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(12) **United States Design Patent**  
**Smith et al.**

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(54) **FLUID END FOR A PUMPING SYSTEM**

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 F15B 13/0896; F16K 27/003; F16K  
 37/00; F04B 47/00; F04B 41/06; F04B  
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(Continued)

(56) **References Cited**

**U.S. PATENT DOCUMENTS**

- 1,576,269 A 3/1926 Durant
- 1,595,459 A 8/1926 Durant

(Continued)

**FOREIGN PATENT DOCUMENTS**

- CN 201149099 11/2008
- CN 102748483 10/2012

(Continued)

**OTHER PUBLICATIONS**

Covert Manufacturing, Inc., "Fluid End Block: Covert Manufacturing", (site visited Jul. 30, 2021), covertmfg.com, URL:<http://www.covertmfg.com/our-capabilities/fluid-end-block/> (Year: 2021).\*

(Continued)

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(57) **CLAIM**

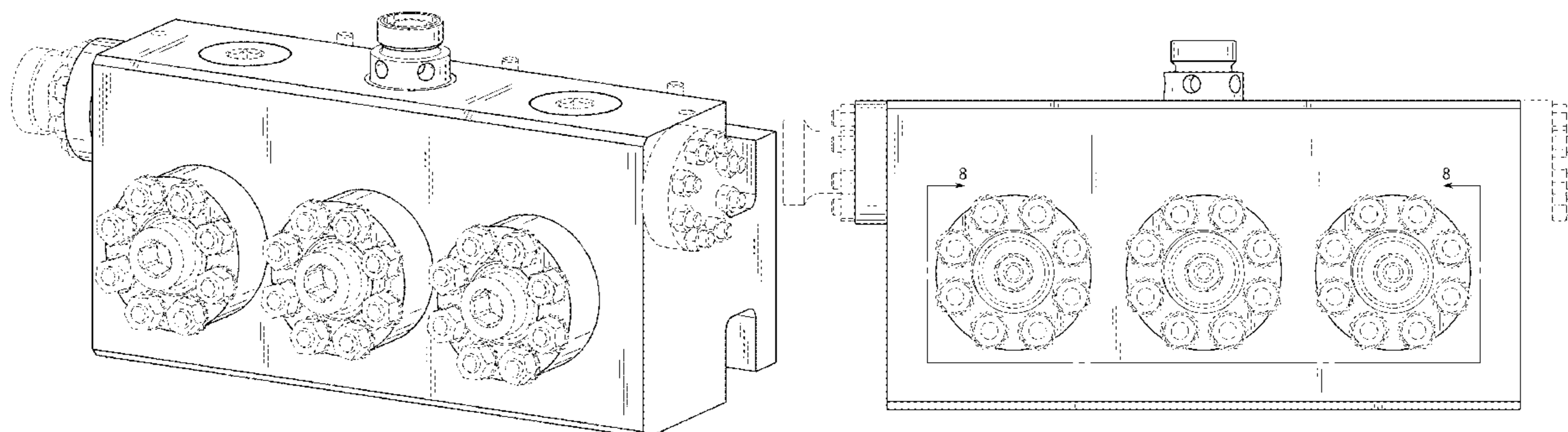
The ornamental design for a fluid end for a pumping system, substantially as shown and described.

**DESCRIPTION**

FIG. 1 is a perspective view of a fluid end;  
 FIG. 2 is a front view of the fluid end;  
 FIG. 3 is a back view of the fluid end;  
 FIG. 4 is a right side view of the fluid end;  
 FIG. 5 is a left side view of the fluid end;  
 FIG. 6 is a top view of the fluid end;  
 FIG. 7 is a bottom view of the fluid end;  
 FIG. 8 is an enlarged view taken along line 8-8 from FIG. 2;  
 FIG. 9 is an enlarged view taken along line 9-9 from FIG. 6; and,  
 FIG. 10 is an enlarged view taken along line 10-10 from FIG. 7.

The broken lines in the drawings depict portions of the fluid end for a pumping system and form no part of the claimed design. The long dash dot broken lines in FIGS. 2, 6 and 7 are provided to define the field of enlargement on FIGS. 7-10, the short dash dot broken lines on FIGS. 7-10 define the bounds of those enlarged regions and form no part of the claimed design.

**1 Claim, 10 Drawing Sheets**



(58) **Field of Classification Search**  
 CPC ..... F04B 35/00; F04B 53/10; F04B 53/02;  
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 See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

1,671,139 A	5/1928	Wilson	5,273,570 A	12/1993	Sato
1,873,318 A	8/1932	Eason	5,314,659 A	5/1994	Hidaka
1,914,737 A	6/1933	Elms	5,478,048 A	12/1995	Salesky
1,948,628 A	2/1934	Penick	5,533,245 A	7/1996	Stanton
1,963,684 A	6/1934	Shimer	5,540,570 A	7/1996	Schuller
1,963,685 A	6/1934	Shimer	5,626,345 A	5/1997	Wallace
2,011,547 A	8/1935	Campbell	5,636,688 A	6/1997	Bassinger
2,069,443 A	2/1937	Hill	5,674,449 A	10/1997	Liang
2,103,504 A	12/1937	White	5,834,664 A	11/1998	Aonuma
2,143,399 A	1/1939	Abercrombie	5,859,376 A	1/1999	Ishibashi
2,304,991 A	12/1942	Foster	5,895,517 A	4/1999	Kawamura
2,506,128 A	5/1950	Ashton	5,949,003 A	9/1999	Aoki
2,547,831 A	4/1951	Mueller	6,139,599 A	10/2000	Takahashi
2,713,522 A	7/1955	Lorenz	6,200,688 B1	3/2001	Liang
2,719,737 A	10/1955	Fletcher	6,328,312 B1	12/2001	Schmitz
2,745,631 A	5/1956	Shellman	6,340,377 B1	1/2002	Kawata
2,756,960 A	7/1956	Church	6,382,940 B1	5/2002	Blume
2,898,082 A	8/1959	Almen	6,436,338 B1	8/2002	Qiao
2,969,951 A	1/1961	Walton	6,460,620 B1	10/2002	LaFleur
2,982,515 A	5/1961	Clinton	6,464,749 B1	10/2002	Kawase
2,983,281 A	5/1961	Bynum	6,482,275 B1	11/2002	Qiao
3,049,082 A	8/1962	Barry	6,485,678 B1	11/2002	Liang
3,053,500 A	9/1962	Atkinson	6,544,012 B1	4/2003	Blume
3,063,467 A	11/1962	Roberts, Jr.	6,623,259 B1	9/2003	Blume
3,224,817 A	12/1965	Carter	6,641,112 B2	11/2003	Antoff
3,276,390 A	10/1966	Bloudoff	6,695,007 B2	2/2004	Vicars
3,288,475 A	11/1966	Benoit	6,702,905 B1	3/2004	Qiao
3,459,363 A	8/1969	Miller	6,880,802 B2	4/2005	Hara
3,474,808 A	10/1969	Elliott	6,910,871 B1	6/2005	Blume
3,483,885 A	12/1969	Leathers	6,916,444 B1	7/2005	Liang
3,489,098 A	1/1970	Roth	6,951,165 B2	10/2005	Kuhn
3,489,170 A	1/1970	Leman	6,951,579 B2	10/2005	Koyama
3,512,787 A	5/1970	Kennedy	6,955,181 B1	10/2005	Blume
3,809,508 A	5/1974	Uchiyama	6,959,916 B2	11/2005	Chigasaki
3,907,307 A	9/1975	Maurer	7,000,632 B2	2/2006	McIntire
3,931,755 A	1/1976	Hatridge	7,036,824 B2	5/2006	Kunz
4,044,834 A	8/1977	Perkins	7,144,440 B2	12/2006	Ando
4,076,212 A	2/1978	Leman	7,168,440 B1	1/2007	Blume
4,184,814 A	1/1980	Parker	7,186,097 B1	3/2007	Blume
4,219,204 A	8/1980	Pippert	7,222,837 B1	5/2007	Blume
4,277,229 A	7/1981	Pacht	7,290,560 B2	11/2007	On-
4,331,741 A	5/1982	Wilson	7,296,591 B2	11/2007	Moe
4,395,050 A	7/1983	Wirz	7,335,002 B2	2/2008	Vicars
4,398,731 A	8/1983	Gorman	7,341,435 B2	3/2008	Vicars
4,440,404 A	4/1984	Roach	7,506,574 B2	3/2009	Jensen
4,508,133 A	4/1985	Hamid	7,513,483 B1	4/2009	Blume
4,518,359 A	5/1985	Yao-Psong	7,513,759 B1	4/2009	Blume
4,527,806 A	7/1985	Ungchusri	7,611,590 B2	11/2009	Liang
4,662,392 A	5/1987	Vadasz	7,681,589 B2	3/2010	Schwegman
4,754,950 A	7/1988	Tada	7,682,471 B2	3/2010	Levin
4,763,876 A	8/1988	Oda	7,726,026 B1	6/2010	Blume
4,770,206 A	9/1988	Sjoberg	7,754,142 B2	7/2010	Liang
4,807,890 A	2/1989	Gorman	7,754,143 B2	7/2010	Qiao
4,811,758 A	3/1989	Piper	7,757,396 B2	7/2010	Sawada
4,861,241 A	8/1989	Gamboa	7,789,133 B2	9/2010	McGuire
4,919,719 A	4/1990	Abe	7,793,913 B2	9/2010	Hara
4,951,707 A	8/1990	Johnson	7,828,053 B2	11/2010	McGuire
5,020,490 A	6/1991	Seko	7,845,413 B2	12/2010	Shampine
5,052,435 A	10/1991	Crudup	7,861,738 B2	1/2011	Erbes
5,061,159 A	10/1991	Pryor	7,866,346 B1	1/2011	Walters
5,062,450 A	11/1991	Bailey	7,891,374 B2	2/2011	Vicars
5,080,713 A	1/1992	Ishibashi	7,954,510 B2	6/2011	Schwegman
5,088,521 A	2/1992	Johnson	7,992,635 B2	8/2011	Cherewyk
5,127,807 A	7/1992	Eslinger	8,069,923 B2	12/2011	Blanco
5,131,666 A	7/1992	Hutchens	8,075,661 B2	12/2011	Chen
5,149,107 A	9/1992	Maringer	8,083,506 B2	12/2011	Maki
5,209,495 A	5/1993	Palmour	8,100,407 B2	1/2012	Stanton
5,249,600 A	10/1993	Blume	8,141,849 B1	3/2012	Blume
5,267,736 A	12/1993	Pietsch	8,181,970 B2	5/2012	Smith
			8,261,771 B2	9/2012	Witkowski
			8,287,256 B2	10/2012	Shafer
			8,291,927 B2	10/2012	Johnson
			8,317,498 B2	11/2012	Gambier
			8,375,980 B2	2/2013	Higashiyama
			8,376,723 B2	2/2013	Kugelev
			8,402,880 B2	3/2013	Patel
			8,430,075 B2	4/2013	Qiao
			D687,125 S *	7/2013	Hawes ..... D23/233
			8,479,700 B2	7/2013	Qiao

