5 Sheets. Sheet 1.

H. I. Crandall,

Machine Gearing.

No. 83,469. Patented Oct. 27, 1868.

Fig: 1.

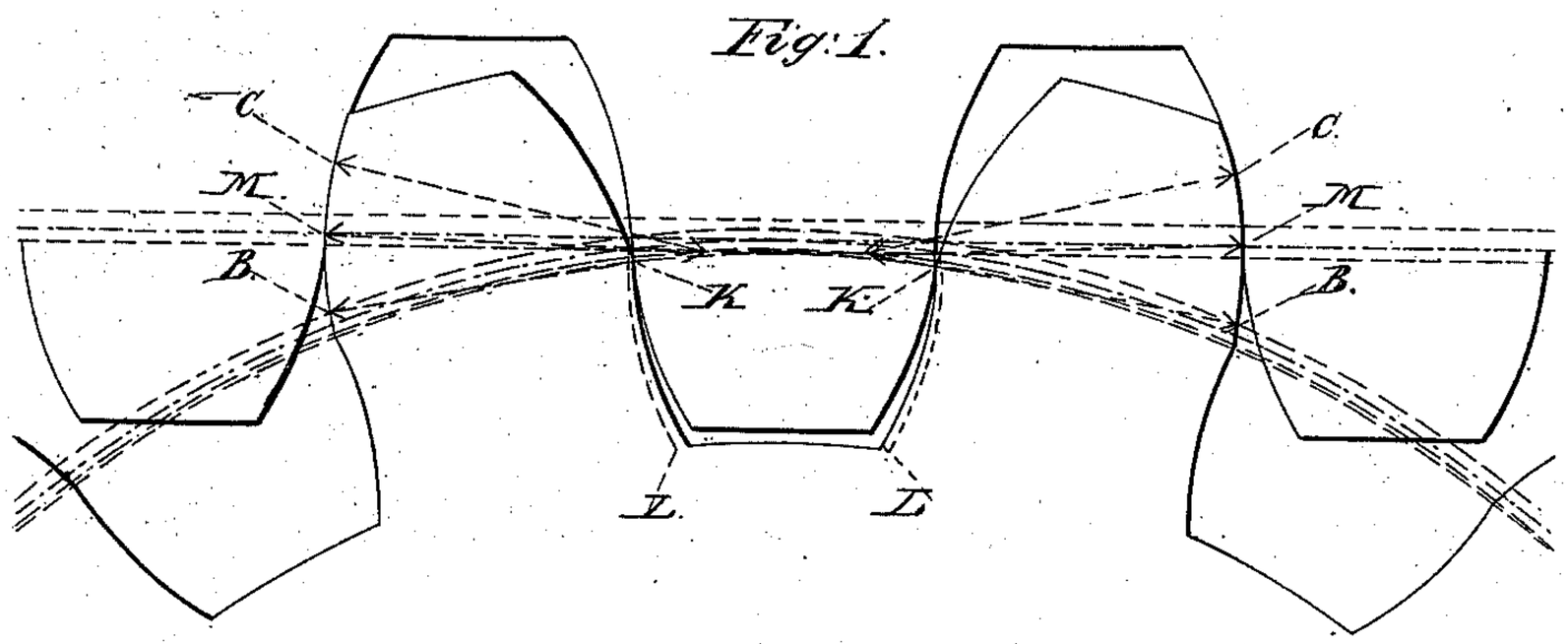
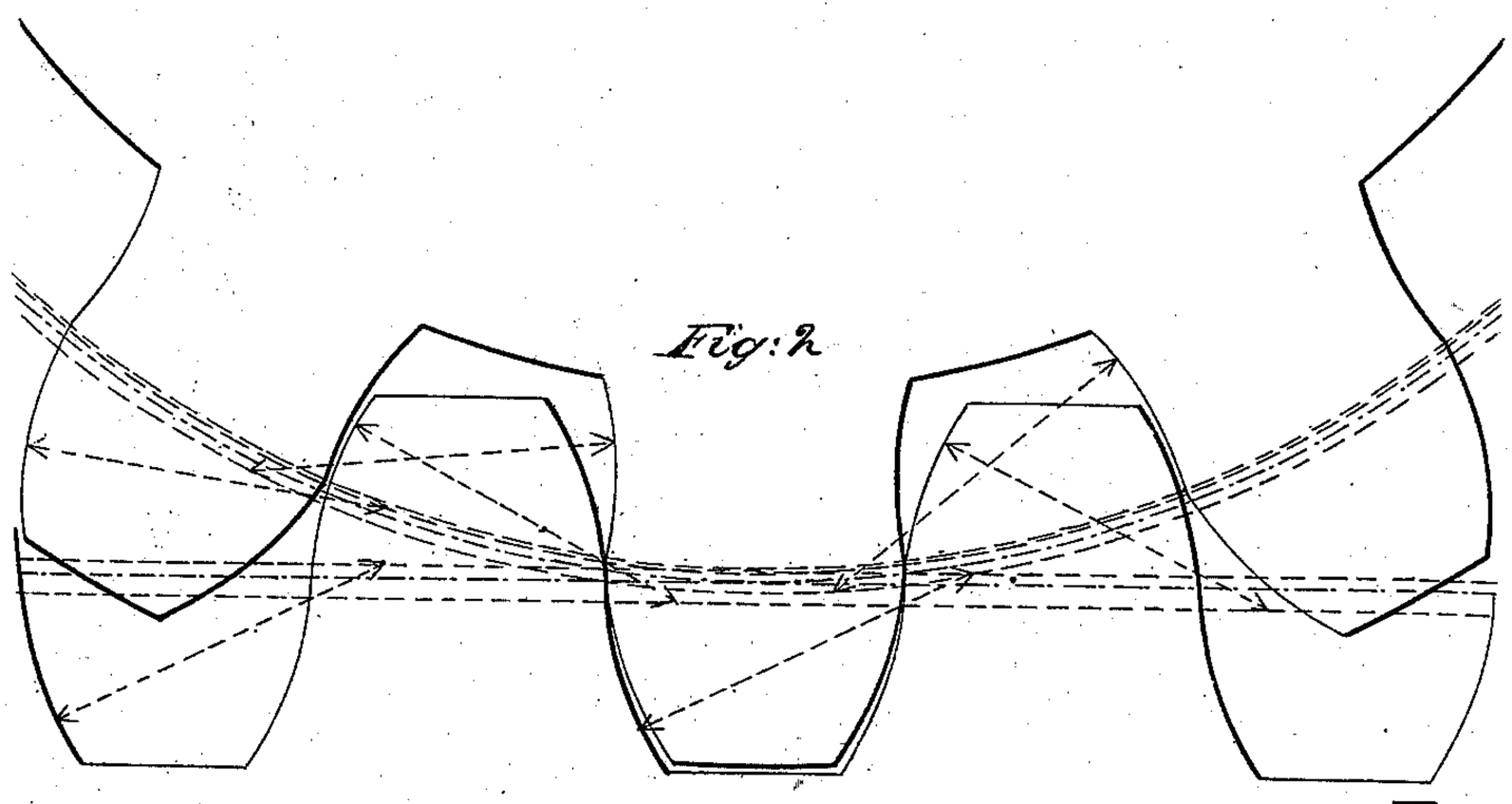


