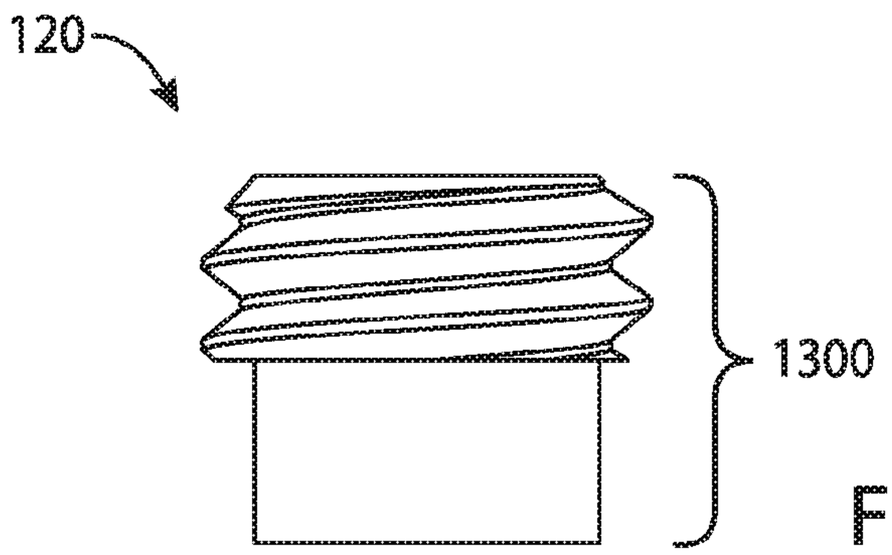


FIG. 13

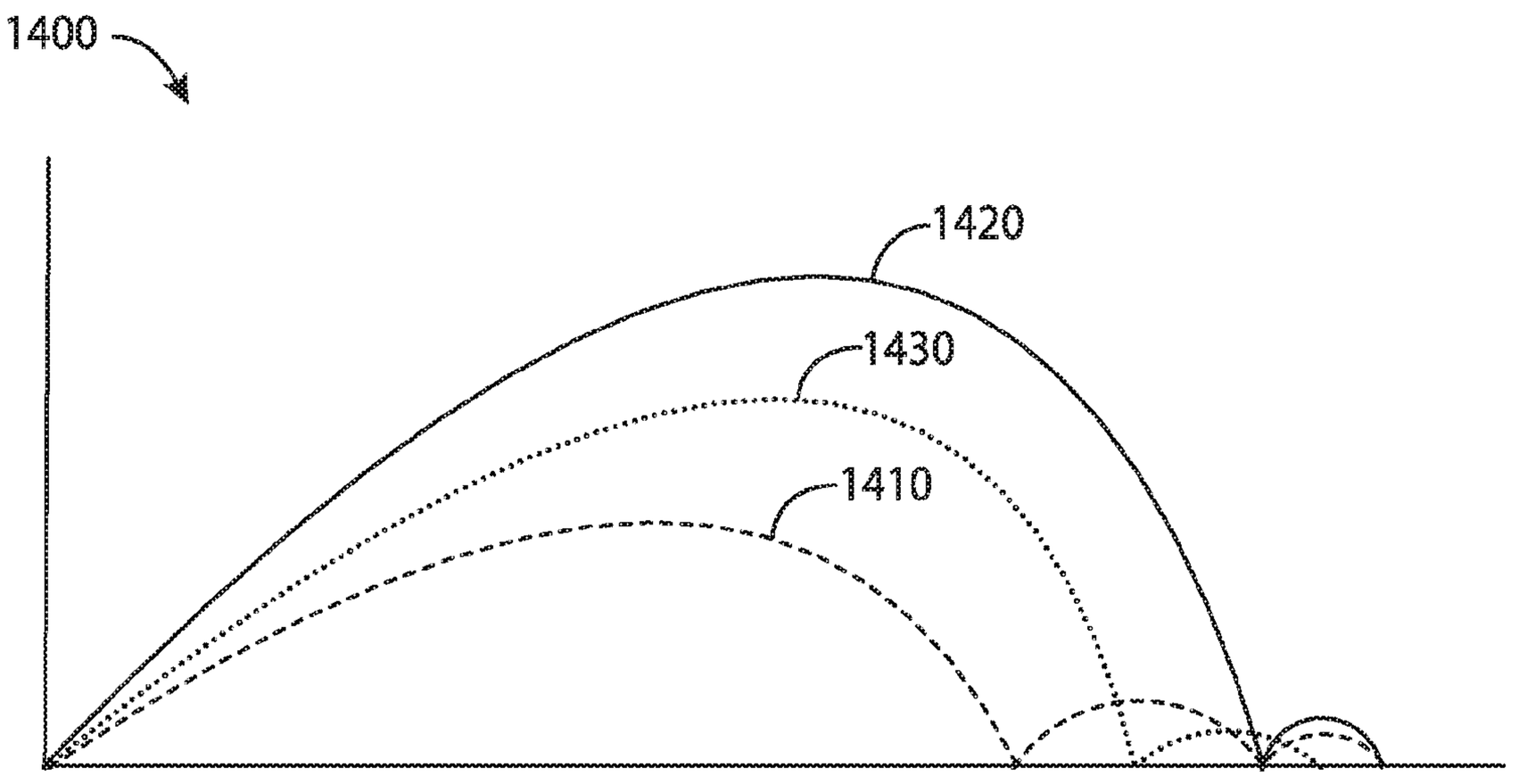


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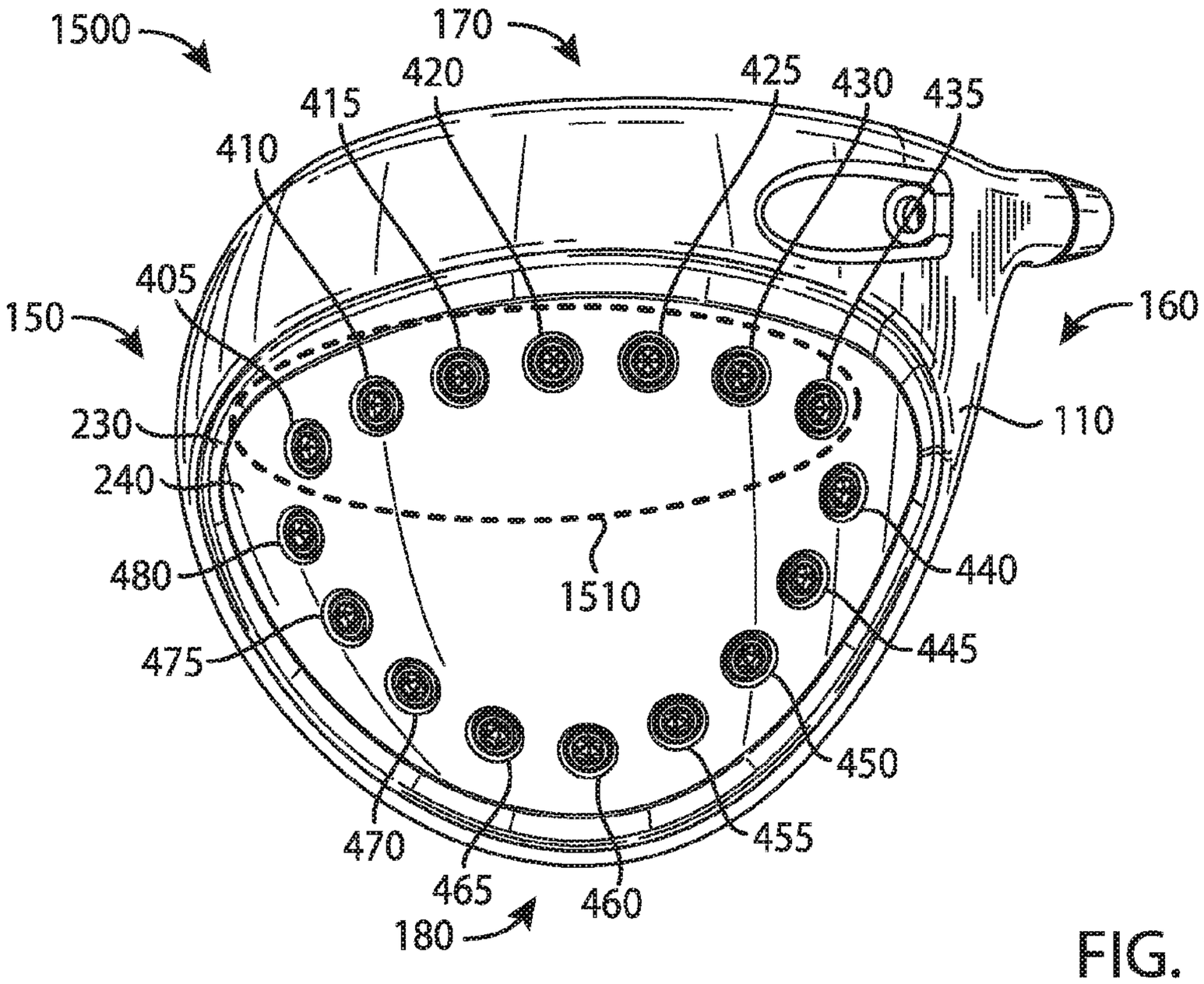

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FIG. 15

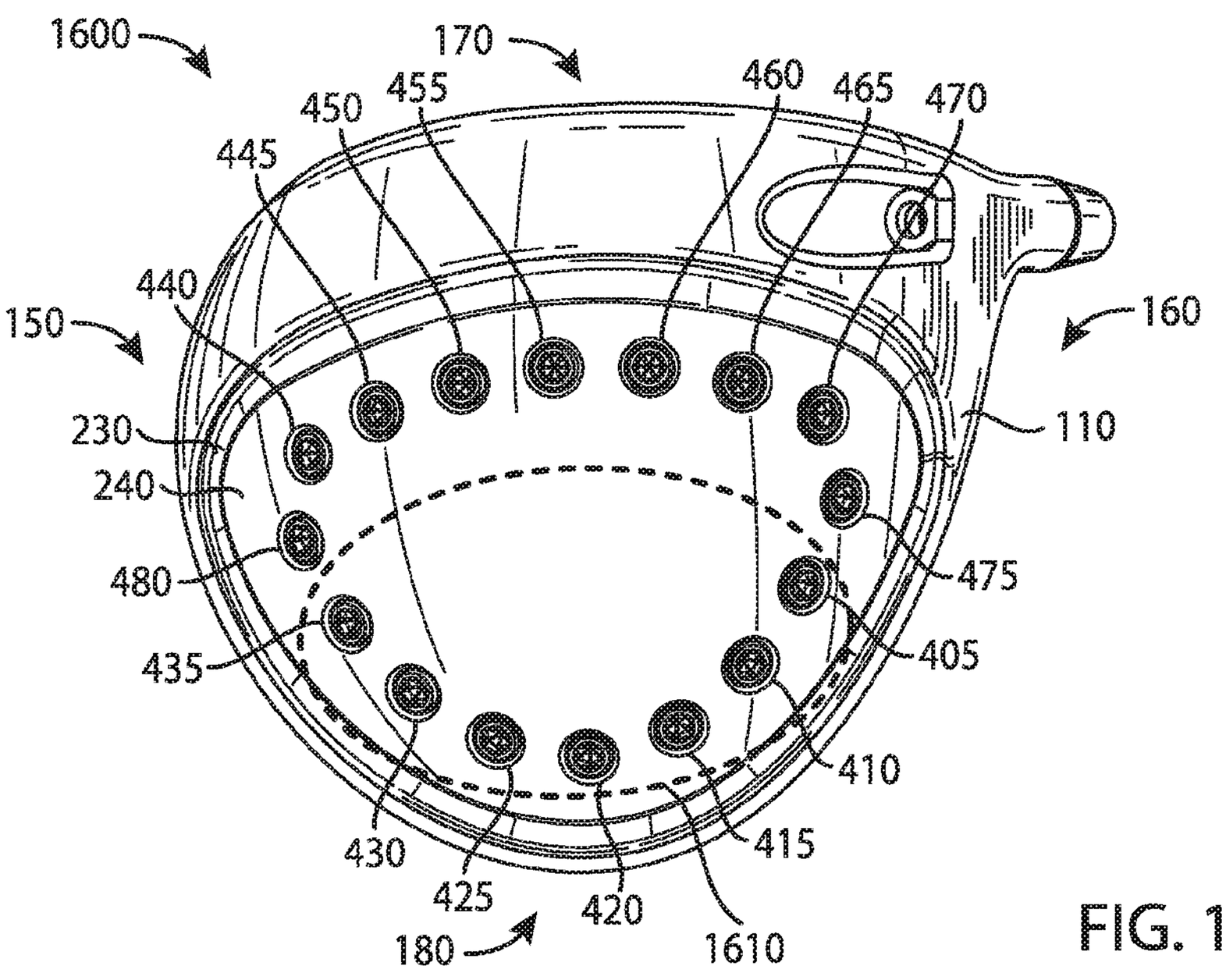

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FIG. 16

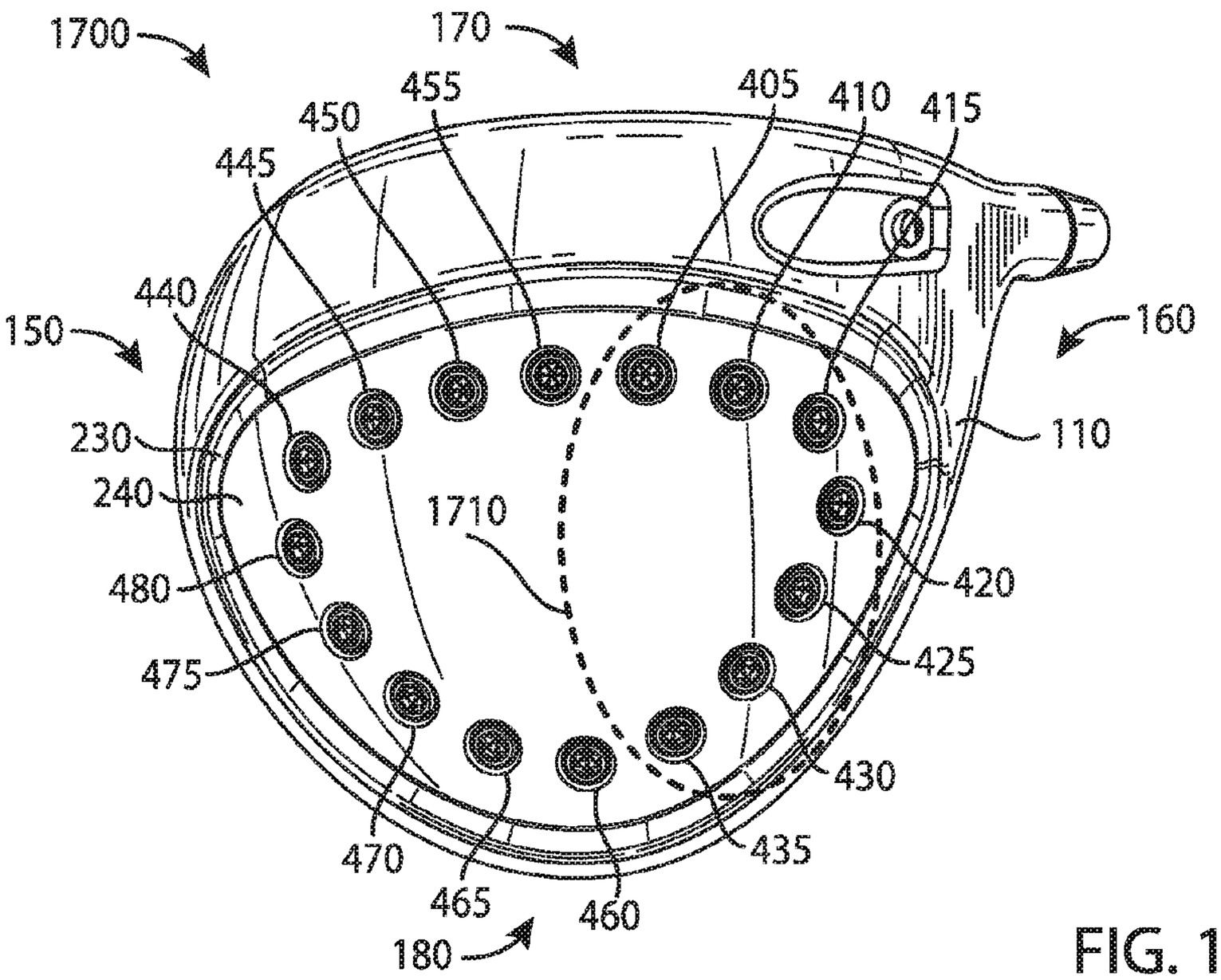

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FIG. 17

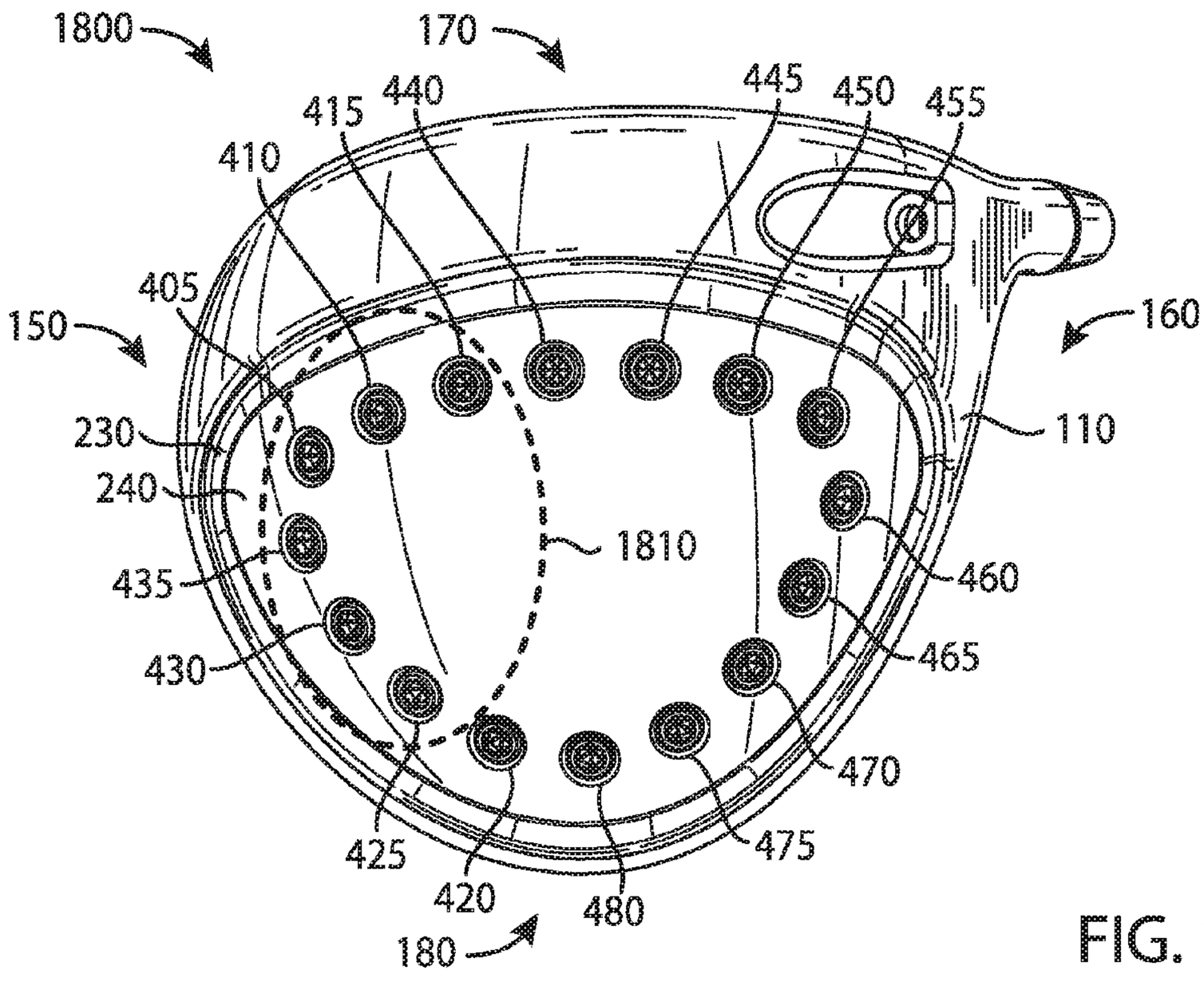

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FIG. 18

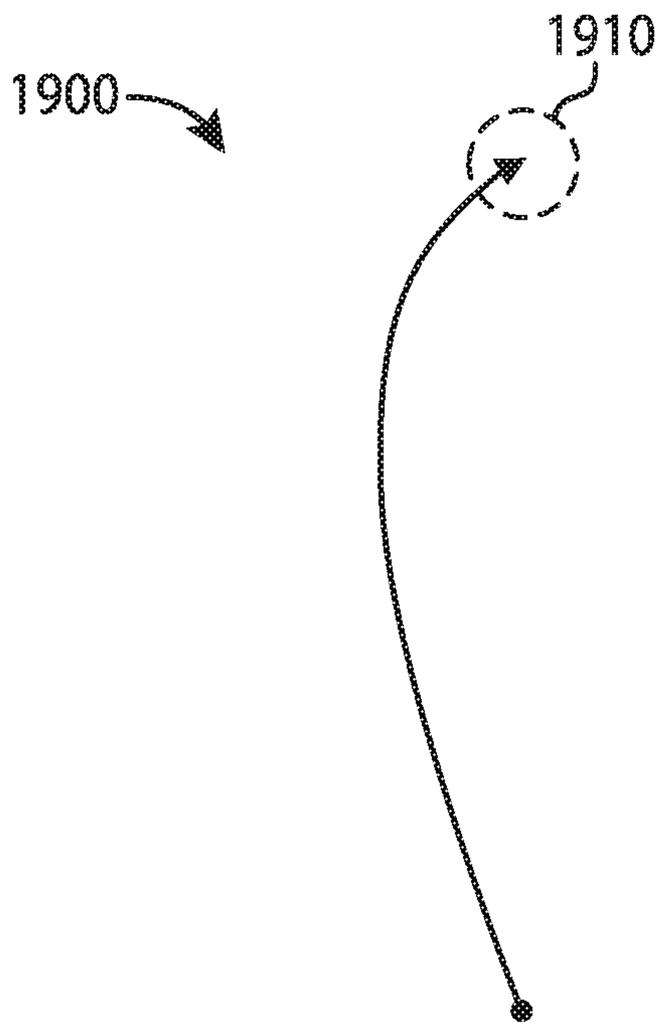

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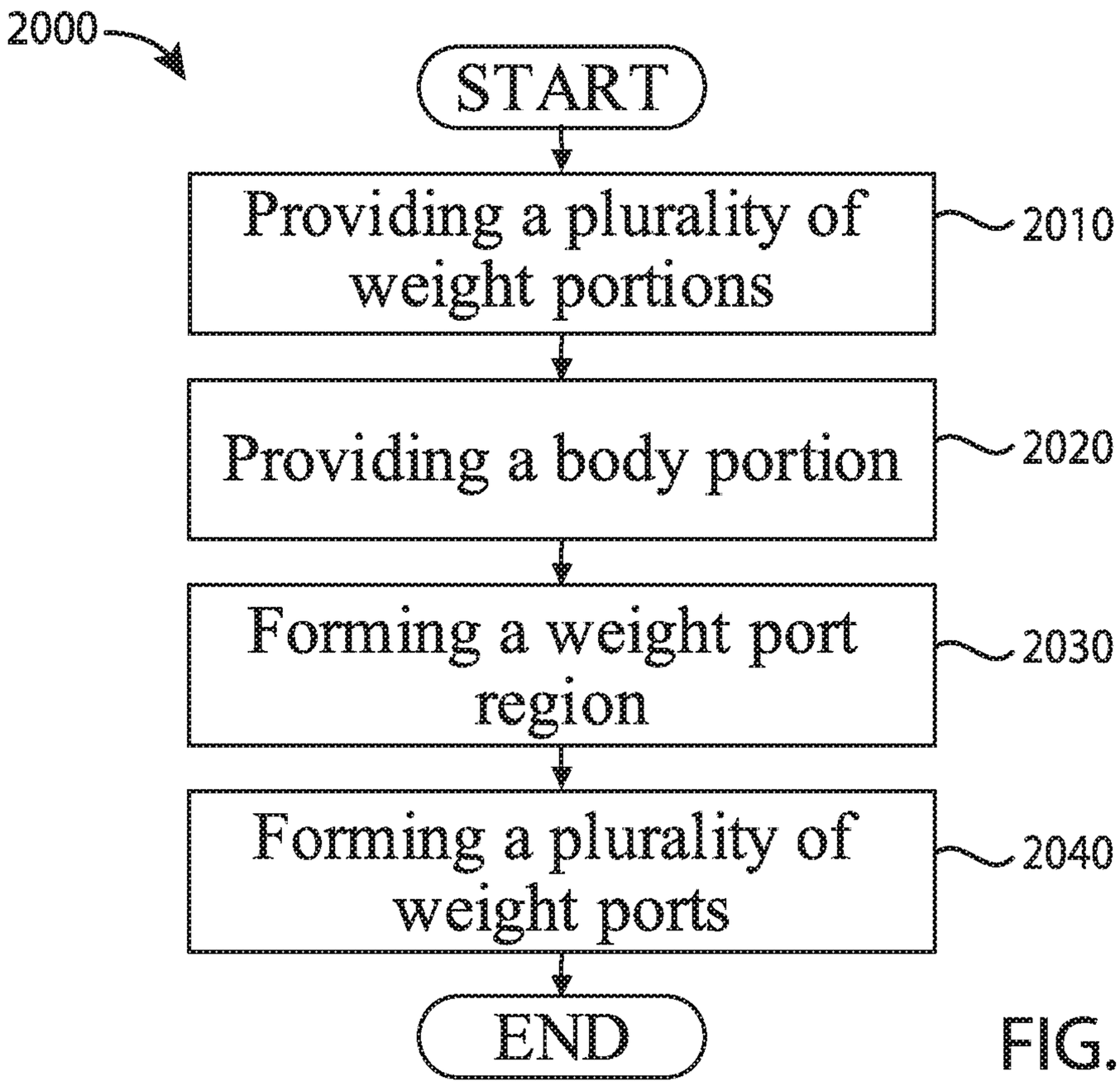

2000
START
Providing a plurality of weight portions
2010
Providing a body portion
2020
Forming a weight port region
2030
Forming a plurality of weight ports
2040
END