(56)

References Cited

U.S. PATENT DOCUMENTS

8,528,585 B2	9/2013	McGuire	10,215,172 B2	2/2019	Wood
8,534,691 B2	9/2013	Schaffer	10,221,848 B2	3/2019	Bayyouk
8,613,886 B2	12/2013	Qiao	10,240,594 B2	3/2019	Bamhouse, Jr.
8,662,864 B2	3/2014	Bayyouk	10,240,597 B2	3/2019	Bayyouk
8,662,865 B2	3/2014	Bayyouk	10,247,182 B2	4/2019	Zhang
8,668,470 B2	3/2014	Bayyouk	10,247,184 B2	4/2019	Chunn
8,707,853 B1	4/2014	Dille	10,273,954 B2	4/2019	Brown
8,733,313 B2	5/2014	Sato	10,288,178 B2	5/2019	Nowell
8,828,312 B2	9/2014	Yao	10,316,832 B2	6/2019	Byrne
8,870,554 B2	10/2014	Kent	10,330,097 B2	6/2019	Skurdalsvold
8,893,806 B2	11/2014	Williamson	10,344,757 B1	7/2019	Stark
8,940,110 B2	1/2015	Qiao	10,364,487 B2	7/2019	Park
8,978,695 B2	3/2015	Witkowski	D856,498 S	8/2019	Bayyouk
8,998,593 B2	4/2015	Vicars	10,378,535 B2	8/2019	Mahmood
9,010,412 B2	4/2015	McGuire	10,393,113 B2	8/2019	Wagner
9,103,448 B2	8/2015	Witkowski	10,400,764 B2	9/2019	Wagner
9,150,945 B2	10/2015	Bei	10,415,348 B2	9/2019	Zhang
9,157,136 B2	10/2015	Chou	10,428,406 B2	10/2019	Yao
9,157,468 B2	10/2015	Dille	10,428,949 B2	10/2019	Miller
9,206,910 B2	12/2015	Kahn	10,443,456 B2	10/2019	Hoeg
D748,228 S	1/2016	Bayyouk	10,465,680 B1 *	11/2019	Guerra ..... F04B 53/162
9,260,933 B2	2/2016	Artherholt	10,472,702 B2	11/2019	Yeh
9,261,195 B2	2/2016	Toynbee	10,487,528 B2	11/2019	Pozybill
9,273,543 B2	3/2016	Baca	10,519,070 B2	12/2019	Sanders
9,284,631 B2	3/2016	Radon	10,519,950 B2	12/2019	Foster
9,285,040 B2	3/2016	Forrest	10,526,862 B2	1/2020	Witkowski
9,291,274 B1	3/2016	Blume	10,557,446 B2	2/2020	Stecklein
9,322,243 B2	4/2016	Baca	10,557,576 B2	2/2020	Witkowski
9,334,547 B2	5/2016	Qiao	10,557,580 B2	2/2020	Mendyk
9,340,856 B2	5/2016	Otobe	10,563,494 B2	2/2020	Graham
9,359,921 B2	6/2016	Hashimoto	10,563,649 B2	2/2020	Zhang
9,365,913 B2	6/2016	Imaizumi	10,570,491 B2	2/2020	Hong
9,371,919 B2	6/2016	Forrest	10,576,538 B2	3/2020	Kato
9,376,930 B2	6/2016	Kim	10,577,580 B2	3/2020	Abbas
9,377,019 B1	6/2016	Blume	10,577,850 B2	3/2020	Ozkan
9,382,940 B2	7/2016	Lee	10,591,070 B2	3/2020	Nowell
9,435,454 B2	9/2016	Blume	10,605,374 B2	3/2020	Takaki
9,441,776 B2	9/2016	Bryne	10,626,856 B2	4/2020	Coldren
9,458,743 B2	10/2016	Qiao	10,633,925 B2	4/2020	Panda
9,464,730 B2	10/2016	Bihlet	10,634,260 B2	4/2020	Said
9,506,382 B2	11/2016	Veager	10,640,854 B2	5/2020	Hu
9,528,508 B2	12/2016	Thomeer	10,655,623 B2	5/2020	Blume
9,528,631 B2	12/2016	McCarty	10,663,071 B2	5/2020	Bayyouk
9,534,473 B2	1/2017	Morris	10,670,013 B2	6/2020	Foster
9,534,691 B2	1/2017	Miller	10,670,153 B2	6/2020	Filipow
9,556,761 B2	1/2017	Koyama	10,670,176 B2	6/2020	Byrne
9,568,138 B2	2/2017	Arizpe	10,677,109 B2	6/2020	Qiao
9,605,767 B2	3/2017	Chhabra	10,677,240 B2	6/2020	Graham
9,631,739 B2	4/2017	Belshan	10,677,365 B2	6/2020	Said
D787,029 S	5/2017	Bayyouk	10,711,754 B2	7/2020	Nelson
9,638,075 B2	5/2017	Qiao	10,711,778 B2	7/2020	Buckley
9,638,337 B2	5/2017	Witkowski	10,718,441 B2	7/2020	Myers
9,650,882 B2	5/2017	Zhang	10,731,523 B2	8/2020	Qu
9,651,067 B2	5/2017	Beschorner	10,731,643 B2	8/2020	DeLeon
9,689,364 B2	6/2017	Mack	10,738,928 B2	8/2020	Arizpe
9,695,812 B2	7/2017	Dille	10,753,490 B2	8/2020	Fuller
9,732,746 B2	8/2017	Chandrasekaran	10,753,495 B2	8/2020	Bayyouk
9,732,880 B2	8/2017	Haines	10,767,520 B1	9/2020	Hattiangadi
9,745,968 B2	8/2017	Kotapish	10,774,828 B1	9/2020	Smith
9,784,262 B2	10/2017	Bayyouk	10,781,803 B2	9/2020	Kumar
9,822,894 B2	11/2017	Bayyouk	10,787,725 B2	9/2020	Fujieda
9,845,801 B1	12/2017	Shek	10,801,627 B2	10/2020	Warbey
9,857,807 B2	1/2018	Baca	10,808,488 B2	10/2020	Witkowski
9,915,250 B2	3/2018	Brasche	10,815,988 B2	10/2020	Buckley
9,920,615 B2	3/2018	Zhang	10,830,360 B2	11/2020	Frank
9,927,036 B2	3/2018	Dille	10,851,775 B2	12/2020	Stark
9,945,362 B2	4/2018	Skurdalsvold	10,865,325 B2	12/2020	Nakao
9,945,375 B2	4/2018	Zhang	10,907,738 B2	2/2021	Nowell
9,989,044 B2	6/2018	Bayyouk	10,914,171 B2	2/2021	Foster
10,029,540 B2	7/2018	Seeger	10,934,899 B2	3/2021	Hattiangadi
10,082,137 B2	9/2018	Graham	10,941,866 B2	3/2021	Nowell
10,094,478 B2	10/2018	Iijima	10,954,938 B2	3/2021	Stark
10,113,679 B2	10/2018	Shuck	10,961,607 B2	3/2021	Oshima
10,190,197 B2	1/2019	Baker	10,962,001 B2	3/2021	Nowell
10,197,172 B2	2/2019	Fuller	D916,240 S *	4/2021	Nowell ..... D23/233
			10,968,717 B2	4/2021	Tran
			10,988,834 B2	4/2021	Lee
			10,989,321 B2	4/2021	Hattiangadi
			11,028,662 B2	6/2021	Rhodes

(56)