Fig: 2



Witnesses;
James Lyle,
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Inventor;
Horace I. Crandall.

5 Sheets-Sheet 2.

H. I. Crandall,

Machine Gearing.

No. 83,469. Patented Oct. 27, 1868.

Fig: 1.

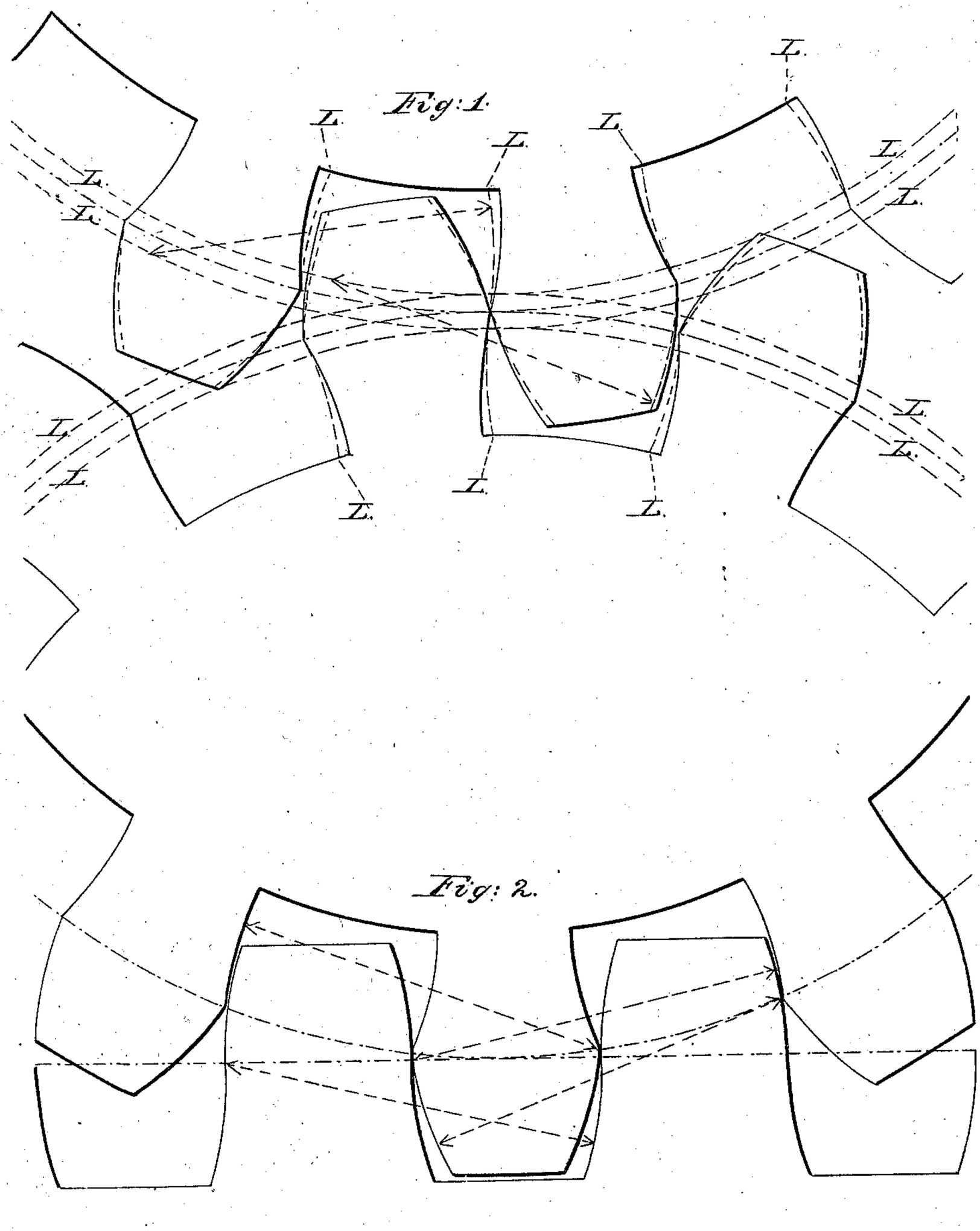
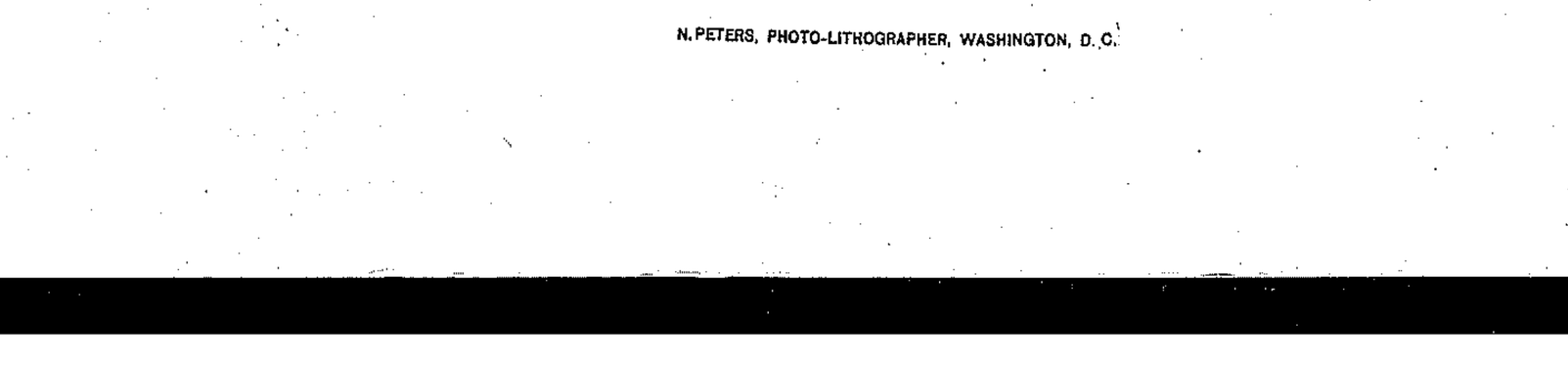


