US00RE48513E

(19) **United States**

(12) **Reissued Patent**

Piller et al.

(10) **Patent Number: US RE48,513 E**

(45) **Date of Reissued Patent: Apr. 13, 2021**

(54) **HOLE SAW**

(71) Applicant: **MILWAUKEE ELECTRIC TOOL CORPORATION**, Brookfield, WI (US)

(72) Inventors: **Geoffrey R. Piller**, Whitefish Bay, WI (US); **Jason M. Thom**, Wauwatosa, WI (US); **Ryan J. Malloy**, Milwaukee, WI (US); **Todd A. Taylor**, West Bend, WI (US)

(73) Assignee: **MILWAUKEE ELECTRIC TOOL CORPORATION**, Brookfield, WI (US)

(21) Appl. No.: **16/517,476**

(22) Filed: **Jul. 19, 2019**

Related U.S. Patent Documents

Reissue of:

(64) Patent No.: **10,086,445**
Issued: **Oct. 2, 2018**
Appl. No.: **15/407,005**
Filed: **Jan. 16, 2017**

U.S. Applications:

(63) Continuation of application No. 13/945,643, filed on Jul. 18, 2013, now Pat. No. 9,579,732.

(Continued)

(51) **Int. Cl.**
B23B 51/04 (2006.01)

(52) **U.S. Cl.**
CPC ***B23B 51/0406*** (2013.01); *B23B 2251/428* (2013.01); *B23B 2260/072* (2013.01); *B23B 2260/082* (2013.01); *Y10T 408/895* (2015.01)

(58) **Field of Classification Search**
CPC B23B 51/0406; B23B 2251/428; B23B 2260/072; B23B 2260/082; Y10T 408/895
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

118,806 A 9/1871 Lafferty et al.
308,842 A 12/1884 Hunt

(Continued)

FOREIGN PATENT DOCUMENTS

CN 2303698 1/1999
CN 201 799668 4/2011

(Continued)

OTHER PUBLICATIONS

Makita Industrial Power Tools, 1998-1999 General Catalog (1998) IS09002, p. 96.

(Continued)

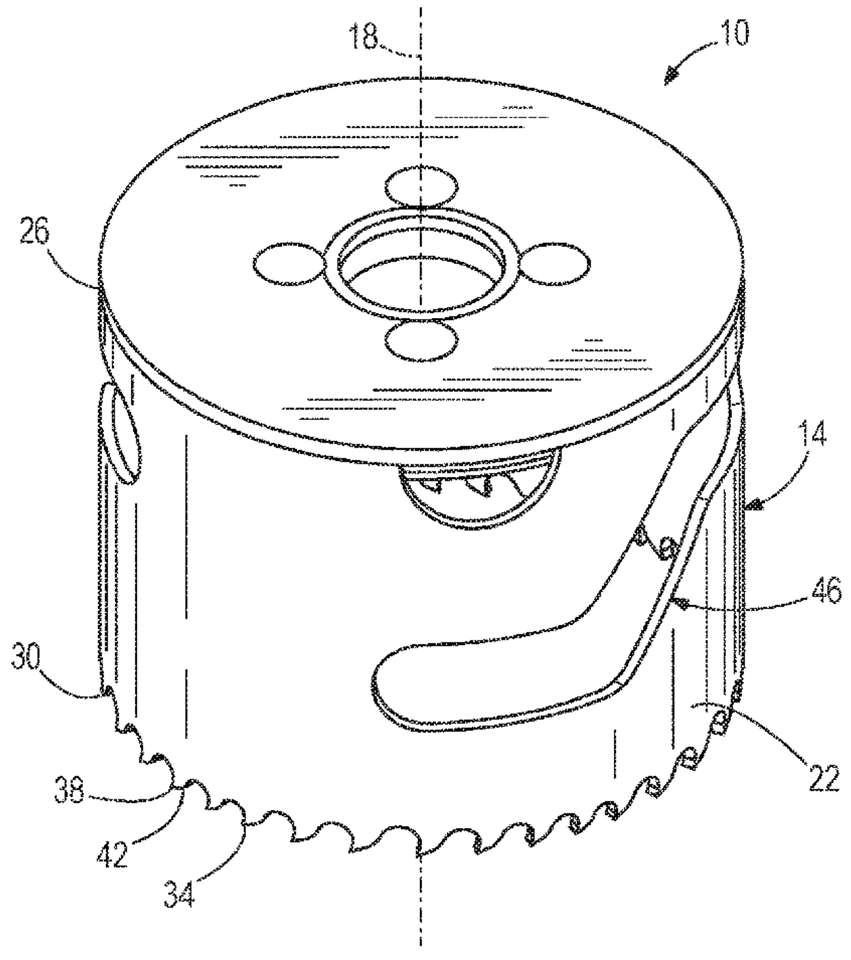
Primary Examiner — Joseph A Kaufman

(74) *Attorney, Agent, or Firm* — Morgan, Lewis & Bockius LLP

(57) **ABSTRACT**

A hole saw includes a cylindrical body disposed along an axis of rotation with a side wall extending axially from a cap end to a cutting end. The cutting end includes a plurality of cutting teeth. The hole saw also includes a cap coupled to the cap end of the cylindrical body. The side wall defines an elongated aperture configured to receive a tool for removing work piece plugs from within the cylindrical body. The elongated aperture has a first slot portion adjacent the cutting edge. The first slot portion is oriented perpendicular to the axis of rotation. The elongated aperture also has a second slot portion connected to the first slot portion and extending from the first slot portion toward the cap end. The second slot portion is oriented at an oblique angle relative to the axis of rotation.

20 Claims, 11 Drawing Sheets



Related U.S. Application Data

(60) Provisional application No. 61/673,124, filed on Jul. 18, 2012, provisional application No. 61/717,389, filed on Oct. 23, 2012, provisional application No. 61/784,172, filed on Mar. 14, 2013.

(56) References Cited

U.S. PATENT DOCUMENTS

2,015,339	A	9/1935	Ellingham
2,062,257	A	11/1936	Douglas et al.
2,237,901	A	4/1941	Chun
2,319,528	A	5/1943	Barbour et al.
2,349,400	A	5/1944	Wendell
2,412,433	A	12/1946	Taylor
2,427,085	A	9/1947	Allison
2,444,099	A	6/1948	Hennessey, Jr.
2,473,077	A	6/1949	Starbuck, Jr.
2,615,245	A	10/1952	Schaumleffel
2,662,428	A	12/1953	Mueller
2,754,864	A	7/1956	Elsy
2,800,812	A	7/1957	Mueller et al.
2,951,683	A	9/1960	Tilden
3,074,392	A	1/1963	Fisher
3,162,067	A	12/1964	Koons et al.
3,265,104	A	8/1966	Gallo, Sr.
3,331,455	A	7/1967	Anderson, Jr. et al.
3,374,696	A	3/1968	Trevathan
3,382,743	A	5/1968	Trevathan
3,494,348	A	2/1970	Lindblad
3,647,310	A	3/1972	Morse
3,778,179	A	12/1973	Rivas
3,824,026	A	7/1974	Gaskins
3,836,278	A	9/1974	McInnes
3,870,431	A	3/1975	Luckenbill et al.
3,920,350	A	11/1975	Southall
3,973,862	A	8/1976	Segal
3,976,387	A	8/1976	Segal
3,997,279	A	12/1976	Porter
4,072,441	A	2/1978	LaPointe
4,077,737	A	3/1978	Morse
4,078,458	A	3/1978	Berendzen
4,101,238	A	7/1978	Reibetanz et al.
4,147,464	A	4/1979	Watson et al.
4,148,593	A	4/1979	Clark
4,189,015	A	2/1980	Acker et al.
4,201,502	A	5/1980	Skendrovic
4,203,692	A	5/1980	Jensen
4,225,275	A	9/1980	Elliott
4,303,357	A	12/1981	Makar
4,330,229	A	5/1982	Croydon
D278,065	S	3/1985	Sydlowski et al.
4,527,449	A	7/1985	Sydlowski et al.
4,529,341	A	7/1985	Greene
D282,369	S	1/1986	de Villiers
4,565,471	A	1/1986	Negishi et al.
4,568,227	A	2/1986	Hogg
4,582,458	A	4/1986	Korb et al.
4,595,321	A	6/1986	Van Dalen
4,605,347	A	8/1986	Jodock et al.
4,741,651	A	5/1988	Despres
4,755,087	A	7/1988	Parent
4,759,667	A	7/1988	Brown
4,760,643	A	8/1988	Juma
D303,118	S	8/1989	Cox
4,906,146	A	5/1990	Bowling
4,961,674	A	10/1990	Wang et al.
4,968,189	A	11/1990	Pidgeon
4,968,193	A	11/1990	Chaconas et al.
5,007,777	A	4/1991	Itokazu
D317,455	S	6/1991	Martin
5,025,871	A	6/1991	Stewart et al.
5,049,010	A	9/1991	Oakes
5,061,126	A	10/1991	Cain et al.
D321,894	S	11/1991	Harris
5,069,584	A	12/1991	Obermeier et al.
5,076,741	A	12/1991	Litlehorn
5,096,341	A	3/1992	Despres
5,098,234	A	3/1992	Judkins et al.
5,115,796	A	5/1992	Schweickhardt
5,145,018	A	9/1992	Schimke et al.
5,171,111	A	12/1992	Kishimoto
D332,492	S	1/1993	Rosenberg et al.
D334,016	S	3/1993	Jonsson
5,205,685	A	4/1993	Herbert
D342,270	S	12/1993	Kwang
5,273,380	A	12/1993	Musacchia
5,288,183	A	2/1994	Chaconas et al.
5,291,806	A	3/1994	Bothum
5,316,416	A	5/1994	Kim
5,353,552	A	10/1994	Hemmings
5,392,759	A	2/1995	Kwang
5,415,504	A	5/1995	Wolf et al.
5,435,672	A	7/1995	Hall et al.
5,451,128	A	9/1995	Hattersley
D363,294	S	10/1995	Ellis
5,466,100	A	11/1995	Ahluwalia
D372,485	S	8/1996	Stone et al.
5,556,399	A	9/1996	Huebner
D376,809	S	12/1996	Stone et al.
5,649,796	A	7/1997	Durney
5,651,646	A	7/1997	Banke et al.
5,690,452	A	11/1997	Baublits
5,700,113	A	12/1997	Stone et al.
D391,974	S	3/1998	Brutscher
D392,297	S	3/1998	Brutscher
D394,663	S	5/1998	Stone et al.
5,762,498	A	6/1998	Gonzalez
5,803,677	A	9/1998	Brutscher et al.
5,810,524	A	9/1998	Wirth, Jr. et al.
5,816,754	A	10/1998	Shallenberger
5,842,820	A	12/1998	Lee et al.
5,888,036	A	3/1999	Arai et al.
D408,424	S	4/1999	Schmotzer
5,904,454	A	5/1999	Washer
5,931,615	A	8/1999	Wiker
5,934,845	A	8/1999	Frey
5,980,169	A	11/1999	Hinch
6,007,279	A	12/1999	Malone, Jr.
D419,576	S	1/2000	Burcher et al.
6,036,410	A	3/2000	Shun'ko
6,050,754	A	4/2000	Thomas
6,113,321	A	9/2000	Mulroy et al.
6,126,367	A	10/2000	Reed
6,152,815	A	11/2000	Meerdink et al.
6,167,792	B1	1/2001	Korb et al.
D438,219	S	2/2001	Brutscher
6,190,097	B1	2/2001	Thomas
6,206,616	B1	3/2001	Smith et al.
6,267,542	B1	7/2001	Salmon
6,269,722	B1	8/2001	Hellbergh
6,273,652	B1	8/2001	Wirth, Jr. et al.
D447,495	S	9/2001	Strobel et al.
6,341,925	B1	1/2002	Despres
D455,446	S	4/2002	Collins
6,409,436	B1	6/2002	Despres
6,419,428	B2	7/2002	Ajimi et al.
6,428,250	B2	8/2002	Giebmanns
6,431,289	B1	8/2002	Potter et al.
6,443,674	B1	9/2002	Jaconi
6,588,310	B2	7/2003	Lee et al.
6,588,992	B2	7/2003	Rudolph
6,599,063	B1	7/2003	Capstran
D478,105	S	8/2003	Morton et al.
D478,106	S	8/2003	Morton et al.
D478,339	S	8/2003	Morton et al.
D478,919	S	8/2003	Morton et al.
6,619,413	B2	9/2003	Hamilton et al.
6,641,338	B2	11/2003	Despres
6,641,395	B2	11/2003	Kumar et al.
6,652,203	B1	11/2003	Risen, Jr.
6,676,342	B2	1/2004	Mast et al.
6,676,711	B2	1/2004	Omi
6,698,981	B1	3/2004	Beno et al.
6,705,807	B1	3/2004	Rudolph et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,746,187	B2	6/2004	Alm	
6,786,684	B1	9/2004	Ecker	
D497,547	S	10/2004	Kumakura et al.	
6,817,428	B1	11/2004	Miyanaga	
6,817,936	B1 *	11/2004	Skeem	B23D 61/18 125/13.01
6,820,519	B2	11/2004	Lefebvre	
6,857,831	B2	2/2005	Davis	
6,857,832	B2	2/2005	Nygard	
6,863,529	B2	3/2005	Strong et al.	
D504,446	S	4/2005	Kobayashi	
6,884,245	B2	4/2005	Spranza, III	
6,890,133	B2	5/2005	Singh et al.	
6,893,194	B2	5/2005	Jones et al.	
D507,585	S	7/2005	Held	
6,939,092	B2	9/2005	Korb et al.	
6,945,414	B1	9/2005	Stevens et al.	
6,945,850	B2	9/2005	Perrey	
6,948,574	B2	9/2005	Cramer et al.	
6,988,859	B2	1/2006	Borschert et al.	
7,001,116	B2	2/2006	Kozak	
D516,594	S	3/2006	Morton	
7,017,465	B2	3/2006	Dion et al.	
7,018,143	B2	3/2006	Moore	
D519,531	S	4/2006	Kobashi	
D523,398	S	6/2006	Ellis	
D526,670	S	8/2006	Ibey	
7,112,016	B2	9/2006	Nordlin	
D529,525	S	10/2006	Waldron et al.	
7,127,923	B2	10/2006	Biederman et al.	
7,140,451	B2	11/2006	Yoshimizu et al.	
7,160,064	B2	1/2007	Jasso	
7,175,372	B2	2/2007	Davis	
7,201,543	B2	4/2007	Muhlfriedel et al.	
D544,892	S	6/2007	Watson et al.	
7,237,291	B2	7/2007	Redford	
7,237,984	B1	7/2007	Guzda et al.	
7,237,986	B2	7/2007	Anjanappa et al.	
7,246,975	B2	7/2007	Corso et al.	
D551,269	S	9/2007	Burke, III	
7,264,428	B2	9/2007	Cossette	
7,267,514	B2	9/2007	Wetzl et al.	
7,275,898	B2	10/2007	Malagnino et al.	
7,306,411	B2	12/2007	Mabuchi et al.	
D559,874	S	1/2008	Kobayashi	
D560,699	S	1/2008	Omi	
D571,835	S	6/2008	Concari et al.	
D573,165	S	7/2008	Grundvig	
D575,808	S	8/2008	Zeiler et al.	
7,438,509	B1	10/2008	Wong et al.	
D580,462	S	11/2008	Liao et al.	
7,476,067	B2	1/2009	Borschert et al.	
D585,919	S	2/2009	Cantlon	
D585,920	S	2/2009	Liao et al.	
7,488,146	B2	2/2009	Brunson	
D588,175	S	3/2009	Morton	
D588,884	S	3/2009	Burke, III	
7,513,718	B1	4/2009	Arnold	
7,520,703	B2	4/2009	Rompel	
7,556,459	B2	7/2009	Rompel	
7,637,703	B2	12/2009	Khangar et al.	
D608,801	S	1/2010	Evatt et al.	
D608,802	S	1/2010	Ibarra et al.	
7,658,136	B2	2/2010	Rompel et al.	
7,658,576	B1	2/2010	Buzdum et al.	
7,661,913	B2	2/2010	Nordlin	
7,665,935	B1	2/2010	Garrick et al.	
7,674,078	B1	3/2010	Buzdum et al.	
D615,839	S	5/2010	Richter et al.	
7,766,583	B2	8/2010	Kozak	
7,824,137	B2	11/2010	Vasudeva et al.	
7,850,405	B2	12/2010	Keightley	
D630,656	S	1/2011	Lambert et al.	
7,871,224	B2	1/2011	Dost et al.	
7,892,235	B2	2/2011	Ellis	
D634,343	S	3/2011	Burke, III	
7,913,601	B2	3/2011	Petts et al.	
7,934,893	B2	5/2011	Gillissen	
7,938,600	B1	5/2011	Griep et al.	
7,959,371	B2	6/2011	Keightley	
7,967,535	B2	6/2011	Eiserer et al.	
7,988,389	B2	8/2011	Miebach	
8,042,613	B2	10/2011	Hallundbaek et al.	
D659,176	S	5/2012	Novak et al.	
D664,574	S	7/2012	Burke, III	
8,328,474	B2	12/2012	Pangerc et al.	
8,328,476	B2	12/2012	O'Keefe et al.	
D687,472	S	8/2013	Novak et al.	
D690,334	S	9/2013	Zielonka et al.	
D692,470	S	10/2013	Novak et al.	
8,573,907	B2	11/2013	Kalomeris et al.	
8,579,554	B2	11/2013	Novak et al.	
8,646,601	B2	2/2014	Green et al.	
D701,544	S	3/2014	Novak et al.	
D706,845	S	6/2014	Richter	
D708,650	S	7/2014	Richter	
D711,441	S	8/2014	Novak et al.	
2002/0037201	A1	3/2002	Despres	
2003/0103822	A1	6/2003	Wirth et al.	
2003/0133765	A1	7/2003	Capriotti	
2003/0146024	A1	8/2003	Cramer et al.	
2003/0177645	A1	9/2003	Flury et al.	
2004/0179911	A1	9/2004	Keightlev	
2005/0031422	A1	2/2005	Tseng	
2005/0105981	A1	5/2005	Byrley et al.	
2006/0016315	A1	1/2006	Zorich et al.	
2007/0020056	A1	1/2007	Burdick	
2007/0059113	A1	3/2007	Capstran	
2007/0160435	A1	7/2007	Chao	
2008/0166195	A1	7/2008	Gentry et al.	
2008/0187405	A1	8/2008	Nordlin	
2009/0035082	A1	2/2009	Singh	
2009/0044674	A1	2/2009	Neitzell	
2009/0216235	A1	8/2009	Ellis	
2009/0222009	A1	9/2009	Ellis	
2009/0279972	A1	11/2009	Novak et al.	
2010/0028098	A1	2/2010	Shaffer	
2010/0034608	A1	2/2010	Nordlin et al.	
2010/0080665	A1	4/2010	Keightley	
2010/0086372	A1	4/2010	Werner	
2010/0092256	A1	4/2010	Khangar et al.	
2010/0145341	A1	6/2010	Ranck et al.	
2010/0278601	A1	11/2010	Beynon	
2011/0038679	A1	2/2011	Kozak	
2011/0052340	A1	3/2011	Kozak	
2011/0073337	A1	3/2011	Milbourne et al.	
2011/0170965	A1	7/2011	Novak et al.	
2011/0170966	A1	7/2011	Novak et al.	
2011/0170967	A1	7/2011	Novak et al.	
2011/0170969	A1	7/2011	Novak et al.	
2011/0170970	A1	7/2011	Kalomeris et al.	
2011/0170971	A1	7/2011	Novak et al.	
2011/0170972	A1	7/2011	Zielonka et al.	
2012/0155979	A1	6/2012	Khangar et al.	
2012/0247834	A1	10/2012	Buxbaum et al.	
2014/0023446	A1	1/2014	Piller et al.	
2014/0158569	A1	6/2014	Green et al.	
2014/0271007	A1	9/2014	Richter	
2015/0239051	A1	8/2015	Novak et al.	