References Cited

U.S. PATENT DOCUMENTS

11,041,570	B1	6/2021	Buckley	2016/0215588	A1	7/2016	Belshan
11,078,903	B2	8/2021	Nowell	2016/0238156	A1	8/2016	Hubenschmidt
11,104,981	B2	8/2021	Chen	2016/0245280	A1	8/2016	Todorov
11,105,185	B2	8/2021	Spencer	2016/0319626	A1	11/2016	Dille
11,105,327	B2	8/2021	Hurst	2016/0319805	A1	11/2016	Dille
11,105,328	B2	8/2021	Bryne	2017/0067459	A1	3/2017	Bayyouk
11,105,428	B2	8/2021	Warbey	2017/0089473	A1	3/2017	Nowell
11,111,915	B2	9/2021	Bayyouk	2017/0097107	A1	4/2017	Hotz
11,131,397	B2	9/2021	Fan	2017/0159655	A1	6/2017	Morreale
D933,104	S	10/2021	Ellisor	2017/0218951	A1	8/2017	Graham
D933,105	S	10/2021	Ellisor	2017/0218993	A1*	8/2017	Freed ..... F04B 19/22
D933,106	S	10/2021	Mullins	2017/0297149	A1	10/2017	Shinohara
D933,107	S	10/2021	Mullins	2017/0298932	A1	10/2017	Wagner
11,149,514	B2	10/2021	Witkowski	2017/0314097	A1	11/2017	Hong
11,162,859	B2	11/2021	Lei	2017/0342776	A1	11/2017	Bullock
11,181,101	B2	11/2021	Byrne	2017/0342976	A1	11/2017	Reddy
11,181,108	B2	11/2021	Brooks	2018/0017173	A1	1/2018	Nowell
11,231,111	B2	1/2022	Hurst	2018/0058431	A1	3/2018	Blume
11,242,849	B1	2/2022	Smith	2018/0202434	A1*	7/2018	Barnhouse, Jr. .... F04B 19/22
2002/0084004	A1	7/2002	Takahashi	2018/0298894	A1	10/2018	Wagner
2002/0124961	A1	9/2002	Porter	2018/0312946	A1	11/2018	Gigliotti, Jr
2002/0159914	A1	10/2002	Yeh	2018/0320258	A1	11/2018	Stewart
2003/0205864	A1	11/2003	Dietle	2018/0340245	A1	11/2018	Kemion
2003/0233910	A1	12/2003	Jeong	2018/0354081	A1*	12/2018	Kalyani ..... F04B 39/123
2004/0170507	A1	9/2004	Vicars	2019/0011051	A1*	1/2019	Yeung ..... F04B 53/10
2004/0194576	A1	10/2004	Ando	2019/0017503	A1	1/2019	Foster
2004/0234404	A1	11/2004	Vicars	2019/0024198	A1	1/2019	Hong
2004/0255410	A1	12/2004	Schonewille	2019/0024225	A1	1/2019	Tang
2004/0258557	A1	12/2004	Shun	2019/0032685	A1*	1/2019	Foster ..... F04B 1/053
2005/0095156	A1	5/2005	Wolters	2019/0032720	A1	1/2019	Bayyouk
2005/0200081	A1	9/2005	Stanton	2019/0047049	A1	2/2019	Fujieda
2005/0226754	A1	10/2005	Orr	2019/0049052	A1	2/2019	Shuck
2006/0002806	A1*	1/2006	Baxter ..... F04B 39/10 417/539	2019/0063427	A1	2/2019	Nowell
2006/0027779	A1	2/2006	McGuire	2019/0071755	A1	3/2019	Lee
2006/0045782	A1	3/2006	Kretzinger	2019/0072088	A1	3/2019	DeLeon
2007/0086910	A1	4/2007	Liang	2019/0072089	A1*	3/2019	Buckley ..... F04B 1/0461
2007/0154342	A1	7/2007	Tu	2019/0085806	A1	3/2019	Meibgeier
2007/0273105	A1	11/2007	Stanton	2019/0085978	A1	3/2019	Chase
2007/0295411	A1	12/2007	Schwegman	2019/0101109	A1	4/2019	Cortes
2008/0031769	A1	2/2008	Yeh	2019/0107226	A1	4/2019	Bayyouk
2008/0092384	A1	4/2008	Schaake	2019/0120389	A1	4/2019	Foster
2008/0279706	A1	11/2008	Gambier	2019/0136842	A1*	5/2019	Nowell ..... F04B 53/16
2009/0041611	A1	2/2009	Sathian	2019/0145400	A1*	5/2019	Graham ..... F04B 1/0538 417/53
2009/0278069	A1	11/2009	Blanco	2019/0145568	A1	5/2019	Nick
2009/0261575	A1	12/2009	Bull	2019/0154033	A1*	5/2019	Brooks ..... F04B 53/1087
2010/0272597	A1	12/2010	Qiao	2019/0170137	A1	6/2019	Chase
2011/0079302	A1	4/2011	Hawes	2019/0170138	A1	6/2019	Bayyouk
2011/0142701	A1*	6/2011	Small ..... F04B 53/16 417/521	2019/0194786	A1	6/2019	Chuang
2011/0189040	A1	8/2011	Vicars	2019/0226058	A1	7/2019	Fujieda
2011/0255993	A1	10/2011	Ochoa	2019/0063430	A1	8/2019	Byrne
2012/0141308	A1	6/2012	Saini	2019/0242373	A1*	8/2019	Wernig ..... F04B 53/16
2012/0163969	A1	6/2012	Ongole	2019/0264683	A1	8/2019	Smith
2012/0304821	A1	12/2012	Ando	2019/0292633	A1	9/2019	Porret
2013/0020521	A1	1/2013	Byrne	2019/0301314	A1	10/2019	Kamo
2013/0202457	A1	8/2013	Bayyouk	2019/0301447	A1	10/2019	Skurdalsvold
2013/0202458	A1	8/2013	Byrne	2019/0316685	A1	10/2019	Wang
2013/0319220	A1	12/2013	Luharuka	2019/0376508	A1	12/2019	Wagner
2014/0083541	A1	3/2014	Chandrasekaran	2020/0056272	A1	2/2020	Hong
2014/0083547	A1	3/2014	Hwang	2020/0063899	A1	2/2020	Witkowski
2014/0196883	A1	7/2014	Artherholt	2020/0080660	A1	3/2020	Dyer
2014/0260954	A1*	9/2014	Young ..... E21B 43/26 92/169.4	2020/0080661	A1	3/2020	Mullins
2014/0286805	A1	9/2014	Dyer	2020/0157663	A1	5/2020	Vang
2014/0322034	A1	10/2014	Bayyouk	2020/0158123	A1	5/2020	Chen
2014/0348677	A1	11/2014	Moeller	2020/0173317	A1	6/2020	Keating
2015/0132157	A1	5/2015	Whaley	2020/0208776	A1	7/2020	Bayyouk
2015/0144826	A1	5/2015	Bayyouk	2020/0217424	A1	7/2020	Rasmussen
2015/0147194	A1*	5/2015	Foote ..... F04B 53/16 417/53	2020/0240531	A1	7/2020	Nowell
2015/0219096	A1	8/2015	Jain	2020/0256149	A1	8/2020	Witkowski
2015/0300332	A1	10/2015	Kotapish	2020/0284253	A1	9/2020	Foster
2015/0368775	A1	12/2015	Baker	2020/0284365	A1	9/2020	Bayyouk
2016/0201169	A1	7/2016	Vecchio	2020/0290118	A1	9/2020	Chen
				2020/0291731	A1	9/2020	Haiderer
				2020/0300240	A1	9/2020	Nowell
				2020/0308683	A1	10/2020	Kue
				2020/0347843	A1	11/2020	Mullins
				2020/0355182	A1	11/2020	DeLeon
				2020/0392613	A1	12/2020	Won
				2020/0393054	A1	12/2020	Fuller

(56) **References Cited**

U.S. PATENT DOCUMENTS

2020/0399979 A1 12/2020 Webster  
 2020/0400003 A1 12/2020 Webster  
 2020/0400130 A1 12/2020 Poehls  
 2020/0400132 A1 12/2020 Kumar  
 2020/0400140 A1 12/2020 Bayyouk  
 2020/0400242 A1 12/2020 Spencer  
 2021/0010113 A1 1/2021 Qiao  
 2021/0010470 A1\* 1/2021 Blume ..... F04B 1/0452  
 2021/0017830 A1 1/2021 Witkowski  
 2021/0017982 A1 1/2021 Bayyouk  
 2021/0017983 A1 1/2021 Myers  
 2021/0040836 A1\* 2/2021 Baskin ..... E21B 4/003  
 2021/0054486 A1 2/2021 Kim  
 2021/0102630 A1 4/2021 Nowell  
 2021/0130936 A1 5/2021 Wu  
 2021/0148471 A1 5/2021 Murugesan  
 2021/0180156 A1 6/2021 Kim  
 2021/0190053 A1 6/2021 Wagner  
 2021/0190223 A1 6/2021 Bayyouk  
 2021/0197524 A1 7/2021 Maroli  
 2021/0215071 A1 7/2021 Oikawa  
 2021/0215154 A1\* 7/2021 Nowell ..... F04B 1/0408  
 2021/0230987 A1 7/2021 Tanner  
 2021/0239111 A1 8/2021 Zitting  
 2021/0246537 A1 8/2021 Maroli  
 2021/0260704 A1 8/2021 Hu  
 2021/0270261 A1 9/2021 Zhang  
 2021/0285551 A1 9/2021 Renollett  
 2021/0310484 A1 10/2021 Myers  
 2021/0381504 A1 12/2021 Wagner  
 2021/0381615 A1 12/2021 Riedel  
 2021/0388832 A1 12/2021 Byrne

FOREIGN PATENT DOCUMENTS

CN 102410194 4/2021  
 EP 0 414 955 3/1991

OTHER PUBLICATIONS

KerrPumps, “Super Stainless Steel Better Than The Best,” [http://kerrpumps.com/superstainless?gclid=EAlalQobChMlg47o482q6wIViITich2XPA-qEAAAYASAAEgKrxPD\\_BwE](http://kerrpumps.com/superstainless?gclid=EAlalQobChMlg47o482q6wIViITich2XPA-qEAAAYASAAEgKrxPD_BwE), 2013, last accessed: Aug. 21, 2020, 6 pages.  
 U.S. Appl. No. 16/814,267, 194 pages.  
 U.S. Appl. No. 17/120,121, 110 pages.  
 U.S. Appl. No. 62/234,483, 45 pages.  
 U.S. Appl. No. 62/315,343, 41 pages.  
 U.S. Appl. No. 62/318,542, 44 pages.  
 U.S. Appl. No. 62/346,915, 41 pages.  
 U.S. Appl. No. 62/379,462, 24 pages.  
 “Flush Free Sealing Benefits,” Oct. 3, 2011, <http://empoweringpumps.com/flush-free-sealing-benefits/>, accessed May 9, 2020, 5 pages.  
 Gardner Denver, Well Servicing Pump Model GD-3000—Operating and Service Manual, Apr. 2011, 44 pages.  
 Gardner Denver, Well Servicing Pump Model GD-1000Q—Fluid End Parts List, Sep. 2011, 24 pages.  
 Gardner Denver, Well Servicing Pump Model HD-2250—Operating and Service Manual, Jan. 2005, 44 pages.  
 Gardner Denver, Gd 2500Q HDF Frac & Well Service Pump, 2 pages.  
 Gutting Tool Engineering, “Groove milling,” Aug. 1, 2012, <https://www.ctemag.com/news/articles/groove-milling>, accessed May 13, 2020, 11 pages.  
 Vargususa, “Groovex Innovative Grooving Solutions - Groove Milling,” Dec. 12, 2011, <http://www.youtube.com/watch?v=vrFxHJUXjvk>, 68 pages.  
 Kerr Pumps, Kerr KA-3500B/KA-3500BCB Plunger Pump Parts and Service Manual, 41 pages.  
 Kerr Pumps, Kerr KD-1250B/KD-1250BCB Plunger Pump Service Manual, 38 pages.