FIG. 20

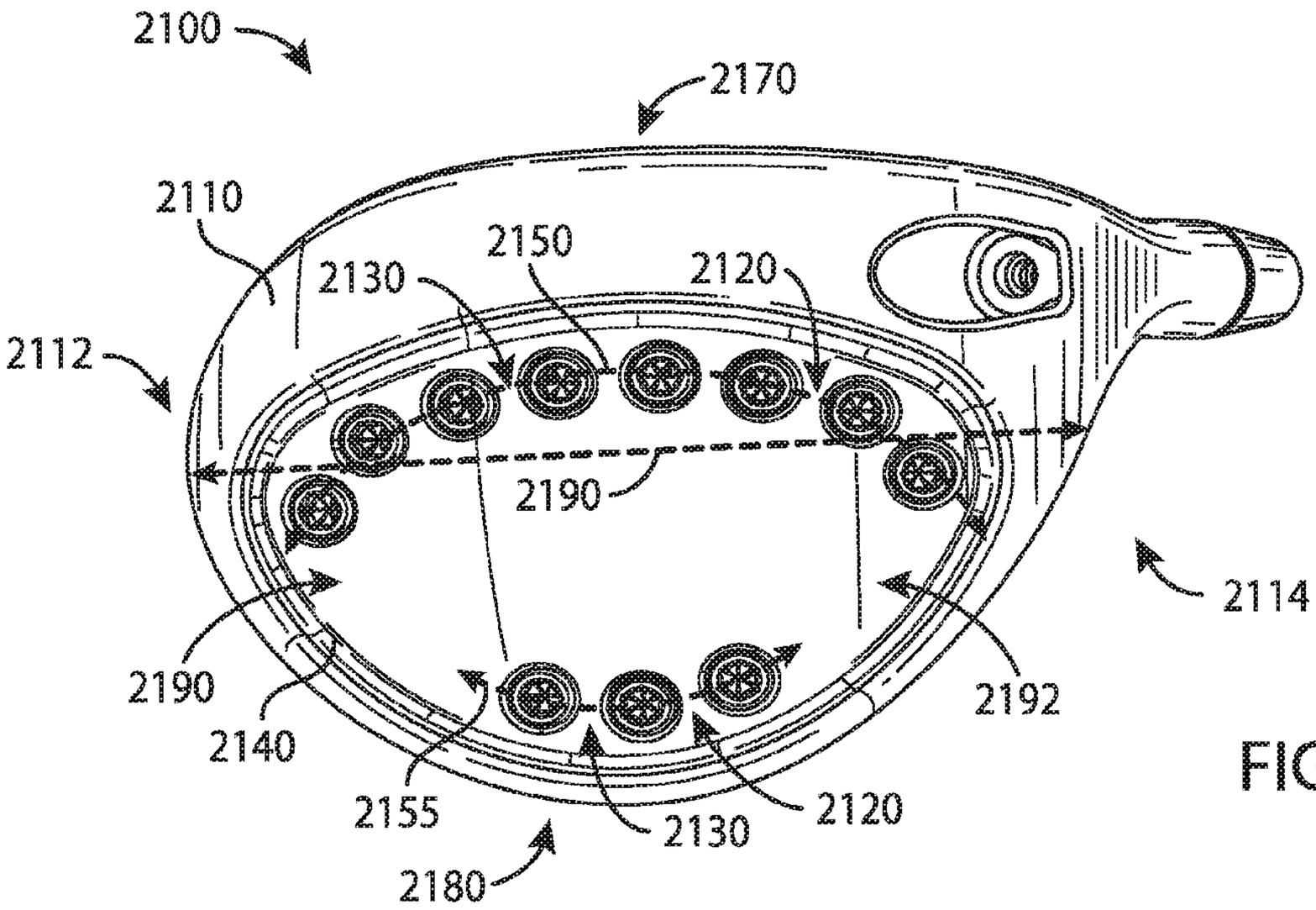

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FIG. 21

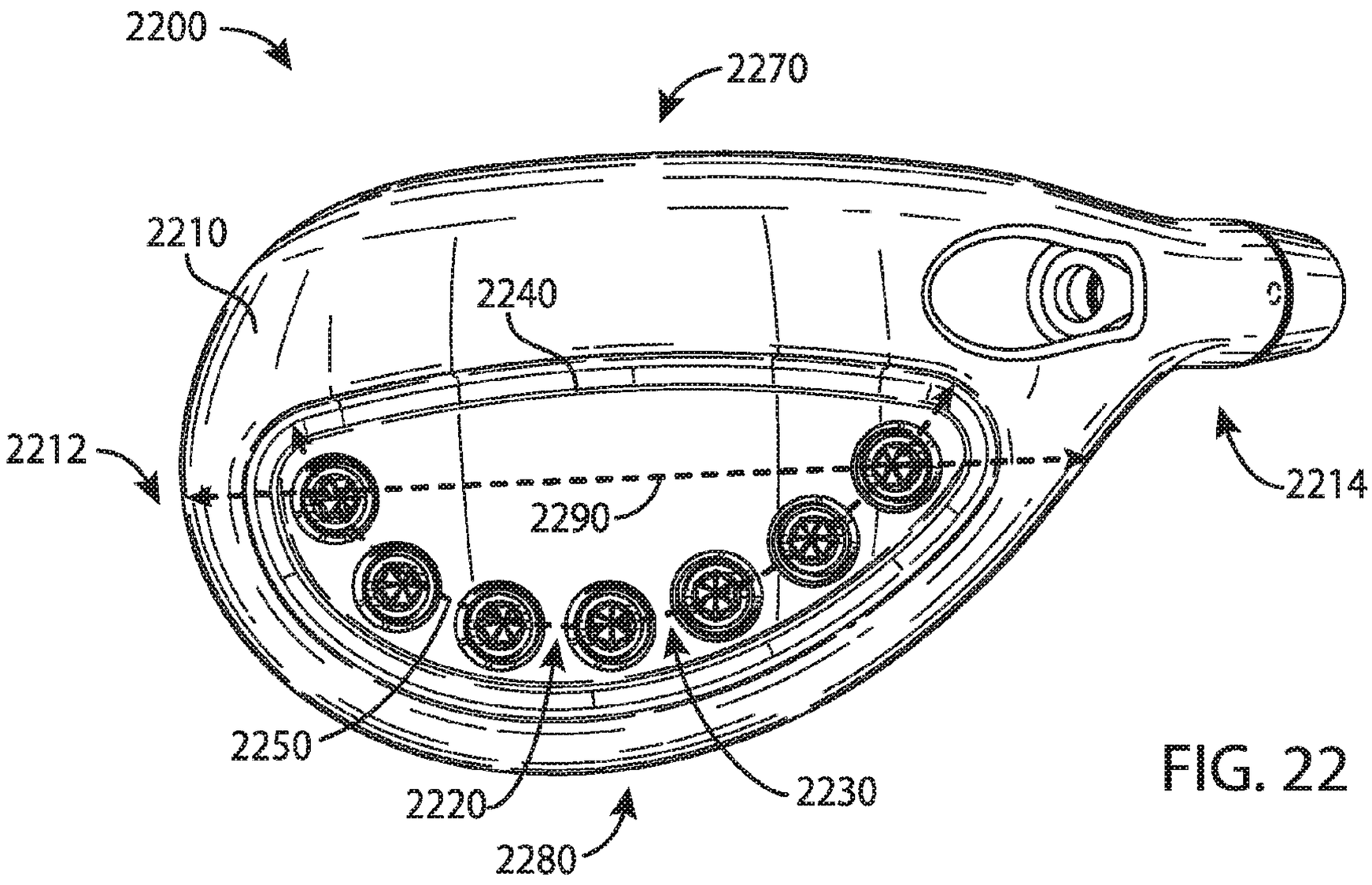

2200
2270
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2220
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2280

FIG. 22

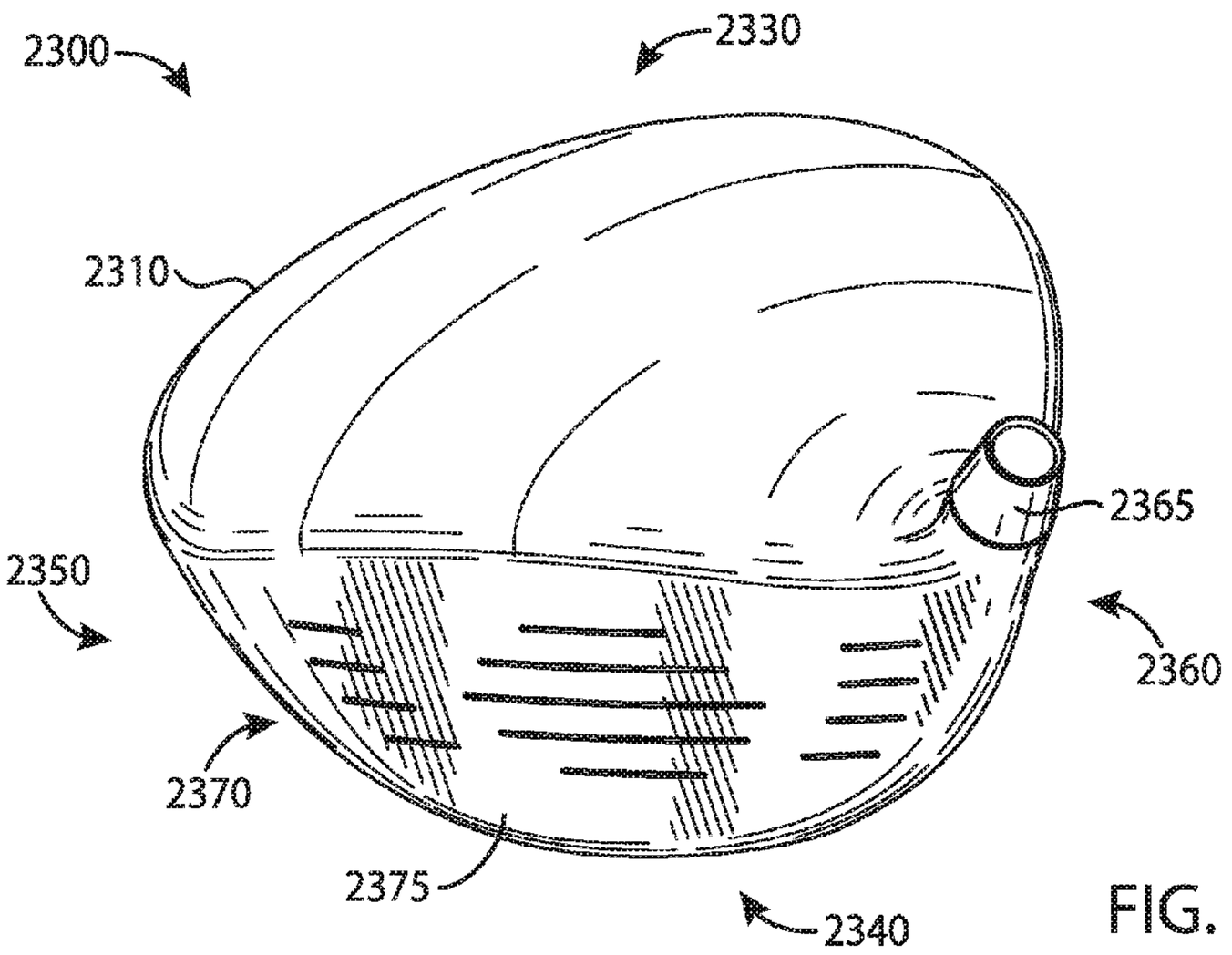

2300
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2340

FIG. 23

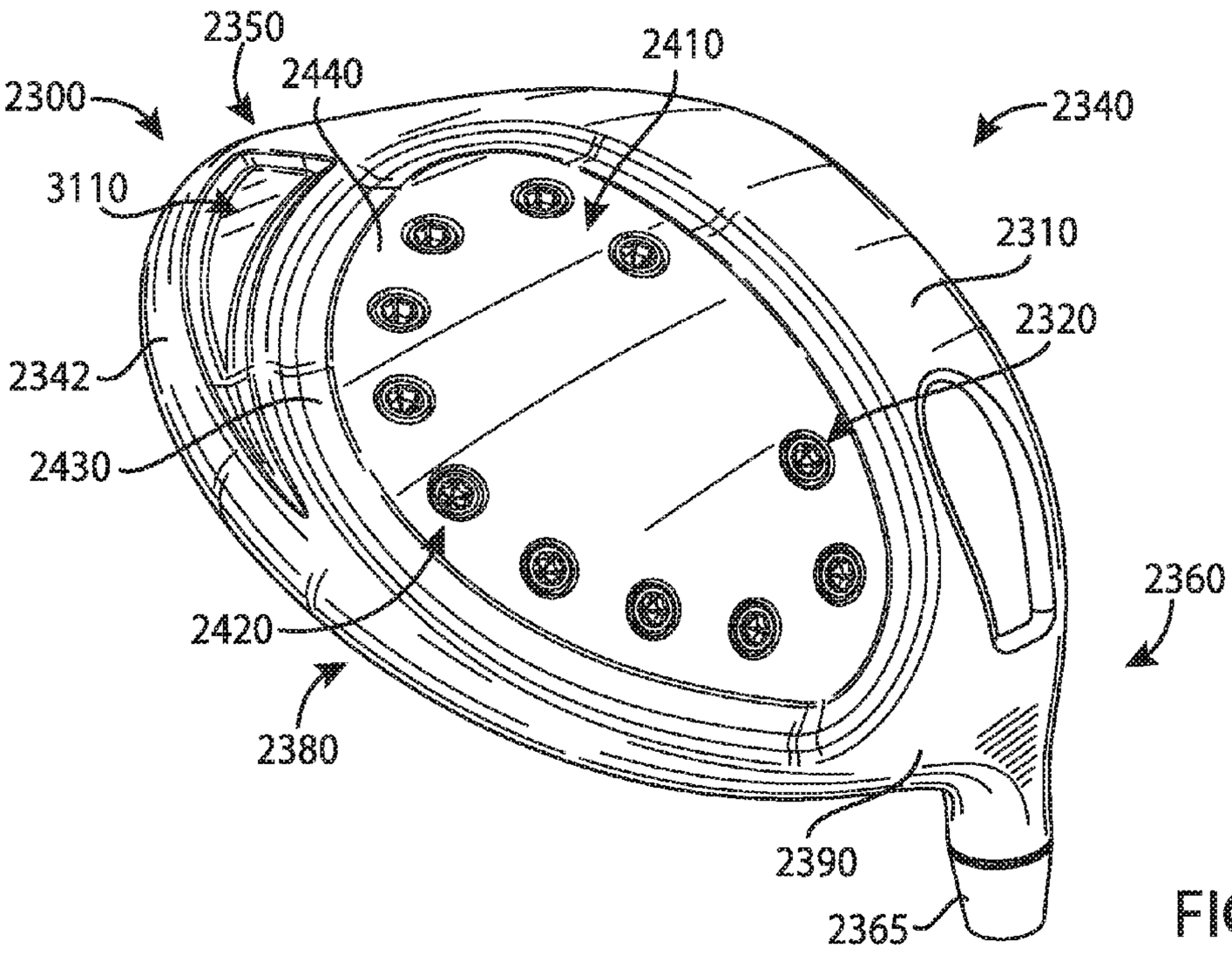

2350
2440
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2340
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2420
2380
2390
2365

FIG. 24

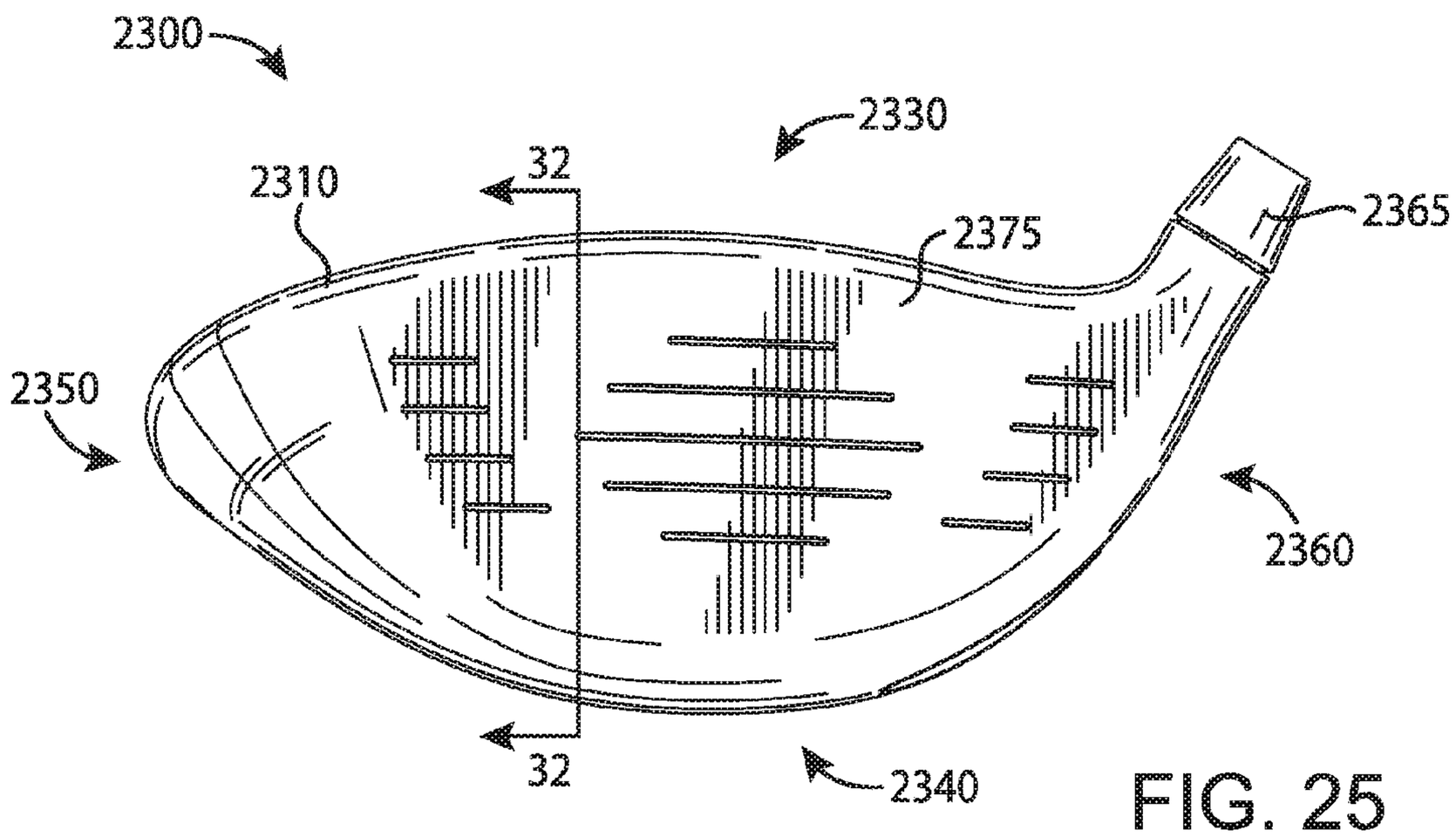

2300
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32
2375
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2350
2360
32
2340

FIG. 25

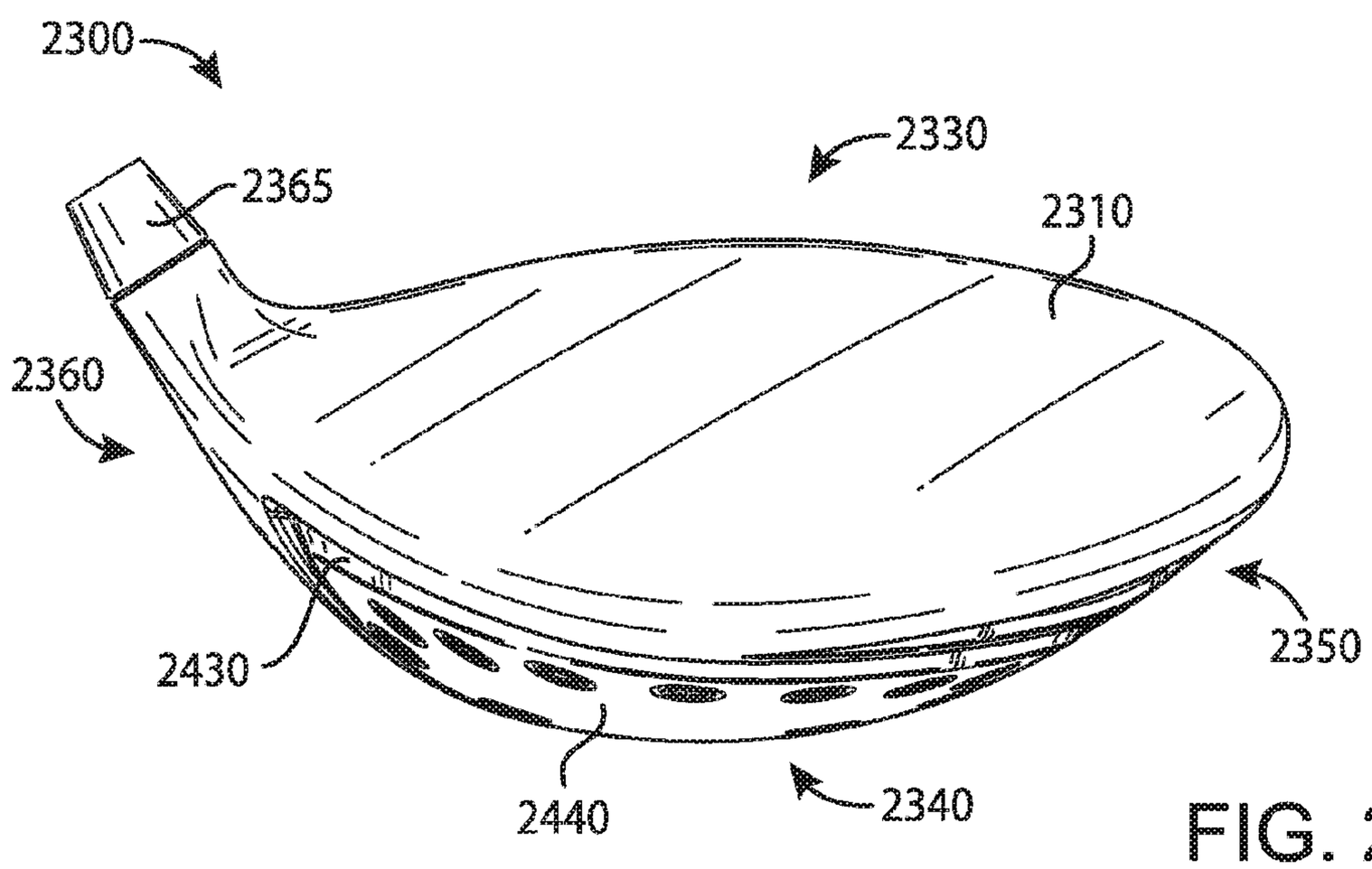

2300
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FIG. 26

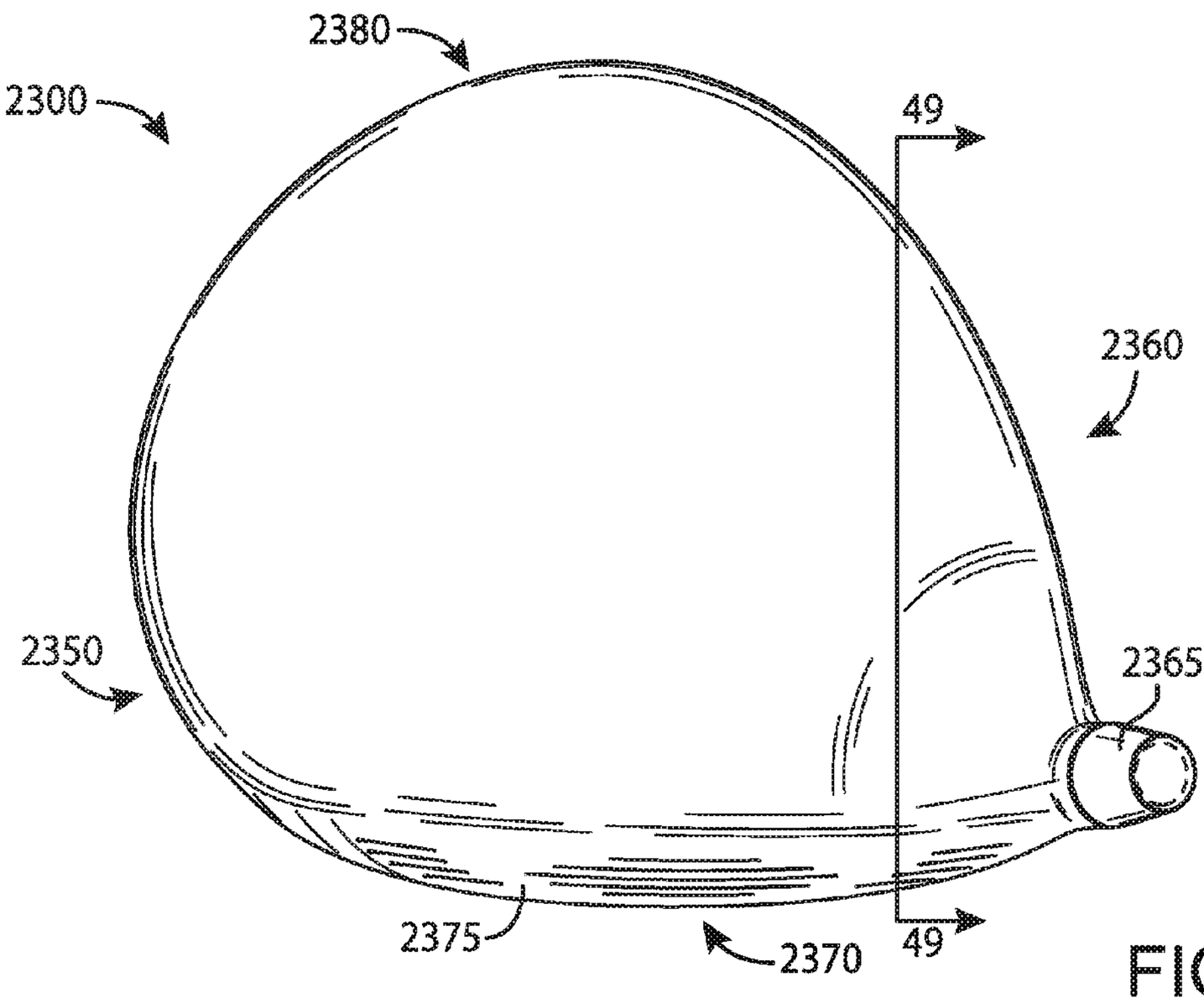

2380
2300
49
2360
2350
2365
2375
2370
49

FIG. 27

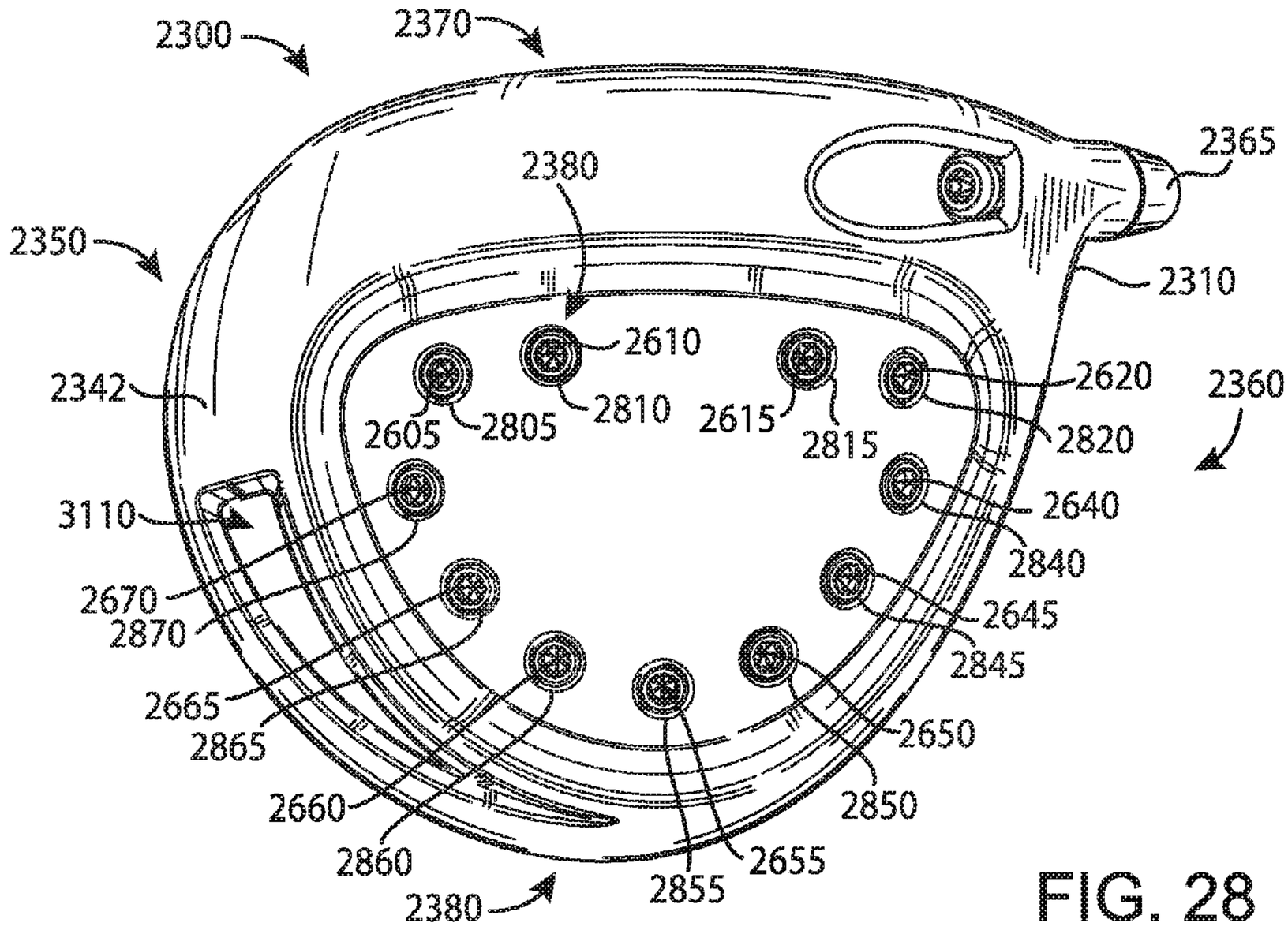

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2610
2342
2620
2360
2605
2805
2810
2615
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2820
3110
2640
2840
2670
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2870
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2655
2855
2380