FOREIGN PATENT DOCUMENTS

CN	201799668	4/2011
DE	2845123	4/1980
DE	3214209	10/1983
DE	29907717	8/1999
DE	20201300	7/2003
DE	20318529	4/2005
DE	102005012026	9/2006
EP	0612575	8/1994
EP	0792705	9/1997
EP	0965407	12/1999
EP	2070618	6/2009
GB	911093	11/1962

(56) **References Cited**

FOREIGN PATENT DOCUMENTS

GB	1476437	6/1977
GB	2040741	9/1980
GB	1589293	5/1981
GB	2338438	12/1999
GB	2451947	2/2009
JP	56089414	7/1981
JP	4171108	6/1992
JP	H0525013	4/1993
JP	3019727	1/1996
JP	9192912	7/1997
JP	2003200415	7/2003
JP	2008018490	1/2008
KR	2012039417	4/2012
NL	9400753	12/1995
WO	WO9015683	12/1990
WO	WO0009284	2/2000
WO	WO2008064409	6/2008
WO	WO2011088269	7/2011

OTHER PUBLICATIONS

Inter Partes Review No. 2015-01461, "Petition for Inter Partes Review of U.S. Pat. No. 8,579,554", dated Jun. 22, 2015 (56 pages).
Inter Partes Review No. 2015-01461, "Petitioner Exhibit 1002 Declaration of James Pangerc", dated Jun. 22, 2015 (11 pages).
Makita Industrial Power Tools, 2003-2004 General Catalog (2003) 2 pages.