Kerr Pumps, Kerr KJ-2250B and KJ-2250BCB Plunger Pump Service Manual, 38 pages.  
 Kerr Pumps, Kerr KM-3250B / KM-3250BCB Plunger Pump Service Manual, 35 pages.  
 Kerr Pumps, Kerr KP-3300B / KP-3300BCB Plunger Pump Service Manual, 41 pages.  
 Kerr Pumps, Kerr KT-3350B/BCB KT-3400BCB Plunger Pump Service Manual, 46 pages.  
 Kerr Pumps, Kerr triplex pump km3250bcb 10,000 psi @ 5.1 gmp, Feb. 2, 2021, <http://imged.com/kerr-triplex-pump-km3250bcb-10-000-psi-5-1-gmp-8234739.html>, 2 pages.  
 Lex Machina, 77 Federal district court cases for Alan D Albright of W.D. Tex., [http://law.lexmachina.com/court/txwd/udge/5198506/cases?status=open&filed\\_on-from=2020-02-19&filed\\_on-to=2020-04-19&pending-](http://law.lexmachina.com/court/txwd/udge/5198506/cases?status=open&filed_on-from=2020-02-19&filed_on-to=2020-04-19&pending-), 7 pages.  
 Lex Machina, Motion Metrics Report for 834 orders issued by District Judge Alan D Albright (ADA) in 1,603 cases from the Search for federal district court cases before Judge Alan D Albright, [https://law.lexmachina.com/motions/motion\\_metrics?cases\\_key=yyix9Y8-k2k](https://law.lexmachina.com/motions/motion_metrics?cases_key=yyix9Y8-k2k), generated on Sep. 23, 2020, 1 page.  
 Lex Machina, 6:20-cv-00200-ADA, *Kerr Machine Co. v. Vulcan Industrial Holdings, LLC* Docket Entries, <https://law.lexmachina.com/cases/2004206451#docket-entries>, 6 pages.  
 Jonathan Maes, “Machining Square Inside Corners: Conquer the Nightmare!,” accessed Sep. 8, 2020, <https://makeitfrommetal.com/machining-square-inside-corners-the-night->, 22 pages.  
 Ross Mackay, “Process Engineering: Properly seal that pump,” May 17, 2005, <https://www.chemicalprocessing.com/articles/2005/465>, 11 pages.  
 MSI Fluid End Components, <https://www.scribd.com/document/421304589/Fluid-End>, 1 page.  
 MSI Dixie Iron Works, Ltd., MSI QI-1000 Technical Manual for 1000 HP Quintuplex MSI QI-1000 Pump, Feb. 21, 2004, 90 pages.  
 MSI, Product Listing and Pricing, accessed Mar. 8, 2016, 19 pages.  
 National Oilwell Varco, 267Q-6M Quinuplex Plunger Pump: Parts List, Jul. 21, 2008, 13 pages.  
 Oil and Gas Well Servicing, Audit Procedures for Oil and Gas Well Servicing, May 2010, Texas Comptroller of Public Accounts, Audit Division, 68 pages.  
 Tony Atkins and Marcel Escudier, Oxford Dictionary of Mechanical Engineering, Oxford University Press, 2013, 10 pages.  
 Parker Hannifin Corporation and Autoclave Engineers, Technical Information, 2016, 16 pages.  
 Girdhar, Moniz and Mackay, “Chapter 5.4 Centrifugal pump design,” *Plant and Process Engineering* 360, 2010, pp. 519-536.  
 Parker Hannifin Corporation, PolyPak Seals for Hydraulic Applications Catalog EPS 5370\_PolyPak, 2015, 38 pages.  
 Paresh Girdhar and Octo Moniz, “Practical Centrifugal Pumps—Design, Operation and Maintenance,” Newnes, 2005, 33 pages.  
 Reinhard Preiss, “Stress concentration factors of flat end to cylindrical shell connection with a fillet or stress relief groove subjected to internal pressure,” 1997, *Int. J. Pres. Ves & Piping*, vol. 73, pp. 183-190.  
 Caterpillar, WS255 Quintuplex Well Stimulation Pump, 2 pages.  
 Gardner Denver Pumps, Redline Series Brochure, 3 pages.  
 Eaton Aerospace Group, Resilient Metallic Seals, TF100-35D, Oct. 2013, 60 pages.  
 Scott McKeown, “District Court Trial Dates Tend to Slip After PTAB Discretionary Denials—Patents Post-Grant,” Jul. 24, 2020, *Ropes & Gray*, accessed Sep. 23, 2020, 3 pages.  
 Ricky Smith and R. Keith Mobley, “Rules of Thumb for Maintenance and Reliability Engineers—Chapter 14: Packing and Seals,” Elsevier, 2008, pp. 239-250.  
 Schlumberger, Jet Manual 02—Reciprocating Pumps, Aug. 7, 2015, 63 pages.  
 Schlumberger, Treating Equipment Manual: Fluid Ends, Section 10, Apr. 2000, 87 pages.  
 SPM Oil & Gas, SP, QEM 3000 Frac Pump, 2021, 4 pages.  
 Supplemental Declaration of Steven M. Tipton, Ph.D., P.E.—Case PGR2020-00065, U.S. Pat. No. 10,591,070, Mar. 2, 2021, 35 pages.  
 Servagroup, TPD 600 Triplex Pump Brochure, Mar. 24, 2011, 2 pages.

(56)

## References Cited

## OTHER PUBLICATIONS

Utex Industries, Inc., Well Service Products Catalog, Jun. 2017, 51 pages.

Utex Industries, Inc., Well Service Packing - Packing Assemblies Complete & Replacement, May 2013, 40 pages.

Vargus Ltd., Groove Milling High Precision Tools for Groove Milling, Dec. 2012, pp. 2-22.

U.S. Appl. No. 16/722,139, 104 pages.

*Kerr Machine Co., v Vulcan Industrial Holdings, LLC*, Vulcan Energy Services, LLC, and Cizion, LLC d/b/a/Vulcan Industrial Manufacturing, Case No. 6:20-CV-00200-ADA, Docket Entry, Aug. 2, 2020, 1 page.

*Acquanlan Deonshay Harris v. Cenlar*, FSB, Case No. 6:20-CV-00271-ADA-JCM, Document 13, Scheduling Order, Aug. 20, 2020, 4 pages.

*Kerr Machine Co. vs. Vulcan Industrial Holdings, LLC*, Case No. WA:20-CV-00200-ADA, Order Setting Markman Hearing, May 29, 2020, 1 page.

*Kendra Coufal v. Roger Lee Thomas and Apple Logistics, Inc.*, Case No. 6:20-CV-00356-ADA-JCM, Document 12, Scheduling Order, Jul. 28, 2020, 4 pages.

*Tipton International, Inc., v. Vetbizcorp, LLC and Samuel Cody*, Case No. 6:20-CV-00554-ADA-JCM, Document 8, Scheduling Order, Aug. 20, 2020, 4 pages.

Declaration of Duncan Hall from Internet Archive/Wayback Machine, Feb. 3, 2021, Kerr Plunger Pump Manuals, 20 pages.

Michael Agnes, Editor, Webster's New World College Dictionary, Fourth Edition, 1999, 5 pages.

Weir SPM Oil & Gas, Grooveless Fluid End, 2008, 1 page.

Weir SPM Oil & Gas, Weir SPM General Catalog, 2009, 40 pages.

Weir SPM Oil & Gas, Well Service Pump Reference Guide, 2008, 55 pages.

*Intellectual Ventures I LLC v VMWare, Inc.*, Case No. 1:19-CV-01075-ADA, Document 91 (W.D. Tex. Jun. 3, 2020), Defendant VMWare, Inc.'s Stipulation of Invalidity Contentions for U.S. Pat. No. 7,949,752, Jun. 3, 2020, 5 pages.

*Vulcan Industrial Holding, LLC et al. v. Kerr Machine Co.* Case No. 4:21-cv-433, Document 1, Complaint for Declaratory Judgment of Patent Non-Infringement, Feb. 9, 2021, 17 pages.

*Trilogy Enterprises, Inc., v. Trilogy Education Services, LLC*, Case No. 6:19-cv-199-ADA-JCM, Document 35, Fifth Amended Scheduling Order, Sep. 8, 2020, 4 pages.

*Dr. Corneliu Bolbocean v Baylor University*, Case No. 6:19-CV-00465-ADA-JCM, Document 34, Scheduling Order, Apr. 6, 2020, 4 pages.

*Kerr Machine Co., v Vulcan Energy Services, LLC, Vulcan Industrial Holdings, LLC, and Cizion, LLC d/b/a/ Vulcan industrial Manufacturing*, Case No. 6:21-CV-00044-ADA, Document 4, Plaintiffs Amended Complaint for Patent infringement and Jury Demand, Jan. 19, 2021, 30 pages.

*Kerr Machine Co., v Vulcan Energy Services, LLC, Vulcan Industrial Holdings, LLC, and Cizion, LLC d/b/a/ Vulcan industrial Manufacturing*, Case No. 6:21-CV-00044, Document 1, Plaintiffs Original Complaint for Patent Infringement and Jury Demand, Jan. 19, 2021, 47 pages.

*Kerr Machine Co., v Vulcan Energy Services, LLC, Vulcan Industrial Holdings, LLC, and Cizion, LLC d/b/a/ Vulcan Industrial Manufacturing*, Case No. 6:21-CV-00044-ADA, Document 10, Plaintiffs Second Amended Complaint for Patent Infringement and Jury Demand, Feb. 1, 2021, 88 pages.

*Kerr Machine Co., v Vulcan Industrial Holdings, LLC, Vulcan Energy Services, LLC, Cizion, LLC*, Case No. W-20-CV-00200-ADA-24, Order Setting Trial Date, Jun. 14, 2020, 1 page.

*Kerr Machine Co., v Vulcan Industrial Holdings, LLC, Vulcan Energy Services, LLC, Cizion, LLC*, Case No. W-20-CV-00200-ADA-29, Order Setting Trial Date, Aug. 2, 2020, 1 page.

*Kerr Machine Co., v. Vulcan Industrial Holdings, LLC*, Case No. 6:20-CV-00200-ADA, Affidavit of Service, Apr. 7, 2020, 1 page.

*Kerr Machine Co., v Vulcan Industrial Holdings, LLC, Vulcan Energy Services, LLC, and Cizion, LLC d/b/a/ Vulcan industrial*

*Manufacturing*, Case No. 6:20-CV-00200-ADA, Plaintiffs First Amended Complaint for Patent Infringement and Jury Demand, Jun. 4, 2020, 11 pages.

*Kerr Machine Co., v Vulcan Industrial Holdings, LLC, Vulcan Energy Services, LLC, and Cizion, LLC d/b/a/ Vulcan industrial Manufacturing*, Case No. 6:20-CV-00200-ADA, Document 26, Defendant Cizion, LLC d/b/a Vulcan Industrial Manufacturing, LLC's Motion to Dismiss or Transfer, Jul. 22, 2020, 10 pages.

*Kerr Machine Co., v Vulcan Industrial Holdings, LLC, Vulcan Energy Services, LLC, and Cizion, LLC d/b/a/ Vulcan Industrial Manufacturing*, Case No. 6:20-CV-00200-ADA, Defendants' Opposed Motion to Stay Litigation Pending the Outcome of the Pending Post-Grant Review Proceeding Before the Patent Trial and Appeal Board, Jul. 31, 2020, 14 pages.

*Kerr Machine Co., v Vulcan Industrial Holdings, LLC*, Case No. 6:20-CV-00200-ADA, Plaintiffs Preliminary Infringement Contentions, May 22, 2020, 50 pages.

*Kerr Machine Co., v Vulcan Industrial Holdings, LLC, Vulcan Energy Services, LLC, and Cizion, LLC d/b/a/ Vulcan Industrial Manufacturing*, Case No. 6:20-CV-00200-ADA, Defendants' Preliminary Invalidity Contentions, Aug. 13, 2020, 29 pages.