Fig: 2.



Witnesses;
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Horace P. Crandall.

5 Sheets-Sheet 3.

H. I. Crandall,

Machine Gearing.

No. 83,469. Patented Oct. 27, 1868.

Fig: 1.

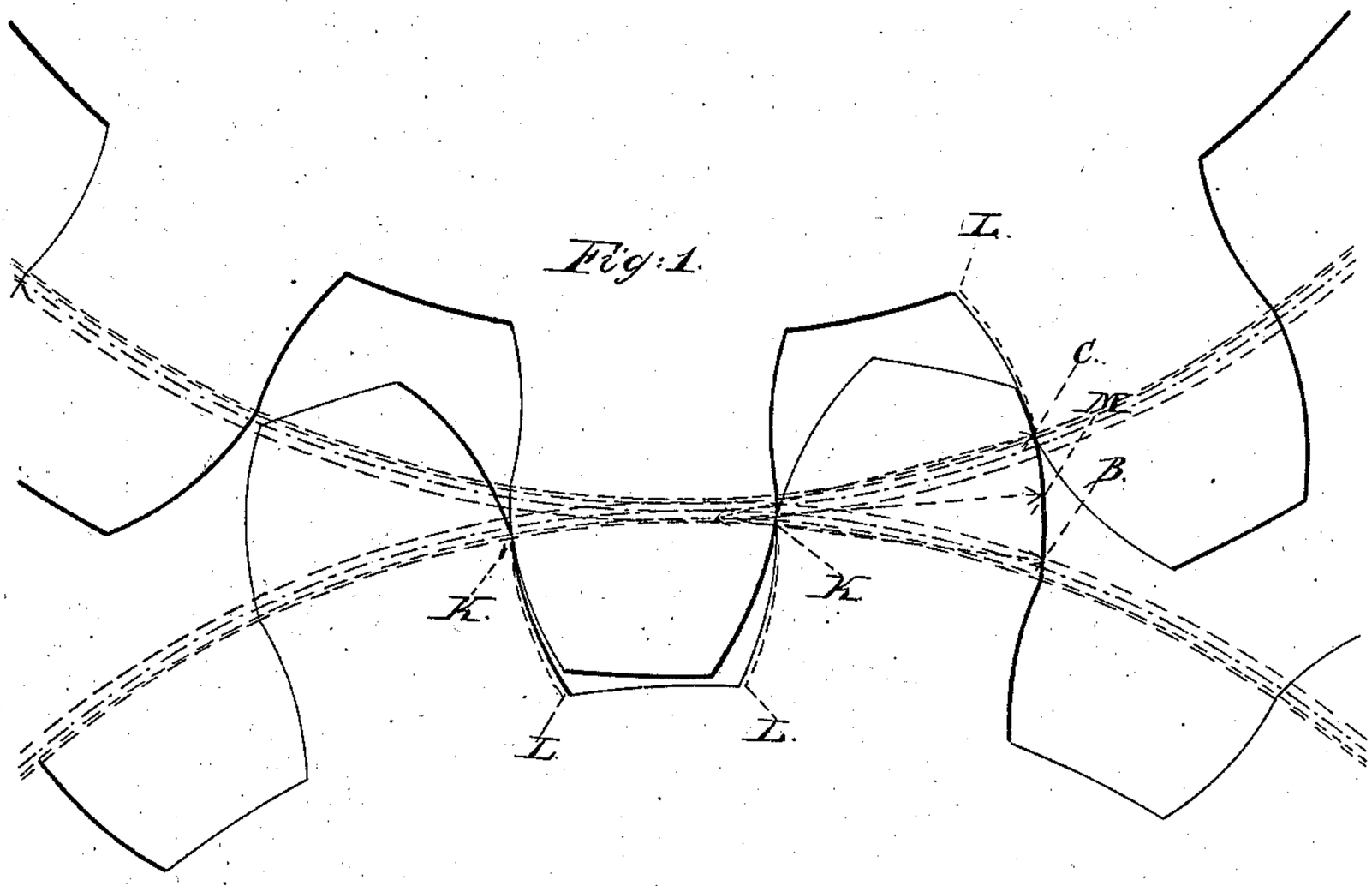
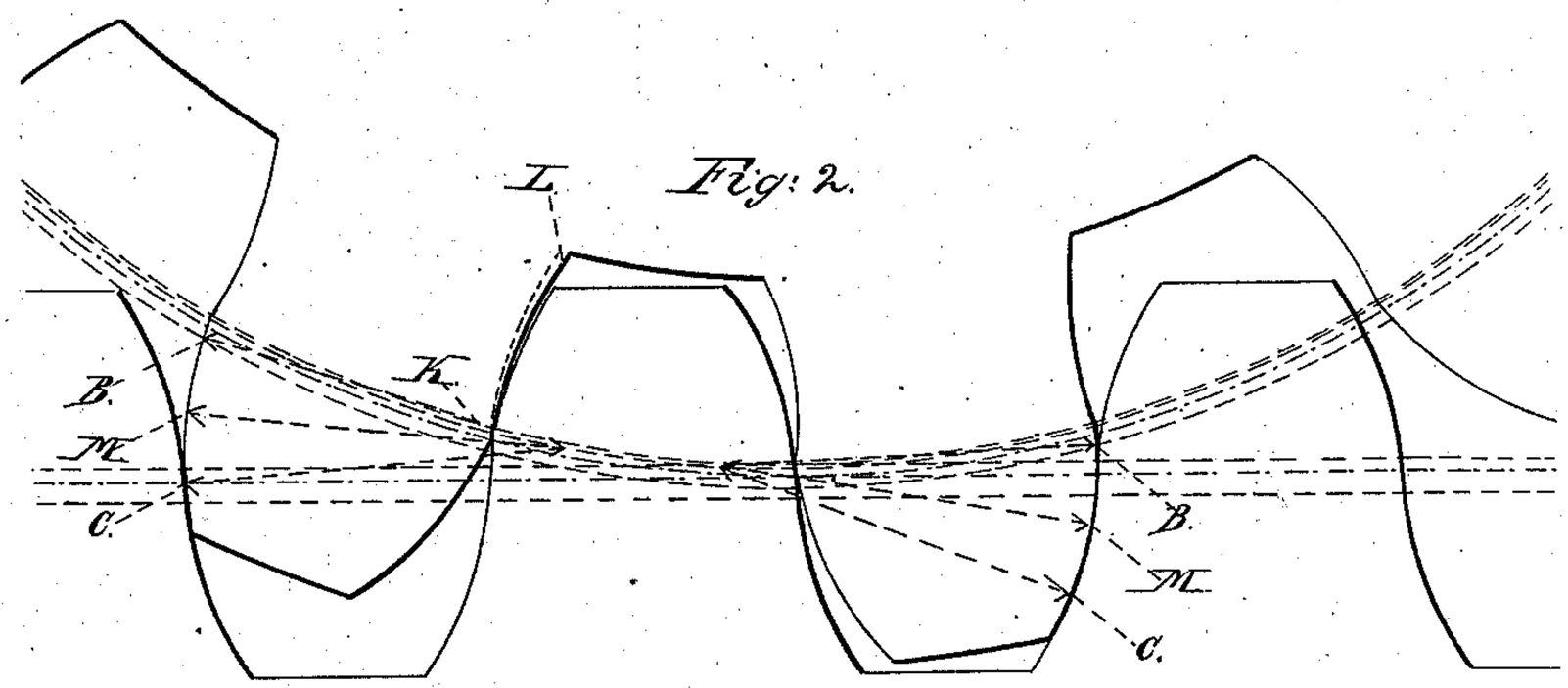


Fig: 2.



Witnesses;
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Inventor;
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5 Sheets - Sheet 4.

H. I. Crandall,

Machine Gearing.

No. 83,469. Patented Oct. 27, 1868.

Fig: 1.