* cited by examiner

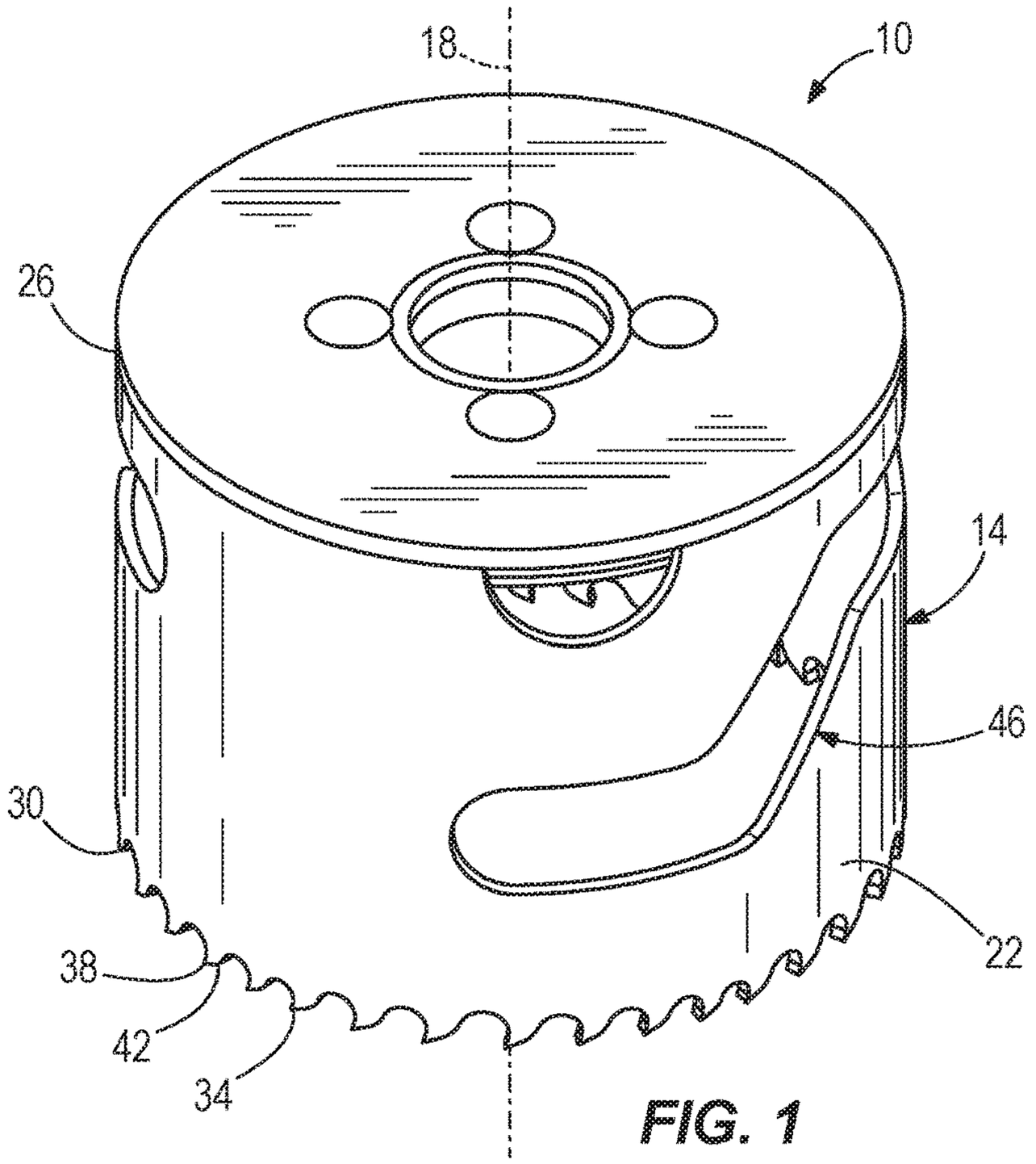


FIG. 1

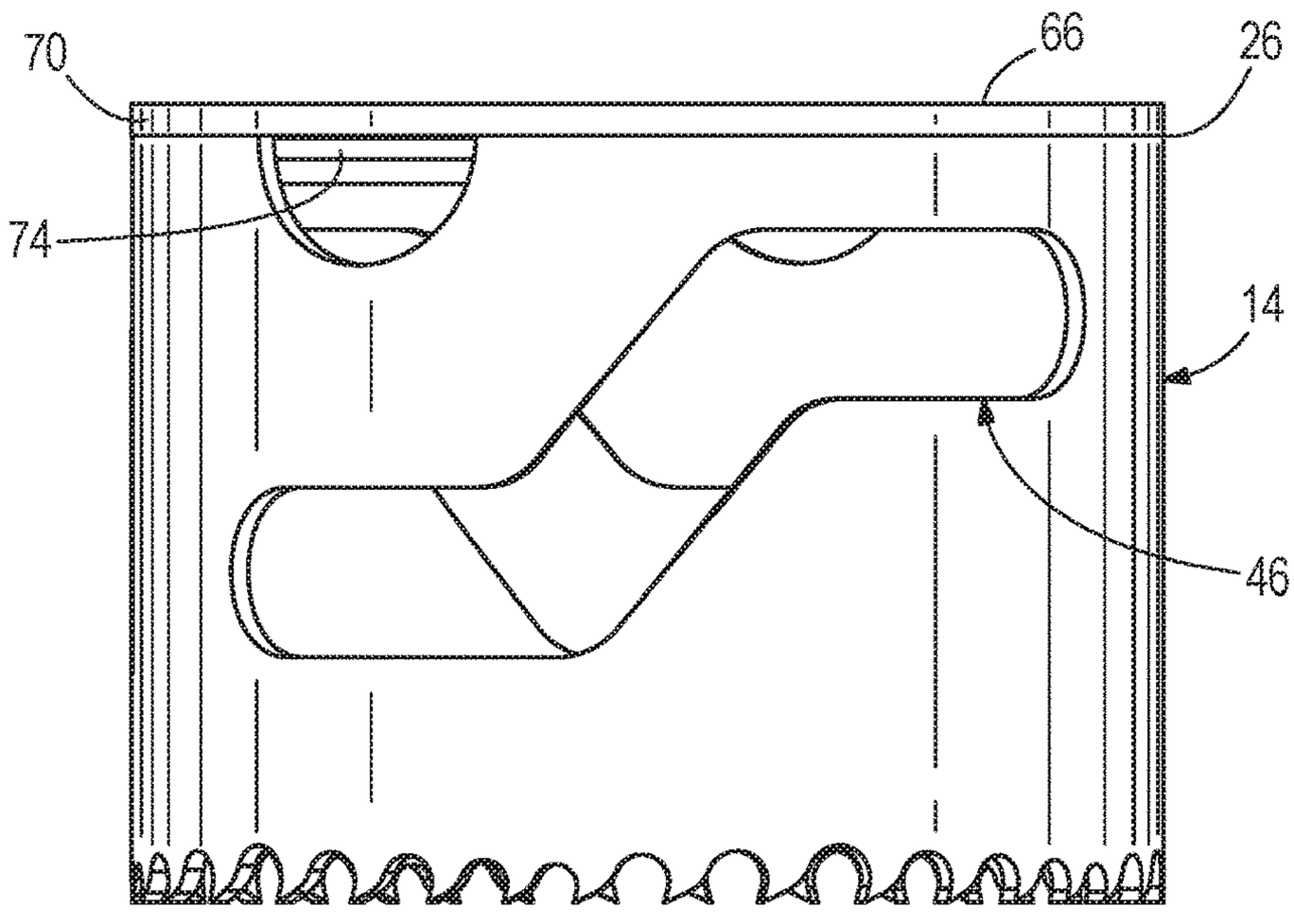


FIG. 2

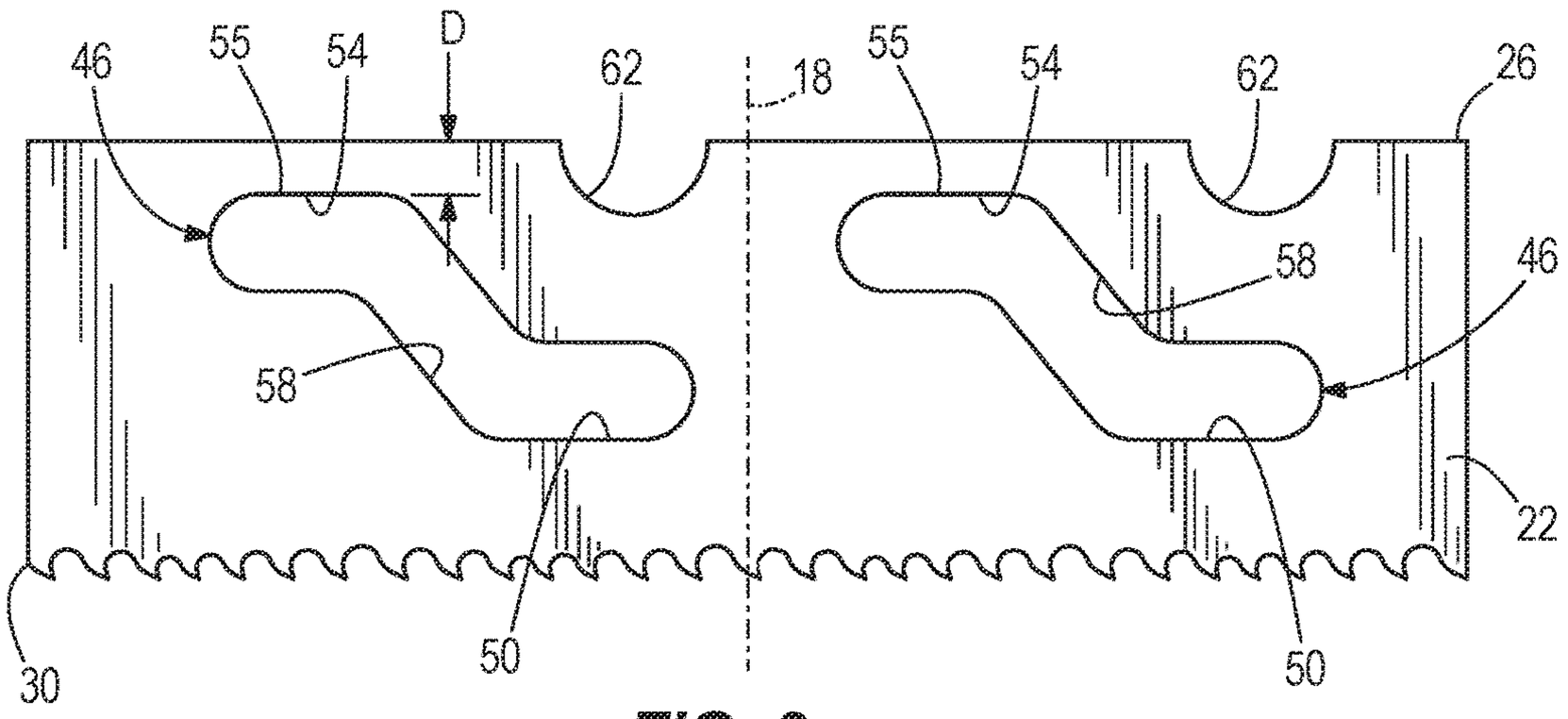


FIG. 3

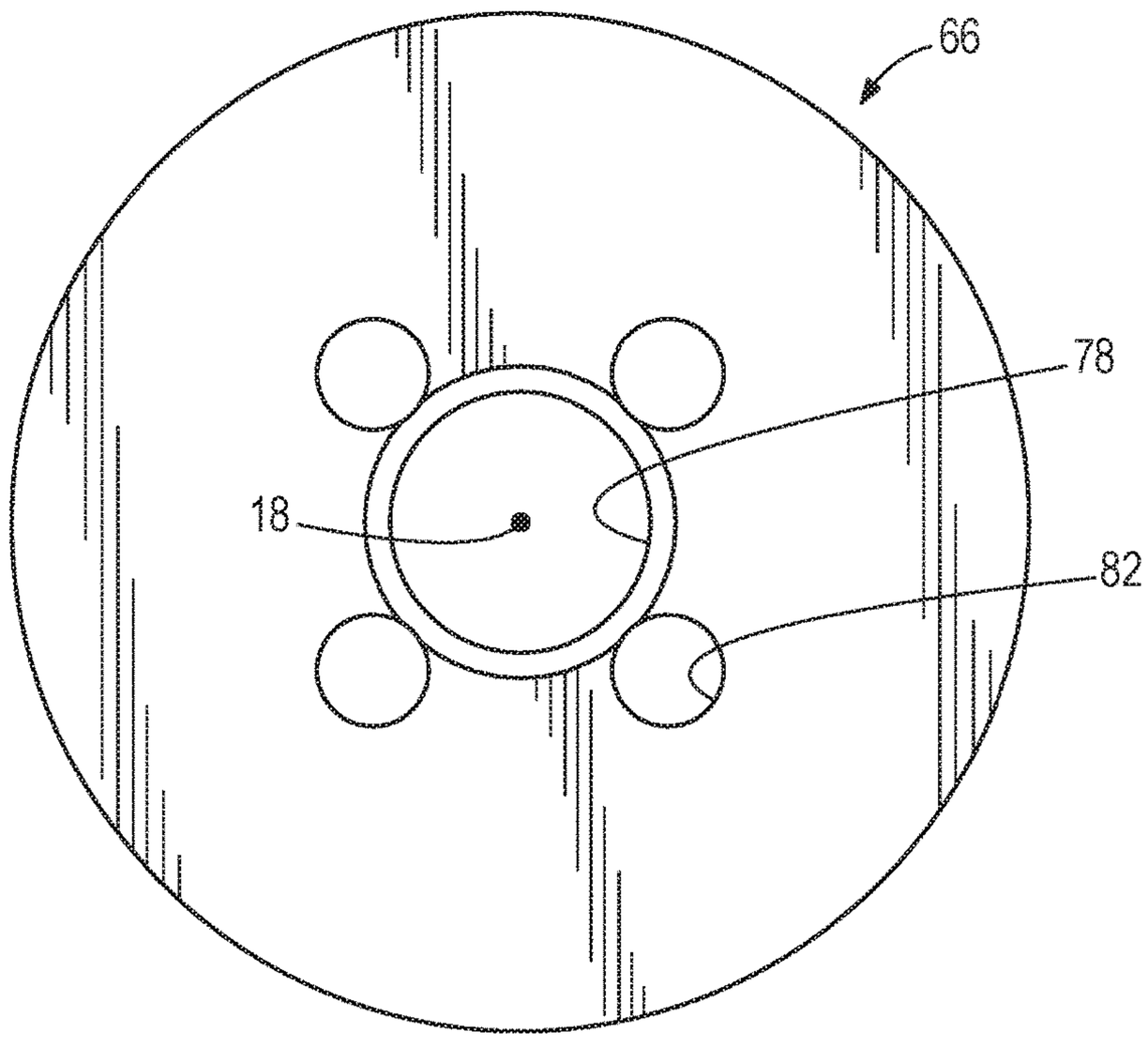


FIG. 4

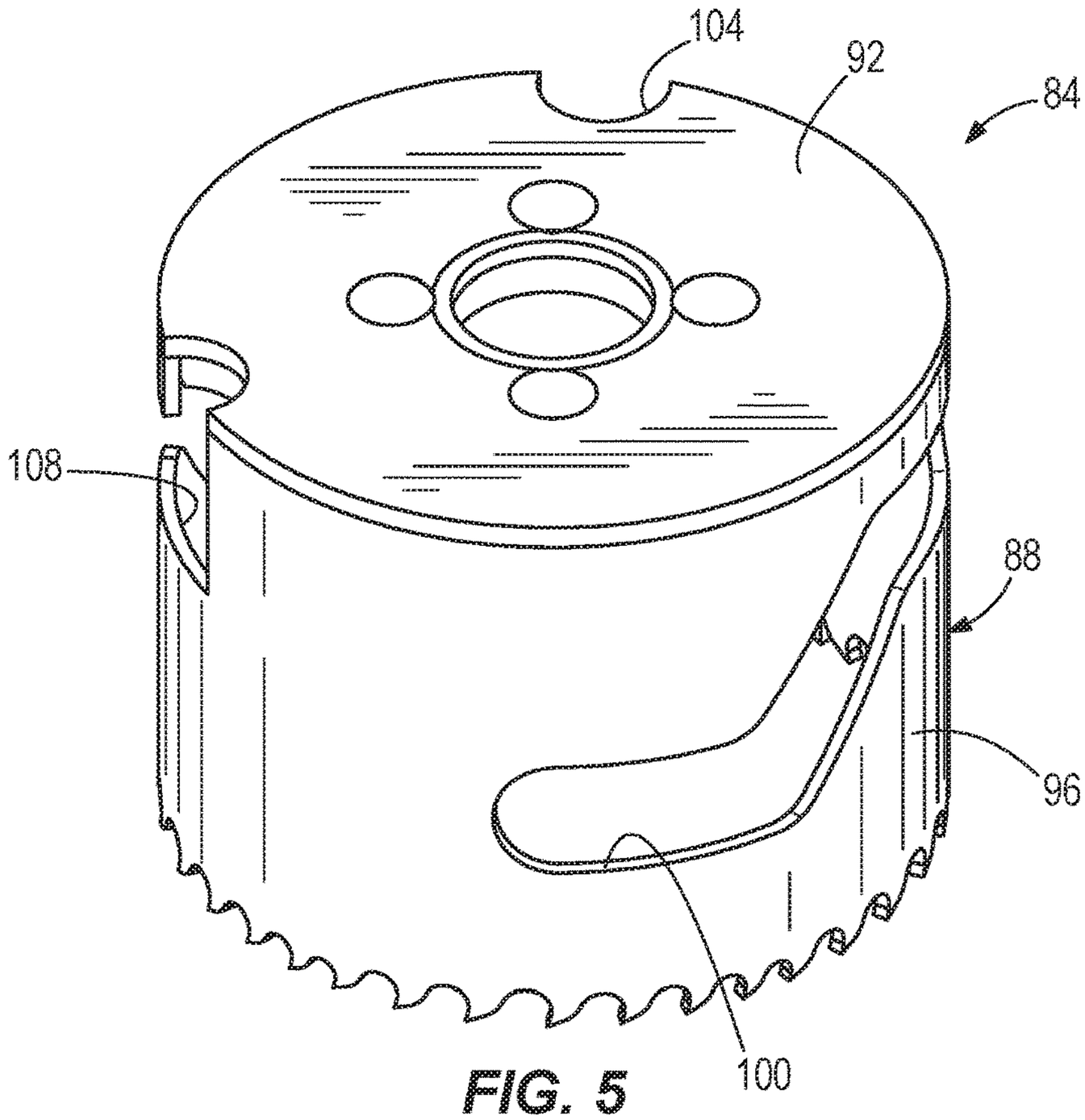


FIG. 5

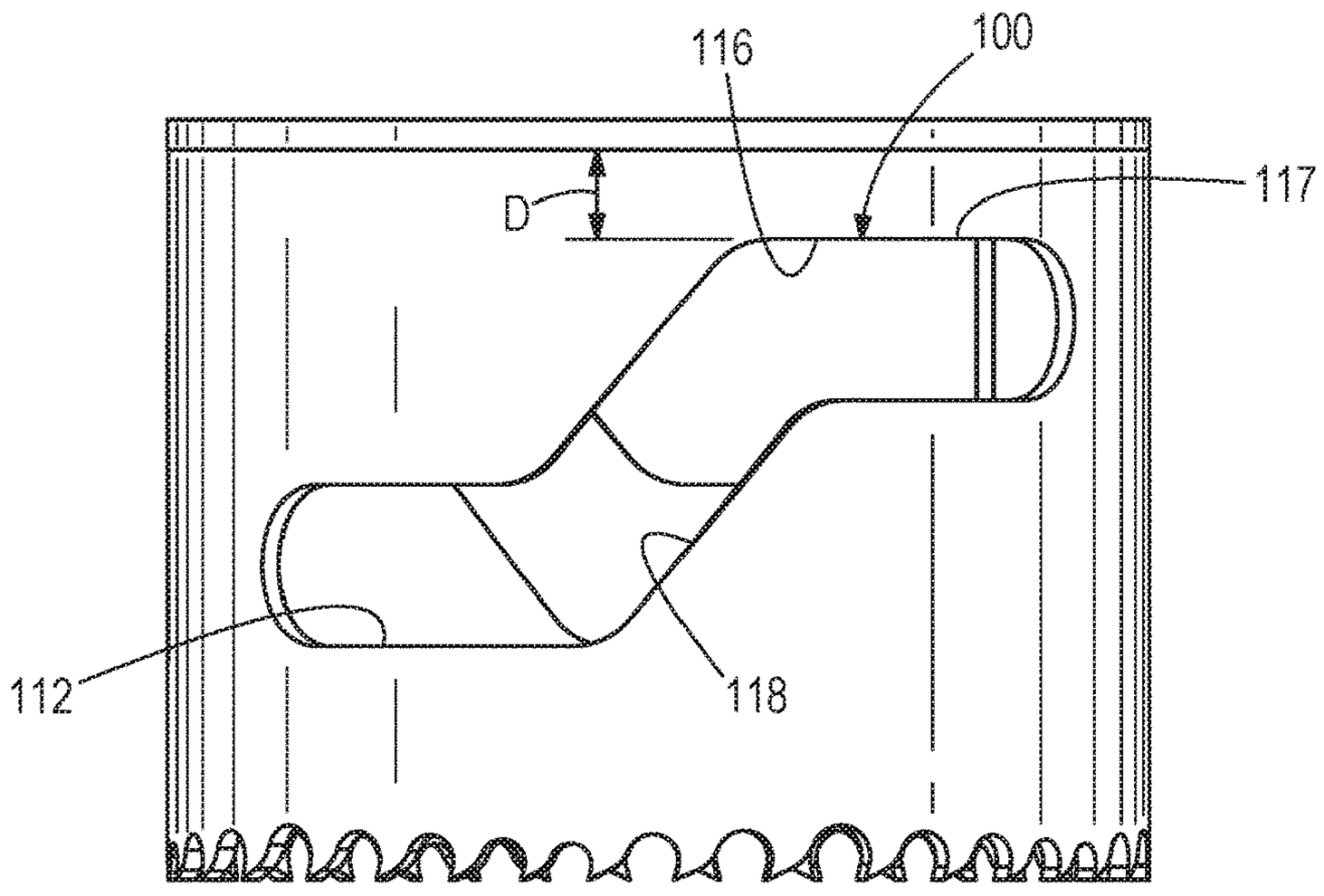


FIG. 6

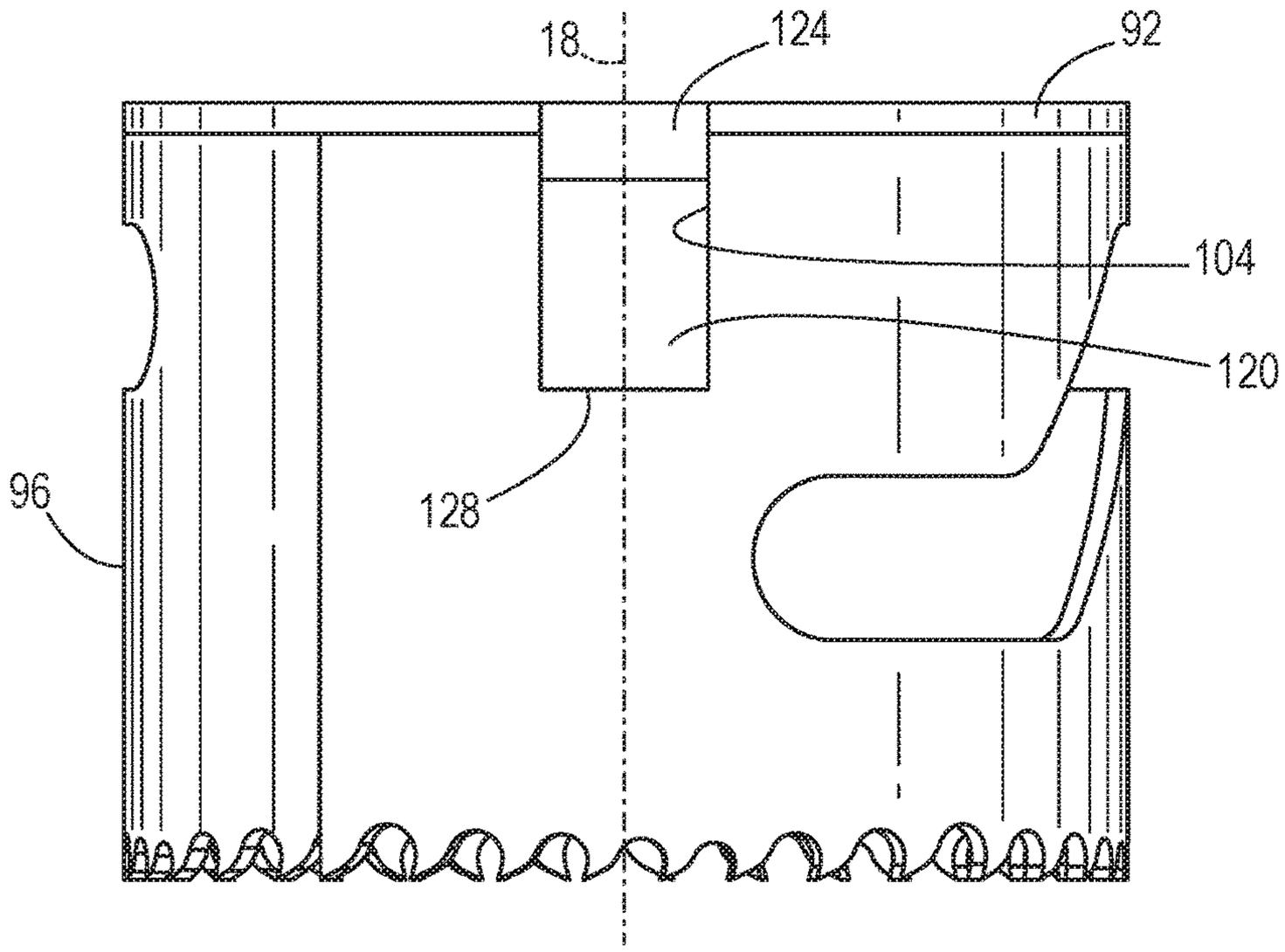