*Kerr Machine Co., v Vulcan Industrial Holdings, LLC, Vulcan Energy Services, LLC, and Cizion, LLC d/b/a/ Vulcan Industrial Manufacturing*, Case No. 6:20-CV-00200-ADA, Document 34, Scheduling Order, Aug. 11, 2020, 3 pages.

*Kerr Machine Co., v Vulcan Industrial Holdings, LLC, Vulcan Energy Services, LLC, and Cizion, LLC d/b/a/ Vulcan industrial Manufacturing*, Case No. 6:20-CV-00200-ADA, Document 38, Plaintiffs Second Amended Complaint for Patent Infringement and Jury Demand, Sep. 25, 2020, 11 pages.

*Kerr Machine Co., v Vulcan Industrial Holdings, LLC, Vulcan Energy Services, LLC, and Cizion, LLC d/b/a/ Vulcan Industrial Manufacturing*, Case No. 6:20-CV-00200-ADA, Document 5, Standing Order regarding Scheduled Hearings in Civil Cases in Light of Chief Judge Garcia's 24 Amended Order, Mar. 24, 2020, 4 pages.

*Kerr Machine Co., v Vulcan Industrial Holdings, LLC, Vulcan Energy Services, LLC, and Cizion, LLC d/b/a/ Vulcan Industrial Manufacturing*, Civil Docket for Case No. 6:20-cv-00200-ADA, accessed Sep. 11, 2020, 7 pages.

*Kerr Machine Co., v Vulcan Industrial Holdings, LLC, Vulcan Energy Services, LLC, and Cizion, LLC d/b/a/ Vulcan Industrial Manufacturing*, Case No. 6:20-CV-00200-ADA, Document 54, Claim Construction Order, Dec. 3, 2020, 3 pages.

*Kerr Machine Co., v Vulcan Industrial Holdings, LLC*, Case No. 6:20-CV-00200, Document 1, Plaintiffs Original Complaint for Patent Infringement and Jury Demand, Mar. 19, 2020, 39 pages.

*Adriana del Rocio Barberena-Rovira, et al., v Kuiper Dairy, LLC, et al.*, Case No. 6:20-CV-00250-ADA-JCM, Document 20, Scheduling Order, Jul. 22, 2020, 4 pages.

Senior Living Properties, LLC c. Ironshore Speciality, Insurance Company, Case No. 6:20-CV-00282-ADA-JCM, Document 12, Scheduling Order, Jul. 7, 2020, 4 pages.

Dionne Bracken, Individually and as Next Friend of A.M.B., v Michael D. Ashcraft and Envirovac Waste Transport Systems, Inc., Case No. 6:20-CV-00308-ADA-JCM, Document 17, Scheduling Order, Jul. 28, 2020, 4 pages.

*Kendra Coufal v. Roger Lee Thomas and Apple Logistics, Inc.*, Case No. 6:20-CV-00356-ADA-JCM, Document 12, Scheduling Order, July 228, 2020, 4 pages.

*Tipton International, Inc., v. Vetizcorp, LLC and Samuel Cody*, Case No. 6:20-CV-00554-ADA-JCM, Document 8, Scheduling Order, Jul. 7, 2020, 4 pages.

*Dynaenergetics GmbH & Co. KG and Dynaenergetics US, Inc., v. Hunting Titan, Ltd.; Hunting Titan, Inc.; and Hunting Energy Services, Inc.*, Case No. H-17-3784, Order, Sep. 4, 2020, 2 pages. Slip Opinion, In re Sand Revolution LLC, Case No. 2020-00145 (Fed. Cir. Sep. 28, 2020), 3 pages.

In re Vulcan Industrial Holdings, LLC, Case No. 2020-00151 (Fed. Cir. Sep. 29, 2020), Petition for Writ of Mandamus, 43 pages.

*Densys Ltd., v. 3Shape Trios A/S and 3Shape A/S*, Case No. WA:19-CV-00680-ADA, Document 27, Scheduling Order, Apr. 8, 2020, 4 pages.

(56)

## References Cited

## OTHER PUBLICATIONS

Flowserve, “Dynamic Balance Plug Valve and Double DB Plug Valve: Installation, Operation and Maintenance,” 2011, [https://www.flowserve.com/sites/default/files/2016-07/NVENIM2005-00\\_0.pdf](https://www.flowserve.com/sites/default/files/2016-07/NVENIM2005-00_0.pdf), 36 pages.

Weir Oil & Gas, “SPM Well Service Pumps & Flow Control Products TWS600S Fluid End Operation Instruction and Service Manual,” Feb. 27, 2017, <https://www.global.weir/assets/files/oil%20and%20gas%20ebrochures/manuals/tws600s-fluid-end-2p121260.pdf>, 41 pages.

White Star Pump Co., “Maintenance Manual: Triplex Pump WS-1300/1600,” 2005, [http://www.whitestarpump.com/ES/Jocs/user\\_tpdf](http://www.whitestarpump.com/ES/Jocs/user_tpdf), 45 pages.

Kerrpumps, “Super Stainless Steel Better Than The Best,” [http://kerrpumps.com/superstainless?gclid=EAialQobChMlg47o482q6wIViITich2XPA-qEAYASAAEgKrxPD\\_BwE](http://kerrpumps.com/superstainless?gclid=EAialQobChMlg47o482q6wIViITich2XPA-qEAYASAAEgKrxPD_BwE), 2013, last accessed: Aug. 21, 2020, 6 pages.

Kerrpumps, “Frac One Pumps—Fluid End—Fracing,” <http://kerrpumps.com/fracone>, 2013, last accessed: Aug. 21, 2020, 3 pages.

Kerrpumps, “KerrPumps—Frac Pump & Mud Pump Fluid End—Fluid End Pump,” <http://kerrpumps.com/fluidends>, 2013, last accessed: Aug. 21, 2020, 6 pages.

Vulcan Industrial, “Vulcan,” <http://www.vulcanindustrial.com/>, 2019, last accessed: Aug. 21, 2020, 3 pages.

Vulcan Industrial, “Vulcan,” <http://www.vulcanindustrial.com/fluid-ends/>, 2019, last accessed: Aug. 21, 2020, 3 pages.

Kerr Pumps, “the most advanced fluid ends,” (site visited Aug. 5, 2021), [kerrpumps.com](http://kerrpumps.com/fluidends), URL: <<http://kerrpumps.com/fluidends>> (Year: 2021).

Shandong Baorun, 2250 Triplex Plunger Pump Fluid End Exchangeable with Spm, (site visited Aug. 5, 2021), <https://sdbaorun.en.made-in-china.com/product/wNixIDXYrshL/China-2250-Triplex-Plunger-Pump-Fluid-End-Exchangeable-with-Spm.html> (Year: 2021).

John Miller, “The Reciprocating Pump, Theory, Design and Use,” 1995, 2nd Edition, Krieger Publishing Company, Malabar, Florida, 1 page.

“QIH-1000 Hp Quintuplex,” Dixie Iron Works, 2017, <https://web.archive.org/web/20171031221150/http://www.diwmsi.com/pumping/qi-1000/>.

Technical Manual MSI Hybrid Well Service Pump Triplex and Quintuplex Models, Dixie Iron Works, Mar. 12, 2019, 38 pages. <https://www.diwmsi.com/pumping/qi-1000/>.

Carpenter, “CarTech Ferrium C61 Data Sheet,” 2015, 2 pages. The American Heritage Dictionary, Second College Edition, 1982, 6 pages.

Matthew Bultman, “Judge in West Texas Patent Hot Spot Issues Revised Guidelines,” Sep. 23, 2020, Bloomberg Law News, 3 pages.

David L. Taylor, “Machine Trades Blueprint Reading: Second Edition,” 2005, 3 pages.

Blume, U.S. Pat. No. 6,544,012, issued Apr. 8, 2003, Fig. 12A.

Caterpillar, “Cat Fluid Ends For Well Stimulation Pumps,” 2015, 2 pages.

Claim Chart for U.S. Pat. No. 6,544,012, 23 pages.

Claim Chart for U.S. Pat. No. 7,186,097, 22 pages.

Claim Chart for U.S. Pat. No. 7,845,413, 8 pages.

Claim Chart for U.S. Pat. No. 9,534,472, 8 pages.

Claim Chart for U.S. Pat. Pub. No. 2013/0319220, 17 pages.

Claim Chart for U.S. Pat. Pub. No. 2014/0348677, 10 pages.

Claim Chart for U.S. Pat. Pub. No. 2015/0132157, 23 pages.

Claim Chart for “GD-3000,” 9 pages.

Claim Chart for “NOV-267Q,” 14 pages.

Collins English Dictionary, “annular,” <https://www.collinsdictionary.com/US/dictionary/english/annular>, 2021, 4 pages.

Collins English Dictionary, “circumference,” <https://www.collinsdictionary.com/us/dictionary/english/circumference>, 2021, 7 pages.

Collins English Dictionary, “plug,” <https://www.collinsdictionary.com/us/dictionary/english/plug>, 2021, 17 pages.

Collins English Dictionary, “profile,” <https://www.collinsdictionary.com/us/dictionary/english/profile>, 2021, 10 pages.

Collins English Dictionary, “sleeve,” “therethrough,” “through,” “tube,” and “tubular,” 8 pages.

Collins English Dictionary, “space,” <https://www.collinsdictionary.com/US/dictionary/english/space>, 2021, 13 pages.

Collins English Dictionary, “stairstep,” <https://www.collinsdictionary.com/us/dictionary/english/stairstep>, 2021, 3 pages.

Congressional Record—Extensions of Remarks, Apr. 18, 2007, pp. E773-E775.

Congressional Record, Mar. 7, 2011, 31 pages.

“Declaration of Steven M. Tipton, Ph.D., P.E., Submitted with Patent Owner’s Preliminary Response,” Sep. 11, 2020, 155 pages.

“Declaration of William D. Marscher, P.E. - U.S. Pat. No. 10,914,171,” Feb. 11, 2021, 308 pages.

“Declaration of William D. Marscher, P.E.—U.S. Pat. No. 10,591,070,” May 25, 2020, 209 pages.

Email dated Sep. 22, 2020 in PGR2020-00065, 3 pages.

Email dated Sep. 25, 2020 in *Kerr Machine v Vulcan Industrial Holdings*, 1 page.

U.S. Pat. No. 10,288,178, 353 pages.

U.S. Pat. No. 10,519,950, 142 pages.

U.S. Pat. No. 10,591,070, 168 pages.

U.S. Pat. No. 10,914,171, 104 pages.

U.S. Appl. No. 13/773,271, 250 pages.

U.S. Appl. No. 15/719,124, 183 pages.