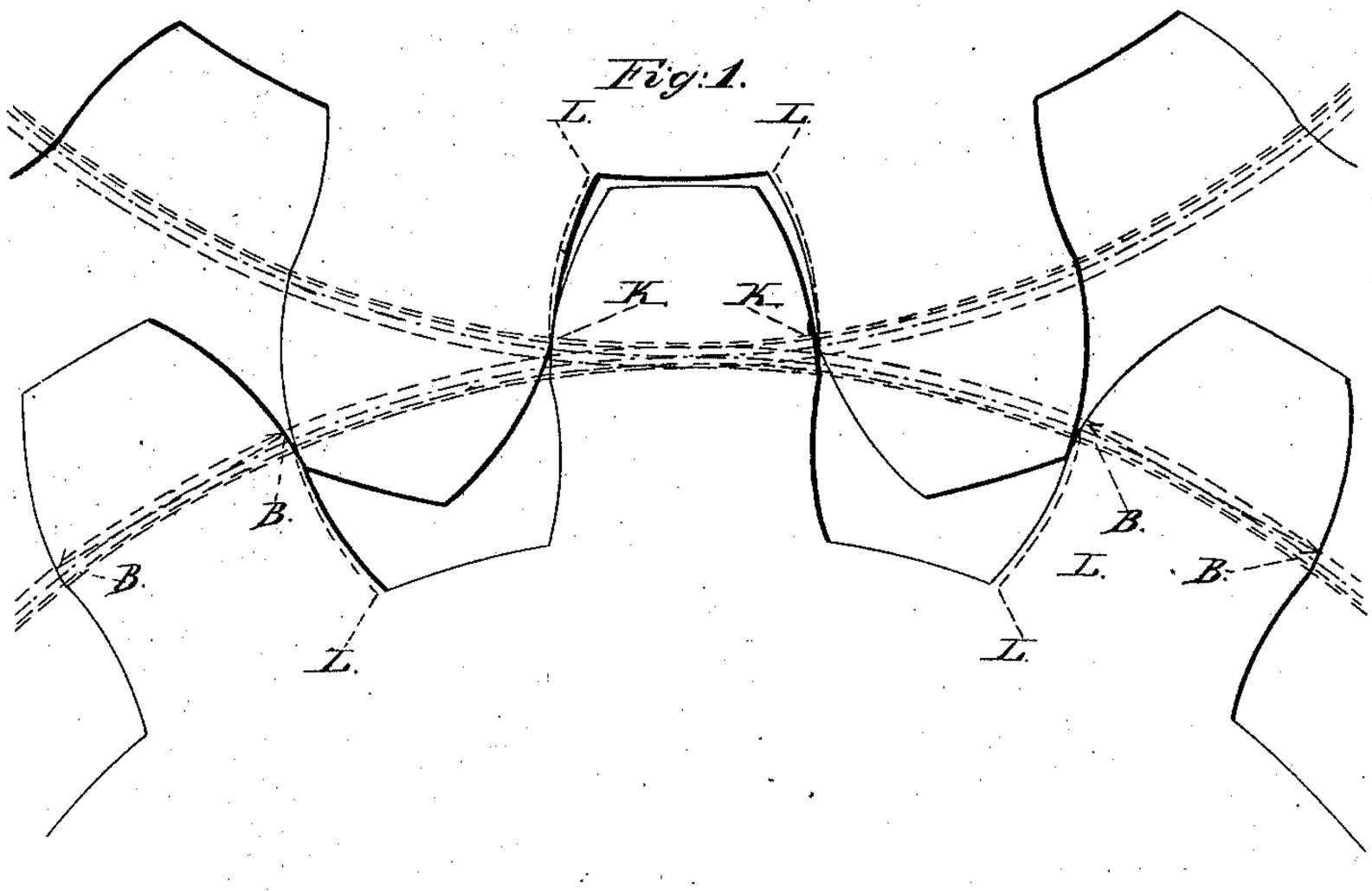
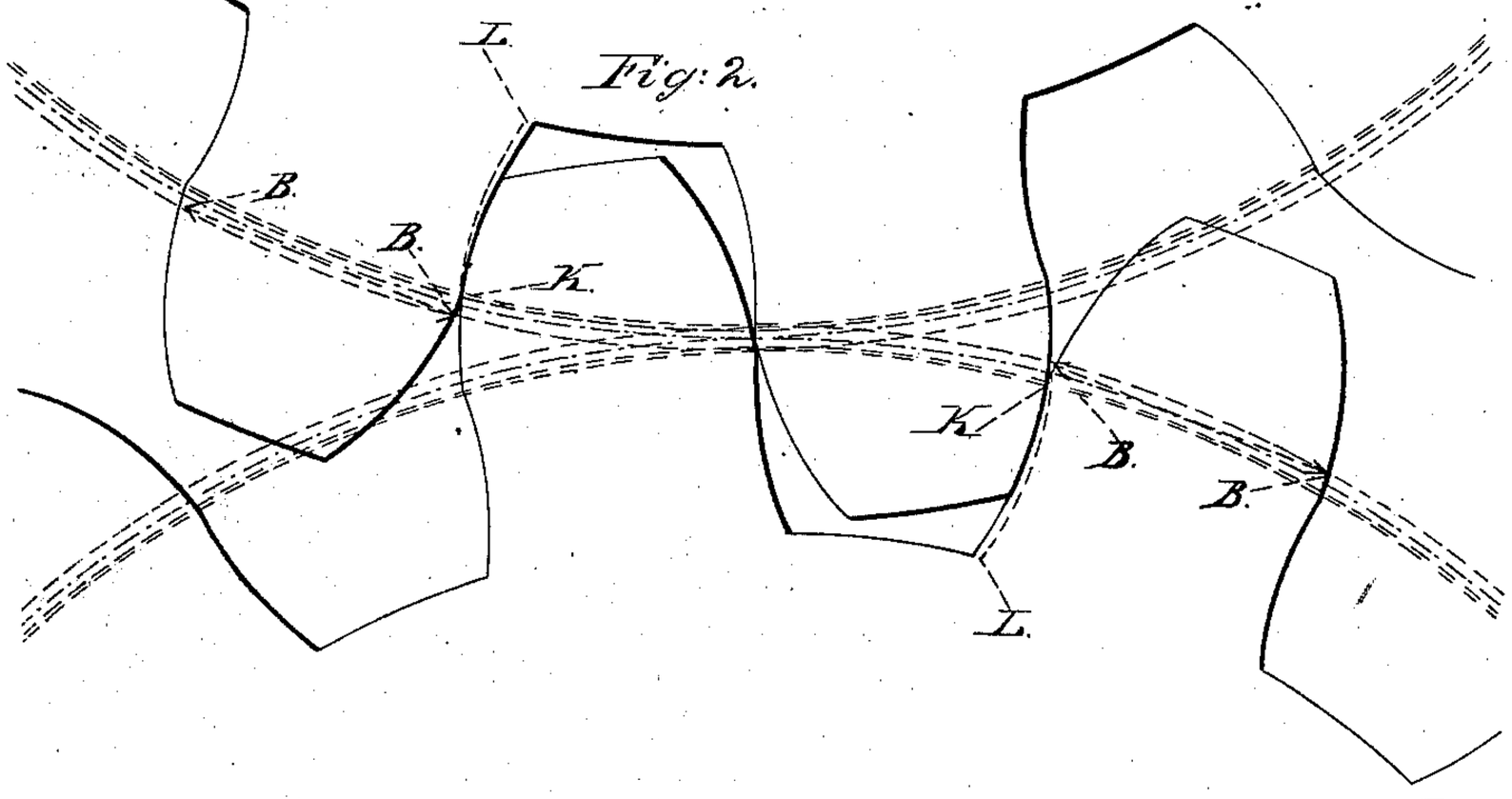


Fig: 2.