FIG. 7

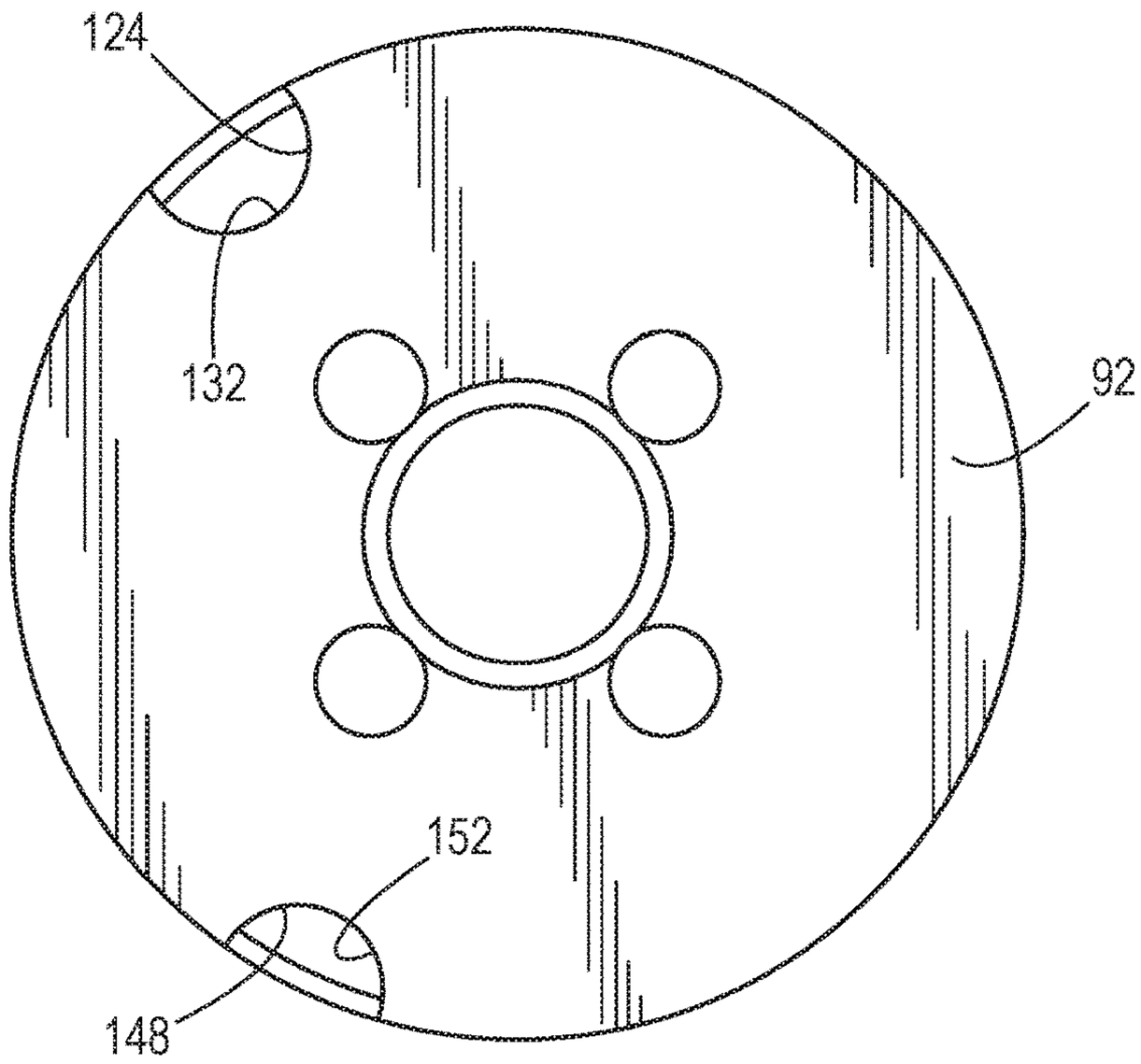


FIG. 8

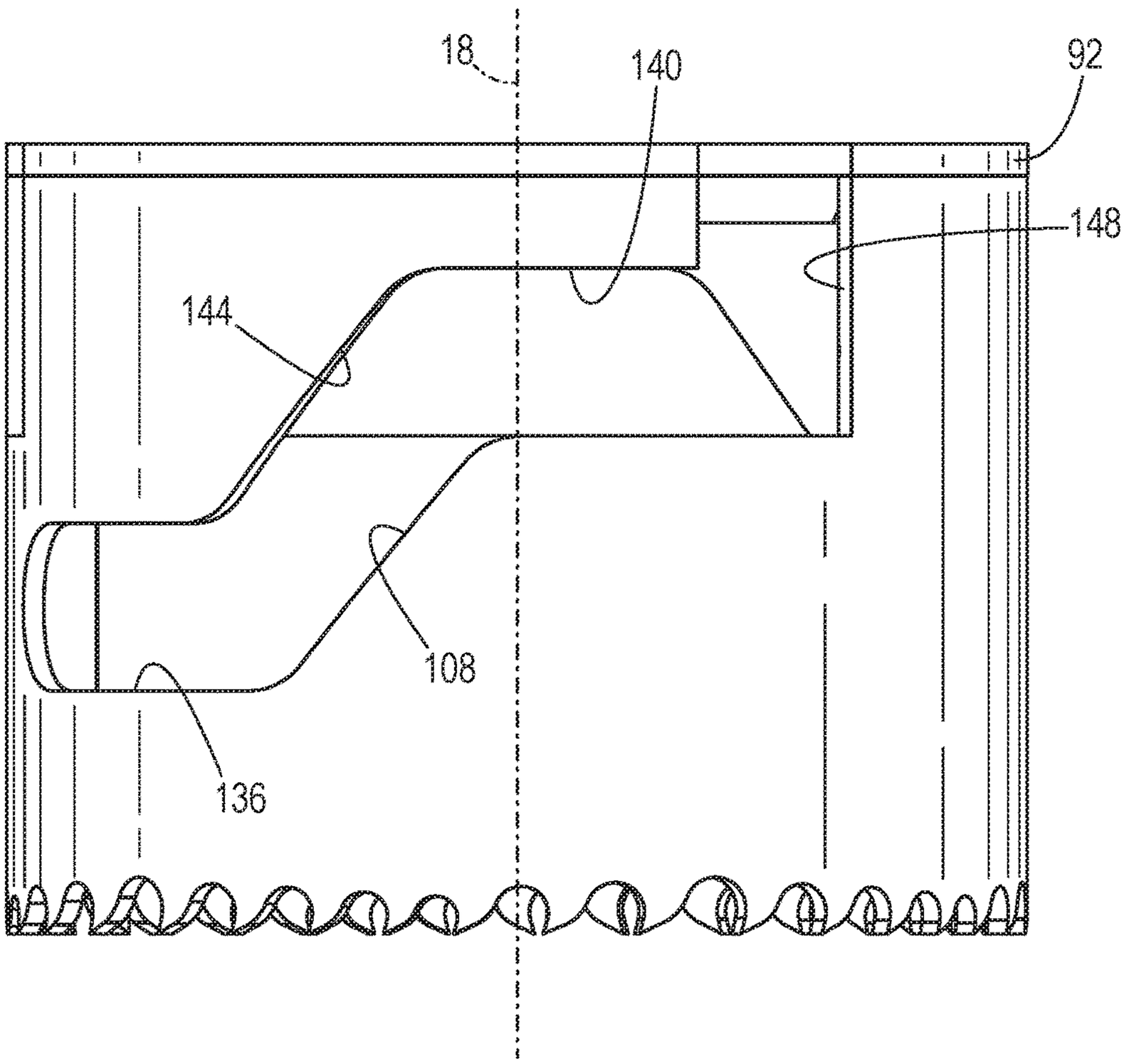


FIG. 9

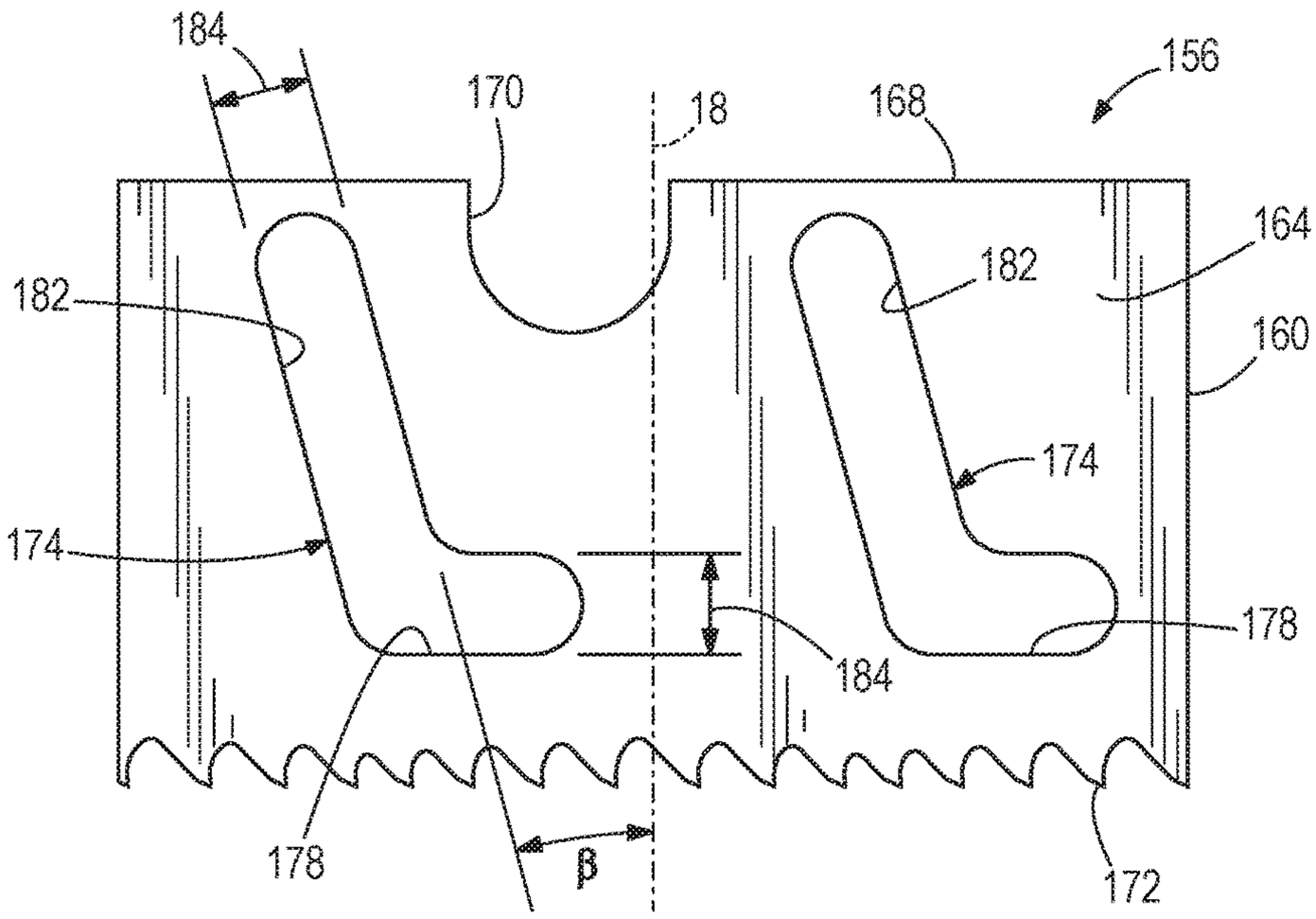

184
170
18
168
156
182
182
164
160
174
174
178
184
178
β
172

FIG. 10

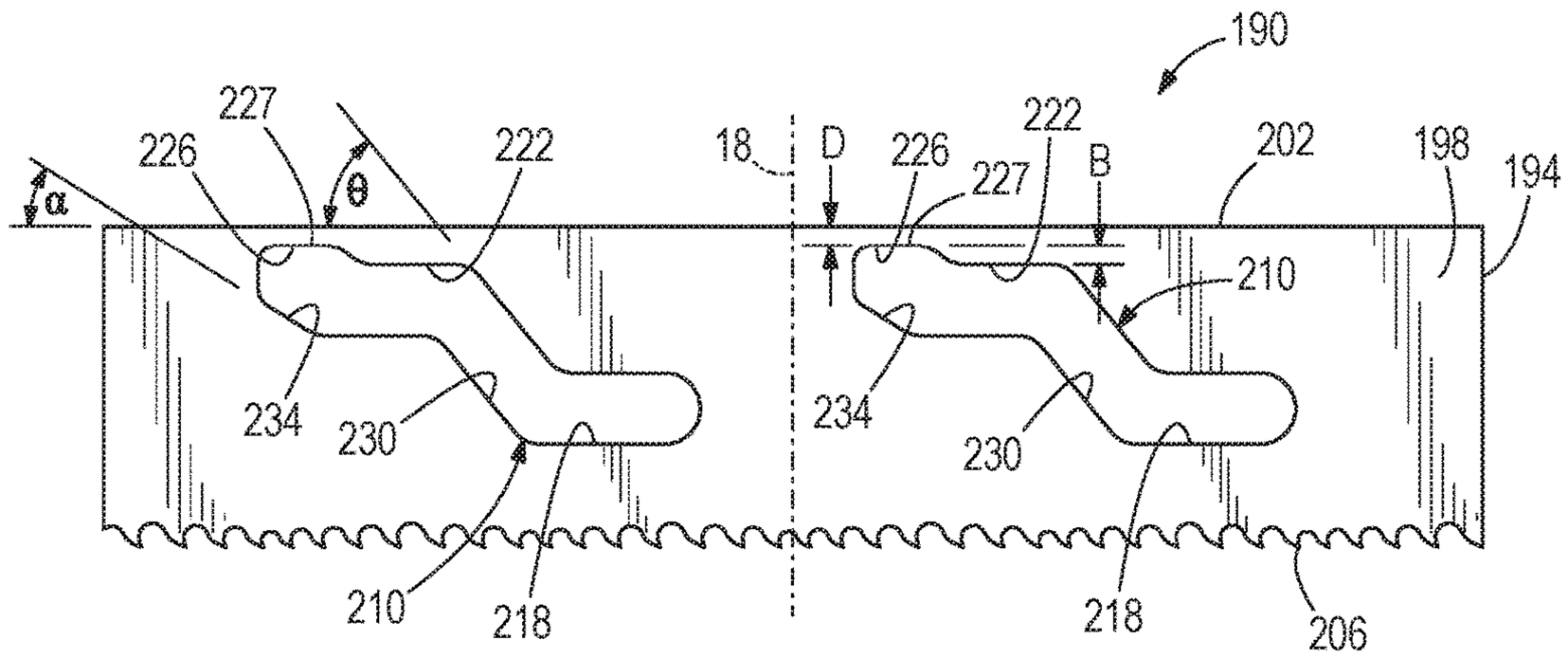

190
227
226
222
18
D
226
222
227
B
202
198
194
α
θ
210
234
230
234
230
210
218
218
206