\* cited by examiner

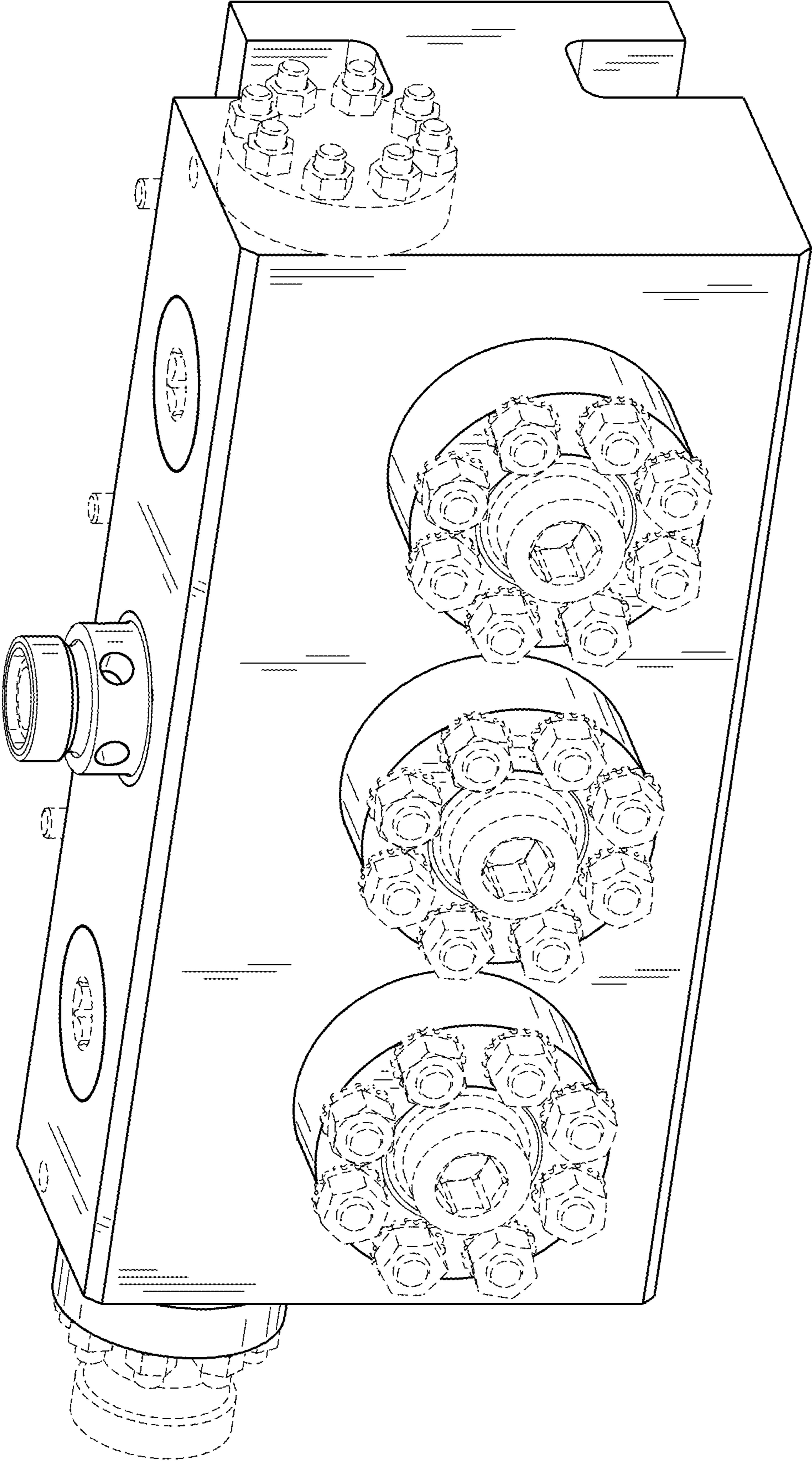


FIG. 1



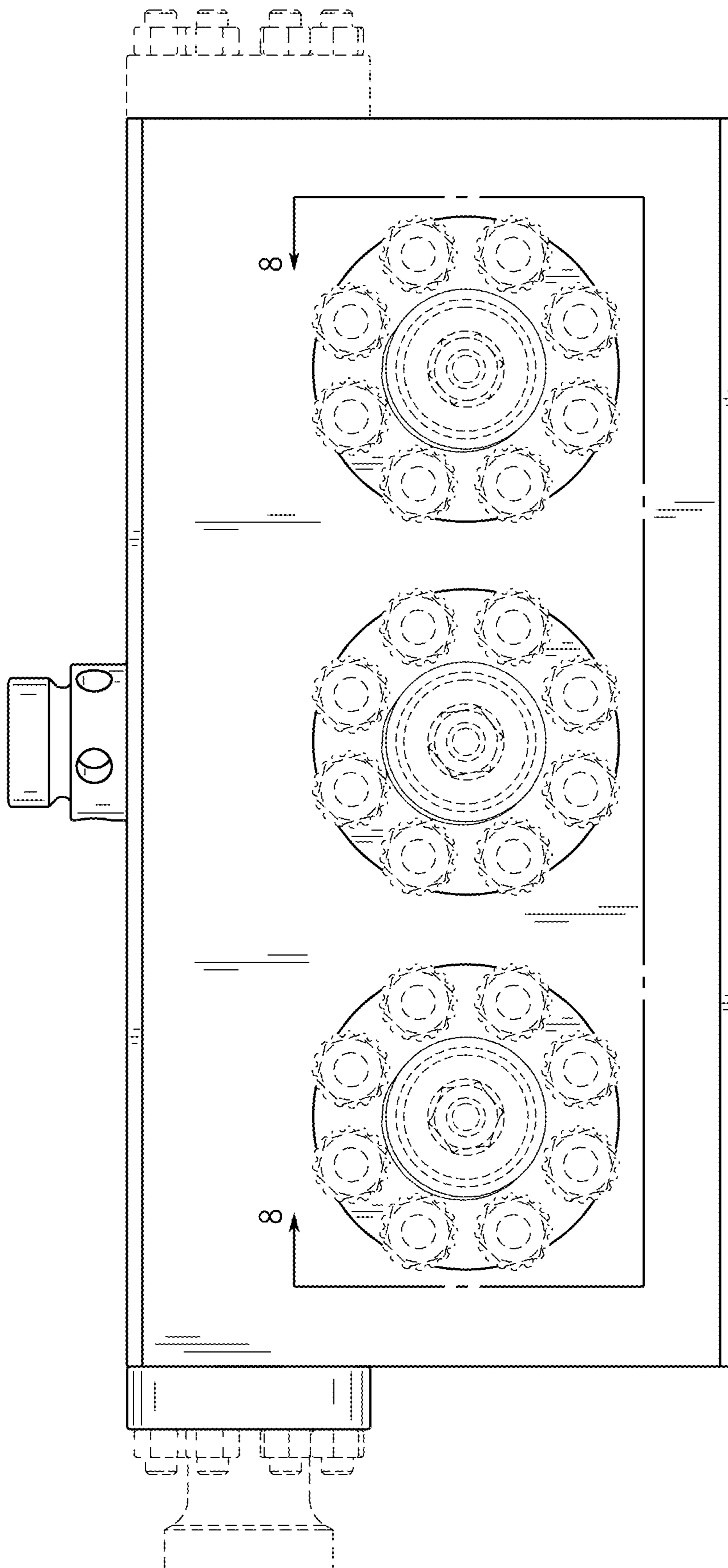


FIG. 2

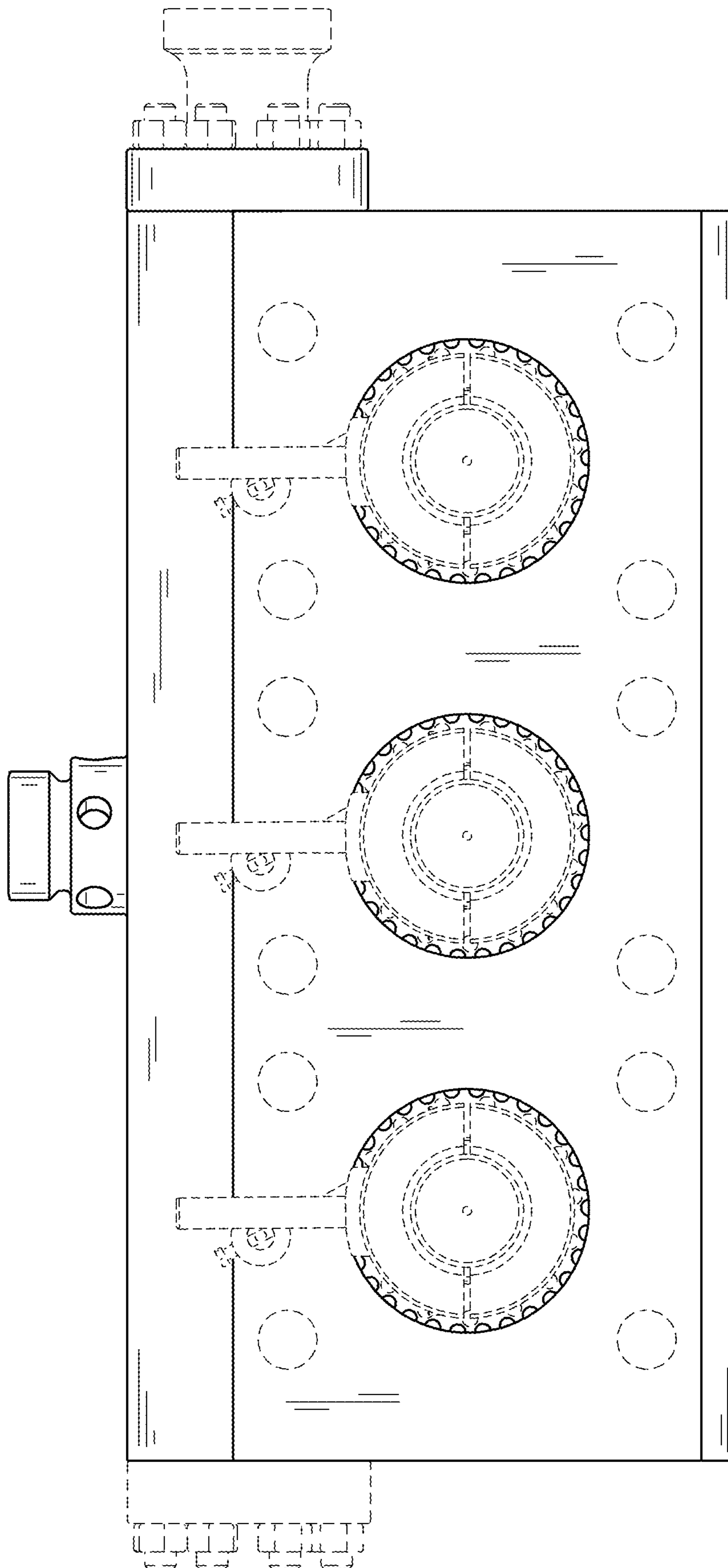


FIG. 3