Witnesses;
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Inventor;
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5 Sheets. Sheet 5.

H. I. Crandall,

Machine Gearing.

No. 83,469. Patented Oct. 27, 1868.

Fig: 1.

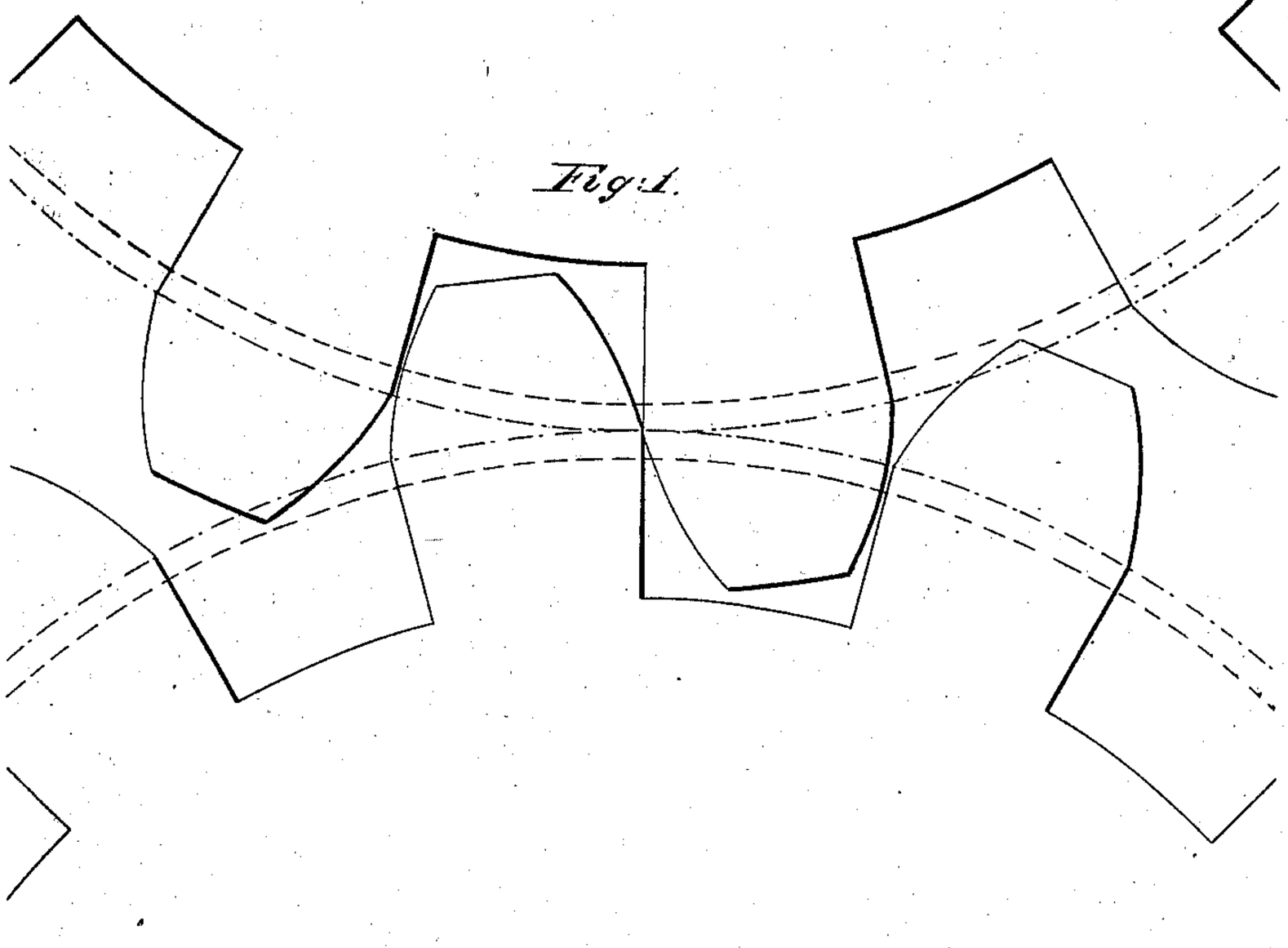
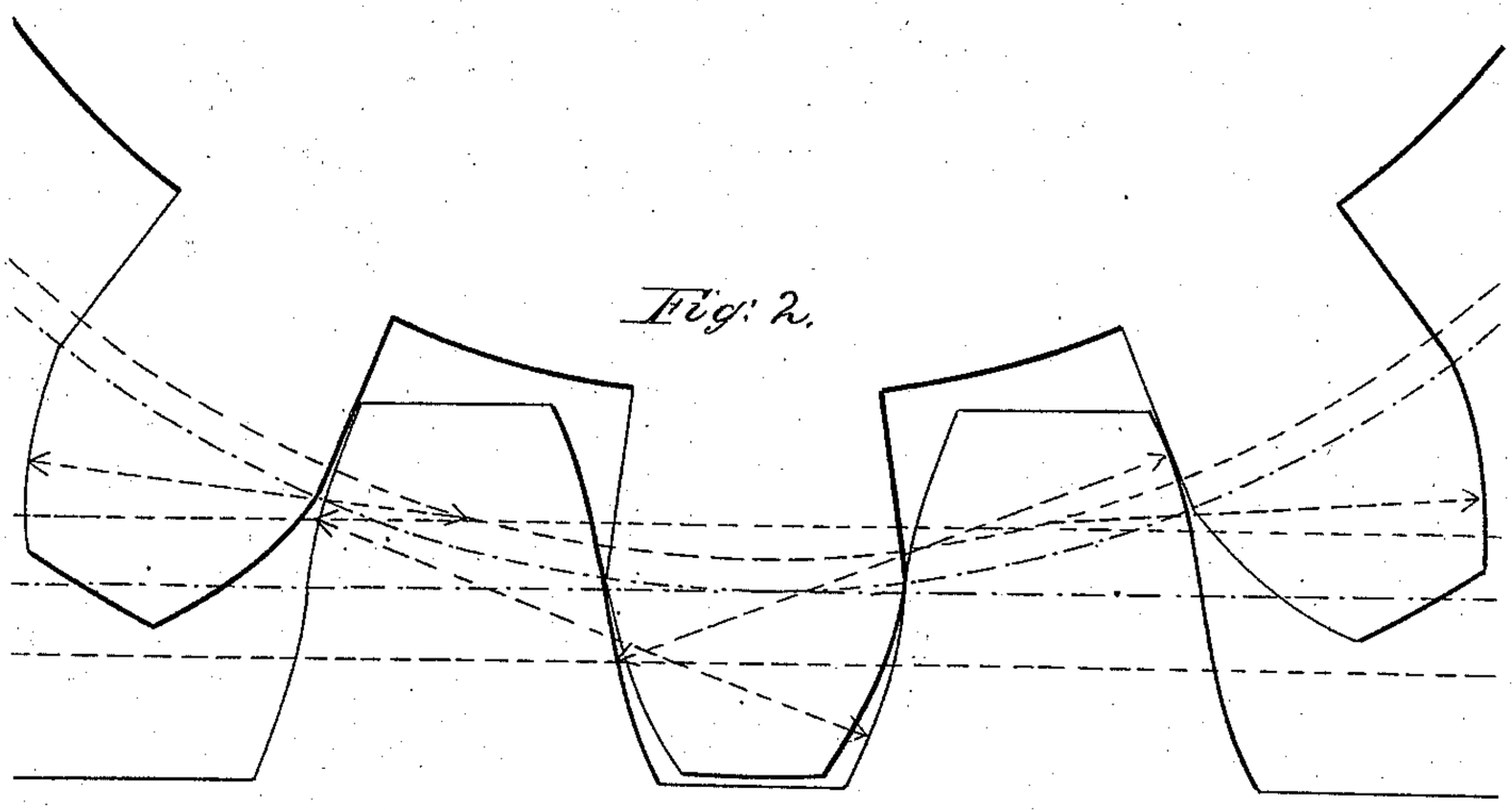