FIG. 11

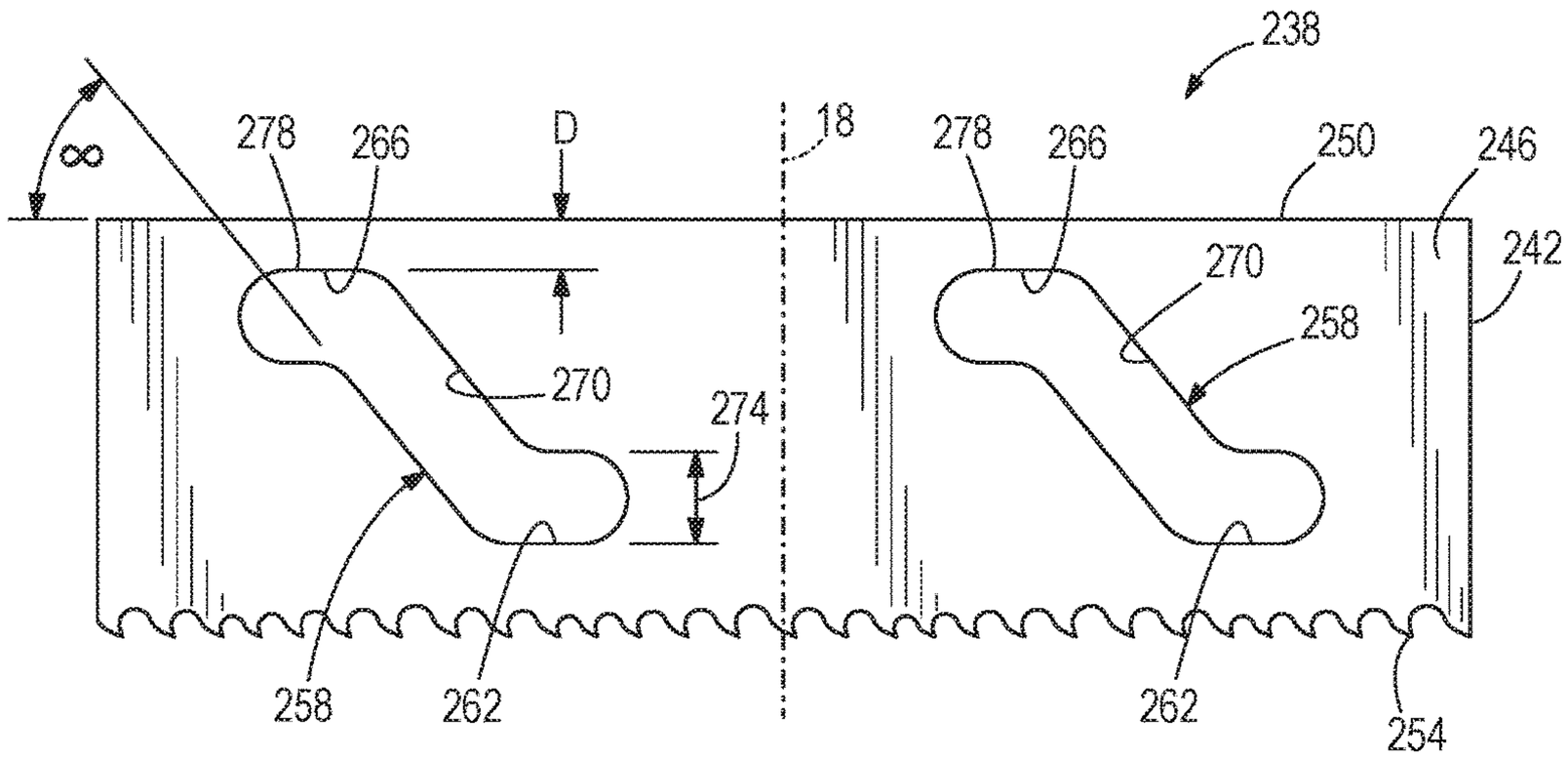

238
∞
278
266
D
18
278
266
250
246
242
270
258
270
274
258
262
262
254

FIG. 12

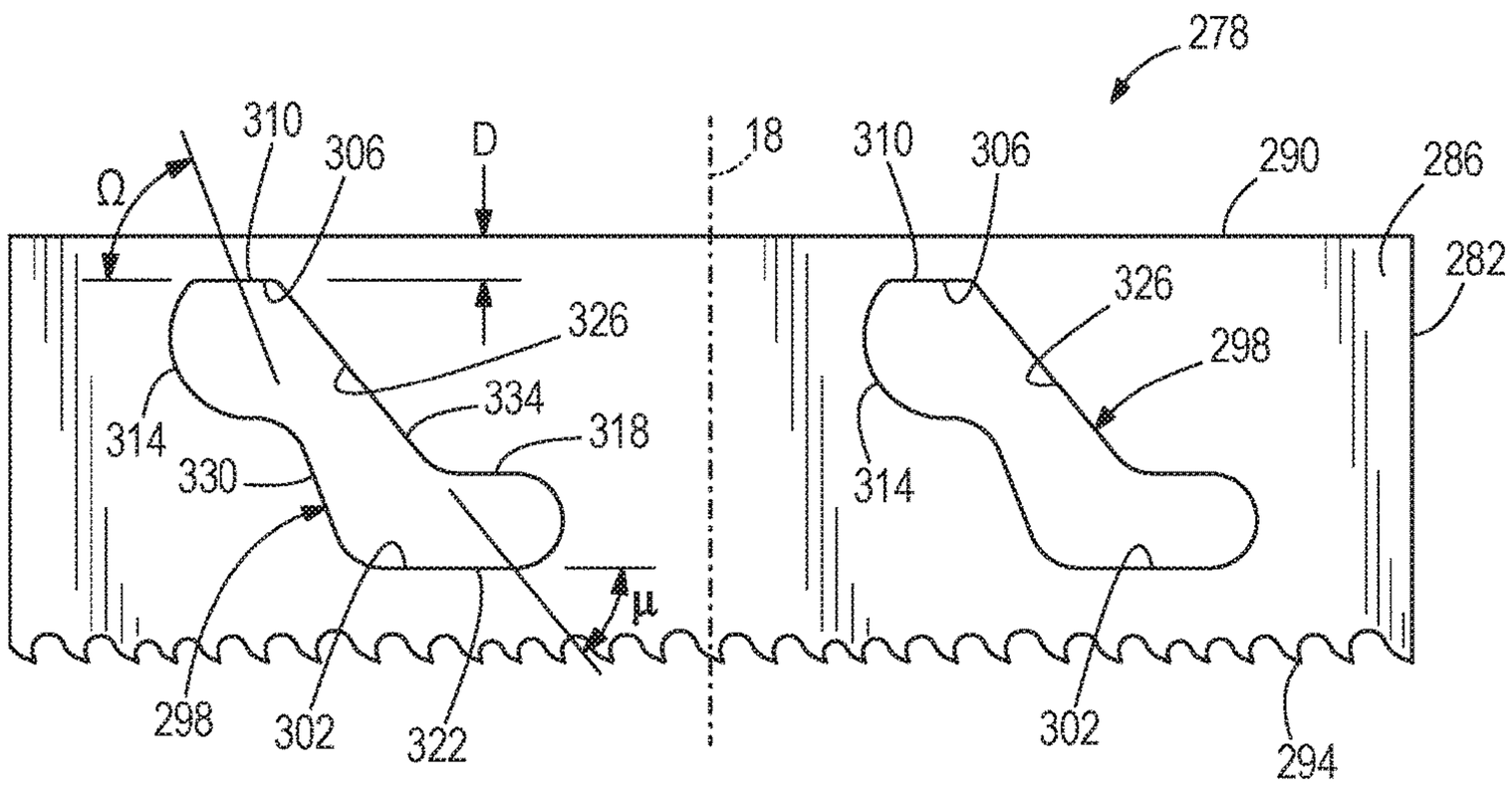

278
Ω
310
306
D
18
310
306
290
286
282
326
326
298
334
318
314
330
314
μ
298
302
322
302
294