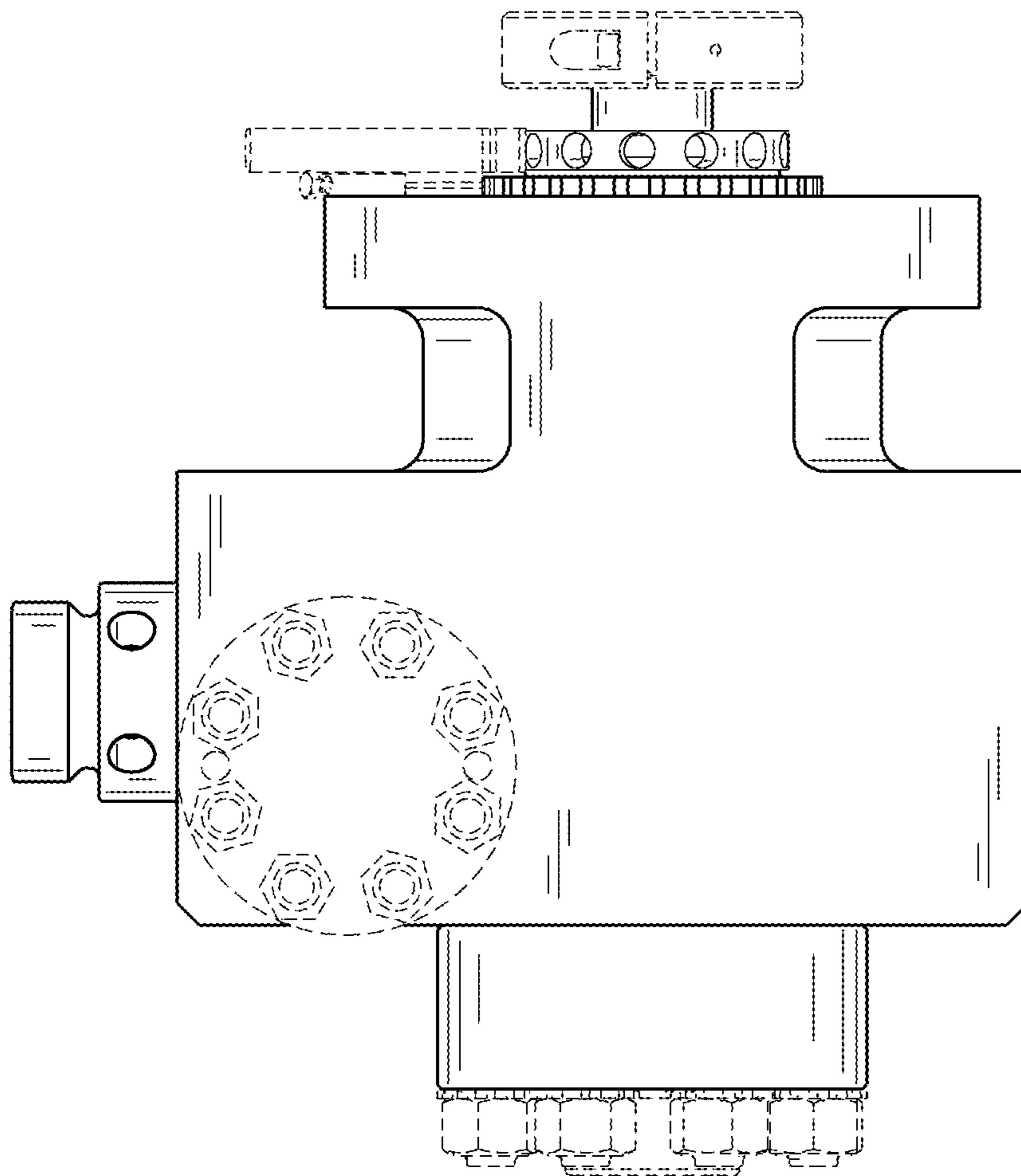


FIG. 4

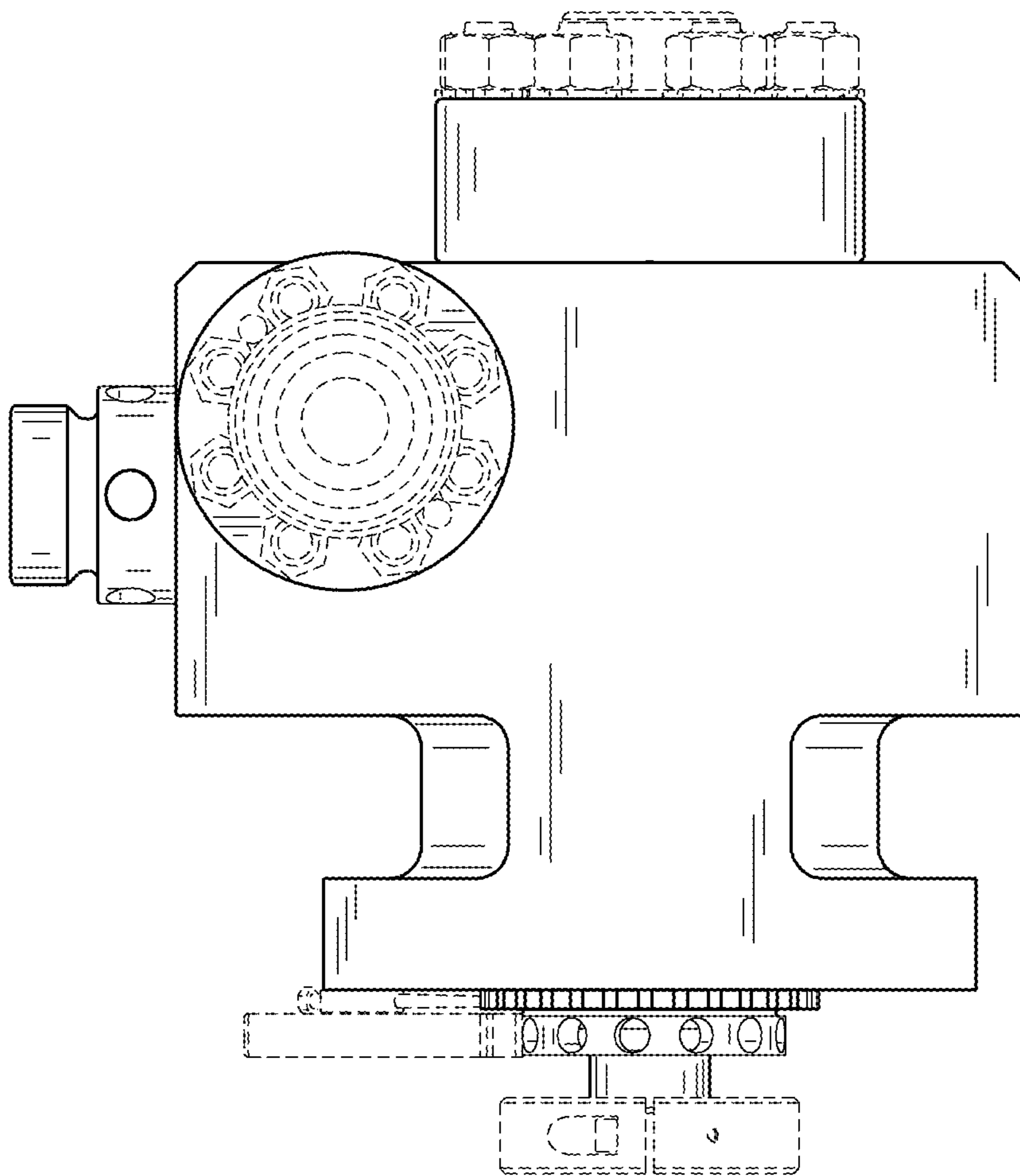


FIG. 5

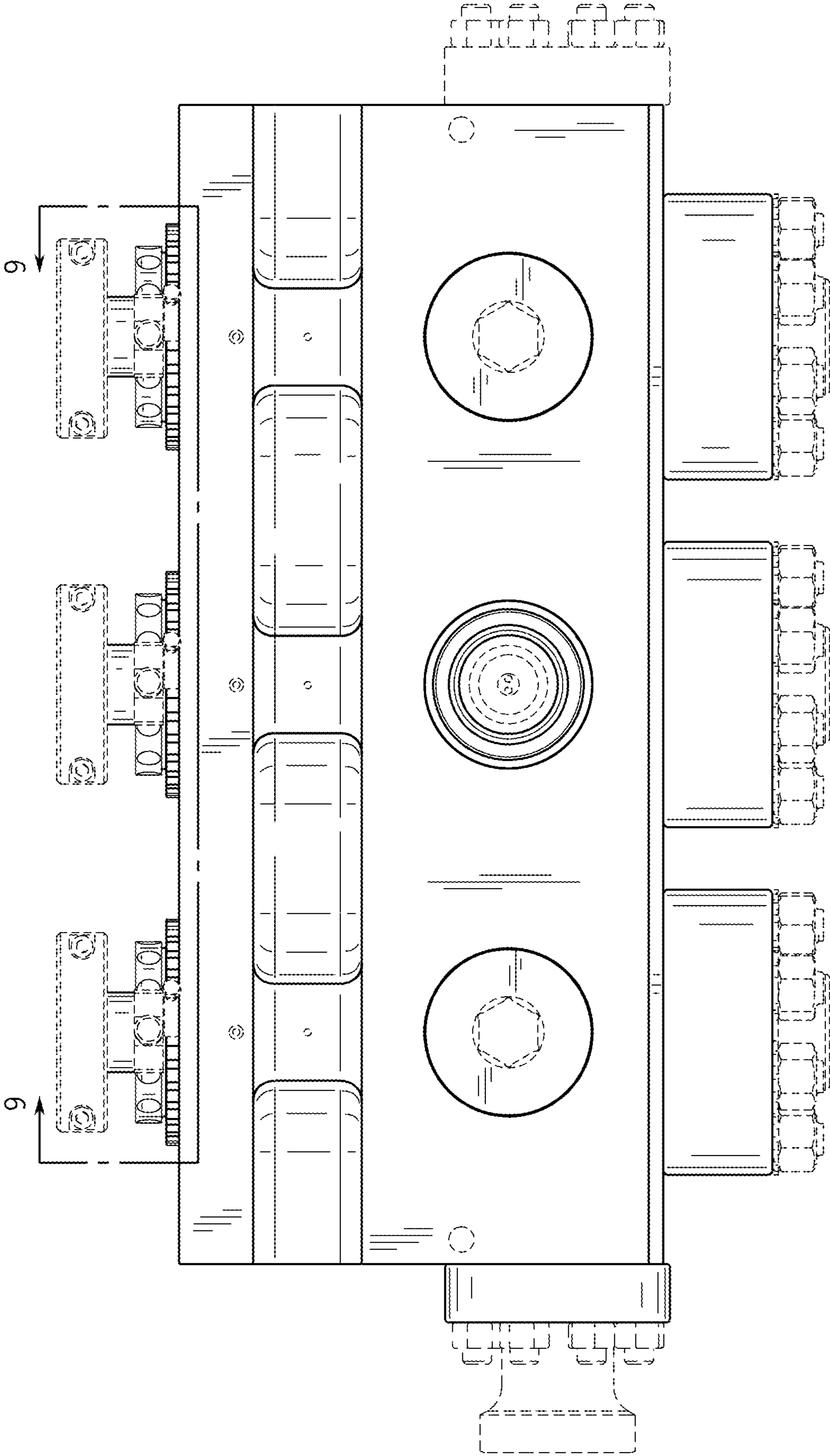


FIG. 6

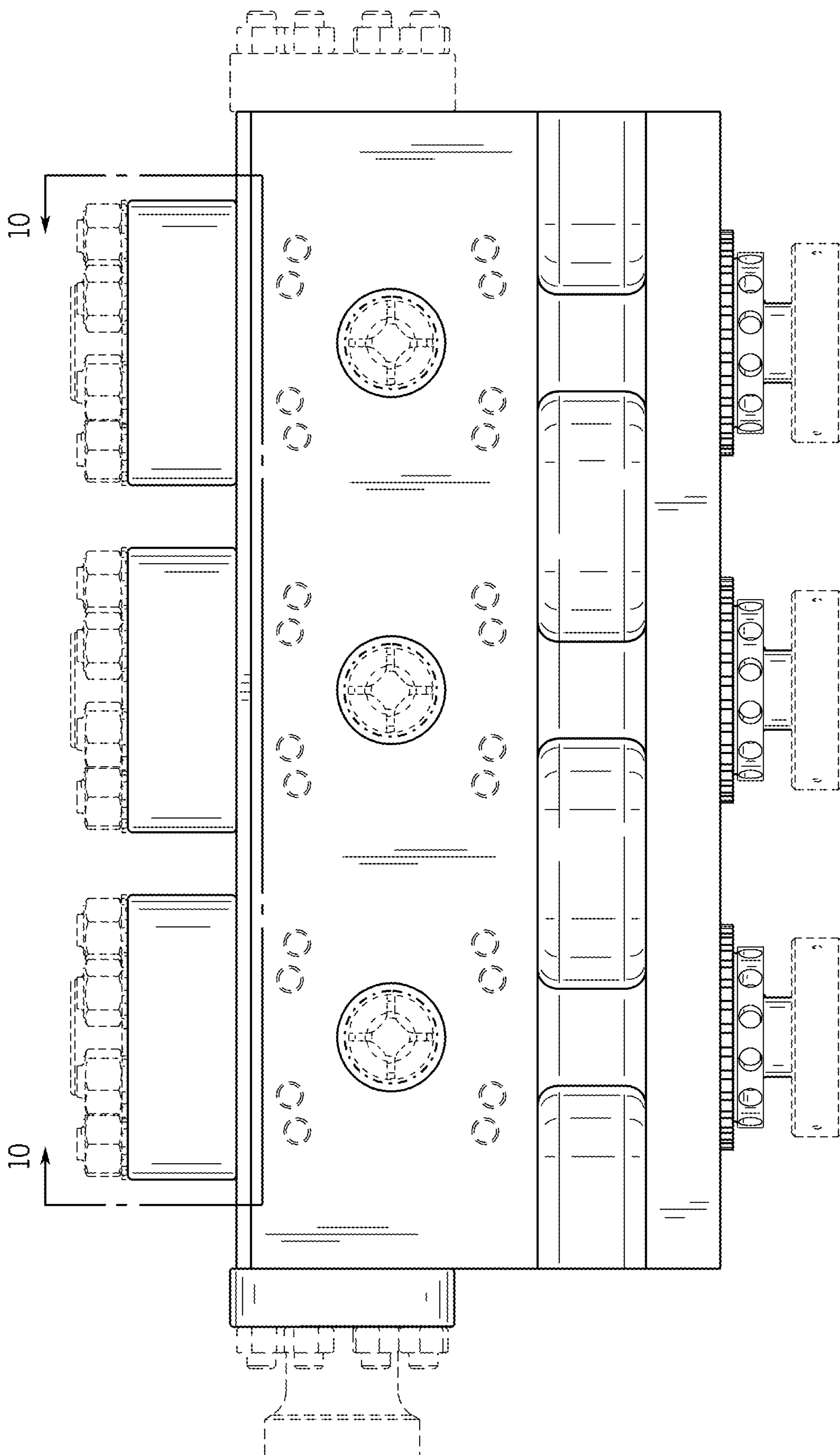