FIG. 28

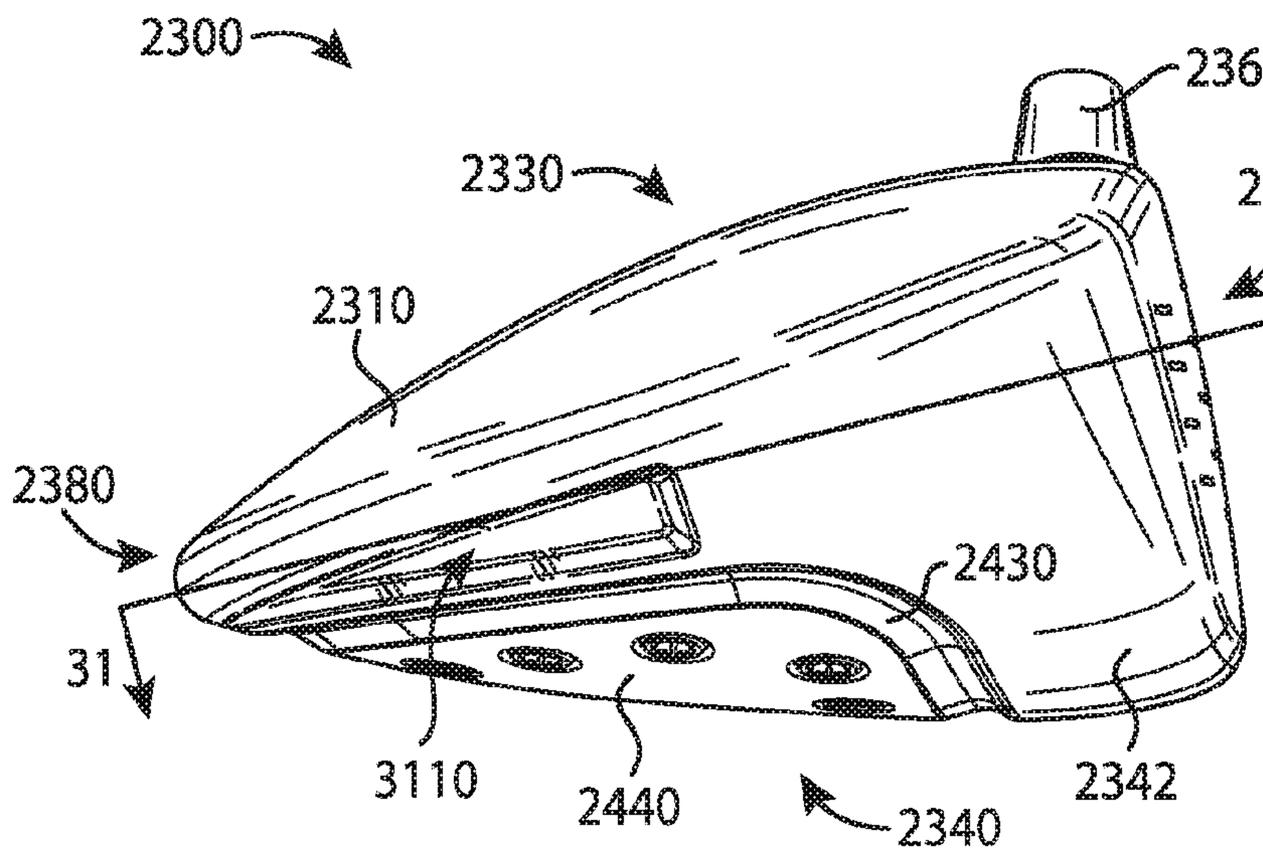

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2380
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31
3110
2440
2340
2342

FIG. 29

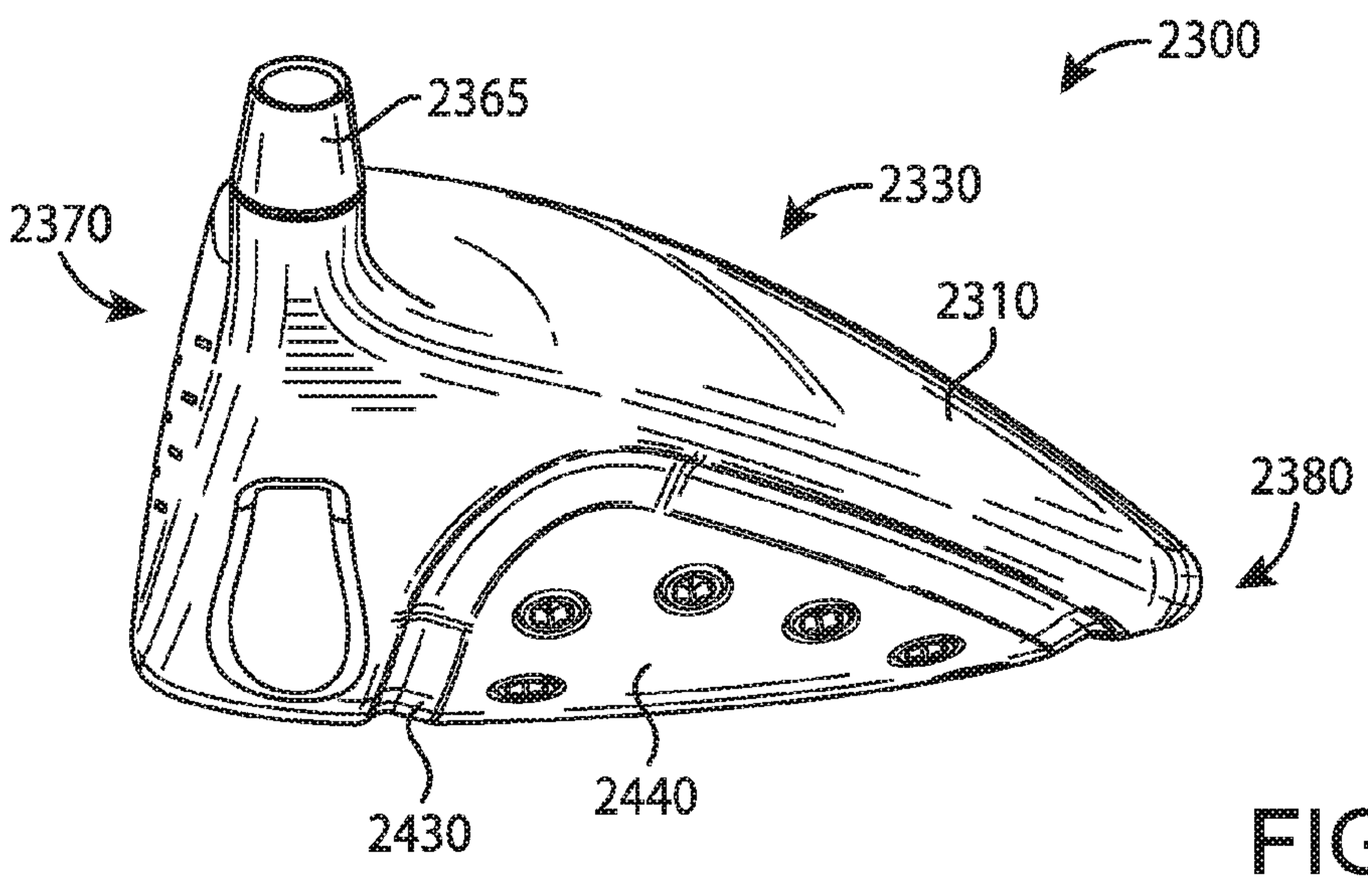

2300
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FIG. 30

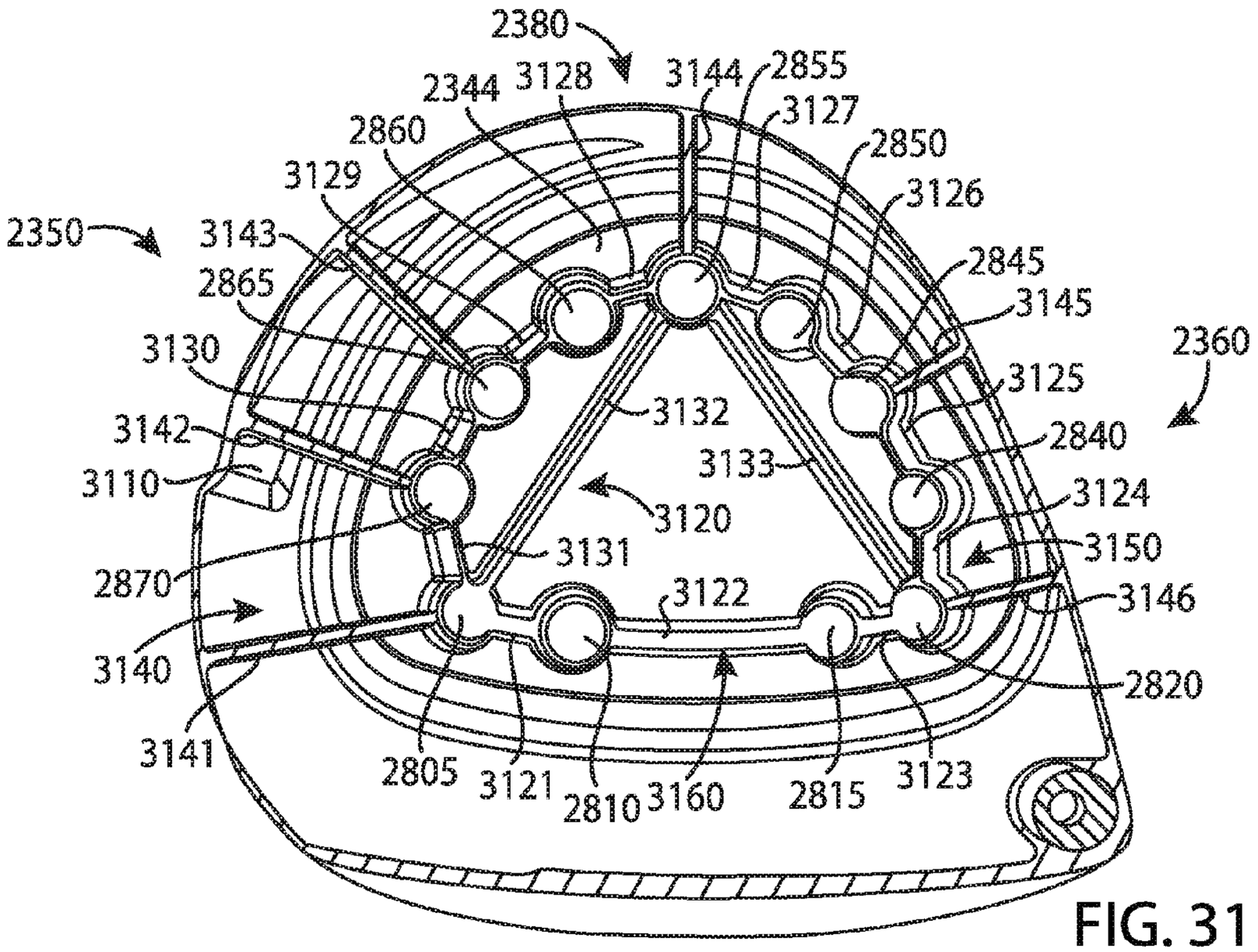

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3128
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3125
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3142
2840
3133
3110
3124
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3160
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3123

FIG. 31

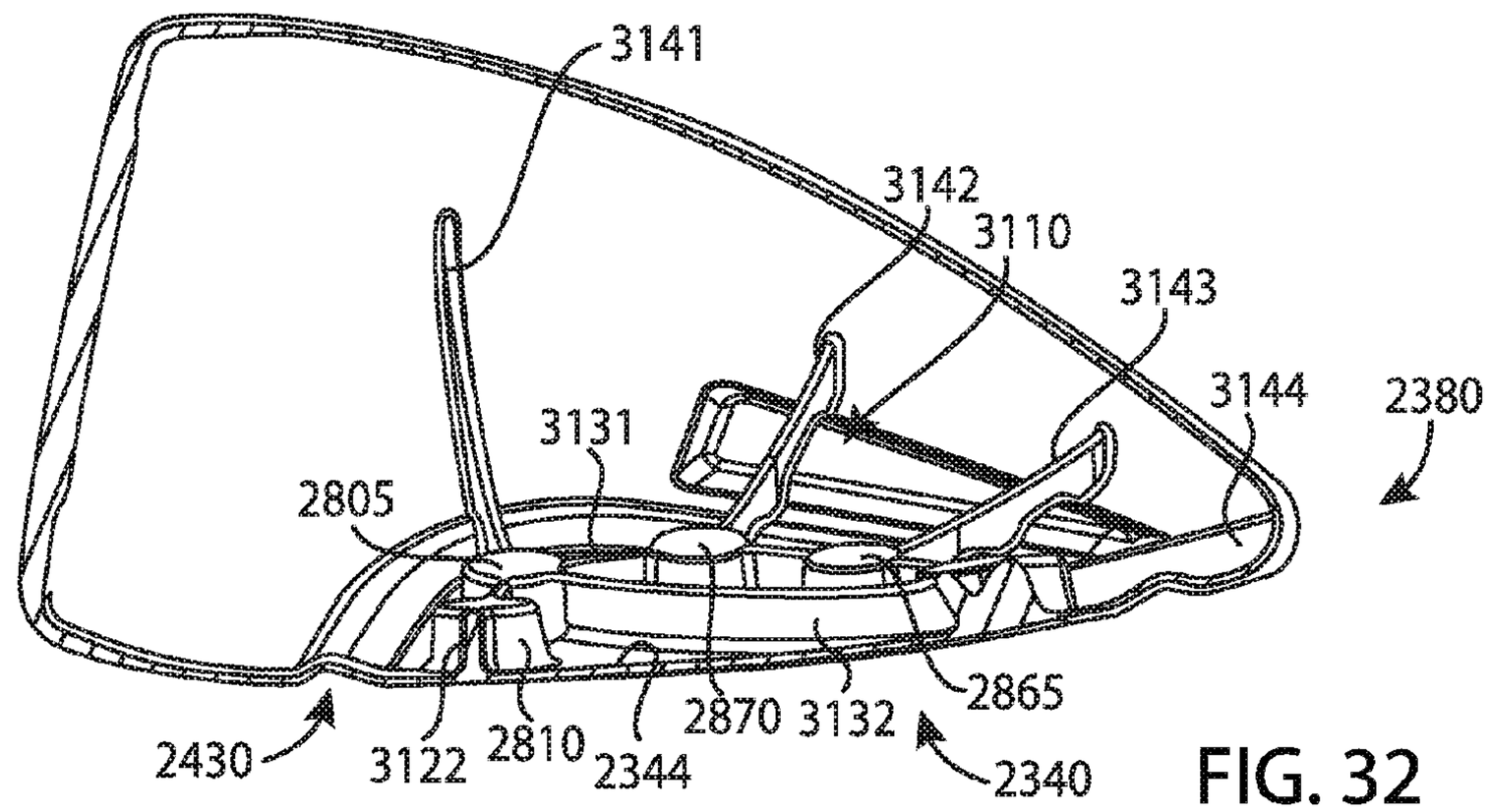

3141
3142
3110
3143
3144
2380
3131
2805
2865
2870
3132
2430
3122
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2344
2340

FIG. 32

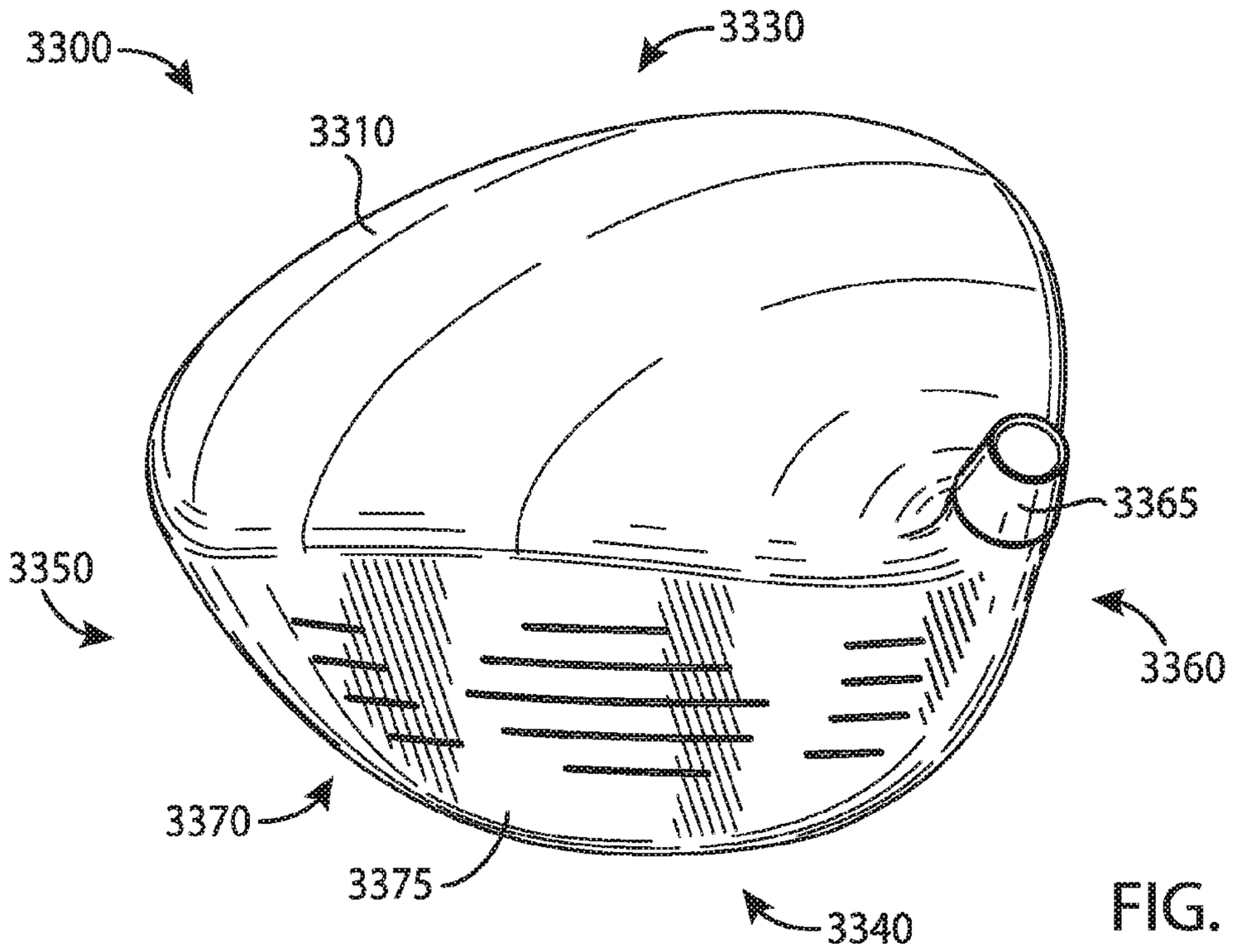

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FIG. 33

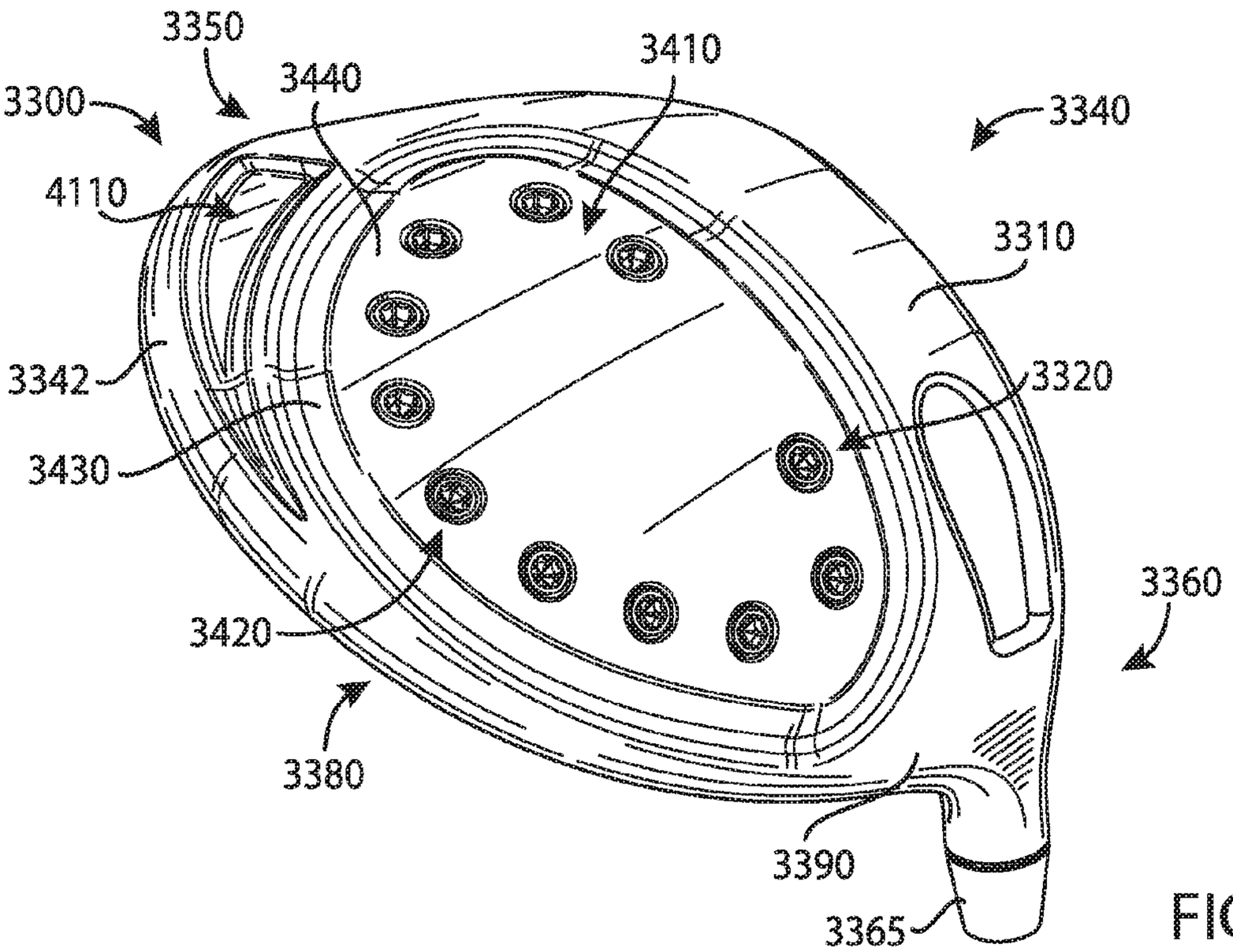

3350
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4110
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3342
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3420
3380
3390
3365