FIG. 13

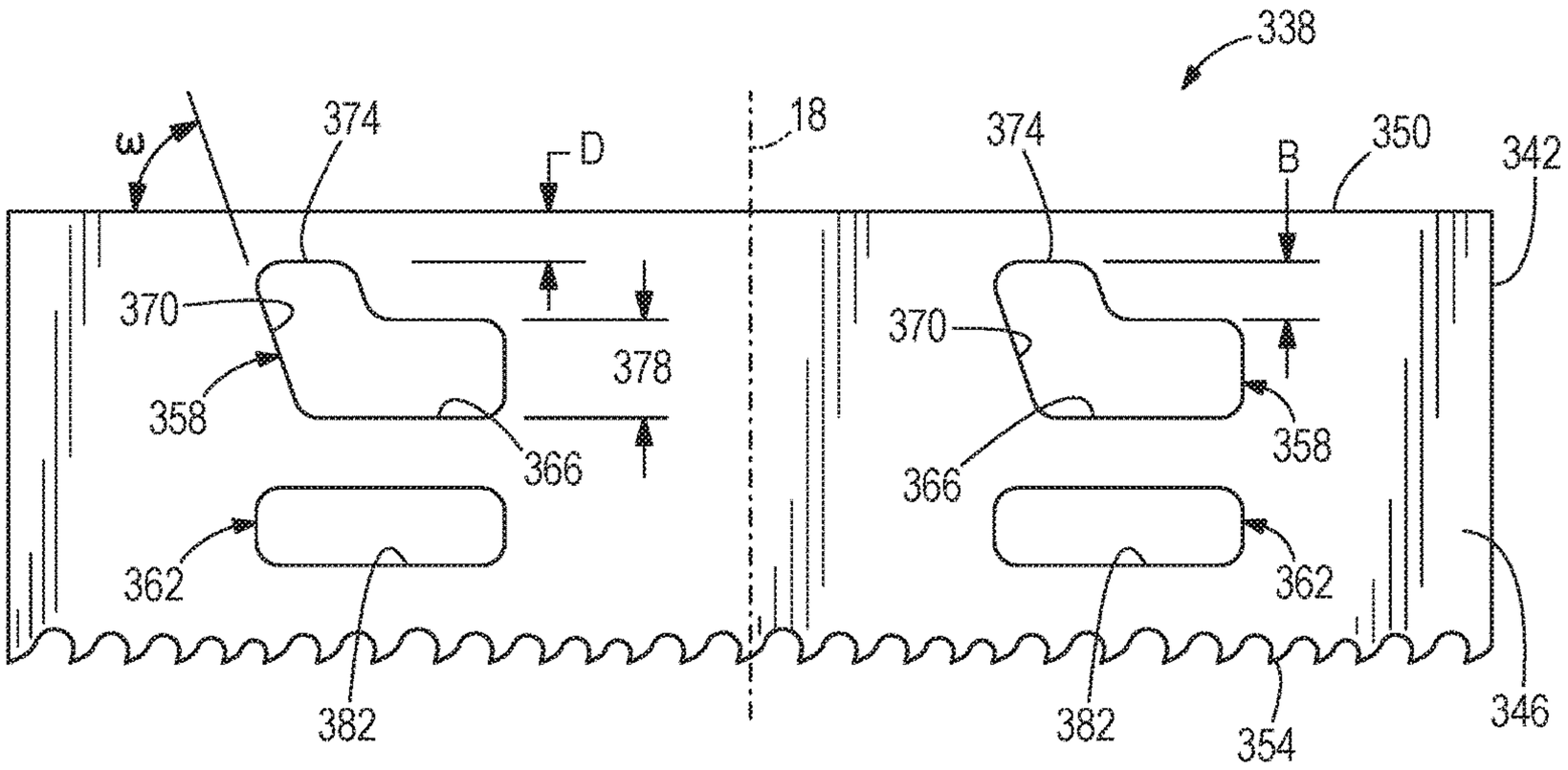

338
ω
374
D
18
374
B
350
342
370
358
366
378
362
382
370
366
358
362
382
354
346

FIG. 14

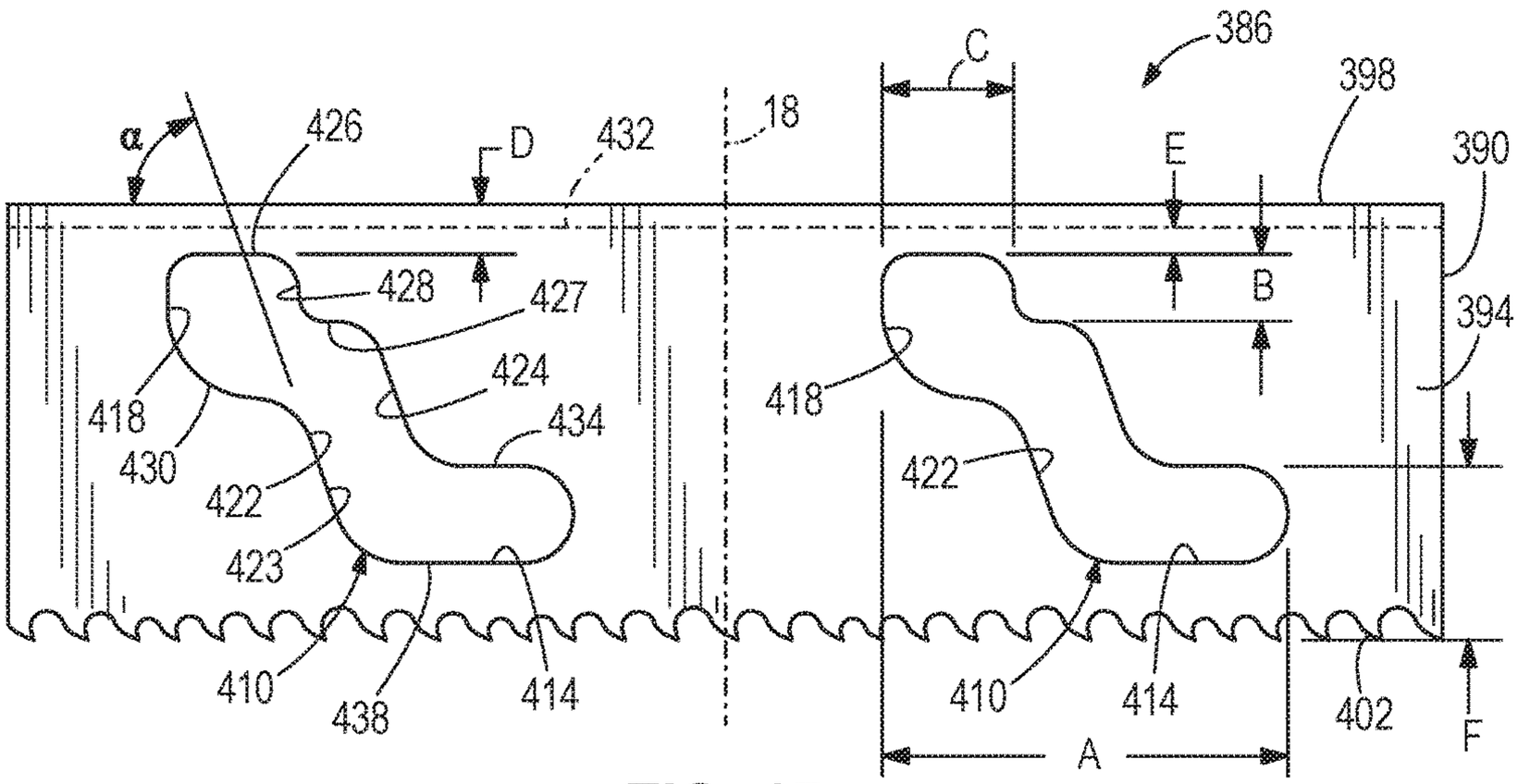

386
C
398
α
426
D
432
18
E
390
428
427
B
394
424
418
434
430
422
423
418
422
410
438
414
410
414
402
A
F

FIG. 15

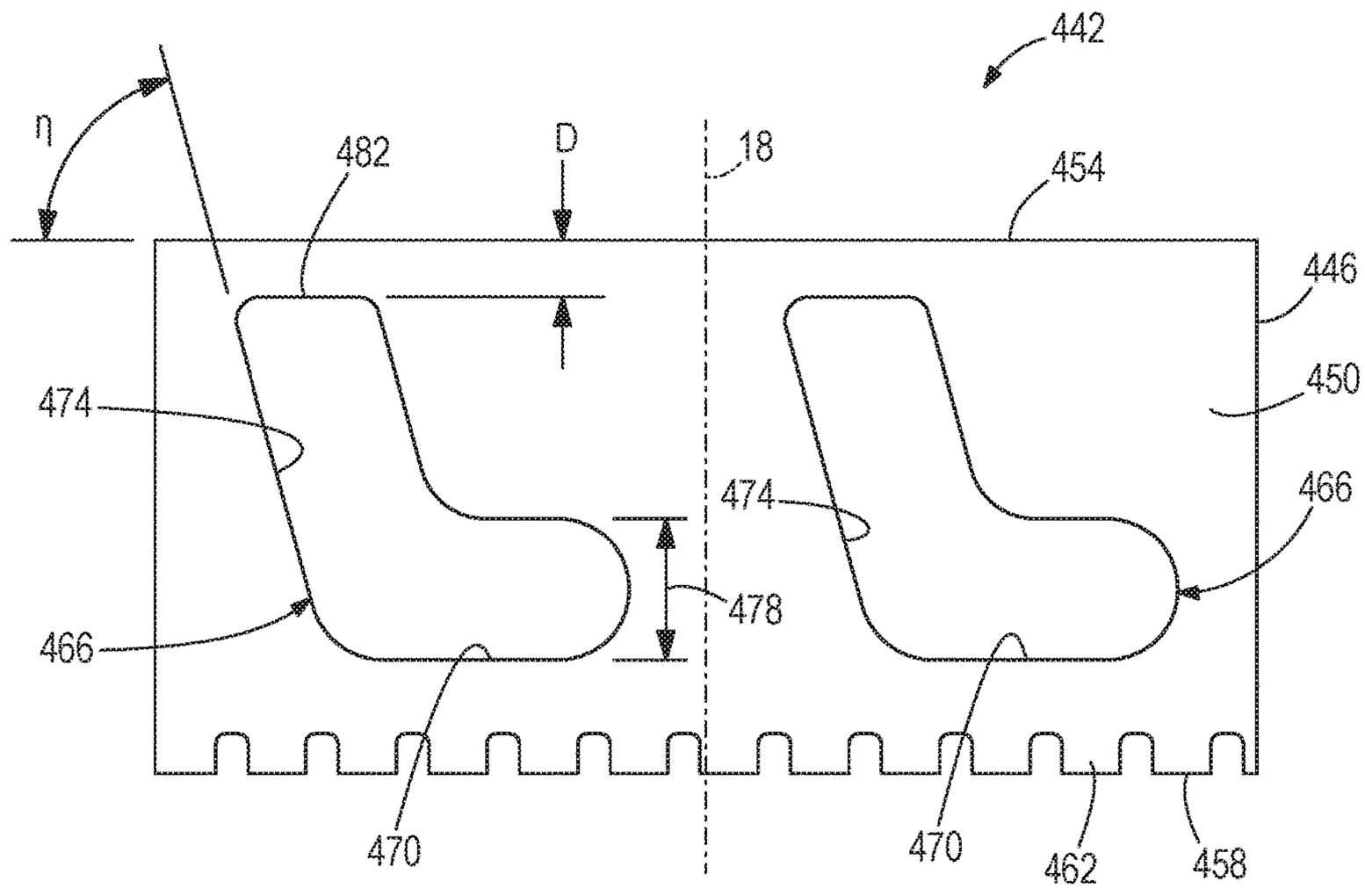


FIG. 16

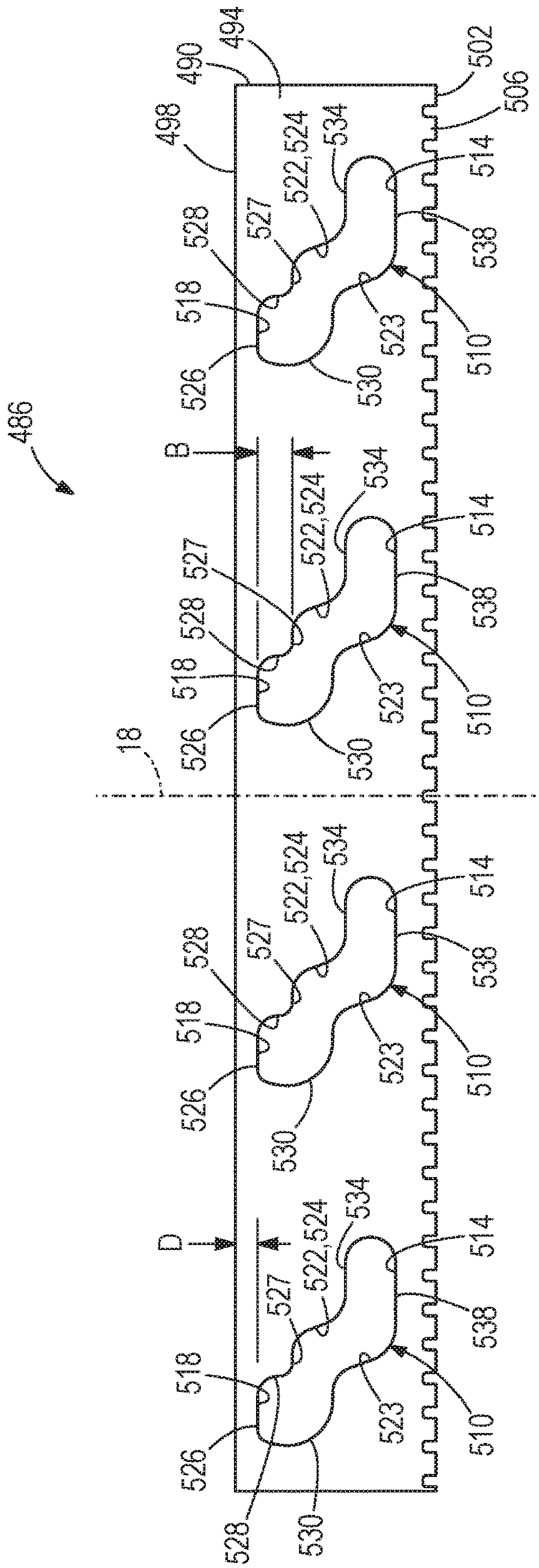

486
490
494
498
502
506
514
518
522,524
523
526
527
528
530
534
538
510
B
D
18

FIG. 17

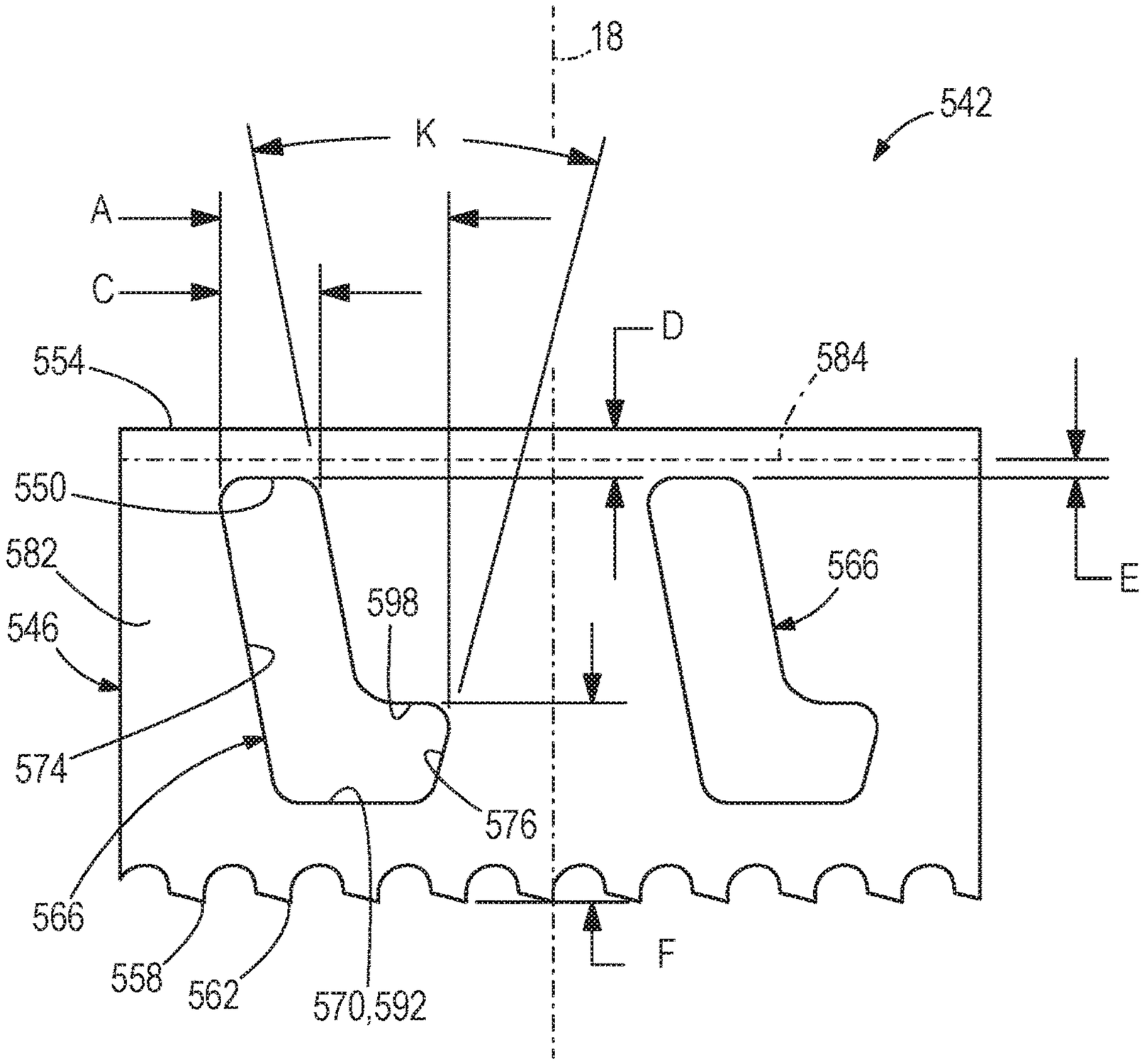

18
542
K
A
C
D
554
584
550
582
598
566
546
E
574
576
566
558
562
570,592
F

FIG. 18

HOLE SAW

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue; a claim printed with strikethrough indicates that the claim was canceled, disclaimed, or held invalid by a prior post-patent action or proceeding.

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 13/945,643, filed Jul. 18, 2013, now U.S. Pat. No. 9,579,732, which claims priority to U.S. Provisional Patent Application No. 61/673,124, filed Jul. 18, 2012, U.S. Provisional Patent Application No. 61/717,389, filed Oct. 23, 2012, and U.S. Provisional Patent Application No. 61/784,172, filed Mar. 14, 2013, the contents of each of which are incorporated by reference herein.

BACKGROUND

The present invention relates to power tool accessories, and more specifically, to hole saws.

A hole saw is a type of circular saw with a cylindrical, cup-like body that is rotated about a central axis in order to cut a cylindrical plug from a work piece, thereby forming a circular aperture in the work piece. The plug, or core, of the work piece is received within the cup-like body as the hole saw progresses through the work piece. Under certain conditions, the plug can become trapped within the body, necessitating manual removal of the plug by the user.

SUMMARY

In one embodiment, the invention provides a hole saw including a cylindrical body disposed along an axis of rotation with a side wall extending axially from a cap end to a cutting end. The cutting end includes a plurality of cutting teeth. A cap includes a rim portion seated on the cap end and an axially extending portion extending into the cylindrical body from the cap end. The side wall defines an aperture including a first slot portion and a second slot portion disposed closer to the cap end than the first slot portion. A wall of the second slot portion nearest the cap end is between approximately 0.010 inches and approximately 0.120 inches axially offset from the axially extending portion of the cap.

In another embodiment the invention provides a hole saw. A cylindrical body is disposed along an axis of rotation and includes a side wall extending axially from a cap end to a cutting end. The cutting end includes a plurality of cutting teeth. A cap includes a rim portion seated on the cap end and an axially extending portion extending into the cylindrical body from the cap end. The side wall defines an aperture including a first slot portion oriented substantially perpendicular to the axis and a second slot portion disposed closer to the cap end than the first slot portion. A wall of the second slot portion nearest the cap end is between approximately 0.010 inches and approximately 0.120 inches axially offset from the axially extending portion of the cap. A connecting slot portion connects the first slot portion and the second slot portion.

Other aspects of the invention will become apparent by consideration of the detailed description and accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a hole saw according to a first embodiment of the invention.

FIG. **2** is a side view of the hole saw of FIG. **1**.

FIG. **3** is a planar view of a cylindrical body of the hole saw of FIG. **1**.

FIG. **4** is a top view of the hole saw of FIG. **1**.

FIG. **5** is a perspective view of a hole saw according to another embodiment of the invention.

FIG. **6** is a side view of a first aperture of the hole saw of FIG. **5**.

FIG. **7** is a side view of a second aperture of the hole saw of FIG. **5**.

FIG. **8** is a top view of the hole saw of FIG. **5**.

FIG. **9** is a side view of a third aperture of the hole saw of FIG. **5**.

FIG. **10** is a planar view of a cylindrical body of a hole saw according to another embodiment of the invention.

FIG. **11** is a planar view of a cylindrical body of a hole saw according to another embodiment of the invention.

FIG. **12** is a planar view of a cylindrical body of a hole saw according to another embodiment of the invention.

FIG. **13** is a planar view of a cylindrical body of a hole saw according to another embodiment of the invention.

FIG. **14** is a planar view of a cylindrical body of a hole saw according to another embodiment of the invention.

FIG. **15** is a planar view of a cylindrical body of a hole saw according to another embodiment of the invention.

FIG. **16** is a planar view of a cylindrical body of a hole saw according to another embodiment of the invention.

FIG. **17** is a planar view of a cylindrical body of a hole saw according to another embodiment of the invention.

FIG. **18** is a planar view of a cylindrical body of a hole saw according to another embodiment of the invention.

Before any embodiments of the invention are explained in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangement of components set forth in the following description or illustrated in the following drawings. The invention is capable of other embodiments and of being practiced or of being carried out in various ways.

DETAILED DESCRIPTION

FIGS. **1-18** illustrate a power tool accessory, such as, for example, a hole-saw, for operation with a power tool (e.g., a drill, a driver-drill, a screwdriver, and the like). In some embodiments, the power tool accessory is operable to cut holes of different sizes in a work piece and/or to remove plugs from the work piece. Each of the embodiments of the invention described below includes a cylindrical body defining at least one slot or aperture (e.g., a pair of slots or apertures). Hole saws including any number (e.g., one, two, three, or more) of the disclosed slots or apertures, and variations thereof, are within the scope of the invention.

FIGS. **1-4** illustrates an embodiment of a power tool accessory, and more specifically, a hole saw **10**. The hole saw **10** includes a cylindrical body **14** disposed along an axis of rotation **18**. The cylindrical body **14** is defined by a side wall **22** that extends between a cap end **26** and a cutting end **30**. As shown in FIG. **1**, the cutting end **30** includes cutting teeth **34**. Each of the teeth **34** is defined by a leading edge **38** and a trailing edge **42**.