Fig: 2.



Witnesses;
James Lyle,
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Inventor;
Horace I. Crandall.

United States Patent Office.

HORACE I. CRANDALL, OF NEW BEDFORD, MASSACHUSETTS.

Letters Patent No. 83,469, *dated October* 27, 1868.

IMPROVEMENT IN COG-WHEELS FOR GEARING.

The Schedule referred to in these Letters Patent and making part of the same.

Be it known that I, HORACE I. CRANDALL, of New Bedford, in the county of Bristol, in the State of Massachusetts, have invented a new Form for the Teeth of Gears, which will greatly increase their usefulness in the several points hereinafter described, reference being had to the accompanying drawings, and to the letters of reference marked thereon.

The nature of my invention consists of three distinct features, which, in combination, will produce such a form of tooth (for double-faced teeth) that any two of the same pitch can run equally correct together in all their various positions.

To enable those skilled in the arts to apply my invention, I will proceed to describe the same.

The rule for making the old English system of teeth is to space off the thickness of the teeth on the pitch-line or circle from the radial centre-line of each tooth, then using the pitch for the radius for sweeping the faces of the teeth, the fixed leg of the compass resting upon the pitch-line or circle, as represented in Figures 1 and 2, plate 1.

Some makers have endeavored to overcome the errors of the above system by adopting a new radius and locus-centre line on which to rest the fixed leg of the compass, which reduces the thickness of the points, and increases the thickness of the roots. (See dotted lines L L, fig. 1, plate 1.)

The teeth in Willis's system of gears are formed by the use of an instrument called the odontograph, from the use of which the locus-centres and radii are derived.

By reference to fig. 2, plate 2, it will be seen that the pinion-teeth are just as thick as they can be at the pitch-circle to work into the rack. Now look at fig. 1 on same plate, where two such pinions are meshed into each other, and an error or a lack occurs in which the teeth do not fill the opposing cavities by about $\frac{7}{100}$ of an inch, a portion of which is its error in angular velocity.

The same error will appear in any of the modifications of the English system, only to a greater degree than in Willis's. (See English, figs. 1 and 2, plate 1.)

In my system of gears, there are three peculiar and distinct features, neither of which has been used or claimed by any writer upon the subject previous to my invention.

The first of these features is, that the thickness of all teeth must be spaced at right angles from the radial centre-line of each tooth, from the intersection of that line with the pitch-circle. (See B B, figs. 1 and 2, plate 5.)

This feature, when properly used, will give a universal condition of thickness, regardless of the curvature of the pitch-circle, or of radii, or locus-centres.

The second feature of my system is, that the meeting-point of the root and point-faces is not at the pitch-circle, but inside of it, in proportion to the pitch and number of teeth. (This point will hereafter be called the knuckle.)