FIG. 34

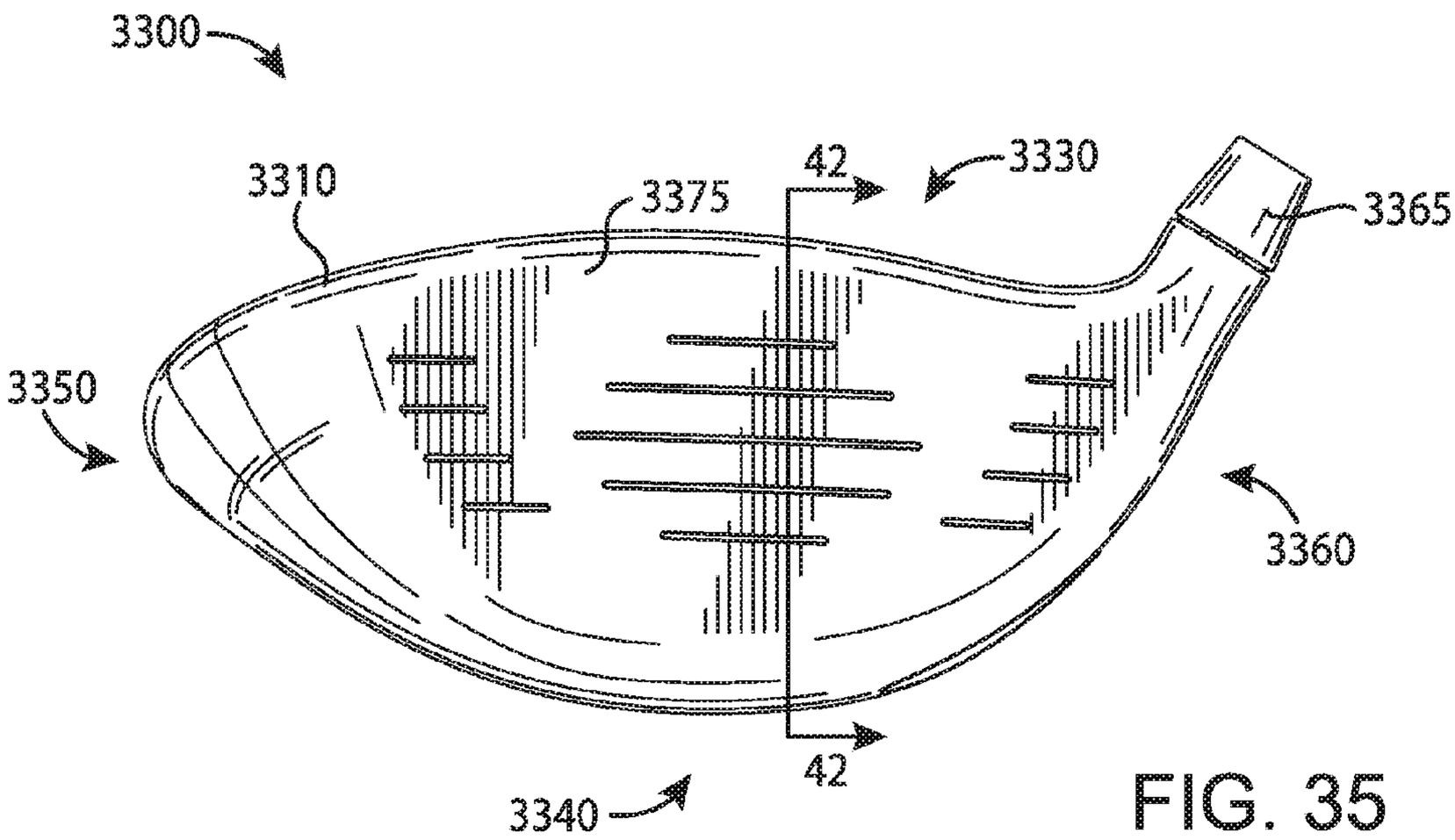

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42
3340

FIG. 35

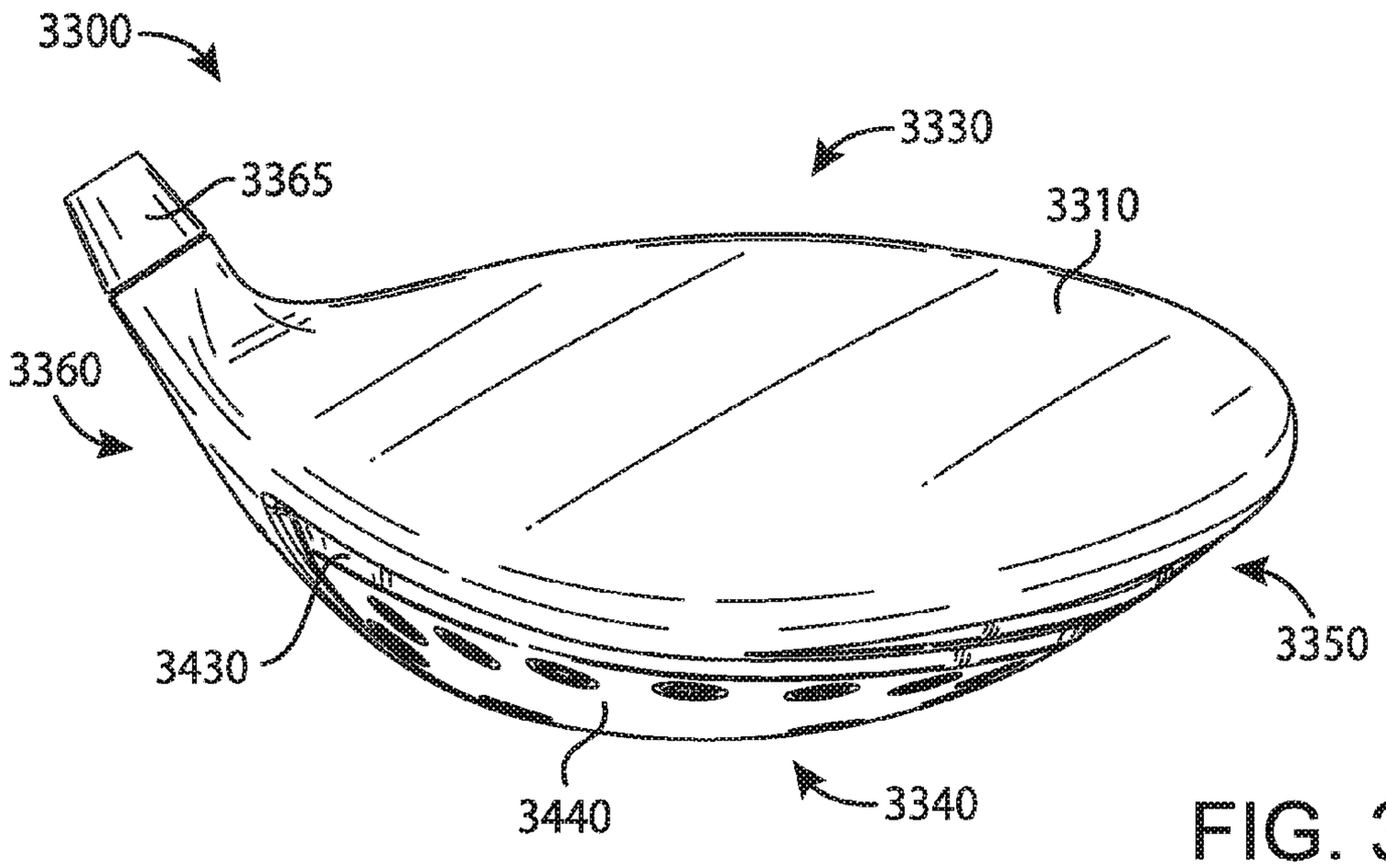

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FIG. 36

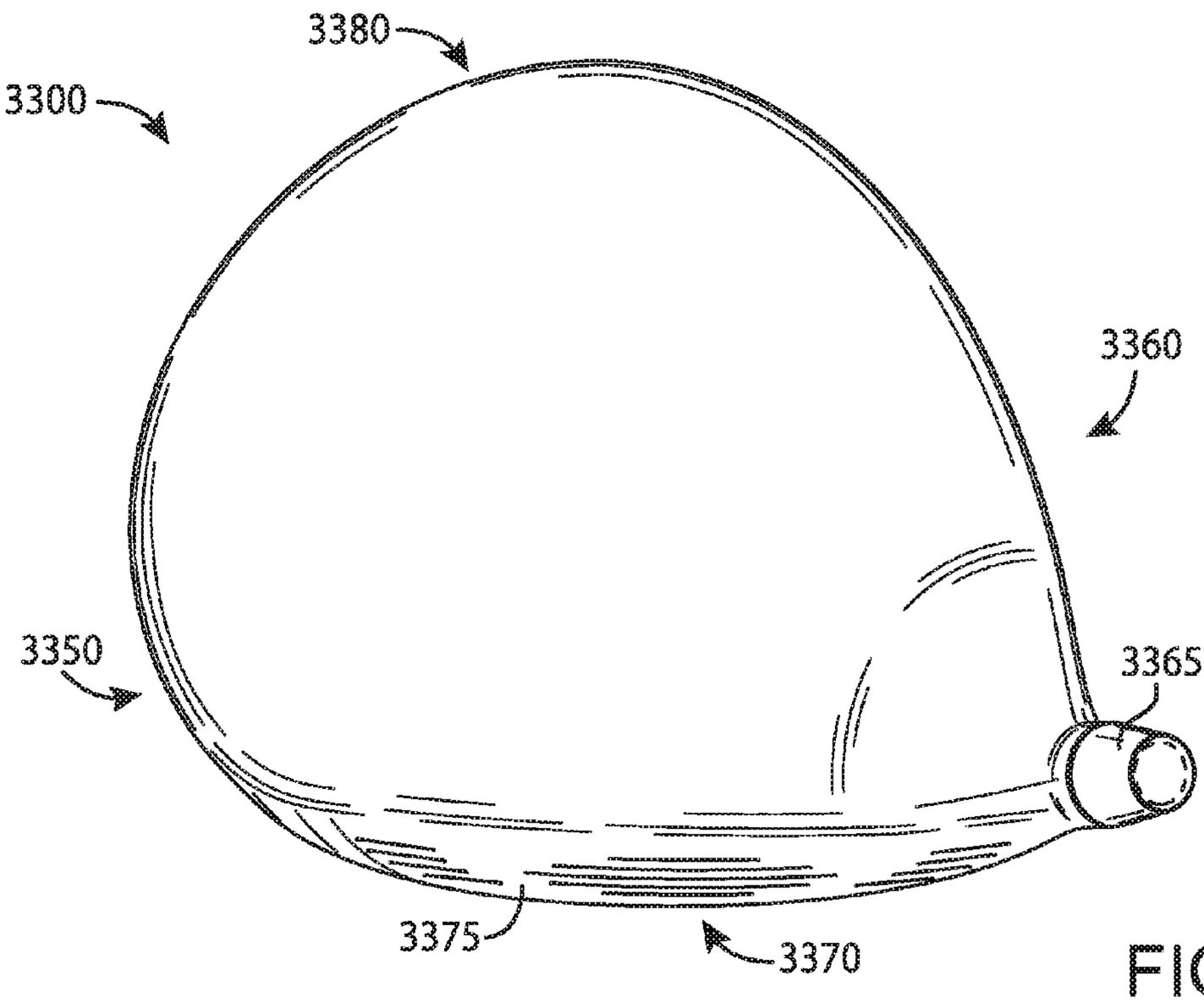

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FIG. 37

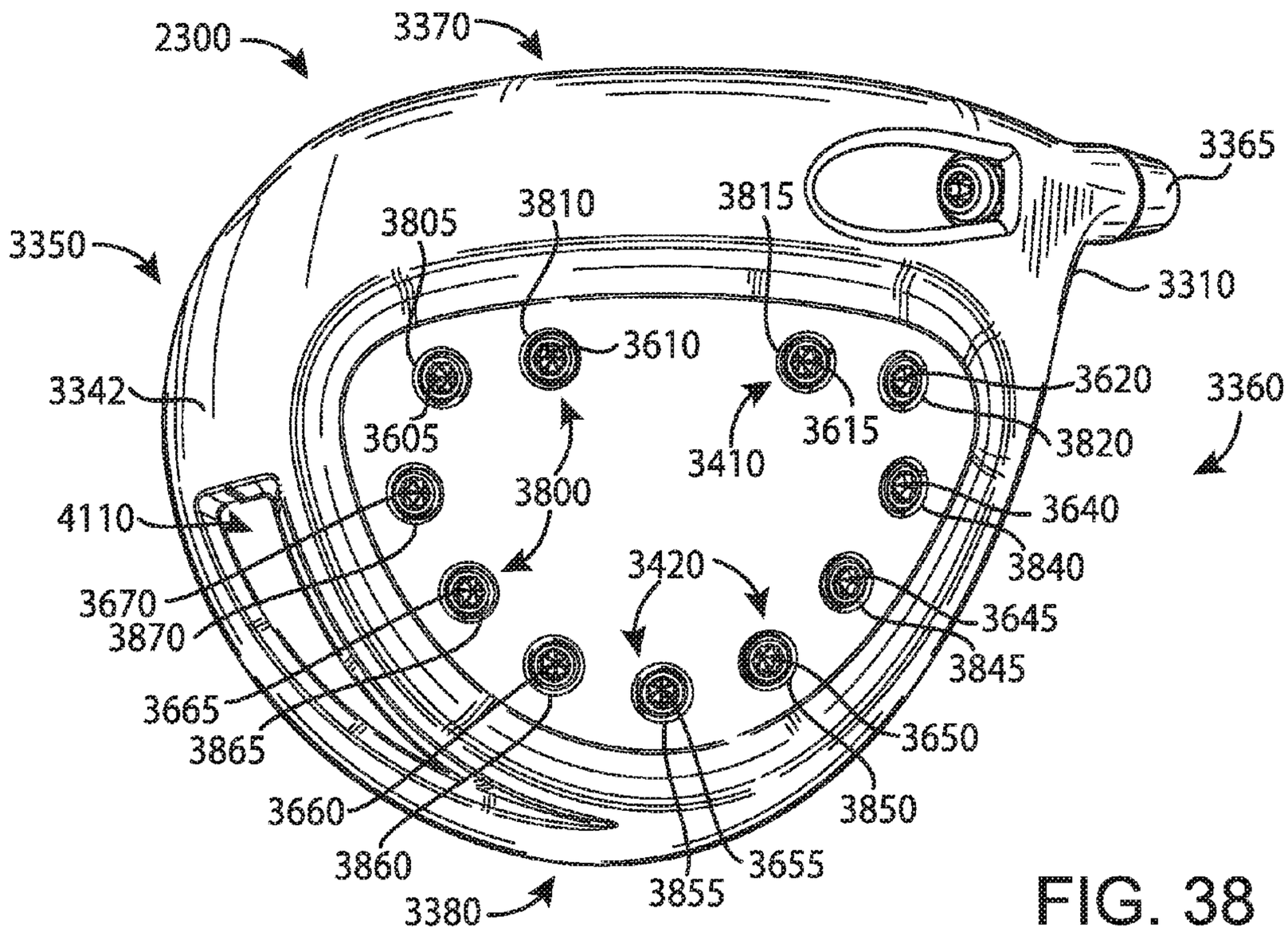

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3805
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3605
3615
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3800
3640
4110
3840
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3855
3380

FIG. 38

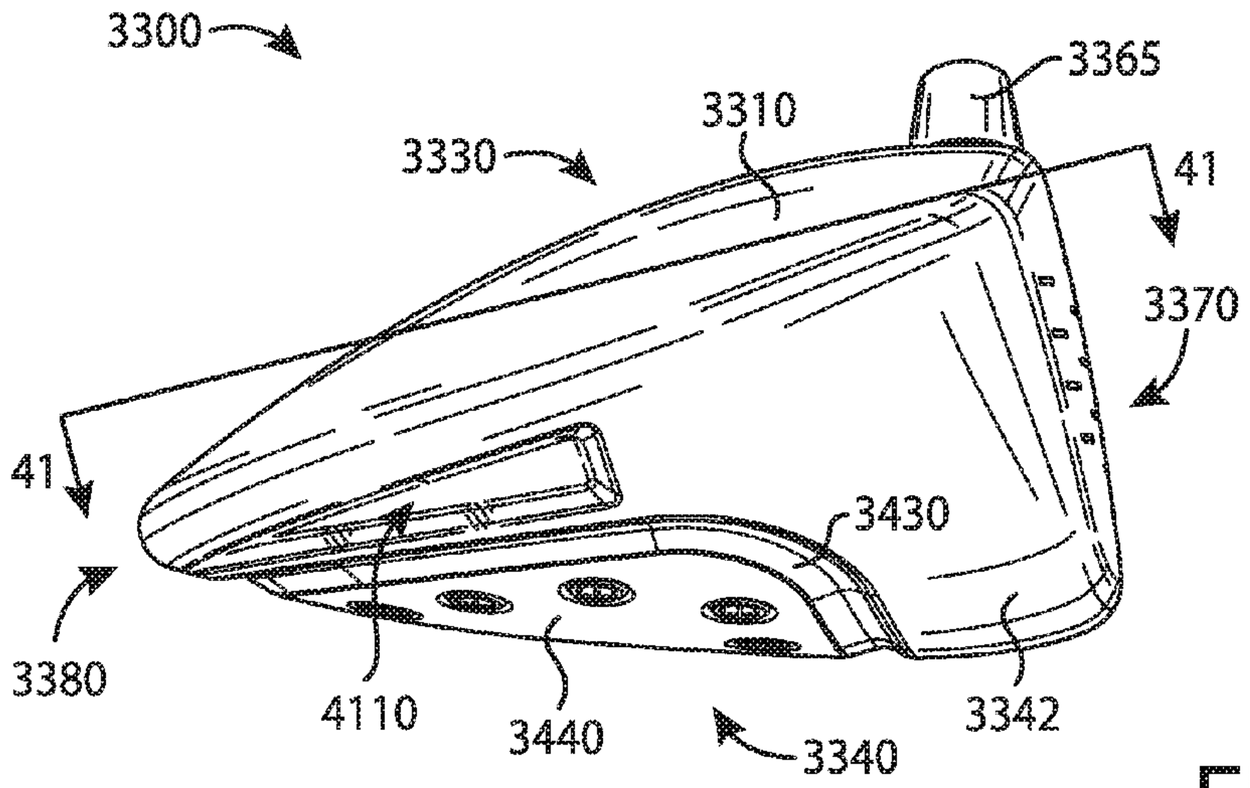

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FIG. 39

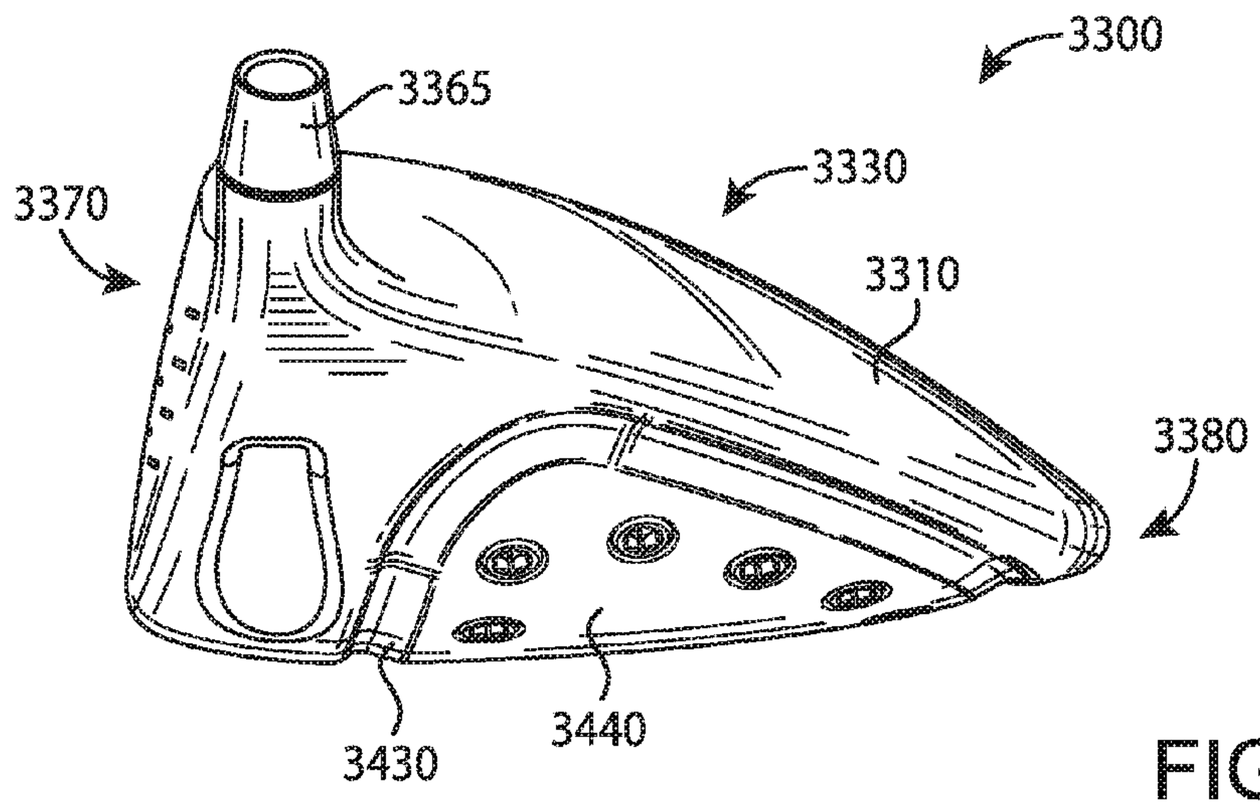

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FIG. 40

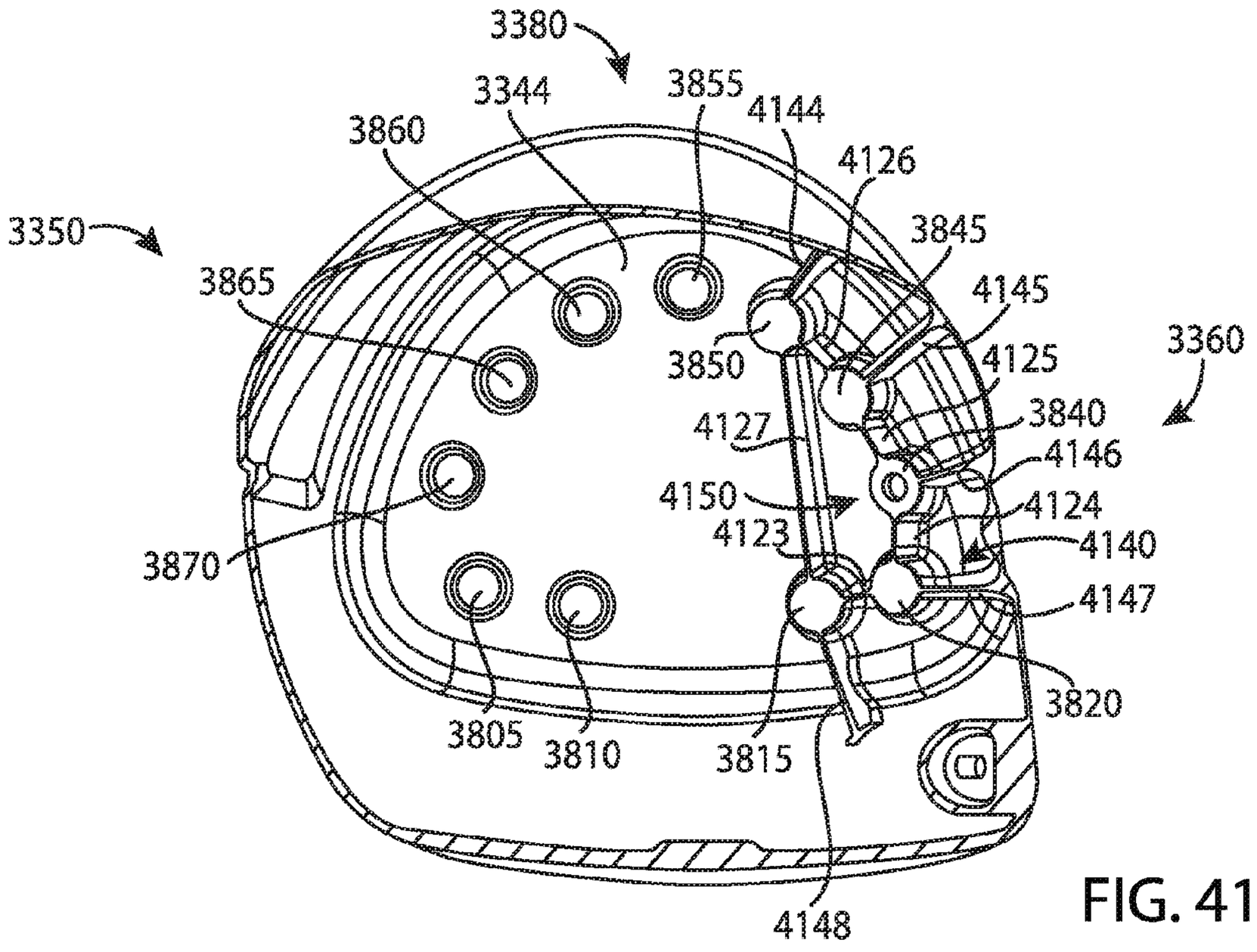

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4123
4140
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3805
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4148

FIG. 41

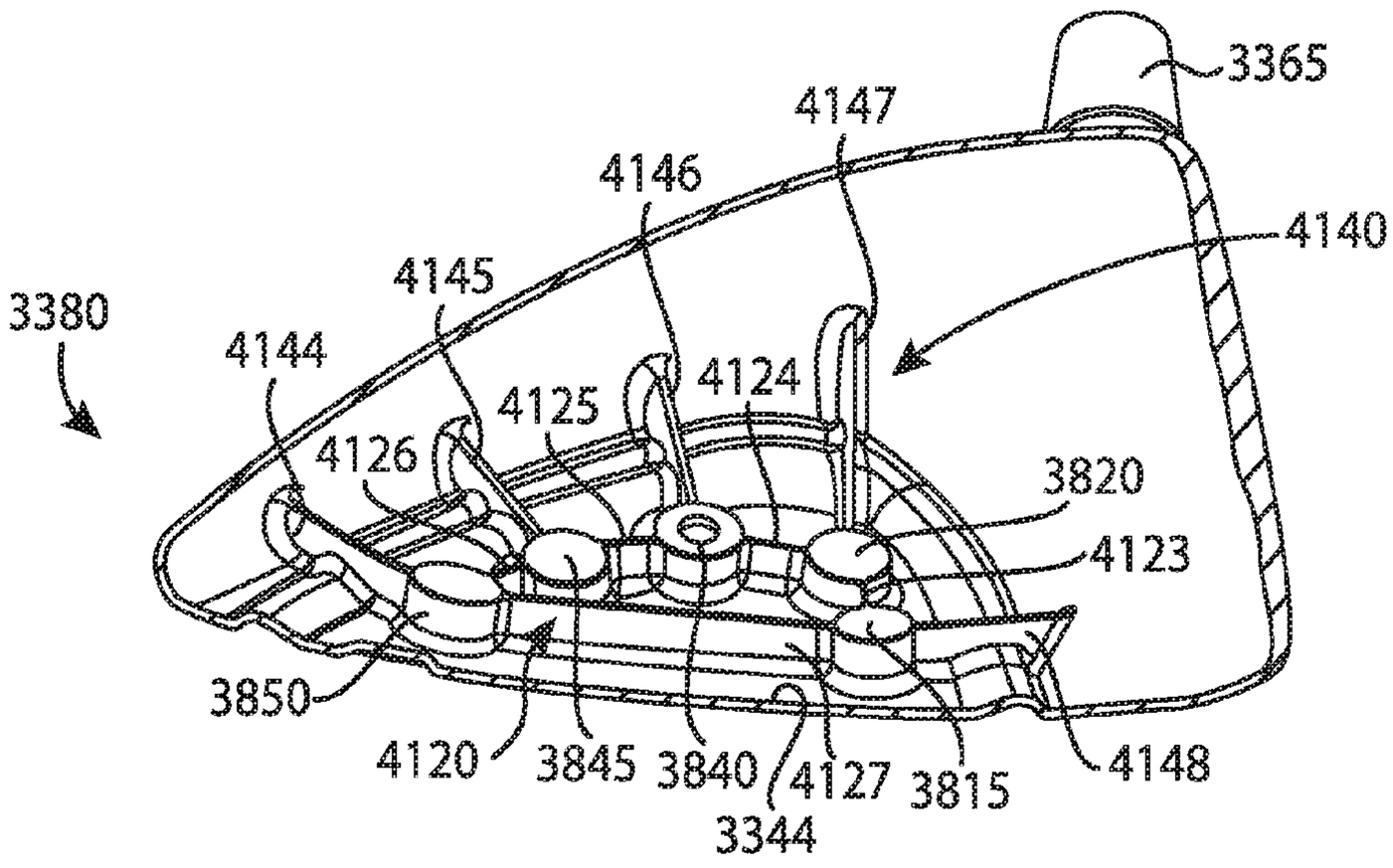

3365
4147
4146
4140
4145
3380
4144
4124
4125
4126
3820
4123
3850
4120
3845
3840
4127
3815
4148
3344

FIG. 42

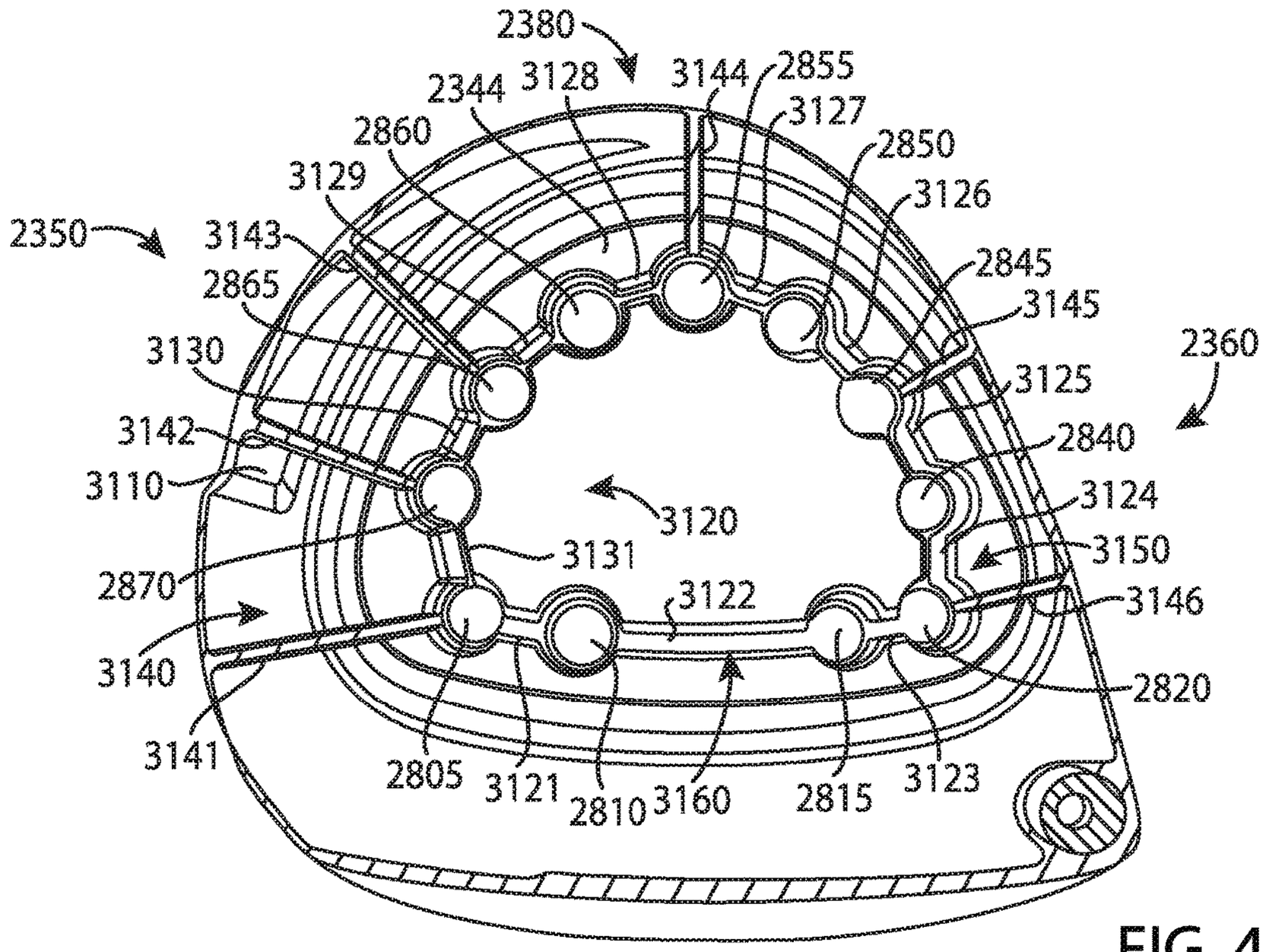

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3143
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3125
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2840
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3124
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3131
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FIG. 43