As shown in FIG. **3**, elongated apertures **46** are defined within the side wall **22**. Each elongated aperture **46** is defined by a first slot portion **50** and a second slot portion **54**,

each orientated substantially perpendicular to the axis **18**. The first slot portion **50** is axially disposed closer to the cutting end **30**, and the second slot portion **54** is disposed closer to the cap end **26**. The first slot portion **50** is offset relative to the second slot portion **54**. A connecting slot portion **58** connects the first slot portion **50** and the second slot portion **54**. The connecting slot portion **58** is at an angle relative to the cap end **26** and the cutting end **30**. The first slot portion **50**, the second slot portion **54**, and the connecting slot portion **58** all have substantially the same width, though in other embodiments they may have different widths. The second slot portion **54** includes an upper wall **55** that is substantially parallel to the cap end **26** and is located at a maximum distance D of approximately 0.2 inches from the cap end **26**. Alternatively, the upper wall **55** of the second slot portion **54** may be flush with the cap end **26** such that distance D is zero, or the second slot portion **54** may extend through a cap (not shown). The apertures **46** are configured to receive a tool (not shown) for removing plugs from within the cylindrical body **14**.

As illustrated in FIG. **3**, the cap end **26** defines semi-circular slots **62** configured to receive a plug-removing tool (not shown).

Referring to FIG. **2**, a cap **66** is coupled to the cap end **26** of the cylindrical body **14**. The cap **66** has substantially the same diameter as the cylindrical body **14** and is welded to the cap end **26** with a substantially continuous weld between the semi-circular slots **62**. The cap **66** includes a rim portion **70** that seats on the cap end **26** and an axially extending portion **74** that extends into the cap end **26** of the cylindrical body. The rim portion **70** is substantially perpendicular to the axially extending portion **74**. As shown in FIG. **4**, the cap **66** defines a main aperture **78** centered about the axis **18** and configured to receive a mandrel or equivalent tool (not shown). A plurality of holes **82** are defined in the cap **66** and surround the main aperture **78**. The plurality of holes **82** are circumferentially arranged about the axis **18**.

FIGS. **5-9** illustrate another embodiment of a hole saw **84**. The hole saw **84** has substantial similarities to the hole saw **10** described with respect to FIGS. **1-4**, and only those aspects that differ from the embodiments of FIGS. **1-4** will be described herein. Referring to FIG. **5**, the hole saw **84** includes a cylindrical body **88** and a cap **92**. The cylindrical body **88** includes a side wall **96** having a first aperture **100**, a second aperture **104**, and a third aperture **108**. The apertures **100**, **104**, **108** are configured to receive a tool (not shown) for removing the plugs from within the cylindrical body **88**.

As shown in FIG. **6**, the first aperture **100** is defined by a first slot portion **112** and a second slot portion **116**. The first slot portion **112** and the second slot portion **116** are each orientated substantially perpendicular to the axis **18**. A connecting slot portion **118** connects the first slot portion **112** and the second slot portion **116**. The second slot portion **116** includes an upper wall **117** that is substantially parallel to the cap end **92** and is located at a maximum distance D of approximately 0.2 inches from the cap end **92**. Alternatively, the upper wall **117** of the second slot portion **116** may be flush with the cap end **92** such that distance D is zero, or the second slot portion **116** may extend through the cap **92** (FIG. **5**).

As shown in FIG. **7**, the second aperture **104** is defined by a sidewall portion **120** and a cap portion **124**. The sidewall portion **120** extends through the side wall **96** and terminates at an edge **128** that is substantially perpendicular to the axis **18**. The cap portion **124** extends through the cap **92** and terminates at a semi-circular edge **132** as shown in FIG. **8**.

Referring to FIG. **9**, the third aperture **108** includes a first slot portion **136**, a second slot portion **140**, a connecting slot portion **144**, and a vertical slot portion **148**. The first slot portion **136** and the second slot portion **140** are each oriented substantially perpendicular to the axis **18** and are connected by the connecting slot portion **144**. The vertical slot portion **148** extends from the second slot portion **140** through the cap **92** and terminates at a semi-circular edge **152** within the cap **92** as shown in FIG. **8**.

The cap **92** is welded to the body **88**, with a substantially continuous welds interrupted by the cap portion **124** of the second aperture **104** and the vertical slot portion **148** of the third aperture.

FIG. **10** illustrates yet another embodiment of a hole saw **156**. The hole saw **156** has substantial similarities to the hole saw **10** described with respect to FIGS. **1-4**, and only those aspects that differ from the embodiments of FIGS. **1-4** will be described herein.

Referring to FIG. **10**, the hole saw **156** includes a cylindrical body **160** having a side wall **164** extending between a cap end **168** and a cutting end **172**. The cap end **168** defines a semi-circular slot **170** configured to receive a plug-removing tool (not shown).

A pair of elongated apertures **174** are defined within the side wall **164**. Each aperture **174** is configured to receive a tool (not shown) for removing work piece plugs from within the cylindrical body **160**. Each elongated aperture **174** is defined by a first slot portion **178** and a second slot portion **182**. The first slot portion **178** is oriented substantially perpendicular to the axis **18**. The second slot portion **182** connects to the first slot portion **178** and is oriented at an angle β relative to the axis **18**. In the illustrated embodiment, the angle β is between approximately 14.5 degrees and approximately 15.5 degrees, but other embodiments may include other orientations. The first slot portion **178** and the second slot portion **182** have substantially the same width **184**.

FIG. **11** illustrates yet another embodiment of a hole saw **190**. The hole saw **190** has substantial similarities to the hole saw **10** described with respect to FIGS. **1-4**, and only those aspects that differ from the embodiments of FIGS. **1-4** will be described herein.

As shown in FIG. **11**, the hole saw **190** includes a cylindrical body **194** having a side wall **198** extending between a cap end **202** and a cutting end **206**. A pair of elongated apertures **210** are defined within the side wall **214**. The elongated apertures **210** are configured to receive a tool (not shown) for removing plugs from within the cylindrical body **194**. Each elongated aperture **210** is defined by a first slot portion **218**, a second slot portion **222**, and a third slot portion **226**, each oriented substantially perpendicular to the axis **18**. The first slot portion **218** is disposed closer to the cutting end **206**, and the third slot portion **226** is disposed closer to the cap end **202**. The second slot portion **222** is disposed between the first slot portion **218** and the third slot portion **226**. The third slot portion **226** includes an upper wall **227** that is substantially parallel to the cap end **202**. The upper wall **227** is offset a distance B from the second slot portion **222**. In the illustrated embodiment, distance B is between less than half of an axial height of the aperture **210**. The upper wall **227** is located at a maximum distance D of approximately 0.2 inches from the cap end **202**. Alternatively, the upper wall **227** of the third slot portion **226** may be flush with the cap end **202** such that distance D is zero, or the third slot portion **226** may extend through a cap (not shown) coupled to the cap end **202**.

A first connecting slot portion **230** connects the first slot portion **218** and the second slot portion **222**. The first connecting slot portion **230** is oriented an angle θ relative to the cap end **202** and the cutting end **206**. In the illustrated embodiment, the angle θ is between approximately 50.2 degrees and approximately 51.2 degrees, but other embodiments may include other orientations.

A second connecting slot portion **234** connects the second slot portion **222** and the third slot portion **226**. The second connecting slot portion **234** is oriented at an angle α relative to the cap end **202** and the cutting end **206**. In the illustrated embodiment, the angle α is between approximately 31.3 degrees and approximately 32.3 degrees, but other embodiments may include other angle ranges.

FIG. **12** illustrates yet another embodiment of a hole saw **238**. The hole saw **238** has substantial similarities to the hole saw **10** described with respect to FIGS. **1-4**, and only those aspects that differ from the embodiments of FIGS. **1-4** will be described herein.

As shown in FIG. **12**, the hole saw **238** includes a cylindrical body **242** having a side wall **246** extending between a cap end **250** and a cutting end **254**. A pair of elongated apertures **258** are defined within the side wall **246**. Each elongated aperture **258** is defined by a first slot portion **262** and a second slot portion **266**, each orientated substantially perpendicular to the axis **18**. The first slot portion **262** is circumferentially disposed closer to the cutting end **254**, and the second slot portion **266** is disposed closer to the cap end **250**, whereby the first slot portion **262** is offset relative to the second slot portion **266**. A connecting slot portion **270** connects the first slot portion **262** and the second slot portion **266**. The connecting slot portion **270** is oriented at an angle ∞ relative to the cap end **250** and the cutting end **254**. In the illustrated embodiment, the angle ∞ is between approximately 50.3 degrees and approximately 51.3 degrees, but other embodiments may include other angle ranges. The first slot portion **262**, the second slot portion **266**, and the connecting slot portion **270** all have substantially the same width **274**. The second slot portion **266** includes an upper wall **278** that is substantially parallel to the cap end **250** and is located at a maximum distance D of approximately 0.2 inches from the cap end **250**. Alternatively, the upper wall **278** of the second slot portion **266** may be oriented flush with the cap end **250** such that distance D is zero, or the second slot portion **266** may extend through a cap (not shown) coupled to the cap end **250**. The apertures **258** are configured to receive a tool (not shown) for removing plugs from within the cylindrical body **242**.

FIG. **13** illustrates yet another embodiment of a hole saw **278**. The hole saw **278** has substantial similarities to the hole saw **10** described with respect to FIGS. **1-4**, and only those aspects that differ from the embodiments of FIGS. **1-4** will be described herein.

As shown in FIG. **13**, the hole saw **278** includes a cylindrical body **282** having a side wall **286** extending between a cap end **290** and a cutting end **294**. A pair of elongated apertures **298** are defined within the side wall **286**. Each elongated aperture **298** is defined by a first slot portion **302** and a second slot portion **306**. The first slot portion **302** is disposed closer to the cutting end **294**, and the second slot portion **306** is disposed closer to the cap end **290**. The second slot portion **306** includes an upper wall **310** orientated substantially parallel to the cap end **290**, and a radial wall **314** extends from the upper wall **310**. The upper wall **310** is located at a maximum distance D of approximately 0.2 inches from the cap end **290**. Alternatively, the upper wall **310** of the second slot portion **306** may be oriented flush with the cap end **290** such that distance D is zero, or the second slot portion **306** may extend through a cap (not shown) coupled to the cap end **290**.

Referring to FIG. **13**, the first slot portion **302** includes an upper wall **318** and a lower wall **322**, each oriented substantially perpendicular to the axis **18**. A connecting slot portion **326** connects the first slot portion **302** and the second slot portion **306** and includes a first wall **330** and a second wall **334**. The radial wall **314** connects to the first wall **330**, which connects to the lower wall **322**. The second wall **334** extends between the upper wall **310** and the upper wall **318**. The first wall **330** is oriented at an angle Ω relative to the cap end **290** and the cutting end **294**. In the illustrated embodiment, the angle Ω is between approximately 69.5 degrees and approximately 70.5 degrees, but other embodiments may include other angle ranges. The second wall **334** is oriented at an angle μ relative to the cap end **290** and the cutting end **294**. In the illustrated embodiment, the angle μ is between approximately 50.1 degrees and approximately 51.1 degrees, but other embodiments may include other angle ranges.

FIG. **14** illustrates yet another embodiment of a hole saw **338**. The hole saw **338** has substantial similarities to the hole saws **10** and **156** described with respect to FIGS. **1-4** and **10**, and only those aspects that differ from the embodiments of FIGS. **1-4** and **10** will be described herein.

As shown in FIG. **14**, the hole saw **338** includes a cylindrical body **342** having a side wall **346** extending between a cap end **350** and a cutting end **354**. The side wall **346** includes a first pair of elongated apertures **358** and a second pair of elongated apertures **362**. The first pair of elongated apertures **358** are disposed closer to the cap end **350**, and the second pair of elongated apertures **362** are disposed closer to the cutting end **354**. Each of the first pair of apertures **358** includes a first slot portion **366** and second slot portion **370**.

The first slot portion **366** is oriented substantially perpendicular to the axis **18**. The second slot portion **370** extends from the first slot portion **366** and is oriented at an angle ω relative to the cap end **350** and the cutting end **354**. In the illustrated embodiment, the angle ω is between approximately 69.5 degrees and approximately 70.5 degrees, but other embodiments may include other angle ranges. The second slot portion **370** includes an upper wall **374** that is substantially parallel to the cap end **350**. The upper wall **374** is offset a distance B from the lower slot portion **366**. In the illustrated embodiment, distance B is less than half of an axial height of the aperture **358**. The upper wall **374** is located at a maximum distance D of approximately 0.2 inches from the cap end **350**. Alternatively, the upper wall **374** of the second slot portion **370** may be flush with the cap end **350** such that distance D is zero, or the second slot portion **370** may extend through a cap (not shown) coupled to the cap end **350**. The first slot portion **366** and the second slot portion **370** have substantially the same width **378**.

Each of the second pair of apertures **362** is defined by a first slot portion **382** oriented substantially perpendicular to the axis **18**. The first pair of apertures **358** and the second pair of apertures **362** are generally aligned in the same position and orientation relative to the axis **18**, though in other embodiments they may be staggered or in other orientations.

FIG. **15** illustrates yet another embodiment of a hole saw **386**. The hole saw **386** has substantial similarities to the hole saw **10** described with respect to FIGS. **1-4**, and only those aspects that differ from the embodiments of FIGS. **1-4** will be described herein.

As shown in FIG. **15**, the hole saw **386** includes a cylindrical body **390** having a side wall **394** extending between a cap end **398** and a cutting end **402**. A pair of elongated apertures **410** are defined within the side wall **394**. Each elongated aperture **410** is defined by a first slot portion **414** and a second slot portion **418**, each orientated substantially perpendicular to the axis **18**. The first slot portion **414** is disposed closer to the cutting end **402**, and the second slot portion **418** is disposed closer to the cap end **398**. A connecting slot portion **422** connects the first slot portion **414** and the second slot portion **418** and is oriented at an angle α relative to the cap end **398** and the cutting end **402**. In the illustrated embodiment, the angle α is between approximately 60 degrees and approximately 80 degrees, more specifically approximately 70 degrees, but other embodiments may include other angles. The connecting slot portion **422** includes a first wall **423** and second wall **424**. The elongated aperture **410** has a circumferential width A, measured in a direction parallel to the cap end **398** and cutting end **402**. In the illustrated embodiment, the circumferential width A is between approximately 1.250 inches and approximately 2.150 inches, more specifically between approximately 1.475 inches and approximately 1.925 inches, and even more specifically, approximately 1.700 inches. A circumferential width A within these ranges provides for greater access to a user when removing a work piece plug from the hole saw **386**.

The second slot portion **418** includes an upper wall **426** orientated substantially perpendicular to the axis **18**, a lower wall **427** oriented substantially perpendicular to the axis **18**, a side wall **428**, and a radial wall **430** that extends from the upper wall **426**. The radial wall **430** connects to the first wall **423**, which connects to the lower wall **438**. The second wall **424** connects to the lower wall **427**, which connects to the side wall **428**. The upper wall **426** and lower wall **427** are axially separated by a slot height B. In the illustrated embodiment, the slot height B is between approximately 0.018 inches and approximately 0.038 inches, more specifically approximately 0.028 inches. Having slot height B within this range of values provides for optimal removal of deep work piece plugs within the hole saw **386**.