FIG. 7

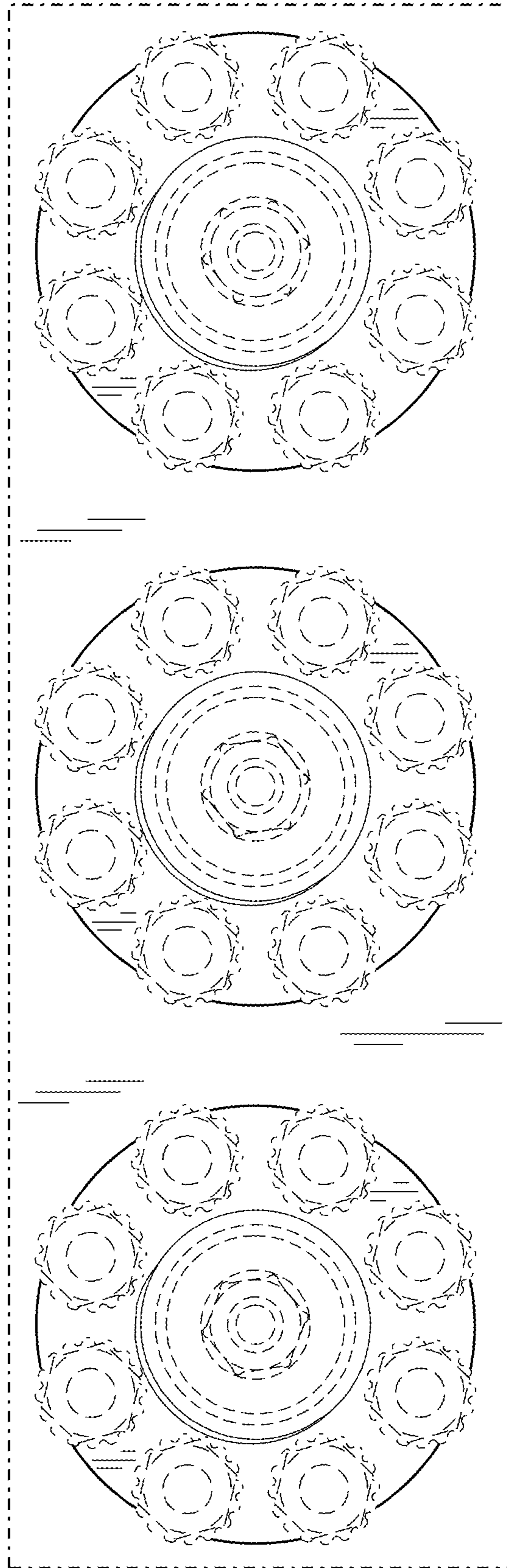


FIG. 8

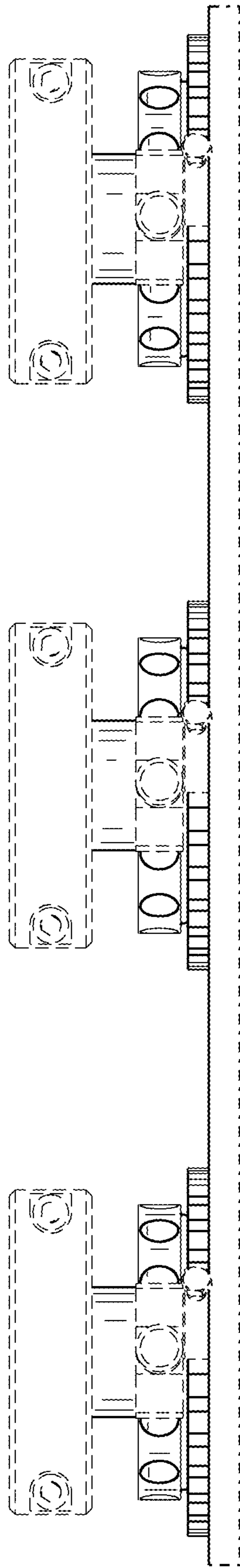


FIG. 9



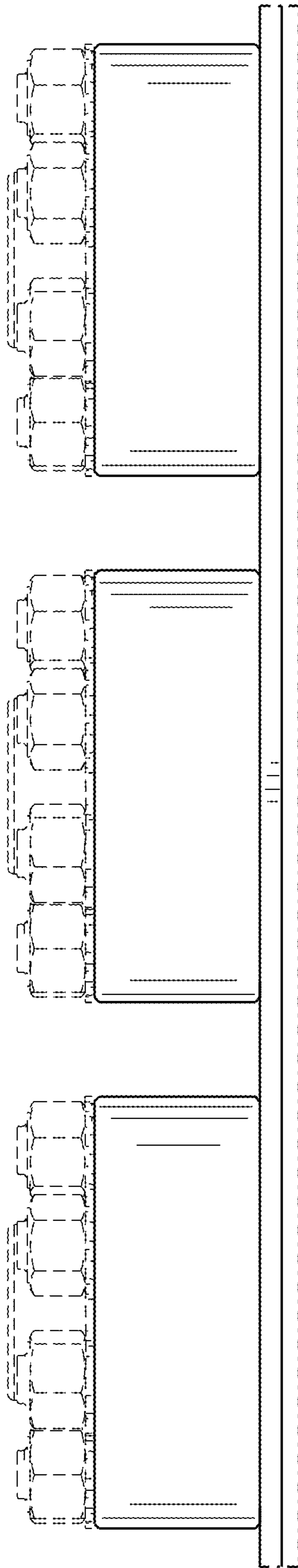


FIG. 10