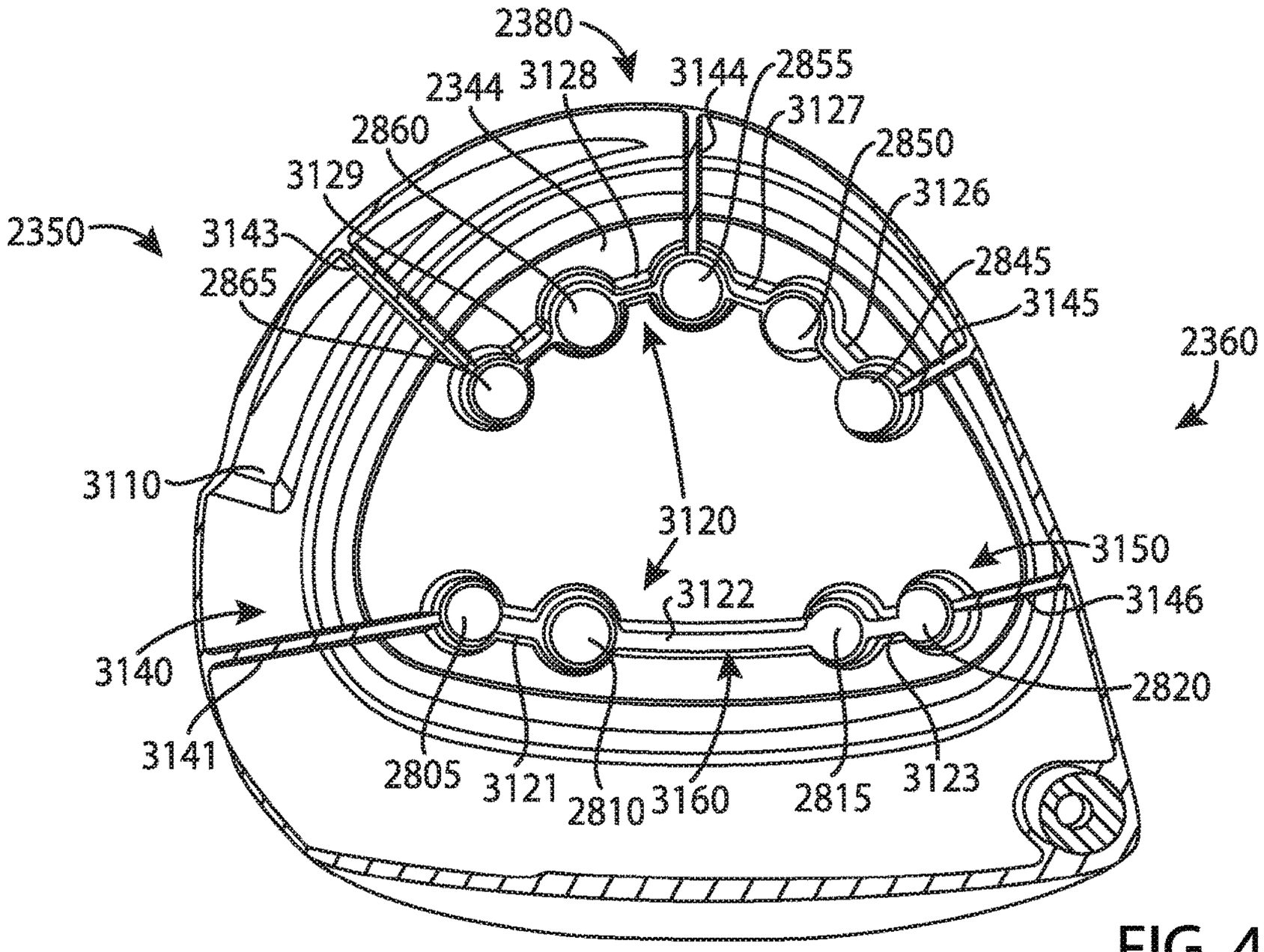

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3126
2350
3143
2845
2865
3145
2360
3110
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2820
3141
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3121
2810
3160
2815
3123

FIG. 44

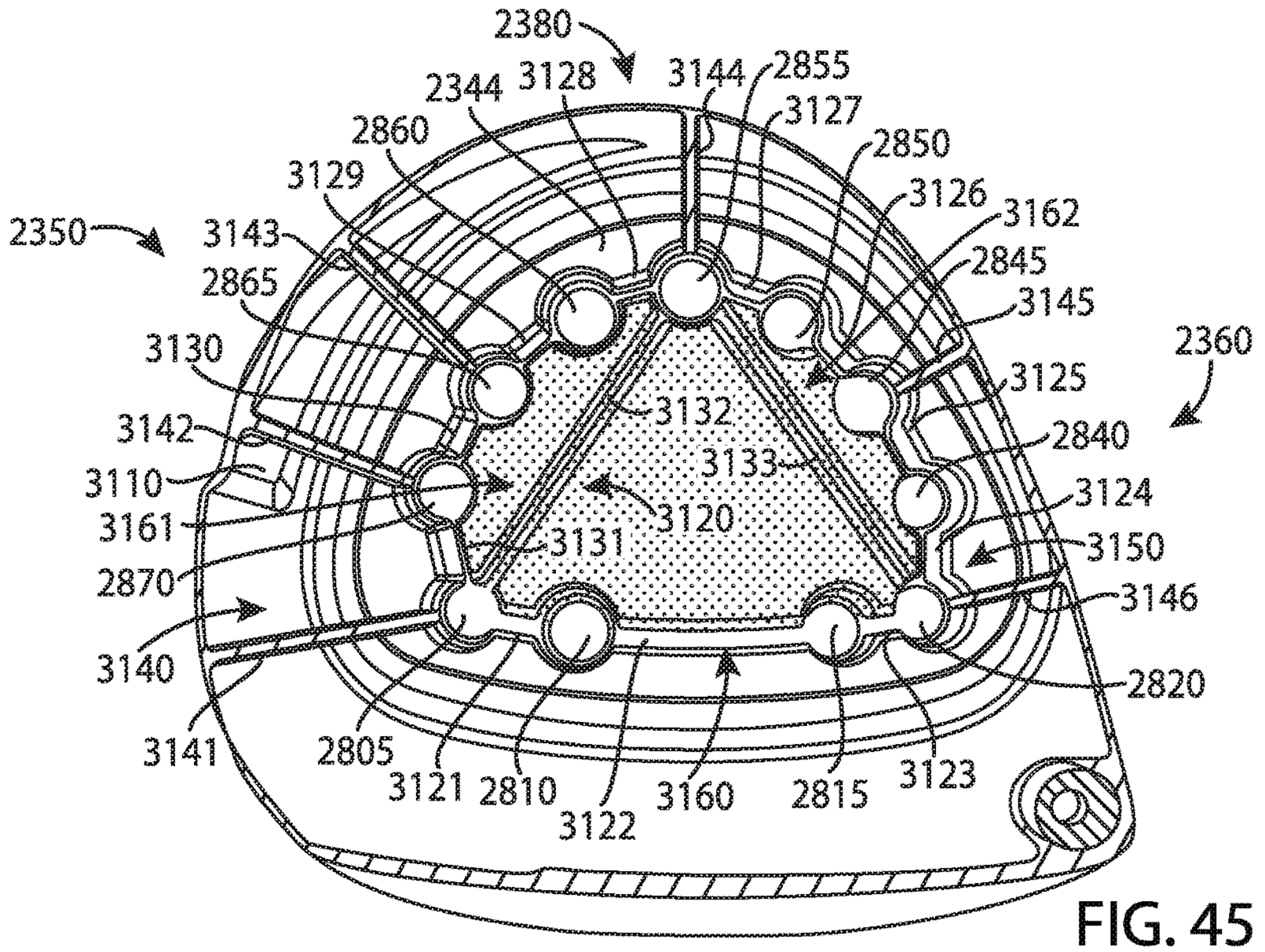

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2855
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3126
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2350
3143
2845
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3145
3130
2360
3125
3132
3142
2840
3133
3110
3124
3120
3161
3131
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2820
3141
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2810
3160
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3123
3122

FIG. 45

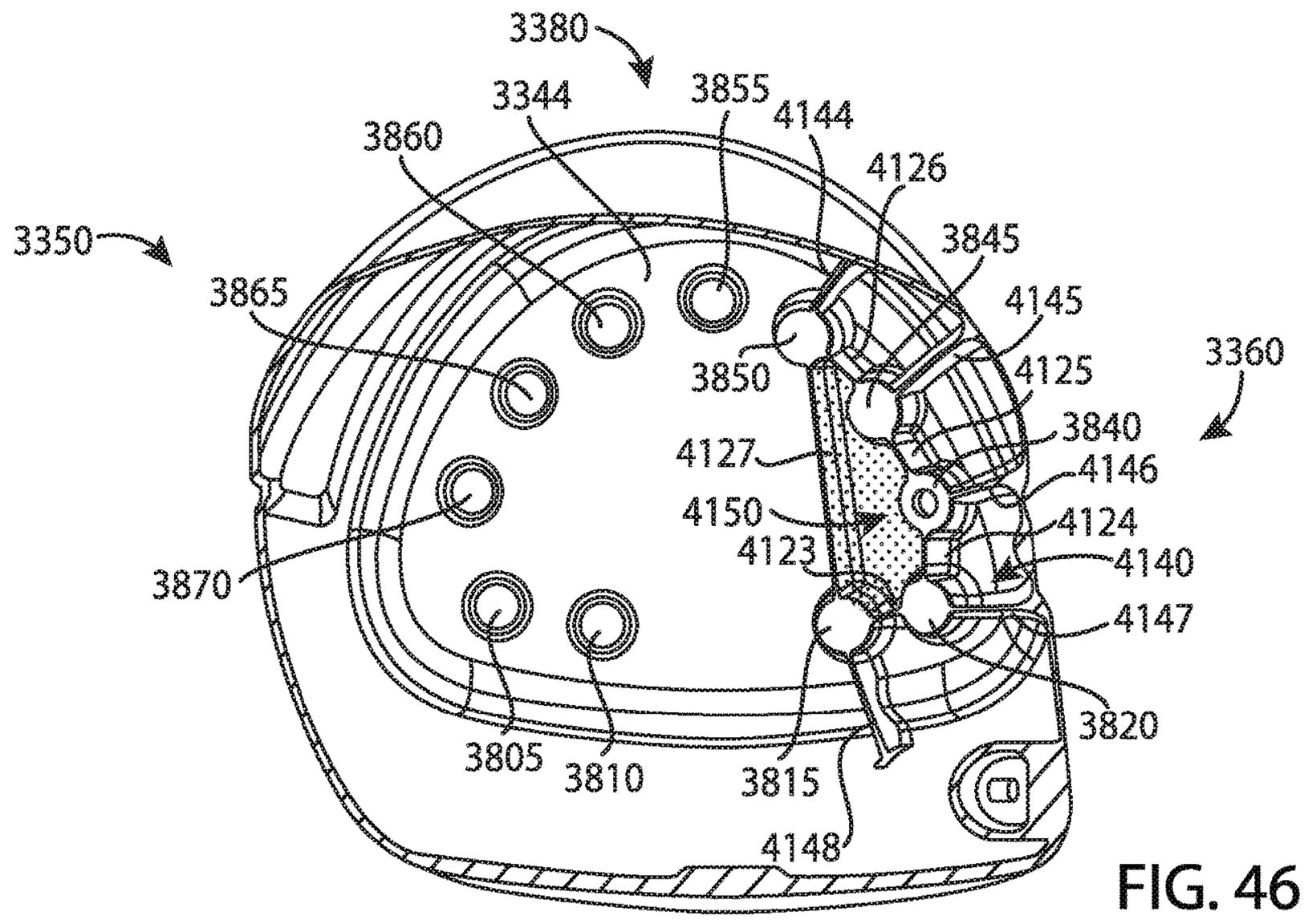

3380
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3845
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4145
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4125
3360
3840
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4146
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4124
4123
4140
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4147
3820
3805
3810
3815
4148

FIG. 46

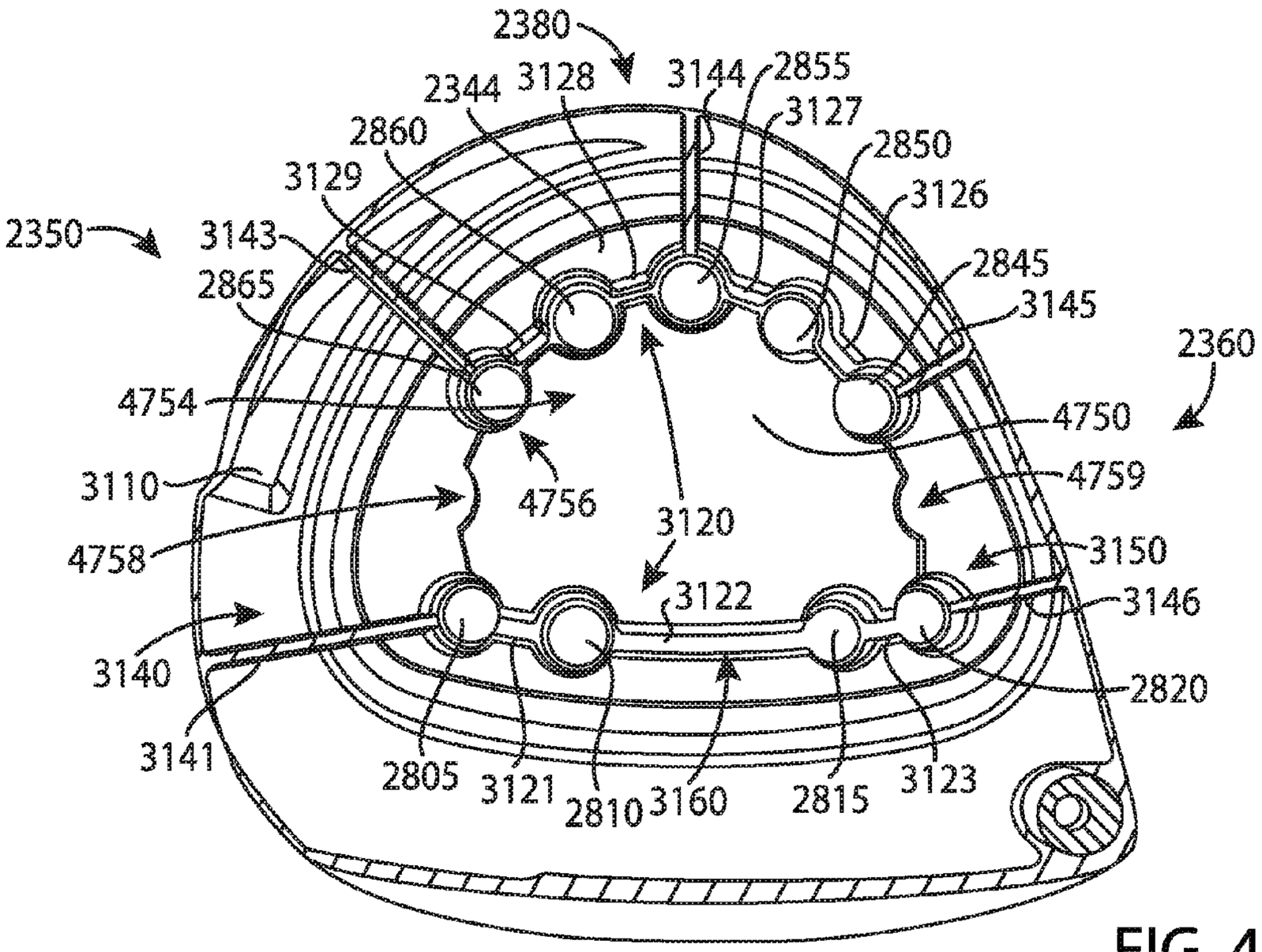

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2850
3129
3126
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3143
2845
2865
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3110
4759
4756
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4758
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3141
2805
3121
2810
3160
2815
3123

FIG. 47

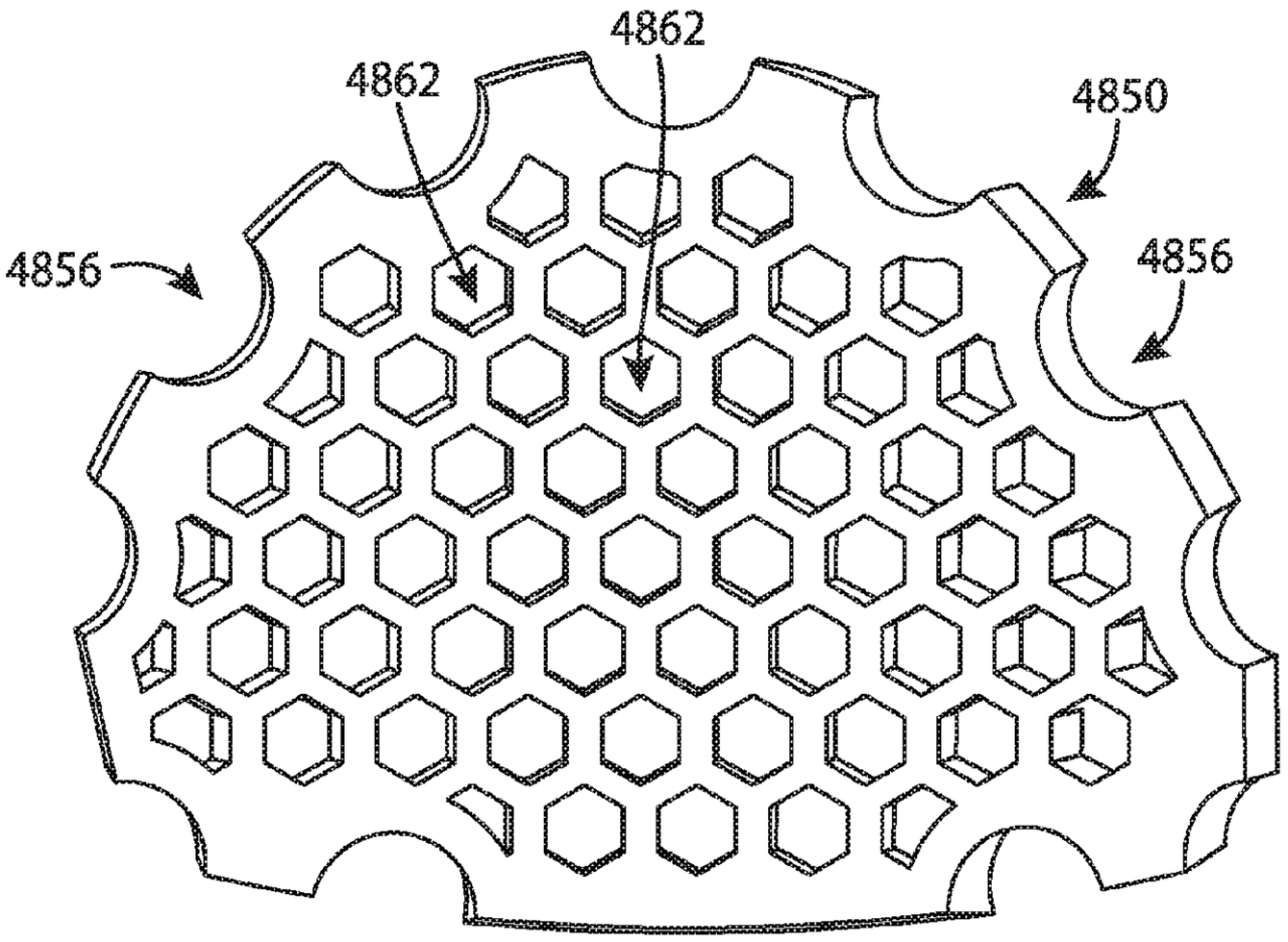

4862
4862
4850
4856
4856

FIG. 48

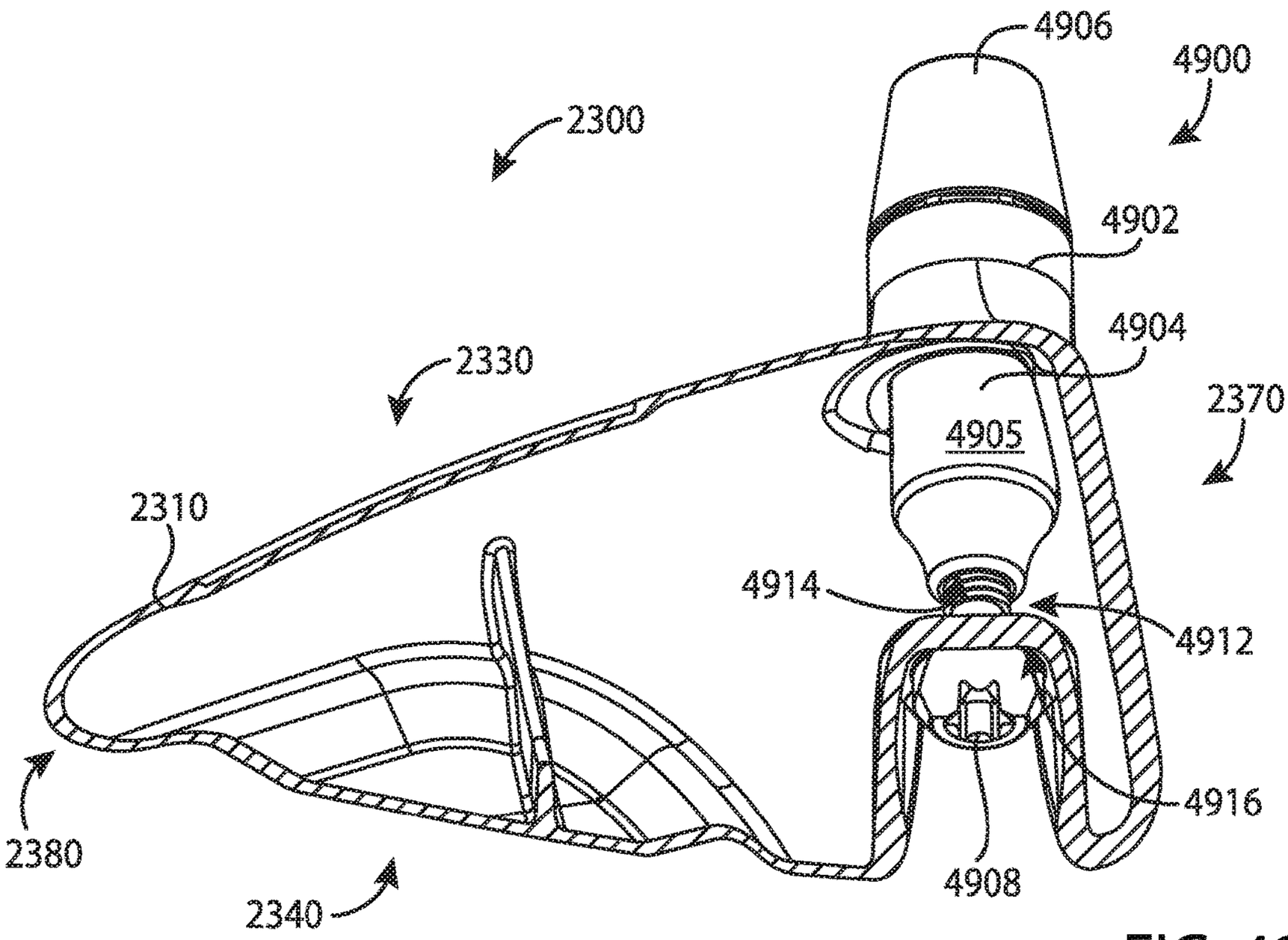

4906
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2300
4902
4904
2330
2370
4905
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4914
4912
4916
2380
4908
2340

FIG. 49

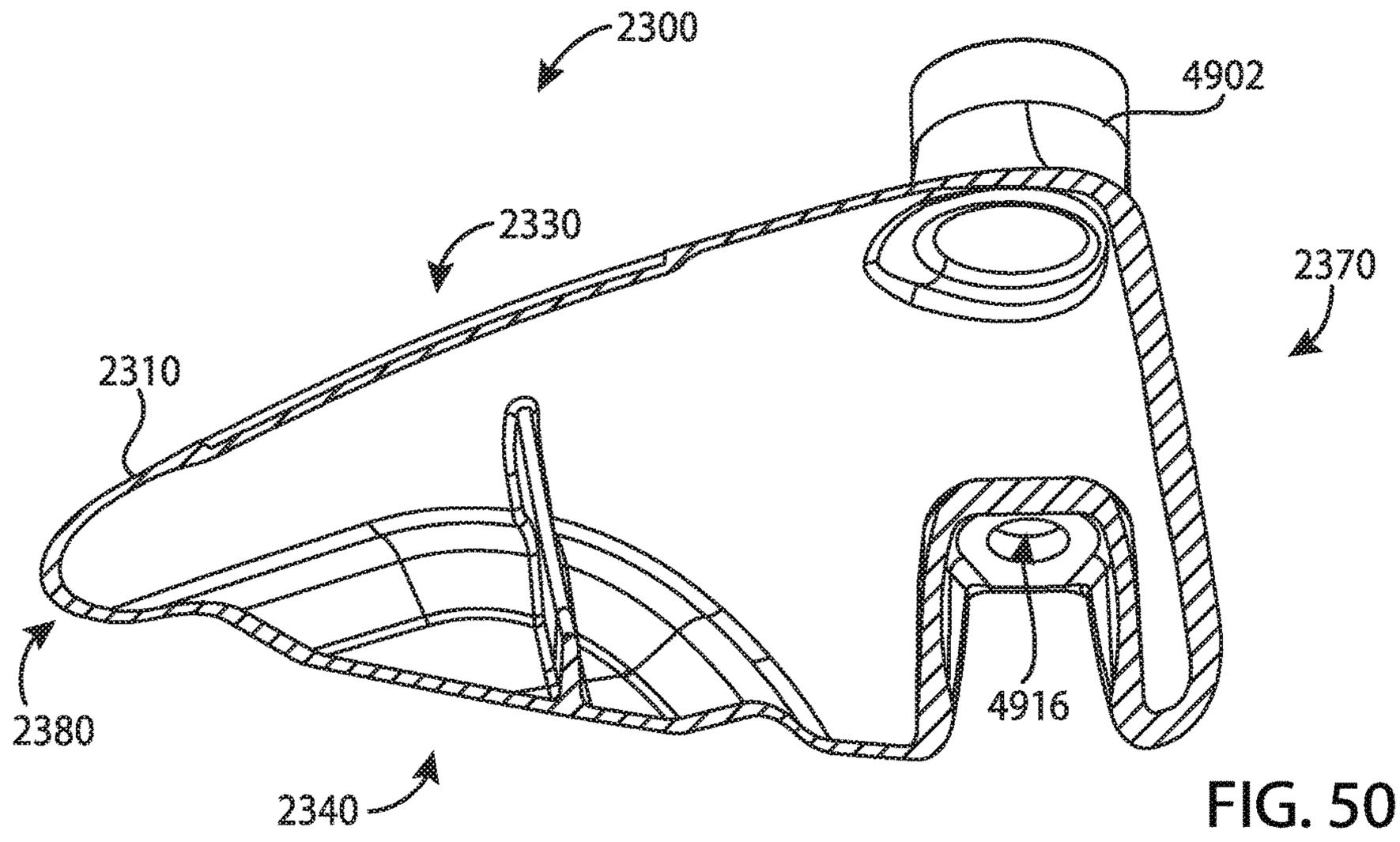

2300
4902
2330
2370
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2380
4916
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FIG. 50

GOLF CLUB HEADS AND METHODS TO MANUFACTURE GOLF CLUB HEADS

CROSS REFERENCE

This application claims the benefit of U.S. Provisional Application No. 62/281,639, filed Jan. 21, 2016, U.S. Provisional Application No. 62/296,506, filed on Feb. 17, 2016, U.S. Provisional Application No. 62/301,756, filed on Mar. 1, 2016, U.S. Provisional Application No. 62/337,184, filed May 16, 2016, U.S. Provisional Application No. 62/361,988, filed Jul. 13, 2016, and U.S. Provisional Application No. 62/362,491, filed Jul. 14, 2016. This application is a continuation-in-part of U.S. application Ser. No. 15/040,892, filed Feb. 10, 2016, now U.S. Pat. No. 9,550,096, which is a continuation-in-part application of U.S. application Ser. No. 14/939,849, filed Nov. 12, 2015, now U.S. Pat. No. 9,555,295, which is a continuation application of U.S. application Ser. No. 14/615,606, filed Feb. 6, 2015, no U.S. Pat. No. 9,199,140, which claims the benefits of U.S. Provisional Application No. 62/042,155, filed Aug. 26, 2014, U.S. Provisional Application No. 62/048,693, filed Sep. 10, 2014, U.S. Provisional Application No. 62/101,543, filed Jan. 9, 2015, U.S. Provisional Application No. 62/105,123, filed on Jan. 19, 2015, and U.S. Provisional Application No. 62/109,510, filed Jan. 29, 2015. This application is also a continuation-in-part application of U.S. application Ser. No. 29/559,452, filed Mar. 28, 2016, which is a continuation-in-part application of U.S. application Ser. No. 29/552,228, filed Jan. 21, 2016. The disclosures of the referenced applications are incorporated herein by reference.