A slot width C of the second slot portion **418**, measured in a direction parallel to the cap end **398**, is between approximately 0.305 inches and approximately 0.805 inches, more specifically, between approximately 0.430 inches and approximately 0.680 inches, and even more specifically, approximately 0.555 inches. A slot width C within these ranges of values allows for a greater range of tools to be inserted into the slot in order to remove a work piece plug. The upper wall **426** is located at a maximum distance D of approximately 0.2 inches from the cap end **398**. The upper wall **426** is located an axial offset E from a depth **432** of an axially extending portion of a cap (e.g., the axially extending portion **74** of the cap **66** described with respect to FIG. **2**). In the illustrated embodiment, the axial offset E is between approximately 0.051 inches and approximately 0.126 inches, more specifically between approximately 0.072 inches and approximately 0.108 inches, and even more specifically, approximately 0.090 inches. Having an axial offset E within this range of values provides for easier removal of deep work piece plugs from within hole saw **386**. Alternatively, the upper wall **426** of the second slot portion **418** may be oriented flush with the cap end **398** such that distance D is zero, or the second slot portion **418** may extend through a cap (not shown) coupled to the cap end **398**.

The first slot portion **414** includes an upper wall **434** and a lower wall **438**, each oriented substantially perpendicular to the axis **18**. The upper wall **434** is disposed a distance F from the cutting end **402**. In the illustrated embodiment, distance F is between approximately 0.541 inches and approximately 0.895 inches, more specifically between approximately 0.627 inches and approximately 0.809 inches, and even more specifically, approximately 0.718 inches. Having distance F within this range of values allows a user to apply more axially-aligned force when removing a plug from the hole saw **386**. Each aperture **410** is configured to receive a tool (not shown) for removing work piece plugs from within the cylindrical body **390**.

FIG. **16** illustrates yet another embodiment of a hole saw **442**. The hole saw **442** has substantial similarities to the hole saw **10**, **156**, and **338** described with respect to FIGS. **1-4**, **10**, and **14**, and only those aspects that differ from the embodiments of FIGS. **1-4**, **10**, and **14** will be described herein.

As shown in FIG. **16**, the hole saw **442** includes a cylindrical body **446** having a side wall **450** extending between a cap end **454** and a cutting end **458**. The cutting end **458** includes a plurality of cutting teeth **462**. The plurality of cutting teeth **462** may be coated with an abrasive coating, e.g., diamond grit.

Elongated apertures **466** are defined within the side wall **450**. Each elongated aperture **466** is defined by a first slot portion **470** and a second slot portion **474**. The first slot portion **470** is oriented substantially perpendicular to the axis **18**. The second slot portion **474** connects to the first slot portion **470** and is oriented at an angle η relative to the cap end **454** and the cutting end **458**. In the illustrated embodiment, the angle η is between approximately 73.5 degrees and approximately 74.5 degrees, but other embodiments may include other ranges. The first slot portion **470** and the second slot portion **474** have substantially the same width **478**. The second slot portion **474** includes an upper wall **482** that is substantially parallel to the cap end **454** and is located at a maximum distance D of approximately 0.2 inches from the cap end **454**. Alternatively, the upper wall **482** of the second slot portion **474** may be oriented flush with the cap end **454** such that distance D is zero, or the second slot portion **474** may extend through a cap (not shown) coupled to the cap end **454**. Each aperture **466** is configured to receive a tool (not shown) for removing work piece plugs from within the cylindrical body **446**.

FIG. **17** illustrates yet another embodiment of a hole saw **486**. The hole saw **486** has substantial similarities to the hole saws **10** and **386** described with respect to FIGS. **1-4** and **15**, and only those aspects that differ from the embodiments of FIGS. **1-4** and **15** will be described herein.

As shown in FIG. **17**, the hole saw **486** includes a cylindrical body **490** having a side wall **494** extending between a cap end **498** and a cutting end **502**. The cutting end **502** includes a plurality of cutting teeth **506**. The plurality of cutting teeth **506** may be coated with an abrasive coating, e.g., diamond grit.

The side wall **494** defines a plurality of elongated apertures **510**. Each elongated aperture **510** is defined by a first slot portion **514** and a second slot portion **518**, each orientated substantially perpendicular to the axis **18**. The first slot portion **514** is disposed closer to the cutting end **502**, and the second slot portion **518** is disposed closer to the cap end **498**. A connecting slot portion **522** connects the first slot portion **514** and the second slot portion **518** and is oriented at an

acute angle relative to the cap end **498** and the cutting end **502**. The connecting slot portion includes a first wall **523** and second wall **524**.

The second slot portion **518** includes an upper wall **526** orientated substantially perpendicular to the axis **18**, a lower wall **527** oriented substantially perpendicular to the axis **18**, a side wall **528**, and a radial wall **530** that extends from the upper wall **526**. A distance B defined between the upper wall **526** and the lower wall **527** is less than half of an axial height of the aperture **510**. The upper wall **526** is located at a maximum distance D of approximately 0.2 inches from the cap end **498**. Alternatively, the upper wall **526** of the second slot portion **518** may be oriented flush with the cap end **498** such that distance D is zero, or the second slot portion **518** may extend through a cap (not shown) coupled to the cap end **498**. The first slot portion **514** includes an upper wall **534** and a lower wall **538**, each oriented substantially perpendicular to the axis **18**. The radial wall **530** connects to the first wall **523**, which connects to the lower wall **538**. The second wall **524** connects to the lower wall **527**, which connects to the side wall **528**. Each aperture **510** is configured to receive a tool (not shown) for removing work piece plugs from within the cylindrical body **490**.

FIG. **18** illustrates yet another embodiment of a hole saw **542**. The hole saw **542** has substantial similarities to the hole saw **10**, **156**, **338**, and **442** described with respect to FIGS. **1-4**, **10**, **14** and **16**, and only those aspects that differ from the embodiments of FIGS. **1-4**, **10**, **14** and **16** will be described herein.

As shown in FIG. **18**, the hole saw **542** includes a cylindrical body **546** having a side wall **550** extending between a cap end **554** and a cutting end **558**. The cutting end **558** includes a plurality of cutting teeth **562**. The plurality of cutting teeth **562** may be coated with an abrasive coating, e.g., diamond grit.

Elongated apertures **566** are defined within the side wall **550**. Each aperture **566** is configured to receive a tool (not shown) for removing work piece plugs from within the cylindrical body **446**. Each elongated aperture **566** is defined by a first slot portion **570** and a second slot portion **574**. The elongated apertures **566** each have a circumferential width A, measured in a direction parallel to the cap end **554** and cutting end **558**. In the illustrated embodiment, the circumferential width A is between approximately 0.595 inches and approximately 0.895 inches, more specifically between approximately 0.670 inches and approximately 0.820 inches, and even more specifically, approximately 0.745 inches. A circumferential width A within these ranges provides for greater access to a user when removing a work piece plug from the hole saw **542**.

The first slot portion **570** is oriented substantially perpendicular to the axis **18**. The second slot portion **574** connects to the first slot portion **570** and is oriented at an angle κ relative to an end wall **576** of the first slot portion **570**, where the end wall **576** is oriented at approximately 15 degrees relative to the axis **18**. In the illustrated embodiment, the angle κ is between approximately 25.5 degrees and approximately 26.5 degrees, but other embodiments may include other ranges.

A slot width C of the second slot portion **574**, measured in a direction parallel to the cap end **554**, is between approximately 0.280 inches and approximately 0.480 inches, more specifically, between approximately 0.330 inches and approximately 0.430 inches, and even more specifically, approximately 0.380 inches. A slot width C within these ranges of values allows for a greater range of tools to be inserted into the slot in order to remove a work piece plug.

The second slot portion **574** includes an upper wall **582** that is parallel to the cap end **554** and is located at a maximum distance D of approximately 0.188 inches from the cap end **554**. The upper wall **582** is located at an axial offset E from a depth **584** of an axially extending portion of a cap (e.g., the axially extending portion **74** of the cap **66** described with respect to FIG. **2**). In the illustrated embodiment, the axial offset E is between approximately 0.010 inches and approximately 0.120 inches, more specifically between approximately 0.030 inches and approximately 0.090 inches, and even more specifically, approximately 0.050 inches. Having an axial offset E within this range of values provides for easier removal of deep work piece plugs from within hole saw **542**. Alternatively, the upper wall **582** of the second slot portion **574** may be oriented flush with the cap end **554** such that distance D is zero, or the second slot portion **574** may extend through a cap (not shown) coupled to the cap end **554**.

The first slot portion **570** includes an upper wall **588** and a lower wall **592**, each oriented substantially perpendicular to the axis **18**. The upper wall **588** is disposed a distance F from the cutting end **558**. In the illustrated embodiment, distance F is between approximately 0.050 inches and approximately 0.895 inches, more specifically between approximately 0.670 inches and approximately 0.820 inches, and even more specifically, approximately 0.745 inches. Having distance F within these ranges of values allows a user to apply more axially-aligned force when removing a plug from the hole saw **542**.

Although the invention has been described with reference to certain preferred embodiments, variations and modifications exist within the scope and spirit of one or more independent aspects of the invention as described.

Thus, the invention provides, among other things, a hole saw. Various features and advantages of the invention are set forth in the following claims.

What is claimed is:

1. A hole saw comprising:

a cylindrical body disposed along an axis of rotation with a side wall extending axially from a cap end to a cutting end, the cutting end including a plurality of cutting teeth; and

a cap coupled to the cap end of the cylindrical body;

wherein the side wall defines an elongated aperture configured to receive a tool for removing work piece plugs from within the cylindrical body, the elongated aperture comprising:

a first slot portion adjacent the cutting end, the first slot portion defined by a first edge of the side wall that is perpendicular to the axis of rotation and a second edge of the side wall that is spaced apart from the first edge and perpendicular to the axis of rotation, the first slot portion having a first length and a first width, the first length being perpendicular to the axis of rotation, and the first length being greater than the first width; and

a second slot portion connected to the first slot portion and extending from the first slot portion toward the cap end, the second slot portion oriented at an oblique angle relative to the axis of rotation, the second slot portion having a second length and a second width, the second length being oriented at the oblique angle relative to the axis of rotation, and the second length being greater than the second width.

2. The hole saw of claim 1, wherein the first slot portion and the second slot portion have the same width.

3. The hole saw of claim 1, wherein the oblique angle is between 14.5 degrees and 15.5 degrees.

4. The hole saw of claim 1, wherein the second slot portion is connected to and extends from an end of the first slot portion.

5. The hole saw of claim 1, wherein the second slot portion is longer than the first slot portion.

6. The hole saw of claim 1, wherein the side wall defines a plurality of elongated apertures *including the elongated aperture in claim 1*, each *of the plurality of* elongated **[**aperture**]** *apertures* comprising:

a first slot portion adjacent the cutting end, the first slot portion defined by a first edge of the side wall that is perpendicular to the axis of rotation and a second edge of the side wall that is spaced apart from the first edge and perpendicular to the axis of rotation, and

a second slot portion connected to the first slot portion and extending from the first slot portion toward the cap end, the second slot portion oriented at an oblique angle relative to the axis of rotation.

7. The hole saw of claim 1, wherein the cap end defines a semi-circular slot configured to receive **[**a plug-removing**]** *the* tool.

8. The hole saw of claim 1, wherein the plurality of cutting teeth includes an abrasive coating.

9. The hole saw of claim 1, wherein the first slot portion does not extend through the cutting end of the cylindrical body.

10. The hole saw of claim 1, wherein the second slot portion does not extend through the cap end of the cylindrical body.

11. The hole saw of claim 1, wherein the cap includes a rim portion seated on the cap end and an axially extending portion extending into the cylindrical body from the cap end.

12. A hole saw comprising:

a cylindrical body disposed along an axis of rotation with a side wall extending axially from a cap end to a cutting end, the cutting end including a plurality of cutting teeth; and

a cap coupled to the cap end of the cylindrical body;

wherein the side wall defines a pair of elongated apertures configured to receive a tool for removing work piece plugs from within the cylindrical body, each elongated aperture comprising:

a first slot portion adjacent the cutting end, the first slot portion defined by a first edge of the side wall that is perpendicular to the axis of rotation and a second edge of the side wall that is spaced apart from the first edge and perpendicular to the axis of rotation, the first slot portion having a first length and a first width, the first length being perpendicular to the axis of rotation, and the first length being greater than the first width; and

a second slot portion connected to the first slot portion and extending from the first slot portion toward the cap end, the second slot portion oriented at an oblique angle relative to the axis of rotation, the second slot portion having a second length and a second width, the second length being oriented at the oblique angle relative to the axis of rotation, and the second length being greater than the second width.

13. The hole saw of claim 12, wherein the first slot portion and the second slot portion have the same width.

14. The hole saw of claim 12, wherein the oblique angle is between 14.5 degrees and 15.5 degrees.

15. The hole saw of claim 12, wherein the second slot portion is connected to and extends from an end of the first slot portion.

16. The hole saw of claim 12, wherein the second slot portion is longer than the first slot portion.

17. A hole saw comprising:

a cylindrical body disposed along an axis of rotation with a side wall extending axially from a first end to a cutting end, the cutting end opposing the first end and including a plurality of cutting teeth;

wherein the side wall defines a first elongated aperture configured to receive a tool for removing work piece plugs from within the cylindrical body, the first elongated aperture comprising:

a first slot portion adjacent the cutting end, the first slot portion defined by a first edge of the side wall that is perpendicular to the axis of rotation and a second edge of the side wall that is spaced apart from the first edge and perpendicular to the axis of rotation, the first slot portion having a first length and a first width, the first length being perpendicular to the axis of rotation, and the first length being greater than the first width; and

a second slot portion connected to the first slot portion and extending from the first slot portion toward the first end, the second slot portion oriented at an oblique angle relative to the axis of rotation, the second slot portion having a second length and a second width, the second length being oriented at the oblique angle relative to the axis of rotation, and the second length being greater than the second width; and

wherein the side wall defines a plurality of elongated apertures including the first elongated aperture, each of the plurality of elongated apertures comprising:

a first slot portion adjacent the cutting end, the first slot portion defined by a first edge of the side wall that is perpendicular to the axis of rotation and a second edge of the side wall that is spaced apart from the first edge and perpendicular to the axis of rotation, and

a second slot portion connected to the first slot portion and extending from the first slot portion toward the first end, the second slot portion oriented at an oblique angle relative to the axis of rotation.

18. A hole saw comprising:

a cylindrical body disposed along an axis of rotation with a side wall extending axially from a first end to a cutting end, the cutting end opposing the first end and including a plurality of cutting teeth;

wherein the side wall defines a pair of elongated apertures configured to receive a tool for removing work piece plugs from within the cylindrical body, each elongated aperture comprising:

a first slot portion adjacent the cutting end, the first slot portion defined by a first edge of the side wall that is perpendicular to the axis of rotation and a second edge of the side wall that is spaced apart from the first edge and perpendicular to the axis of rotation, the first slot portion having a first length and a first width, the first length being perpendicular to the axis of rotation, and the first length being greater than the first width; and

a second slot portion connected to the first slot portion and extending from the first slot portion toward the first end, the second slot portion oriented at an oblique angle relative to the axis of rotation, the

second slot portion having a second length and a second width, the second length being oriented at the oblique angle relative to the axis of rotation, and the second length being greater than the second width.

19. The hole saw of claim 1, wherein the side wall defines a plurality of elongated apertures including the elongated aperture in claim 1, each of the plurality of elongated apertures comprising:

a first slot portion adjacent the cutting end, the first slot portion defined by a first edge of the side wall that is perpendicular to the axis of rotation and a second edge of the side wall that is spaced apart from the first edge and perpendicular to the axis of rotation.

20. The hole saw of claim 1, wherein the side wall defines a plurality of elongated apertures including the elongated aperture in claim 1, each of the plurality of elongated apertures comprising:

a first slot portion adjacent the cutting end; and

a second slot portion extending from the first slot portion toward the cap end, the second slot portion oriented at an oblique angle relative to the axis of rotation.

* * * * *