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FIELD

The present disclosure generally relates to sports equipment, and more particularly, to golf club heads and methods to manufacture golf club heads.

BACKGROUND

In golf, various factors may affect the distance and direction that a golf ball may travel. In particular, the center of gravity (CG) and/or the moment of inertia (MOI) of a golf club head may affect the launch angle, the spin rate, and the direction of the golf ball at impact. Such factors may vary significantly based the type of golf swing.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is top perspective view of an example golf club head according to an embodiment of the apparatus, methods, and articles of manufacture described herein.

FIG. **2** depicts a bottom perspective view of the example golf club head of FIG. **1**.

FIG. **3** depicts a top view of the example golf club head of FIG. **1**.

FIG. **4** depicts a bottom view of the example golf club head of FIG. **1**.

FIG. **5** depicts a front view of the example golf club head of FIG. **1**.

FIG. **6** depicts a rear view of the example golf club head of FIG. **1**.

FIG. **7** depicts a toe view of the example golf club head of FIG. **1**.

FIG. **8** depicts a heel view of the example golf club head of FIG. **1**.

FIG. **9** depicts a bottom view of an example body portion of the example golf club head of FIG. **1**.

FIG. **10** depicts a cross-sectional view of the example body portion of the example golf club head of FIG. **1**.

FIG. **11** depicts two weight ports of the example golf club head of FIG. **1**.

FIG. **12** depicts a top view of an example weight portion of the example golf club head of FIG. **1**.

FIG. **13** depicts a side view of the example weight portion of FIG. **10**.

FIG. **14** depicts example launch trajectory profiles of the example golf club head of FIG. **1**.

FIG. **15** depicts a first weight configuration of the example weight portions.

FIG. **16** depicts a second weight configuration of the example weight portions.

FIG. **17** depicts a third weight configuration of the example weight portions.

FIG. **18** depicts a fourth weight configuration of the example weight portions.

FIG. **19** depicts an example launch trajectory profile of the example golf club head of FIG. **18**.

FIG. **20** depicts one manner in which the example golf club heads described herein may be manufactured.

FIG. **21** depicts a bottom view of another example golf club head.

FIG. **22** depicts a bottom view of yet another example golf club head.

FIG. **23** is top perspective view of an example golf club head according to an embodiment of the apparatus, methods, and articles of manufacture described herein.

FIG. **24** depicts a bottom perspective view of the example golf club head of FIG. **23**.

FIG. **25** depicts a front view of the example golf club head of FIG. **23**.

FIG. **26** depicts a rear view of the example golf club head of FIG. **23**.

FIG. **27** depicts a top view of the example golf club head of FIG. **23**.

FIG. **28** depicts a bottom view of the example golf club head of FIG. **23**.

FIG. **29** depicts a toe view of the example golf club head of FIG. **23**.

FIG. **30** depicts a heel view of the example golf club head of FIG. **1**.

FIG. **31** depicts a cross-sectional view of the example golf club head of FIG. **23** taken at section line **31-31** of FIG. **29**

FIG. **32** depicts a cross-sectional view of the example golf club head of FIG. **23** taken at section line **32-32** of FIG. **25**.

FIG. **33** is top perspective view of an example golf club head according to an embodiment of the apparatus, methods, and articles of manufacture described herein.

FIG. **34** depicts a bottom perspective view of the example golf club head of FIG. **33**.

FIG. **35** depicts a front view of the example golf club head of FIG. **33**.

FIG. **36** depicts a rear view of the example golf club head of FIG. **33**.

FIG. **37** depicts a top view of the example golf club head of FIG. **33**.

FIG. **38** depicts a bottom view of the example golf club head of FIG. **33**.

FIG. **39** depicts a toe view of the example golf club head of FIG. **33**.

FIG. **40** depicts a heel view of the example golf club head of FIG. **33**.

FIG. **41** depicts a cross-sectional view of the example golf club head of FIG. **33** taken at section line **41-41** of FIG. **39**

FIG. **42** depicts a cross-sectional view of the example golf club head of FIG. **33** taken at section line **42-42** of FIG. **35**.

FIG. **43** depicts a cross-sectional view of another example of the golf club head of FIG. **23** taken at section line **31-31** of FIG. **29**.

FIG. **44** depicts a cross-sectional view of another example of the golf club head of FIG. **23** taken at section line **31-31** of FIG. **29**.

FIG. **45** depicts a cross-sectional view of another example golf club head of FIG. **23** taken at section line **31-31** of FIG. **29**.

FIG. **46** depicts a cross-sectional view of another example golf club head of FIG. **33** taken at section line **41-41** of FIG. **39**.

FIG. **47** depicts a cross-sectional view of another example of the golf club head of FIG. **23** taken at section line **31-31** of FIG. **29**.

FIG. **48** depicts a perspective view of an elastic polymer insert according to an embodiment of the apparatus, methods, and articles of manufacture described herein.

FIG. **49** depicts a side perspective cross-sectional view of another example of the golf club head of FIG. **23** taken at section line **49-49** of FIG. **27** according to an embodiment of the apparatus, methods, and articles of manufacture described herein.

FIG. **50** depicts a side perspective cross-sectional view of another example of the golf club head of FIG. **45** taken at section line **49-49** of FIG. **27**.

For simplicity and clarity of illustration, the drawing figures illustrate the general manner of construction, and descriptions and details of well-known features and techniques may be omitted to avoid unnecessarily obscuring the present disclosure. Additionally, elements in the drawing figures are not necessarily drawn to scale. For example, the dimensions of some of the elements in the figures may be exaggerated relative to other elements to help improve understanding of embodiments of the present disclosure.

DESCRIPTION

In general, golf club heads and methods to manufacture golf club heads are described herein. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

In the example of FIGS. **1-13**, a golf club head **100** may include a body portion **110**, and a plurality of weight portions **120**, generally, shown as a first set of weight portions **210** (FIG. **2**) and a second set of weight portions **220** (FIG. **2**). The body portion **110** may include a top portion **130**, a bottom portion **140**, a toe portion **150**, a heel portion **160**, a front portion **170**, and a rear portion **180**. The bottom portion **140** may include a skirt portion **190** defined as a side portion of the golf club head **100** between the top portion **130** and the bottom portion **140** excluding the front portion **170** and extending across a periphery of the golf club head **100** from the toe portion **150**, around the rear portion **180**, and to the heel portion **160**. The bottom portion **140** may include a transition region **230** and a weight port region **240**. For example, the weight port region **240** may be a D-shape region. The weight port region **240** may include a plurality of weight ports **900** (FIG. **9**) to receive the plurality of weight portions **120**. The front portion **170** may include a face portion **175** to engage a golf ball (not shown). The body portion **110** may also include a hosel portion **165** to receive a shaft (not shown). Alternatively, the body portion **110** may include a bore instead of the hosel portion **165**. For example, the body portion **110** may be made partially or entirely of an aluminum-based material, a magnesium-type material, a steel-based material, a titanium-based material, any combination thereof, or any other suitable material. In another example the body portion **110** may be made partially or entirely of a non-metal material such as a ceramic material, a composite material, any combination thereof, or any other suitable material.

The golf club head **100** may have a club head volume greater than or equal to 300 cubic centimeters (cm3 or cc). In one example, the golf club head **100** may be about 460 cc. Alternatively, the golf club head **100** may have a club head volume less than or equal to 300 cc. In particular, the golf club head **100** may have a club head volume between 100 cc and 200 cc. The club head volume of the golf club head **100** may be determined by using the weighted water displacement method (i.e., Archimedes Principle). For example, procedures defined by golf standard organizations and/or governing bodies such as the United States Golf Association (USGA) and/or the Royal and Ancient Golf Club of St. Andrews (R&A) may be used for measuring the club head volume of the golf club head **100**. Although FIG. **1** may depict a particular type of club head (e.g., a driver-type club head), the apparatus, methods, and articles of manufacture described herein may be applicable to other types of club head (e.g., a fairway wood-type club head, a hybrid-type club head, an iron-type club head, a putter-type club head, etc.). The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

Each of the first set of weight portions **210**, generally shown as **405**, **410**, **415**, **420**, **425**, **430**, and **435** (FIG. **4**), may be associated with a first mass. Each of the second set of weight portions **220**, generally shown as **440**, **445**, **450**, **455**, **460**, **465**, **470**, **475**, and **480** (FIG. **4**), may be associated with a second mass. The first mass may be greater than the second mass or vice versa. In one example, the first set of weight portions **210** may be made of a tungsten-based material whereas the second set of weight portions **220** may be made of an aluminum-based material. As described in detail below, the first and second set of weight portions **210** and **220**, respectively, may provide various weight configurations (e.g., FIGS. **15-18**).

Referring to FIGS. **9-11**, for example, the bottom portion **140** of the body portion **110** may include a plurality of weight ports **900**. The plurality of weight ports **900**, generally shown as **905**, **910**, **915**, **920**, **925**, **930**, **935**, **940**, **945**, **950**, **955**, **960**, **965**, **970**, **975**, and **980**, may be located along a periphery of the weight port region **240** of the bottom portion **140**. The plurality of weight ports **900** may extend across the bottom portion **140**. In particular, the plurality of weight ports **900** may extend between the toe and heel portions **150** and **160**, respectively, across the bottom portion **140**. The plurality of weight ports **900** may also extend between the front and rear portions **170** and **180**, respectively, across the bottom portion **140**. The plurality of weight ports **900** may be arranged across the bottom portion **140** along a path that defines a generally D-shaped loop. In one example, the plurality of weight ports **900** may extend more

than 50% of a maximum toe-to-heel distance **500** between of the toe and heel portions **150** and **160**, respectively, across the bottom portion **140**. The maximum toe-to-heel distance **500** of the golf club head **100** may be measured from transition regions between the top and bottom portions **130** and **140**, respectively, at the toe and heel portions **150** and **160**, respectively. Alternatively, the maximum toe-to-heel distance **500** may be a horizontal distance between vertical projections of the outermost points of the toe and heel portions **150** and **160**, respectively. For example, the maximum toe-to-heel distance **500** may be measured when the golf club head **100** is at a lie angle **510** of about 60 degrees. If the outermost point of the heel portion **160** is not readily defined, the outermost point of the heel portion **160** may be located at a height **520** of about 0.875 inches (22.23 millimeters) above a ground plane **530** (i.e., a horizontal plane on which the golf club head **100** is lying on). The plurality of weight ports **900** may extend more than 50% of a maximum toe-to-heel club head distance **500** of the golf club head **110**. In particular, the plurality of weight ports **900** may extend between the toe portion **150** and the heel portion **160** at a maximum toe-to-heel weight port distance **995**, which may be more than 50% of the maximum toe-to-heel club head distance **500** of the golf club head **110**. In one example, the maximum toe-to-heel club head distance **500** of the golf club head **110** may be no more than 5 inches (127 millimeters). Accordingly, the plurality of weight ports **900** may extend a weight port maximum toe-to-heel weight port distance of at least 2.5 inches between the toe and heel portions **150** and **160**, respectively. A maximum toe-to-heel weight port distance **995** may be the maximum distance between the heel-side boundary of the weight port farthest from the toe portion **150** and the toe-side boundary of the weight port farthest from the heel portion **160**. In the example of FIG. **9**, the weight port maximum toe-to-heel weight port distance **995** may be the maximum distance between the heel-side boundary of the weight port **940** and toe-side boundary of the weight port **980**. For example, the maximum toe-to-heel weight port distance **995** may be about 3.7 inches. As the rules of golf may change from time to time (e.g., new regulations may be adopted or old rules may be eliminated or modified by golf standard organizations and/or governing bodies), the lie angle **510** and/or the height **520** for measuring the maximum toe-to-heel club head distance **500** may also change. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

Each of the plurality of weight ports **900** may be associated with a port diameter (Dport) (e.g., two shown as **1105** and **1110** in FIG. **11**). For example, the port diameter of each weight port of the plurality of weight ports **900** may be about 0.3 inch (7.65 millimeters). Alternatively, the port diameters of adjacent weight ports may be different. In one example, the weight port **905** may be associated with a port diameter **1105**, and the weight port **910** may be associated with a port diameter **1110**. In particular, the port diameter **1105** of the weight port **905** may be larger than the port diameter **1110** of the weight port **910** or vice versa. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

The bottom portion **140** may also include an outer surface **990**. As illustrated in FIG. **10**, for example, the plurality of weight ports **900** may be formed on the bottom portion **140** relative to an outer surface curve **1090** formed by the outer surface **990**. In particular, each of the plurality of weight ports **900** may be associated with a port axis generally shown as **1005**, **1010**, and **1015**. A center of a weight port may define the port axis of the weight port. Each port axis may be perpendicular or substantially perpendicular to a plane that is tangent to the outer surface curve **1090** at the point of intersection of the port axis and the outer surface curve **1090**. In one example, substantially perpendicular may refer to a deviation of ±5° from perpendicular. In another example, substantially perpendicular may refer to a deviation of ±3° from perpendicular. The deviation from perpendicular may depend on manufacturing tolerances.

In one example, the port axis **1010** may be perpendicular or substantially perpendicular (i.e., normal) to a tangent plane **1012** of the outer surface curve **1090**. Multiple fixtures may be used to manufacture the plurality of weight ports **900** by positioning the golf club head **100** in various positions. Alternatively, the weight ports may be manufactured by multiple-axis machining processes, which may be able to rotate the golf club head around multiple axes to mill away excess material (e.g., by water jet cutting and/or laser cutting) to form the plurality of weight ports **900**. Further, multiple-axis machining processes may provide a suitable surface finish because the milling tool may be moved tangentially about a surface. Accordingly, the apparatus, methods, and articles of manufacture described herein may use a multiple-axis machining process to form each of the plurality of weight ports **900** on the bottom portion **140**. For example, a five-axis milling machine may form the plurality of weight ports **900** so that the port axis **1000** of each of the plurality weight ports **900** may be perpendicular or substantially perpendicular to the outer surface curve **1090**. The tool of the five-axis milling machine may be moved tangentially about the outer surface curve **1090** of the outer surface **990**.

Turning to FIG. **11**, for example, two adjacent weight ports may be separated by a port distance **1100**, which may be the shortest distance between two adjacent weight ports on the outer surface **990**. In particular, the port distance **1100** may be less than or equal to the port diameter of any of the two adjacent weight ports. In one example, the port distance **1100** between the weight ports **905** and **910** may be less than or equal to either the port diameter **1105** or the port diameter **1110**. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

The plurality of weight portions **120** may have similar or different physical properties (e.g., density, shape, mass, volume, size, color, etc.). In one example, the first set of weight portions **210** may be a black color whereas the second set of weight portions **220** may be a gray color or a steel color. Some or all of the plurality of weight portions **120** may be partially or entirely made of a metal material such as a steel-based material, a tungsten-based material, an aluminum-based material, any combination thereof or suitable types of materials. Alternatively, some or all of the plurality of weight portions **120** may be partially or entirely made of a non-metal material (e.g., composite, plastic, etc.).

In the illustrated example as shown in FIGS. **12** and **13**, each weight portion of the plurality of weight portions **120** may have a cylindrical shape (e.g., a circular cross section). Although the above examples may describe weight portions having a particular shape, the apparatus, methods, and articles of manufacture described herein may include weight portions of other suitable shapes (e.g., a portion of or a whole sphere, cube, cone, cylinder, pyramid, cuboidal, prism, frustum, or other suitable geometric shape). Each weight portion of the plurality of weight portions **120** may be associated with a diameter **1200** and a height **1300**. In one example, each weight portion of the plurality of weight portions **120** may have a diameter of about 0.3 inch (7.62 millimeters) and a height of about 0.2 inch (5.08 millime-

ters). Alternatively, the first and second sets of weight portions **210** and **220**, respectively, may be different in width and/or height.

Instead of a rear-to-front direction as in other golf club heads, each weight portion of the plurality of weight portions **120** may engage one of the plurality of weight ports **400** in a bottom-to-top direction. The plurality of weight portions **120** may include threads to secure in the weight ports. For example, each weight portion of the plurality of weight portions **120** may be a screw. The plurality of weight portions **120** may not be readily removable from the body portion **110** with or without a tool. Alternatively, the plurality of weight portions **120** may be readily removable (e.g., with a tool) so that a relatively heavier or lighter weight portion may replace one or more of the plurality of weight portions **120**. In another example, the plurality of weight portions **120** may be secured in the weight ports of the body portion **110** with epoxy or adhesive so that the plurality of weight portions **120** may not be readily removable. In yet another example, the plurality of weight portions **120** may be secured in the weight ports of the body portion **110** with both epoxy and threads so that the plurality of weight portions **120** may not be readily removable. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

In contrast to other golf club heads, the golf club head **100** may accommodate at least four different types of golf swings. As illustrated in FIG. **14**, for example, each weight configuration may be associated with one of the plurality of launch trajectory profiles **1400**, generally shown as **1410**, **1420**, and **1430**. Referring to FIG. **15**, for example, a first weight configuration **1500** may be associated with a configuration of a first set of weight ports **1510**. The first set of weight ports **1510** may be located at or proximate to the front portion **170** (e.g., weight ports **905**, **910**, **915**, **920**, **925**, **930**, and **935** shown in FIG. **9**). In the first weight configuration **1500**, a first set of weight portions may be disposed toward the front portion **170** according to the configuration of the first set of weight ports **1510**, whereas a second set of weight portions may be disposed toward the rear portion **180**. In particular, the first set of weight portions may form a cluster according to the configuration of the first set of weight ports **1510** at or proximate to the front portion **170**. The weight portions **405**, **410**, **415**, **420**, **425**, **430**, and **435** may define the first set of weight portions and may be disposed in weight ports **905**, **910**, **915**, **920**, **925**, **930**, and **935**, respectively. The weight portions **440**, **445**, **450**, **455**, **460**, **465**, **470**, **475**, and **480** may define the second set of weight portions and may be disposed in weight ports **940**, **945**, **950**, **955**, **960**, **965**, **970**, **975**, and **980**, respectively. The first weight configuration **1500** may be associated with the first launch trajectory profile **1410** (FIG. **14**). In particular, the first weight configuration **1500** may decrease spin rate of a golf ball. By placing relatively heavier weight portions (i.e., the first set of weight portions) towards the front portion **170** of the golf club head **100** according to the configuration of the first set of weight ports **1510**, the center of gravity (GC) of the golf club head **100** may move relatively forward and lower to produce a relatively lower launch and spin trajectory. As a result, the first launch trajectory profile **1410** may be associated with a relatively greater roll distance (i.e., distance after impact with the ground). While the above example may describe the weight portions being disposed in certain weight ports, any weight portion of the first set of weight portions **210** may be disposed in any weight port of the first set of weight ports **1510**.

Turning to FIG. **16**, for example, a second weight configuration **1600** may be associated with a configuration of a second set of weight ports **1610**. The second set of weight ports **1610** may be located at or proximate to the rear portion **180** (e.g., weight ports, **945**, **950**, **955**, **960**, **965**, **970**, and **975** shown in FIG. **9**). In a second weight configuration **1600** as illustrated in FIG. **16**, for example, a first set of weight portions may be disposed toward the rear portion **180** whereas a second set of weight portions may be disposed toward the front portion **170**. In particular, the first set of weight portions may form a cluster **1610** at or proximate to the rear portion **180** according to the configuration of the second set of weight ports **1610**. The weight portions **405**, **410**, **415**, **420**, **425**, **430**, and **435** may define the first set of weight portions and may be disposed in weight ports **945**, **950**, **955**, **960**, **965**, **970**, and **975**, respectively. The weight portions **440**, **445**, **450**, **455**, **460**, **465**, **470**, **475**, and **480** may define the second set of weight portions and may be disposed in weight ports **905**, **910**, **915**, **920**, **925**, **930**, **935**, **940**, and **980**, respectively. The second weight configuration **1600** may be associated with the second launch trajectory profile **1420** (FIG. **14**). In particular, the second weight configuration **1600** may increase launch angle of a golf ball and maximize forgiveness. By placing the relatively heavier weight portion (i.e., the first set of weight portions) towards the rear portion **180** of the golf club head **100** according to the configuration of the second set of weight ports **1610**, the center of gravity (GC) of the golf club head **100** may move relatively back and up to produce a relatively higher launch and spin trajectory. Further, the moment of inertia (MOI) of the golf club head **100** may increase in both the horizontal (front-to-back axis) and vertical axes (top-to-bottom axis), which in turn, provides relatively more forgiveness on off-center hits. As a result, the second launch trajectory profile **1420** may be associated with a relatively greater carry distance (i.e., in-the-air distance).

Turning to FIG. **17**, for example, a third weight configuration **1700** may be associated with a configuration of a third set of weight ports **1710**. In the third weight configuration **1700**, for example, a first set of weight portions may be disposed toward the heel portion **160** whereas a second set of weight portions may be disposed toward the toe portion **150**. In particular, the first set of weight portions may form a cluster of weight portions at or proximate to the heel portion **160** according to the configuration of the third set of weight ports **1710**. The weight portions **405**, **410**, **415**, **420**, **425**, **430**, and **435** may define the first set of weight portions and may be disposed in weight ports **925**, **930**, **935**, **940**, **945**, **950**, and **955**, respectively. The weight portions **440**, **445**, **450**, **455**, **460**, **465**, **470**, **475**, and **480** may define the second set of weight portions and may be disposed in weight ports **905**, **910**, **915**, **920**, **960**, **965**, **970**, **975**, and **980**, respectively. The third weight configuration **1600** may be associated with a third launch trajectory profile **1430** (FIG. **14**). In particular, the third weight configuration **1700** may allow an individual to turn over the golf club head **100** relatively easier (i.e., square up the face portion **175** to impact a golf ball). By placing the relatively heavier weight portions (i.e., the first set of weight portions) towards the heel portion **160** of the golf club head **100**, the center of gravity (GC) of the golf club head **100** may move relatively closer to the axis of the shaft.

Turning to FIG. **18**, for example, a fourth weight configuration **1800** may be associated with a configuration of a fourth set of weight ports **1810**. In a fourth weight configuration **1800**, for example, a first set of weight portions may be disposed toward the toe portion **150** whereas a second set

of weight portions may be disposed toward the heel portion **160**. In particular, the first set of weight portions may form a cluster of weight portions at or proximate to the toe portion **150** according to the configuration of the fourth set of weight ports **1810**. The weight portions **405**, **410**, **415**, **420**, **425**, **430**, and **435** may define the first set of weight portions and may be disposed in weight ports **905**, **910**, **915**, **965**, **970**, **975**, and **980**, respectively. The weight portions **440**, **445**, **450**, **455**, **460**, **465**, **470**, **475**, and **480** may define the second set of weight portions and may be disposed in weight ports **920**, **925**, **930**, **935**, **940**, **945**, **950**, **955**, and **960**, respectively. The fourth weight configuration **1800** may be associated with the third launch trajectory profile **1430** (FIG. **14**). In particular, the fourth weight configuration **1800** may prevent an individual from turning over the golf club head **100** (i.e., the face portion **175** may be more open to impact a golf ball). By placing the relatively heavier weight portions (i.e., the first set of weight portions) towards the toe portion **150** of the golf club head **100**, the center of gravity (GC) of the golf club head **100** may move relatively farther away from the axis of the shaft. The fourth weight configuration **1800** may result in a fade golf shot (as shown in FIG. **19**, for example, a trajectory or ball flight in which a golf ball travels to the left of a target **1910** and curving back to the right of the target for a right-handed individual). The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

FIG. **20** depicts one manner in which the golf club head **100** may be manufactured. In the example of FIG. **20**, the process **2000** may begin with providing a plurality of weight portions (block **2010**). The plurality of weight portions may include a first set of weight portions and a second set of weight portions. Each weight portion of the first set of weight portions may be associated with a first mass whereas each weight portion of the second set of weight portions may be associated with a second mass. The first mass may be greater than the second mass. In one example, each weight portion of the first set of weight portions may be made of a tungsten-based material with a mass 2.6 grams whereas each weight portion of the second set of weight portions may be made of an aluminum-based material with a mass of 0.4 grams. The first set of weight portions may have a gray color or a steel color whereas the second set of weight portions may have a black color.

The process **2000** may provide a body portion of a golf club head (block **2020**). The body portion may include a front portion, a rear portion, a toe portion, a heel portion, a top portion, a bottom portion having an outer surface associated with outer surface curve, and a skirt portion between the top and bottom portion.

The process **2000** may form a weight port region located at or proximate to the bottom and skirts portions (block **2030**). A transition region may surround the weight port region.

The process **2000** may form a plurality of weight ports along a periphery of the weight port region (block **2040**). Each weight port of the plurality of weight ports may be associated with a port diameter and configured to receive at least one weight portion of the plurality of weight portions. Two adjacent weight ports may be separated by less than or equal to the port diameter. Further, each weight port of the plurality of weight ports may be associated with a port axis. The port axis may be perpendicular or substantially perpendicular relative to a tangent plane of the outer surface curve of the bottom portion of the golf club head.

The example process **2000** of FIG. **20** is merely provided and described in conjunction with FIGS. **1-19** as an example of one way to manufacture the golf club head **100**. While a particular order of actions is illustrated in FIG. **20**, these actions may be performed in other temporal sequences. For example, two or more actions depicted in FIG. **20** may be performed sequentially, concurrently, or simultaneously. Although FIG. **20** depicts a particular number of blocks, the process may not perform one or more blocks. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

As shown in the above examples, the plurality of weight portions **120** and the plurality of weight ports **900** may be located on a periphery of the weight port region **240** along a path that defines a generally D-shaped loop formed with two arcs, generally shown as **490** and **495** in FIG. **4**. For example, the weight portions **405**, **410**, **415**, **420**, **425**, **430**, and **435** (FIG. **4**), and the weight ports **905**, **910**, **915**, **920**, **925**, **930**, and **935** (FIG. **9**) may form the first arc **490**. In particular, the first arc **490** may extend between the toe and heel portions **150** and **160**, respectively, across the bottom portion **140**. The weight portions **440**, **445**, **450**, **455**, **460**, **465**, **470**, **475**, and **480** (FIG. **4**), the weight ports **940**, **945**, **950**, **955**, **960**, **965**, **970**, **975**, and **980** (FIG. **9**) may form the second arc **495**. The second arc **495** may generally follow the contour of the rear portion **180** of the body portion **110**. Alternatively, the first and second arcs **490** and **495** may define loops with other shapes that extend across the bottom portion **140** (e.g., a generally O-shaped loop). The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

Although the above examples may depict the plurality of weight portions **120** and the plurality of weight ports **900** forming a particular geometric shape, the apparatus, methods, and articles of manufacture described herein may have weight portions and weight ports located along a periphery of a weight portion region to form other geometric shapes. Turning to FIG. **21**, for example, a golf club head **2100** may include a bottom portion **2110**, and a plurality of weight portions **2120** disposed in a plurality of weight ports **2130**. The plurality of weight ports **2130** may be located along a periphery of a weight port region **2140** of the bottom portion **2110** (i.e., the plurality of weight ports **2130** may extend between the toe and heel portions **2112** and **2114**, respectively, across the bottom portion **2110**). In contrast to the plurality of weight portions **120** and the plurality of weight ports **900** (e.g., FIGS. **4** and **9**), the plurality of weight ports **2130** may form two discrete arcs, generally shown as **2150** and **2155**, extending across the bottom portion **2110**.

The first arc **2150** may extend between the toe portion **2112** and the heel portion **2114**. The first arc **2150** may curve toward the front portion **2170** of the golf club head **2100** (i.e., concave relative to the front portion **2170**). According to the example of FIG. **21**, the first arc **2150** may extend from a region proximate the toe portion **2112** to a region proximate to the front portion **2170** and from the region proximate to the front portion **2170** to a region proximate to the heel portion **2114** (i.e., concave relative to the front portion **2170**). Accordingly, the first arc **2150** may appear as a C-shaped arc facing the rear portion **2180** of the golf club head **2110** that extends between the toe portion **2112** and the heel portion **2114**. The second arc **2155** may also extend between the toe portion **2112** and the heel portion **2114**. The second arc **2155** may curve toward the rear portion **2180** of the golf club head **2100** (i.e., concave relative to the rear portion **2180**). Accordingly, the second arc **2155** may appear as a C-shaped arc facing the front portion **2170** of the golf club head **2110** that extends between the toe portion **2112** and the heel portion **2114**. Further, the first arc **2150** may be

closer to the front portion **2170** than the second arc **2155**. The first arc **2150** and the second arc **2155** may be discrete so that the first and second arcs **2150** and **2155**, respectively, may be spaced apart along the periphery of the bottom portion **2110**. Accordingly, the bottom portion **2110** may include gaps **2190** and **2192** along the periphery of the bottom portion **2110** between the weight ports **2130** of the first arc **2150** and the weight ports **2130** of the second arc **2155**. The gaps **2190** and/or **2192** may be greater than or equal to the port diameter of any of the weight ports **2130** such as the weight ports **2130** that are adjacent to the gaps **2190** and/or **2192**. According to one example as shown in FIG. **21**, the gaps **2190** and **2192** may be several orders or magnitude larger than the diameters of the weight ports **2130** that are adjacent to the gaps **2190** and **2192**. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

Referring to FIG. **21**, for example, the first arc **2150** may include a greater number of weight ports **2130** than the second arc **2155**, which may be suitable for certain golf club heads (e.g., a fairway wood-type golf club head and/or a hybrid-type golf club head). Alternatively, the second arc **2155** may include the same or a greater number of weight ports **2130** than the first arc **2150**. The number of weight ports **2130** in each of the first and second arcs **2150** and **2155**, respectively, the weight portions **2120** associated with each weight port **2130** and the spacing between adjacent weight ports **2130** may be determined based on the type of golf club, a preferred weight distribution of the golf club head **2110**, and/or a center of gravity location of the golf club head **2110**.

The weight ports **2130** of the first arc **2150** and/or the second arc **2155** may be spaced from each other at the same or approximately the same distance along the first arc **2150** and/or the second arc **2155**, respectively. Any variation in the spacing between the weight ports **2130** of the first arc **2150** or the second arc **2155** or any of the weight ports described herein may be due to different manufacturing considerations, such as manufacturing tolerances and/or cost effectiveness associated with manufacturing precision. For example, the variation in the spacing between the weight ports **2130** of the first arc **2150** and/or the second arc **2155** may be between 1/16 of an inch to 0.001 inch. As described herein, the distance between adjacent weight ports **2130** (i.e., port distance) may be less than or equal to the port diameter of any of the two adjacent weight ports. The plurality of weight ports **2130** may extend between the toe portion **2112** and the heel portion **2114** at a maximum toe-to heel weight port distance that is more than 50% of a maximum toe-to-heel club head distance **2195** of the golf club head **2100**. The maximum toe-to-heel weight port distance may be the maximum distance between the heel-side boundary of the weight port farthest from the toe portion **2112** and the toe-side boundary of the weight port farthest from the heel portion **2114**.

In particular, the golf club head **2100** may have a volume of less than 430 cc. In example, the golf club head **2100** may have a volume ranging from 100 cc to 400 cc. In another example, the golf club head **2100** may have a volume ranging from 150 cc to 350 cc. In yet another example, the golf club head **2100** may have a volume ranging from 200 cc to 300 cc. The golf club head **2100** may have a mass ranging from 100 grams to 350 grams. In another example, the golf club head **2100** may have a mass ranging from 150 grams to 300 grams. In yet another example, the golf club head **2100** may have a mass ranging from 200 grams to 250 grams. The golf club head **2100** may have a loft angle ranging from 10° to 30°. In another example, the golf club head **2100** may have a loft angle ranging from 13° to 27°. For example, the golf club head **2100** may be a fairway wood-type golf club head. Alternatively, the golf club head **2100** may be a smaller driver-type golf club head (i.e., larger than a fairway wood-type golf club head but smaller than a driver-type golf club head). The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

As illustrated in FIG. **22**, for example, a golf club head **2200** may include a bottom portion **2210**, and a plurality of weight portions **2220** disposed in a plurality of weight ports **2230**. The plurality of weight ports **2230** located along a periphery of a weight port region **2240** may be arranged along a path that defines an arc, generally shown as **2250**, extending across the bottom portion **2210** (i.e., the plurality of weight ports **2230** may extend between the toe and heel portions **2212** and **2214**, respectively, across the bottom portion **2210**). The arc **2250** may curve toward the rear portion **2280** of the golf club head **2200** (i.e., concave relative to the rear portion **2280**). According to the example of FIG. **22**, the arc **2250** may extend from a region proximate the toe portion **2212** to a region proximate to the rear portion **2280** and from the region proximate to the rear portion **2280** to a region proximate to the heel portion **2214** (i.e., concave relative to the rear portion **2280**). Accordingly, the arc **2250** may appear as a C-shaped arc facing the front portion **2270** of the golf club head **2210** that extends from near the heel portion **2214** to near the toe portion **2212**. Further, the curvature of the arc **2250** is substantially similar to or generally follows the contour of the rear portion **2280** of the golf club head **2210**. The number of weight ports **2230** in the arc **2250**, the weight portions **2220** associated with each weight port **2230** and the spacing between adjacent weight ports **2230** may be determined based on the type of golf club, a preferred weight distribution of the golf club head **2210**, and/or a center of gravity location of the golf club head **2210**.

The weight ports **2230** of the arc **2250** may be spaced from each other at the same or approximately the same distance along the arc **2250** (e.g., the weight ports **2230** may be substantially similarly spaced apart from each other). Any variation in the spacing between the weight ports **2230** of the arc **2250** or any of the weight ports described herein may be due to different manufacturing considerations, such as manufacturing tolerances and/or cost effectiveness associated with manufacturing precision. For example, the variation in the spacing between the weight ports **2130** of the arc **2250** may be between 1/16 of an inch to 0.001 inch. As described herein, the distance between adjacent weight ports **2230** (i.e., port distance) may be less than or equal to the port diameter of any of the two adjacent weight ports. The plurality of weight ports **2230** may extend between the toe portion **2212** and the heel portion **2214** at a maximum toe-to heel weight port distance that is more than 50% of a maximum toe-to-heel club head distance of **2290** the golf club head **2200**. The maximum toe-to-heel weight port distance may be the maximum distance between the heel-side boundary of the weight port farthest from the toe portion **2212** and the toe-side boundary of the weight port farthest from the heel portion **2214**.

In particular, the golf club head **2200** may have a volume of less than 200 cc. In example, the golf club head **2200** may have a volume ranging from 50 cc to 150 cc. In another example, the golf club head **2200** may have a volume ranging from 60 cc to 120 cc. In yet another example, the golf club head **2200** may have a volume ranging from 70 cc

to 100 cc. The golf club head **2200** may have a mass ranging from 180 grams to 275 grams. In another example, the golf club head **2200** may have a mass ranging from 200 grams to 250 grams. The golf club head **2200** may have a loft angle ranging from 15° to 35°. In another example, the golf club head **2200** may have a loft angle ranging from 17° to 33°. For example, the golf club head **2200** may be a hybrid-type golf club head. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

In the example of FIGS. **23-32**, a golf club head **2300** may include a body portion **2310**, and a plurality of weight portions **2320** (FIG. **24**), generally, shown as a first set of weight portions **2410** (FIG. **24**) and a second set of weight portions **2420** (FIG. **24**). The body portion **2310** may include a top portion **2330**, a bottom portion **2340**, a toe portion **2350**, a heel portion **2360**, a front portion **2370**, and a rear portion **2380**. The bottom portion **2340** may include a skirt portion **2390** defined as a side portion of the golf club head **2300** between the top portion **2330** and the bottom portion **2340** excluding the front portion **2370** and extending across a periphery of the golf club head **2300** from the toe portion **2350**, around the rear portion **2380**, and to the heel portion **2360**. The bottom portion **2340** may include a transition region **2430** and a weight port region **2440**. For example, the weight port region **2440** may be a D-shape region. The weight port region **2440** may include a plurality of weight ports **2800** (FIG. **28**) to receive the plurality of weight portions **2320**. The front portion **2370** may include a face portion **2375** to engage a golf ball (not shown). The body portion **2310** may also include a hosel portion **2365** to receive a shaft (not shown). The hosel portion **2365** may be an integral portion or a separate portion of the body portion **2310**. For example, the hosel portion **2365** may include a hosel sleeve with one end to receive a shaft and an opposite end that may be inserted into the body portion **2310**. Alternatively, the body portion **2310** may include a bore instead of the hosel portion **2365**. For example, the body portion **2310** may be made partially or entirely of an aluminum-based material, a magnesium-type material, a steel-based material, a titanium-based material, any combination thereof, or any other suitable material. In another example the body portion **2310** may be made partially or entirely of a non-metal material such as a ceramic material, a composite material, any combination thereof, or any other suitable material.

The golf club head **2300** may have a club head volume greater than or equal to 300 cubic centimeters (cm3 or cc). In one example, the golf club head **2300** may be about 460 cc. Alternatively, the golf club head **2300** may have a club head volume less than or equal to 300 cc. In particular, the golf club head **2300** may have a club head volume between 100 cc and 200 cc. The club head volume of the golf club head **2300** may be determined by using the weighted water displacement method (i.e., Archimedes Principle). For example, procedures defined by golf standard organizations and/or governing bodies such as the United States Golf Association (USGA) and/or the Royal and Ancient Golf Club of St. Andrews (R&A) may be used for measuring the club head volume of the golf club head **2300**. Although FIG. **23** may depict a particular type of club head (e.g., a driver-type club head), the apparatus, methods, and articles of manufacture described herein may be applicable to other types of club head (e.g., a fairway wood-type club head, a hybrid-type club head, an iron-type club head, a putter-type club head, etc.). The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

Each of the first set of weight portions **2410**, generally shown as **2605**, **2610**, **2615**, and **2620** may be associated with a first mass. Each of the second set of weight portions **2420**, generally shown as **2640**, **2645**, **2650**, **2655**, **2660**, **2665**, and **2670** may be associated with a second mass. The first mass may be greater than the second mass or vice versa. In one example, the first set of weight portions **2410** may be made of a tungsten-based material whereas the second set of weight portions **2420** may be made of an aluminum-based material. The first and second set of weight portions **2410** and **2420**, respectively, may provide various weight configurations for the golf club head **2300** that may be similar to the various weight configurations for the golf club head **100** as described in detail herein. Alternatively, all of the weight portions of the first and second set of weight portions **2410** and **2420**, respectively, may have the same mass. That is, the first and second masses may be equal to each other. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

Referring to FIG. **28**, for example, the bottom portion **2340** of the body portion **2310** may include a plurality of weight ports **2800**. The plurality of weight ports **2800**, generally shown as **2805**, **2810**, **2815**, **2820**, **2840**, **2845**, **2850**, **2855**, **2860**, **2865**, and **2870** may be located on and/or along a periphery of the weight port region **2440** of the bottom portion **2340**. Each of the plurality of weight ports **2800** may be associated with a port diameter, which may be similar in many respects to the port diameters (Dport) of the weight ports **900** of the golf club head **100** (generally shown in FIG. **9**). For example, the port diameter of each weight port of the plurality of weight ports **2800** may be about 0.3 inch (7.65 millimeters). Alternatively, the port diameters of adjacent weight ports of the plurality of weight ports **2800** may be different. Further, the plurality of weight ports **2800** may extend across the bottom portion **2340** similar to the configuration of the weight ports **900** of the golf club head **100** as described in detail herein. However, the configuration of the weight ports **2800** on the bottom portion **2340** may be different than the configuration of the weight ports **900** of the golf club head **100**. For example, the distance between two adjacent weight ports **2800** may be less than or equal to the port diameter of any of the two adjacent weight ports, which may be similar to the weight ports **900** of the golf club head **100**. However, in another example, the distance between two adjacent weight ports **2800** may be greater than the port diameter of any of two adjacent weight ports. In yet another example, the distance between two adjacent weight ports of some of the weight ports **2800** may be less than or equal to the port diameter of any of the two adjacent weight ports, while the distance between two adjacent weight ports of some of the other weight ports **2800** may be greater than the port diameter of any of the two adjacent weight ports. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

The plurality of weight ports **2800** may be formed on the bottom portion **2340** similar to the formation of the weight ports **900** of the golf club head **100**. For example, a center axis of each of the weight ports **2800** may be perpendicular or substantially perpendicular to a plane tangent to an outer surface curve of the bottom portion **2340** (e.g., contour of the bottom portion **2340**) at the point of intersection of the center axis and the outer surface curve as described in detail herein with respect to the golf club head **100**. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

The plurality of weight portions **2320** may have similar or different physical properties (e.g., density, shape, mass,

volume, size, color, etc.). The weight portions **2320** may be similar in many respects to the weight portions **120** of the golf club head **100** as described herein. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

In one example shown in FIGS. **23-32**, the bottom portion **2340** may include an outer surface **2342** and an inner surface **2344**. Each of the outer surface **2342** and the inner surface **2344** may include one or a plurality of support portions, generally shown as **3110**, **3120**, and **3140**. The outer surface **2342** may include at least one outer support portion **3110** and the inner surface **2344** may include a first set of inner support portions **3120** (generally shown as inner support portions **3121**, **3122**, **3123**, **3124**, **3125**, **3126**, **3127**, **3128**, **3129**, **3130**, **3131**, **3132** and **3133**), and a second set of inner support portions **3140** (generally shown as inner support portions **3141**, **3142**, **3143**, **3144**, **3145**, and **3146**). The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

The outer support portion **3110** may be positioned on the bottom portion **2340** and/or the skirt portion **2390** between any of the weight ports **2800** and/or a periphery of the body portion **2310** as defined by the toe portion **2350**, the heel portion **2360**, the front portion **2370**, and the rear portion **2380**. However, the outer support portion **3110** may be positioned at any location on the golf club head **2300** for structural support of the golf club head **2310**. As an example shown in FIGS. **23-32**, the outer support portion **3110** may be defined by a groove or indentation that extends on the bottom portion **2340** and/or the skirt portion **2390** from the rear portion **2380** toward and/or to the toe portion **2350** proximate to a periphery of the body portion **2310**. The outer support portion **3110** may have any configuration. As illustrated in FIG. **31**, a width of the outer support portion **3110** may increase from the rear portion **2380** toward the toe portion **2350** while the outer support portion **3110** may follow a contour of the periphery of the body portion **2310** between the rear portion **2380** and the toe portion **2350**. Accordingly, the outer support portion **3110** may resemble a curved triangular groove on the bottom portion **2340**. The depth of the outer support portion **3110** may also vary. Alternatively, the depth of the outer support portion **3110** may be constant. Further, the depth of the outer support portion **3110** may be determined based on the thickness of the bottom portion **2340** and the material from which the bottom portion **2340** is formed. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

Each inner support portion of the first set of inner support portions **3120** may include walls, ribs and/or any projection from the inner surface **2344** of the bottom portion **2340**. Each inner support portion of the first set of inner support portions **3120** may extend from and connect each weight port **2800** to an adjacent weight port or to one or more other non-adjacent weight ports **2800**. As shown in FIG. **31**, for example, the inner support portion **3121** may include a wall projecting from the inner surface **2344** of the bottom portion **2340** and connecting the weight ports **2805** and **2810**. Similarly, as shown in FIG. **31**, each pair of adjacent weight ports **2810** and **2815**, **2815** and **2820**, **2820** and **2840**, **2840** and **2845**, **2845** and **2850**, **2850** and **2855**, **2855** and **2860**, **2860** and **2865**, **2865** and **2870**, **2870** and **2805** may be connected by inner support portions **3122**, **3123**, **3124**, **3125**, **3126**, **3127**, **3128**, **3129**, **3130**, **3131**, respectively. Accordingly, the inner support portions **3121** through **3131** of the first set of inner support portions **3120** may define a loop-shaped support region **3150** on the inner surface **2344** of the bottom portion **2340**. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

Further, the inner support portion **3132** may include a wall projecting from the inner surface **2344** of the bottom portion **2340** and connecting two non-adjacent weight ports such as the weight ports **2805** and **2855**. The inner support portion **3133** may include a wall projecting from the inner surface **2344** of the bottom portion **2340** and connecting two non-adjacent weight ports such as the weight ports **2820** and **2855**. Accordingly, the inner support portions **3121**, **3122**, **3123**, **3132** and **3133** may define a triangular support region **3160** on the inner surface **2344** of the bottom portion **2340** partially within the loop-shaped support region **3150** and partially overlapping the loop-shaped support region **3150**. The weight ports **2805**, **2820** and **2855** may define the vertices of the triangular support region **3160**. The first set of inner support portions **3120** may have any configuration, connect any two or more of the weight ports, and/or define any shape. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

Each inner support portion of the second set of inner support portions **3140** may include walls, ribs and/or any projections on the inner surface **2344** of the bottom portion **2340**. Each inner support portion of the second set of inner support portions **3140** may extend from one or more of the weight ports **2800** toward the periphery and/or the skirt portion **2390** of the body portion **2310**. In one example shown in FIG. **31**, the inner support portion **3141** may include a wall connected to the weight port **2805** and extending from the weight port **2805** toward and/or to the toe portion **2350**. The inner support portion **3142** may include a wall connected to the weight port **2870** and extending from the weight port **2870** toward and/or to the toe portion **2350**. The inner support portion **3143** may include a wall connected to the weight port **2865** and extending from the weight port **2865** toward and/or to the toe portion **2350** or the rear portion **2380**. The length, height, thickness, orientation angle, and/or cross-sectional configuration of each of the inner support portions **3141**, **3142** and **3143** may be configured such that the inner support portions **3141**, **3142** and **3143** may provide or substantially provide structural support to the bottom portion **2340**, the skirt portion **2390**, the toe portion **2350**, the front portion **2370** and/or the rear portion **2380**. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

As illustrated in FIG. **31**, the inner support portion **3144** may include a wall that may be connected to the weight port **2855** and may extend from the weight port **2855** toward and/or to the rear portion **2380**. The inner support portion **3145** may include a wall connected to the weight port **2845** and extending from the weight port **2845** toward and/or to the heel portion **2360**. The inner support portion **3146** may include a wall connected to the weight port **2820** and extending from the weight port **2820** toward and/or to the heel portion **2360**. The length, height, thickness, orientation angle, and/or cross-sectional configuration of each of the inner support portions **3144**, **3145** and **3146** may be configured such that the inner support portions **3144**, **3145** and **3146** may provide or substantially provide structural support to the bottom portion **2340**, the skirt portion **2390**, the heel portion **2380**, the front portion **2370** and/or the rear portion **2380**. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

The first set of inner support portions **3120** may structurally support the bottom portion **2340** by distributing the impact loads exerted on the bottom portion **2340** throughout the bottom portion **2340** when the golf club head **100** strikes

a golf ball (not shown). The second set of inner support portions **3140** may further distribute the impact loads throughout the bottom portion **2340**, the skirt portion **2390**, toe portion **2350**, the heel portion **2360**, the front portion **2370**, and/or the rear portion **2380**. In one example, the second set of inner support portions **3140** may include additional walls, ribs and/or projections (not shown) that connect to any of the weight ports such as weight ports **2840**, **2850** and **2860** to further distribute impact loads throughout the body portion **2310**. While the above examples may depict a particular number of inner support portions, the bottom portion **2340** may include additional inner support portions (not shown). For example, the bottom portion **2340** may include a plurality of inner support portions (not shown) that connect non-adjacent weight ports **2800** (e.g., weight ports **2815** and **2860**) and/or the second set of inner support portions **3140**. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

The width (i.e., thickness), length, height, orientation angle, and/or cross-sectional shape of the inner support portions of the first set of inner support portions **3120** and/or the second set of inner support portions **3140** may be similar or vary and be configured to provide structural support to the golf club head **2300**. For example, the materials from which the bottom portion **2340** and/or the body portion **2310** may be constructed may determine the width, length, height, orientation angle, and/or cross-sectional shape of the inner support portions of the first set of inner support portions **3120** and/or the second set of inner support portions **3140**. For example, the inner support portions of the first set of inner support portions **3120** and/or the second set of inner support portions **3140** may be defined by walls with rectangular cross sections having heights that are similar to the depths of the weight portions **2800**. The length of each inner support portion of the second set of inner support portions **3140** may be configured such that one or more inner support portions of the second set of inner support portions **3140** extend from the bottom portion **2340** to the skirt portion **2390**. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

In the example of FIGS. **33-42**, a golf club head **3300** may include a body portion **3310**, and a plurality of weight portions **3320** (FIG. **34**), generally, shown as a first set of weight portions **3410** (FIG. **34**) and a second set of weight portions **3420** (FIG. **34**). The body portion **3310** may include a top portion **3330**, a bottom portion **3340**, a toe portion **3350**, a heel portion **3360**, a front portion **3370**, and a rear portion **3380**. The bottom portion **3340** may include a skirt portion **3390** defined as a side portion of the golf club head **3300** between the top portion **3330** and the bottom portion **3340** excluding the front portion **3370** and extending across a periphery of the golf club head **3300** from the toe portion **3350**, around the rear portion **3380**, and to the heel portion **3360**. The bottom portion **3340** may include a transition region **3430** and a weight port region **3440**. For example, the weight port region **3440** may be a D-shape region. The weight port region **3440** may include a plurality of weight ports **3800** (FIG. **38**) to receive the plurality of weight portions **3320**. The front portion **3370** may include a face portion **3375** to engage a golf ball (not shown). The body portion **3310** may also include a hosel portion **3365** to receive a shaft (not shown). The hosel portion **3365** may be an integral portion or a separate portion of the body portion **3310**. For example, the hosel portion **3365** may include a hosel sleeve with one end to receive a shaft and an opposite end that may be inserted into the body portion **3310**. Alternatively, the body portion **3310** may include a bore instead of the hosel portion **3365**. For example, the body portion **3310** may be made partially or entirely of an aluminum-based material, a magnesium-type material, a steel-based material, a titanium-based material, any combination thereof, or any other suitable material. In another example the body portion **3310** may be made partially or entirely of a non-metal material such as a ceramic material, a composite material, any combination thereof, or any other suitable material.

The golf club head **3300** may have a club head volume greater than or equal to 300 cubic centimeters (cm^3 or cc). In one example, the golf club head **3300** may be about 460 cc. Alternatively, the golf club head **3300** may have a club head volume less than or equal to 300 cc. In particular, the golf club head **3300** may have a club head volume between 100 cc and 200 cc. The club head volume of the golf club head **3300** may be determined by using the weighted water displacement method (i.e., Archimedes Principle). For example, procedures defined by golf standard organizations and/or governing bodies such as the United States Golf Association (USGA) and/or the Royal and Ancient Golf Club of St. Andrews (R&A) may be used for measuring the club head volume of the golf club head **3300**. Although FIG. **33** may depict a particular type of club head (e.g., a driver-type club head), the apparatus, methods, and articles of manufacture described herein may be applicable to other types of club head (e.g., a fairway wood-type club head, a hybrid-type club head, an iron-type club head, a putter-type club head, etc.). The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

Each of the first set of weight portions **3410**, generally shown as **3605**, **3610**, **3615**, and **3620** may be associated with a first mass. Each of the second set of weight portions **3420**, generally shown as **3640**, **3645**, **3650**, **3655**, **3660**, **3665**, and **3670** may be associated with a second mass. The first mass may be greater than the second mass or vice versa. In one example, the first set of weight portions **3410** may be made of a tungsten-based material whereas the second set of weight portions **3420** may be made of an aluminum-based material. The first and second set of weight portions **3410** and **3420**, respectively, may provide various weight configurations for the golf club head **3300** that may be similar to the various weight configurations for the golf club head **100** as described in detail herein. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

Referring to FIG. **38**, for example, the bottom portion **3340** of the body portion **3310** may include a plurality of weight ports **3800**. The plurality of weight ports **3800**, generally shown as **3805**, **3810**, **3815**, **3820**, **3840**, **3845**, **3850**, **3855**, **3860**, **3865**, and **3870** may be located on and/or along a periphery of the weight port region **3440** of the bottom portion **3340**. Each of the plurality of weight ports **3800** may be associated with a port diameter, which may be similar in many respects to the port diameters (D_{port}) of the weight ports **900** of the golf club head **100** (generally shown in FIG. **9**). For example, the port diameter of each weight port of the plurality of weight ports **3800** may be about 0.3 inch (7.65 millimeters). Alternatively, the port diameters of adjacent weight ports of the plurality of weigh ports **3800** may be different. Further, the plurality of weight ports **3800** may extend across the bottom portion **3340** similar to the configuration of the weight ports **900** of the golf club head **100** as described in detail herein. However, the configuration of the weight ports **3800** on the bottom portion **3340** may be different than the configuration of the weight ports **900** of the

golf club head **100**. For example, the distance between two adjacent weight ports **3800** may be less than or equal to the port diameter of any of the two adjacent weight ports, which may be similar to the weight ports **900** of the golf club head **100**. However, in another example, the distance between two adjacent weight ports **3800** may be greater than the port diameter of any of two adjacent weight ports. In another example, the distance between two adjacent weight ports of some of the weight ports **3800** may be less than or equal to the port diameter of any of the two adjacent weight ports, while the distance between two adjacent weight ports of some of the other weight ports **3800** may be greater than the port diameter of any of the two adjacent weight ports. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

The plurality of weight ports **3800** may be formed on the bottom portion **3340** similar to the formation of the weight ports **900** of the golf club head **100**. For example, a center axis of each of the weight ports **3800** may be perpendicular or substantially perpendicular to a plane tangent to an outer surface curve **3340** (e.g., contour of the bottom portion **3340**) at the point of intersection of the center axis and the outer surface curve as described in detail herein with respect to the golf club head **100**. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

The plurality of weight portions **3320** may have similar or different physical properties (e.g., density, shape, mass, volume, size, color, etc.). The weight portions **3320** may be similar in many respects to the weight portions **120** of the golf club head **100** as described herein. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

In one example shown in FIGS. **33-42**, the bottom portion **3340** may include an outer surface **3342** and an inner surface **3344**. Each of the outer surface **3342** and the inner surface **3344** may include one or a plurality of support portions, generally shown as **4110**, **4120**, **4140**. The outer surface **3342** may include at least one outer support portion **4110** and the inner surface **3344** may include a first set of inner support portions **4120** (generally shown as inner support portions **4123**, **4124**, **4125**, **4126**, and **4127**), and a second set of inner support portions **4140** (generally shown as inner support portions **4144**, **4145**, **4146**, **4147** and **4148**). The first set of inner support portions **4120** and the second set of inner support portions **4140** may be located at any one location or multiple locations on the body portion **3310**. As illustrated in FIGS. **41** and **42**, the first set of inner support portions **4120** and the second set of inner support portions **4140** are closer to the heel portion **3350** than to the toe portion **3340**. For example, the first set of inner support portions **4120** and the second set of inner support portions **4140** may be located on the bottom portion **3340** between a midpoint of the body portion **3310** and the heel portion **3350**. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

The outer support portion **4110** may be positioned on the bottom portion **3340** and/or the skirt portion **3390** between any of the weight ports **3800** and/or a periphery of the body portion **3310** as defined by the toe portion **3350**, the heel portion **3360**, the front portion **3370**, and the rear portion **3380**. However, the outer support portion **4110** may be positioned at any location on the golf club head **3300** for structural support of the golf club head **3310**. In one example shown in FIGS. **33-42**, the outer support portion **4110** may be defined by a groove or indentation that extends on the bottom portion **3340** and/or the skirt portion **3390** from the rear portion **3380** toward and/or to the toe portion **3350** proximate to a periphery of the body portion **3310**. The outer support portion **4110** may have any configuration. As illustrated in FIG. **41**, a width of the outer support portion **4110** may increase from the rear portion **3380** toward and/or to the toe portion **3350** while the outer support portion **4110** may follow a contour of the periphery of the body portion **3310** between the rear portion **3380** and the toe portion **3350**. Accordingly, the outer support portion **4110** may resemble a curved triangular groove on the bottom portion **3340**. The depth of the outer support portion **4110** may also vary. Further, the depth of the outer support portions **4110** may be determined based on the thickness of the bottom portion **3340** and the material from which the bottom portion **3340** may be formed. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

Each inner support portion of the first set of inner support portions **4120** may include walls, ribs and/or any projection from the inner surface **3344** of the bottom portion **3340**. Each inner support portion of the first set of inner support portions **4120** may extend from one or more of the weight ports **3800** and connect two or more adjacent and/or non-adjacent weight ports **3800**. As shown in FIG. **41**, for example, the inner support portion **4123** may include a wall projecting from the inner surface **3344** of the bottom portion **3340** and connecting the weight ports **3815** and **3820**. Similarly, each pair of adjacent weight ports **3815** and **3820**, **3820** and **3840**, **3840** and **3845**, **3845** and **3850**, and **3850** and **3815** may be connected by inner support portions **4123**, **4124**, **4125**, **4126**, and **4127**, respectively. Accordingly, the inner support portions **4123** through **4127** of the first set of inner support portions **4120** may define a loop-shaped support region **4150** on the inner surface **3344** of the bottom portion **3340**. The loop-shaped support region **4150** may be closer to the heel portion **3350** than to the toe portion **3340**. Referring to FIGS. **41** and **42**, for example, the loop-shaped support region **4150** may be located between a midpoint of the body portion **3310** and the heel portion **3350**. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

Each inner support portion of the second set of inner support portions **4140** may include walls, ribs and/or any projections on the inner surface **3344** of the bottom portion **3340**. Each inner support portion of the second set of inner support portions **4140** may extend from one or more of the weight ports **3800** toward the periphery and/or the skirt portion **3390** of the body portion **3310**. Turning back to FIG. **41**, for example, the inner support portion **4144** may include a wall connected to the weight port **3850** and extending from the weight port **3850** toward and/or to the rear portion **3380**. The inner support portion **4145** may include a wall connected to the weight port **3845** and extending from the weight port **3845** toward and/or to the heel portion **3360**. The inner support portion **4146** may include a wall connected to the weight port **3840** and extending from the weight port **3840** toward and/or to the heel portion **3360**. The inner support portion **4147** may include a wall connected to the weight port **3820** and extending from the weight port **3820** toward and/or to the heel portion **3360**. The inner support portion **4148** may include a wall connected to the weight port **3815** and extending from the weight port **3815** toward and/or to the front portion **3370**. The length, height, thickness, orientation angle, and/or cross-sectional configuration of each of the inner support portions **4144**, **4145**, **4146**, **4147** and **4148** may be configured such that the inner support portions **4144**, **4145**, **4146**, **4147** and **4148** may provide or substantially provide structural support to the bottom por-

tion **3340**, the skirt portion **3390**, the heel portion **3360**, the front portion **3370** and/or the rear portion **3380**. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

The first set of inner support portions **4120** may structurally support the bottom portion **3340** by distributing the impact loads exerted on the bottom portion **3340** throughout the bottom portion **3340** when the golf club head **100** strikes a golf ball (not shown). The second set of inner support portions **4140** may further distribute the impact loads throughout the bottom portion **3340**, the skirt portion **3390**, toe portion **3350**, the heel portion **3360**, the front portion **3370**, and/or the rear portion **3380**. In one example, the second set of inner support portions **4140** may include additional walls, ribs and/or projections (not shown) that connect to any of the weight ports to further distribute impact loads throughout the body portion **3310**. While the above examples may depict a particular number of inner support portions, the bottom portion **3340** may include more or less inner support portions. For example, the bottom portion **3340** may include a plurality of inner support portions (not shown) that connect non-adjacent weight ports **3800** (e.g., weight ports **3815** and **3840**) and/or the second set of inner support portions **4140**. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

The width (i.e., thickness), length, height, orientation angle, and/or cross-sectional shape of each inner support portion of the first set of inner support portions **4120** and/or the second set of inner support portions **4140** may be similar or vary and be configured to provide structural support to the golf club head **3300**. For example, the materials from which the bottom portion **3340** and/or the body portion **3310** may be constructed may determine the width, length, height, orientation angle, and/or cross-sectional shape of each of the inner support portions of the first set of inner support portions **4120** and/or the second set of inner support portions **4140**. For example, the inner support portions of the first set of inner support portions **4120** and/or the second set of inner support portions **4140** may be defined by walls with rectangular cross sections having heights that are similar to the depths of the weight portions **3800**. The length of each inner support portion of the second set of inner support portions **4140** may be configured such that one or more of the inner support portions of the second set of inner support portions **4140** extend from the bottom portion **3340** to the skirt portion **3390**. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

Any of the golf club heads described herein may have different configurations of outer support portions and/or inner support portions to provide structural support for the golf club head during impact with a golf ball depending on the size, thickness, materials of construction and/or other characteristics of any portions and/or parts of the golf club head. The different configurations of the outer support portions and/or inner support portions may affect vibration, dampening, and/or noise characteristics of the golf club head when striking a golf ball. Further, the different configurations of the outer support portions and/or the inner support portions may provide structural support to portions of the golf club head that may require additional structural support. For example, a golf club head as described herein may include more inner support portions in addition to the first set of inner support portions and the second set of inner support portions as described herein. For example, a golf club head as described herein may include fewer inner support portions than the first set of inner support portions and the second set of inner support portions as described herein. For example, FIG. **43** shows another example of the golf club head **2300** with a different configuration of the first set of inner support portions **3120**. In the example of FIG. **43**, the inner surface **2344** may include a first set of inner support portions **3120** (generally shown as inner support portions **3121**, **3122**, **3123**, **3124**, **3125**, **3126**, **3127**, **3128**, **3129**, **3130** and **3131**), and a second set of inner support portions **3140** (generally shown as inner support portions **3141**, **3142**, **3143**, **3144**, **3145**, and **3146**). Accordingly, the golf club head **2300** of FIG. **43** may be similar to the golf club head **2300** of FIG. **31**, except that the golf club head **2300** of FIG. **43** does not include the inner support portions **3132** and **3133**. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

In addition to any of the golf club heads described herein having different configurations of outer support portions and/or inner support portions, any of the golf club heads described herein may have different configurations of weight ports in combination with different configurations of the outer support portions and/or the inner support portions. The different configurations of the weight ports may affect the weight distribution of the golf club head. The different configurations of the outer support portions and/or inner support portions may affect stiffness, vibration, dampening, and/or noise characteristics of the golf club head when striking a golf ball. Further, the different configurations of the outer support portions and/or the inner support portions may provide structural support to portions of the golf club head that may require additional structural support. For example, a golf club head as described herein may include more or less weight ports than some of the example golf club heads described herein. For example, a golf club head as described herein may include more inner support portions in addition to the first set of inner support portions and the second set of inner support portions as described herein. For example, a golf club head as described herein may include fewer inner support portions than the first set of inner support portions and the second set of inner support portions as described herein. FIG. **44** shows another example of the golf club head **2300** with a different configuration of the weight ports **2800**, different configuration of the first set of inner support portions **3120**, and different configuration of the second set of inner support portions **3140**. In the example of FIG. **44**, the bottom portion **2340** may include a plurality of weight ports **2800**, which are generally shown as **2805**, **2810**, **2815**, **2820**, **2845**, **2850**, **2855**, **2860**, and **2865**. Accordingly, the golf club head **2300** of FIG. **44** is similar to the golf club head **2300** of FIG. **31**, except that the golf club head **2300** of FIG. **44** may not include weight ports **2840** and **2870**. Also, in the example of FIG. **44**, the inner surface **2344** of the bottom portion **2340** may include a first set of inner support portions **3120** (generally shown as inner support portions **3121**, **3122**, **3123**, **3126**, **3127**, **3128**, and **3129**), and a second set of inner support portions **3140** (generally shown as inner support portions **3141**, **3143**, **3144**, **3145**, and **3146**). Accordingly, the golf club head **2300** of FIG. **44** may be similar to the golf club head **2300** of FIG. **31**, except that the golf club head **2300** of FIG. **44** does not include the inner support portions **3124**, **3125**, **3130**, **3131**, **3132**, **3133** and **3142**. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

In one example shown in FIG. **45**, certain regions of the interior of the body portion **2310** of the golf club head **2300** may include an elastic polymer material or an elastomer material, which may be referred to herein as the filler

material. The filler material may dampen vibration, dampen noise, lower the center of gravity and/or provide a better feel and sound for the golf club head **2300** when striking a golf ball (not shown). According to one example, the triangular support region **3160** may be filled with the filler material. The filler material may extend from the inner surface **2344** of the bottom portion **2340** up to a height of any of the inner support portions **3122**, **3132** and/or **3133**. However, the filler material may extend below or above the height of any of the inner support portions **3122**, **3132** and/or **3133**. Further, the thickness of the filler material, which may be defined as the distance the filler material extends from the inner surface **2344** of the bottom portion **2340**, may vary. In one example, the thickness of the filler material may be greater around a center portion of the triangular support region **3160** than the sides of the triangular support region **3160**. In another example, the thickness of the filler material may be less around a center portion of the triangular support region **3160** than the sides of the triangular support region **3160**. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

According to another example, a support region **3161** defined by the inner support portions **3128**, **3129**, **3130**, **3131** and **3132** may be filled with the filler material. The filler material may extend from the inner surface **2344** of the bottom portion **2340** up to a height of any of the inner support portions **3128**, **3129**, **3130**, **3131** and/or **3132**. However, the filler material may extend below or above the height of any of the inner support portions **3128**, **3129**, **3130**, **3131** and/or **3132**. Further, the thickness of the filler material, which may be defined as the distance the filler material extends from the inner surface **2344** of the bottom portion **2340**, may vary. In one example, the thickness of the filler material may be greater around a center portion of the support region **3161** than the sides of the support region **3161**. In another example, the thickness of the filler material may be less around a center portion of the support region **3161** than the sides of the support region **3161**. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

According to another example, a support region **3162** defined by the inner support portions **3124**, **3125**, **3136**, **3127** and **3133** may be filled with the filler material. The filler material may extend from the inner surface **2344** of the bottom portion **2340** up to a height of any of the inner support portions **3124**, **3125**, **3136**, **3127** and **3133**. However, the filler material may extend below or above the height of any of the inner support portions **3128**, **3129**, **3130**, **3131** and/or **3132**. Further, the thickness of the filler material, which may be defined as the distance the filler material extends from the inner surface **2344** of the bottom portion **2340**, may vary. In one example, the thickness of the filler material may be greater around a center portion of the support region **3162** than the sides of the support region **3162**. In another example, the thickness of the filler material may be less around a center portion of the support region **3162** than the sides of the support region **3162**. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

According to one example, any one or a combination of the support regions **3160**, **3161** and/or **3162** may be filled with the filler material as described herein. In one example, only one support region (e.g., the support region **3160**) may be filled with the filler material as described herein. Alternatively, two or more support regions may be filled with the filler material as described herein. For example, all of the support regions **3160**, **3161** and **3162** may be filled with the filler material as shown in FIG. **45**. In another example, only the support regions **3161** and **3162** may be filled with the filler material as described herein. In yet another example, only the support regions **3160** and **3161** may be filled with the filler material as described herein. In yet another example, only the support regions **3160** and **3162** may be filled with the filler material as described herein. Although the figures may depict a particular number of support regions, the apparatus, methods, and articles of manufacture described herein may include more or less support regions. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

In one example shown in FIG. **46**, certain regions of the interior of the body portion **3310** of the golf club head **3300** may include the filler material, which may be an elastic polymer material or an elastomer material as described. The filler material may dampen vibration, dampen noise, lower the center of gravity and/or provide a better feel and sound for the golf club head **3300** when striking a golf ball (not shown). According to one example, the support region **4150** may be filled with the filler material. The filler material may extend from the inner surface **3344** of the bottom portion **3340** up to a height of any of the inner support portions **4123**, **4124**, **4125**, **4126** and/or **4127**. However, the filler material may extend below or above the height of any of the inner support portions **4123**, **4124**, **4125**, **4126** and/or **4127**. Further, the thickness of the filler material, which may be defined as the distance the filler material extends from the inner surface **2344** of the bottom portion **2340**, may vary. In one example, the thickness of the filler material may be greater around a center portion of the support region **4150** than the sides of the support region **4150**. In another example, the thickness of the filler material may be less around a center portion of the support region **4150** than the sides of the support region **4150**. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

Any of the golf club heads described herein may have one or more interior regions that may include a filler material as described. In one example, the filler material be injected into a region of the golf club head from one or more ports on the golf club head to cover or fill the region. The one or more ports that may be used to inject the filler material may be one or more of the weight ports described herein. Accordingly, the filler material may be molded to the shape of the region in which the filler material is injected to cover or fill the region. Alternatively, one or more inserts may be formed from elastic polymer material or an elastomer material (i.e., filler material) and placed in one or more regions of the interior of golf club head. FIG. **47** shows an example of the golf club head **2300** of FIG. **44** with an insert **4750**, which may be constructed from an elastic polymer material or an elastomer material. The insert **4750** may be manufactured to have a similar shape as the shape of a region **4754** on the inner surface **2344** of the bottom portion **2340**. Accordingly, the insert **4750** may have a curvature similar to the curvature of the bottom portion **2340** at the region **4754** to lay generally flat and in contact with the inner surface **2344** of the bottom portion **2340**, have a shape that may be similar to the shape of the region **4754** to be inserted in the region **4754** and generally fit within the region **4754**, and/or have a plurality of cutout portions **4756** to generally match the shape and/or contour of sidewall portions of each of the weight ports **2800**. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

The insert **4750** may have a thickness that may be similar to the height of any of the weight ports **2800**. Accordingly,

when the insert **4750** is in the region **4754**, the top portion of the insert **4750** at or proximate to the weight ports **2800** may be at the same height as the weight ports **2800**. However, the thickness of the insert **4750** may vary such that the thickness of the insert **4750** at any location of the insert **4750** may be more or less than the height of any of the weight ports **2800**. The insert **4750** may dampen vibration, dampen noise, lower the center of gravity and/or provide a better feel and sound for the golf club head **2300** of FIG. **47** when striking a golf ball (not shown). The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

The insert **4750** may be manufactured for use with any of the golf club heads described herein. As shown in FIG. **47**, the insert **4750** may include a plurality of cutout portions **4756** that may generally match the shape of the outer wall portions of the weight ports **2800**. The insert **4750** shown in FIG. **47** further includes cutout portions **4758** and **4759**. Referring back to FIG. **43**, when the insert **4750** is used with the golf club head **2300** of FIG. **43**, the cut out portions **4758** and **4759** may generally match the shape of the outer wall portions of the weigh ports **2870** and **2840**, respectively. Accordingly, the insert **4750** can be used in both the golf club head **2300** of FIG. **43** and the golf club head **2300** of FIG. **44**.

Referring back to FIG. **31**, the insert **4750** may include channels, grooves or slots (not shown) that may be sized and shaped to receive the inner support portions **3132** and **3133** therein. Accordingly, an insert **4750** may be manufactured with the described channels, grooves or slot for use with the golf club heads **2300** of FIG. **31**, FIG. **43** and FIG. **44**. Alternatively, one or more inserts may be manufactured that may only fit one of the golf club heads described herein. For example, each of the golf club heads described herein may include one or more inserts that may have a certain shape for fitting only within one or more regions in the golf club head. Referring back to FIG. **31**, for example, the golf club head **2300** may include a first insert (not shown) for fitting in the support region **3161**, a second insert (not shown) for fitting in the triangular support region **3160**, and a third insert (not shown) for fitting in the support region **3162**. Referring back to FIG. **41**, for example, the golf club head **3300** may include an insert (not shown) for fitting in the support region **4150**. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

Any of the inserts described herein may be manufactured from an elastic polymer material as a one-piece continuous part. In the example of FIG. **47**, the insert **4750** may be a one-piece continuous part without any recesses and/or holes. Referring to FIG. **48** illustrates an insert **4850** that is similar in many respects to the insert **4750**. Accordingly, in one example, the insert **4850** may be manufactured to have a similar shape as the shape of the region **4754** on the inner surface **2344** of the bottom portion **2340** of the golf club head **23** of FIG. **47** and further include a plurality of cutout portions **4856** as described herein. The insert **4850** further includes a plurality of holes **4862** that may reduce the weight of the insert **4850**. The insert **4850** may include any number of holes **4862** arranged in any configuration on the insert **4850**. In the example of FIG. **48**, the insert **4850** includes a plurality of hexagonal holes **4862** that extend through the thickness of the insert **4850** and are arranged on the insert **4850** similar to a honeycomb pattern. The holes **4862** may have any shape or spacing. Although the above example may describe holes having a particular shape, the apparatus, methods, and articles of manufacture described herein may include holes of other suitable shapes (e.g., circular, triangular, octagonal, or other suitable geometric shape). Further, the openings may be similar or different in shape, size and or arrangement on the insert **4850**. In one example, the insert **4850** may include a plurality of round holes (not shown). In another example, the insert **4850** may include a plurality of slots, grooves and/or slits (not shown). In yet another example, the insert **4850** may include recesses (not shown) instead of holes that do not extend through the insert **4850**. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

The filler material may be an elastic polymer or elastomer material (e.g., a viscoelastic urethane polymer material such as Sorbothane® material manufactured by Sorbothane, Inc., Kent, Ohio), a thermoplastic elastomer material (TPE), a thermoplastic polyurethane material (TPU), and/or other suitable types of materials to absorb shock, isolate vibration, and/or dampen noise. In another example, the filler material may be a high density ethylene copolymer ionomer, a fatty acid modified ethylene copolymer ionomer, a highly amorphous ethylene copolymer ionomer, an ionomer of ethylene acid acrylate terpolymer, an ethylene copolymer comprising a magnesium ionomer, an injection moldable ethylene copolymer that may be used in conventional injection molding equipment to create various shapes, an ethylene copolymer that can be used in conventional extrusion equipment to create various shapes, and/or an ethylene copolymer having high compression and low resilience similar to thermoset polybutadiene rubbers. For example, the ethylene copolymer may include any of the ethylene copolymers associated with DuPont™ High-Performance Resin (HPF) family of materials (e.g., DuPont™ HPF AD1172, DuPont™ HPF AD1035, DuPont® HPF 1000 and DuPont™ HPF 2000), which are manufactured by E.I. du Pont de Nemours and Company of Wilmington, Del. The DuPont™ HPF family of ethylene copolymers are injection moldable and may be used with conventional injection molding equipment and molds, provide low compression, and provide high resilience. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

The filler material including any of the inserts that may be manufactured from the filler material as described herein may be bonded, attached and/or connected to any of the golf club heads described herein by a bonding portion (not shown) to improve adhesion and/or mitigate delamination between the body portion of any of the golf club heads described herein and the filler material. The bonding portion may be a bonding agent, an epoxy, a combination of bonding agents, a bonding structure or attachment device, a combination of bonding structures and/or attachment devices, and/or a combination of one or more bonding agents, one or more bonding structures and/or one or more attachment devices. In one example, the bonding portion may be low-viscosity, organic, solvent-based solutions and/or dispersions of polymers and other reactive chemicals such as MEGUM™, ROBOND™, and/or THIXON™ materials manufactured by the Dow Chemical Company, Auburn Hills, Mich. In another example, the bonding portion may be LOCTITE® materials manufactured by Henkel Corporation, Rocky Hill, Conn. The apparatus, methods, and articles of manufacture are not limited in this regard.

Turning to FIGS. **49** and **50**, for example, the golf club head **2300** may include a hosel assembly **4900** with a hosel **4902**, a hosel sleeve **4904**, and a fastener **4908**. In one example, the hosel **4902** may extend outward from the top portion **2330** and does not extend into the body portion **2310**. The hosel **4902** may be configured to receive the hosel sleeve **4904** such that a portion of the hosel sleeve **4904** may

located inside the body portion **2310** as shown in FIG. **49**. The hosel sleeve **4904** may include an outer wall **4905** and a ferrule portion **4906**. The outer wall **4905** of the portion of the hosel sleeve **4904** inside the body portion **2310** may be exposed to the interior space or the hollow space of the body portion **2310**. In other words, as shown in FIG. **50**, the hosel **4902** does not extend into the body portion **2310** and the body portion **2310** does not include any structure to surround or cover the hose sleeve **4904**. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

The hosel sleeve **4904** may be attached to the hosel **4902** and/or the body portion **2310** by one or more fasteners, one or more adhesives, welding, one or more mechanical locking mechanisms, and/or a combination thereof. In one example shown in FIG. **49**, the hosel sleeve **4904** may be fixed to the body portion by the fastener **4908**, which may be a threaded fastener such as a bolt. The hosel sleeve **4904** may include a first end configured to receive a shaft (not shown) and a second end **4912** having a threaded bore **4914**. The bottom portion **2340** may include an opening **4916** configured to receive the fastener **4908**. The opening **4916** may be generally axially aligned with the threaded bore **4914** at the second end **4912** of the hosel sleeve **4904** when the hosel sleeve **4904** is inserted into the hollow body portion **2310** through the hosel **4902** as shown in FIG. **49**. The fastener **4908** may be inserted into the opening **4916** and threaded into the threaded bore **4914** of the hosel sleeve **4904** to fasten the hosel sleeve **4904** to the hosel **4902** and/or to the body portion **2310**. A shaft (not shown) may then be inserted and affixed in the hosel sleeve **4904**. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

The terms "and" and "or" may have both conjunctive and disjunctive meanings. The terms "a" and "an" are defined as one or more unless this disclosure indicates otherwise. The term "coupled" and any variation thereof refer to directly or indirectly connecting two or more elements chemically, mechanically, and/or otherwise. The phrase "removably connected" is defined such that two elements that are "removably connected" may be separated from each other without breaking or destroying the utility of either element.

The term "substantially" when used to describe a characteristic, parameter, property, or value of an element may represent deviations or variations that do not diminish the characteristic, parameter, property, or value that the element may be intended to provide. Deviations or variations in a characteristic, parameter, property, or value of an element may be based on, for example, tolerances, measurement errors, measurement accuracy limitations and other factors. The term "proximate" is synonymous with terms such as "adjacent," "close," "immediate," "nearby", "neighboring", etc., and such terms may be used interchangeably as appearing in this disclosure.

The apparatus, methods, and articles of manufacture described herein may be implemented in a variety of embodiments, and the foregoing description of some of these embodiments does not necessarily represent a complete description of all possible embodiments. Instead, the description of the drawings, and the drawings themselves, disclose at least one embodiment, and may disclosure alternative embodiments.

As the rules of golf may change from time to time (e.g., new regulations may be adopted or old rules may be eliminated or modified by golf standard organizations and/or governing bodies such as the USGA, the R&A, etc.), golf equipment related to the apparatus, methods, and articles of manufacture described herein may be conforming or non-conforming to the rules of golf at any particular time. Accordingly, golf equipment related to the apparatus, methods, and articles of manufacture described herein may be advertised, offered for sale, and/or sold as conforming or non-conforming golf equipment. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

Further, while the above examples may be described with respect to golf clubs, the apparatus, methods and articles of manufacture described herein may be applicable to other suitable types of sports equipment such as a fishing pole, a hockey stick, a ski pole, a tennis racket, etc.

Although certain example apparatus, methods, and articles of manufacture have been described herein, the scope of coverage of this disclosure is not limited thereto. On the contrary, this disclosure covers all apparatus, methods, and articles of articles of manufacture fairly falling within the scope of the appended claims either literally or under the doctrine of equivalents.

What is claimed is:

1. A golf club head comprising:

a hollow body portion having a front portion, a rear portion, a toe portion, a heel portion, a top portion, and a bottom portion having an inner surface and an outer surface;

a plurality of ports extending from the outer surface of the bottom portion into the hollow body portion; and

a plurality of inner support portions extending from the inner surface of the bottom portion into the hollow body portion, the plurality of inner support portions including a first set of inner support portions and a second set of inner support portions, each inner support portion of the first set of inner support portions connected to two ports of the plurality of ports, and each inner support portion of the second set of inner support portions extending from a corresponding port of the plurality of ports toward a periphery of the hollow body portion,

wherein at least a portion of the hollow body portion between two or more of the plurality of inner support portions includes an elastic polymer material.

2. A golf club head as defined in claim **1**, wherein the portion of the hollow body portion between the two or more of the plurality of inner support portions is filled with an elastic polymer material.

3. A golf club head as defined in claim **1**, wherein the portion of the hollow body portion between the two or more of the plurality of inner support portions includes an insert comprising an elastic polymer material.

4. A golf club head as defined in claim **1** further comprising an outer support portion extending on the outer surface of the bottom portion between the front portion and the rear portion near the toe portion.

5. A golf club head as defined in claim **1**, wherein each inner support portion of the first set of inner support portions extends between corresponding adjacent ports of the plurality of ports.

6. A golf club head as defined in claim **1**, further comprising a hosel assembly comprising a hosel on the top portion, and a hosel sleeve extending from the hosel into the hollow body portion, the sleeve having an outer wall, wherein the outer wall of the portion of the sleeve that is in the hollow body portion is exposed to the hollow interior of the hollow body portion.

7. A golf club head as defined in claim **1** further comprising a plurality of weight portions, each port of the

plurality of ports configured to receive a weight portion of the plurality of weight portions.

8. A golf club head comprising:

a hollow body portion having a front portion, a rear portion, a toe portion, a heel portion, a top portion, and a bottom portion having an inner surface and an outer surface;

a plurality of weight portions;

a plurality of ports extending from the outer surface of the bottom portion into the hollow body portion, each port of the plurality of ports configured to receive a weight portion of the plurality of weight portions;

a plurality of inner support portions extending from the inner surface of the bottom portion into the hollow body portion;

an outer support portion extending on the outer surface of the bottom portion between the front portion and the rear portion near the toe portion; and

an elastic polymer material in the hollow body portion in contact with the inner surface of the bottom portion and extending from the inner surface of the bottom portion into the hollow body portion,

wherein at least a portion of the hollow body portion between two or more of the plurality of inner support portions includes the elastic polymer material.

9. A golf club head as defined in claim **8**, wherein the portion of the hollow body portion between the two or more of the plurality of inner support portions is filled with an elastic polymer material.

10. A golf club head as defined in claim **8**, wherein the portion of the hollow body portion between the two or more of the plurality of inner support portions includes an insert comprising an elastic polymer material.

11. A golf club head as defined in claim **8**, wherein the plurality of inner support portions further comprises a first set of inner support portions and a second set of inner support portions, and wherein each inner support portion of the first set of inner support portions extends between corresponding ports of the plurality of ports.

12. A golf club head as defined in claim **8**, wherein the plurality of inner support portions further comprises a first set of inner support portions and a second set of inner support portions, and wherein each inner support portion of the second set of inner support portions extends from a corresponding port of the plurality of ports toward a periphery of the hollow body portion.

13. A golf club head as defined in claim **8**, wherein the plurality of inner support portions further comprises a first set of inner support portions and a second set of inner support portions, and wherein each inner support portion of the first set of inner support portions extends between corresponding adjacent ports of the plurality of ports.

14. A golf club head as defined in claim **8** wherein the outer support portion is defined by an indentation in the bottom portion extending on the outer surface of the bottom portion between the front portion and the rear portion near the toe portion.

15. A golf club head comprising:

a hollow body portion having a front portion, a rear portion, a toe portion, a heel portion, a top portion, and a bottom portion;

a plurality of inner support portions in the hollow body portion; and

a plurality of ports extending from the bottom portion into the hollow body portion, each port of the plurality of ports being connected by an inner support portion of the plurality of inner support portions to another port of the plurality of ports, and at least a pair of nonadjacent ports of the plurality of ports being connected by an inner support portion of the plurality of inner support portions,

wherein at least a portion of the hollow body portion between two or more of the plurality of inner support portions includes an elastic polymer material.

16. A golf club head as defined in claim **15**, wherein the portion of the hollow body portion between the two or more of the plurality of inner support portions is filled with an elastic polymer material.

17. A golf club head as defined in claim **15**, wherein the portion of the hollow body portion between the two or more of the plurality of inner support portions includes an insert comprising an elastic polymer material.

18. A golf club head as defined in claim **15** further comprising an outer support portion defined by an indentation in the bottom portion extending on the outer surface of the bottom portion between the front portion and the rear portion near the toe portion.

19. A golf club head as defined in claim **15**, wherein the plurality of inner support portions further comprises inner support portions extending from corresponding ports of the plurality of ports toward a periphery of the hollow body portion.

20. A golf club head as defined in claim **15** further comprising a plurality of weight portions, each port of the plurality of ports configured to receive a weight portion of the plurality of weight portions.

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