By reference to dotted lines L L on fig. 1, plate 3, also L L, plates 4 and 5, it will be seen that without this knuckle the teeth could never be tight in those positions; and referring to tooth A A of rack on fig. 1, plate 3, it will be seen that without this feature of the knuckle K K, the tooth A A would not be in contact with either of the pinion-teeth, and that whichever was the driver, either rack or pinion, the operative points would be at M M, which is at an angle of twenty-two and a half degrees from the centre of motion, and the rack-tooth A A, which ought to be doing nearly all the work in this position, would, without this feature of the knuckle, be doing nothing; and similar to this will be the result of all double-faced teeth that have their culminating points at the pitch-circle.

The third feature of my system is, that the pinion which has the least number of teeth in the set, determines and furnishes the radius for sweeping the faces of all the teeth that are included in that set.

The three points necessary for forming a segment of this circle are found in the following manner:

The point B $B^{\times}$, fig. 1, plate 3, and figs. 1 and 2, plates 4 and 5, indicating the thickness of teeth, as before described, is a fixed point.

The second point of the segment is indicated at M M, fig. 1, plate 3, and figs. 1 and 2, plate 4, which point cannot be deviated from and maintain constant contact of the teeth.

For the third point of the segment, reference must be had to point C C, figs. 1 and 2, plate 4, which is likewise a fixed point in the segment of the circle which forms the faces of the teeth; and from these three points are found the radius and locus-centre for the same.

For the obtaining of the radius and locus-centres, reference must be had to the following rules and tables of coefficients:

Table of Coefficients for Crandall's System of Gears.—Coefficients for finding the Locus-Centre Line for Faces of Points.

No. of teeth.	Coefficient.	No. of teeth.	Coefficient.	No. of teeth.	Coefficient.	No. of teeth.	Coefficient.	No. of teeth.	Coefficient.	No. of teeth.	Coefficient.	No. of teeth.	Coefficient.	No. of teeth.	Coefficient.
1	.....	26	,08502	51	,05153	76	,03649	101	,02742	126	,02358	151	,02080	176	,01839
2	.....	27	,08266	52	,05081	77	,03600	102	,02721	127	,02346	152	,02070	177	,01830
3	.....	28	,08041	53	,05011	78	,03548	103	,02701	128	,02334	153	,02060	178	,01821
4	.....	29	,07827	54	,04942	79	,03501	104	,02682	129	,02322	154	,02050	179	,01812
5	.....	30	,07624	55	,04874	80	,03455	105	,02664	130	,02310	155	,02040	180	,01803
6	.....	31	,07430	56	,04807	81	,03410	106	,02646	131	,02298	156	,02030	181	,01795
7	.....	32	,07250	57	,04741	82	,03366	107	,02629	132	,02286	157	,02020	182	,01787
8	.....	33	,07080	58	,04676	83	,03323	108	,02612	133	,02274	158	,02010	183	,01779
9	.....	34	,06920	59	,04612	84	,03281	109	,02596	134	,02262	159	,02000	184	,01771
10	,15270	35	,06770	60	,04549	85	,03240	110	,02580	135	,02250	160	,01990	185	,01763
11	,14602	36	,06628	61	,04487	86	,03200	111	,02565	136	,02238	161	,01980	186	,01755
12	,13976	37	,06492	62	,04426	87	,03161	112	,02550	137	,02226	162	,01970	187	,01747
13	,13390	38	,06366	63	,04366	88	,03123	113	,02535	138	,02214	163	,01960	188	,01739
14	,12842	39	,06246	64	,04307	89	,03086	114	,02520	139	,02202	164	,01950	189	,01731
15	,12330	40	,06130	65	,04249	90	,03050	115	,02505	140	,02190	165	,01940	190	,01723
16	,11852	41	,06020	66	,04191	91	,03016	116	,02491	141	,02180	166	,01930	191	,01716
17	,11406	42	,05915	67	,04134	92	,02984	117	,02477	142	,02170	167	,01920	192	,01709
18	,10990	43	,05815	68	,04077	93	,02953	118	,02463	143	,02160	168	,01911	193	,01702
19	,10602	44	,05720	69	,04020	94	,02923	119	,02449	144	,02150	169	,01902	194	,01695
20	,10240	45	,05630	70	,03964	95	,02894	120	,02435	145	,02140	170	,01893	195	,01688
21	,09902	46	,05544	71	,03909	96	,02866	121	,02422	146	,02130	171	,01884	196	,01681
22	,09586	47	,05461	72	,03845	97	,02839	122	,02409	147	,02120	172	,01875	197	,01674
23	,09290	48	,05381	73	,03792	98	,02813	123	,02396	148	,02110	173	,01866	198	,01667
24	,09012	49	,05303	74	,03740	99	,02788	124	,02383	149	,02100	174	,01857	199	,01660
25	,08750	50	,05227	75	,03699	100	,02764	125	,02370	150	,02090	175	,01848	200	,01653

Rule for the above.

Multiply the coefficients in the table corresponding to the number of teeth by the pitch in inches and hundredths, and by the number of teeth; the product will be in hundredths of an inch. This gives the distance inside of the pitch-circle or line, for the point face—locus-centre line. All number of teeth above 200 to be calculated as 200.

Coefficient for finding the locus-centre line for faces of roots, the distance outside of pitch-circle. } 1,85. RULE.—Multiply by pitch. Ans. in 100ths.

Coefficient for the distance outside of pitch-knuckle, 24,00.

" " " *inside of pitch-knuckle*, 24,00. RULE.—Multiply by pitch and divide by No. teeth. Ans. in 100ths.

" " " *Radius for sweeping faces of teeth*, 61,75. RULE.—Multiply by pitch. Ans. in 100ths.

" " " *Depth of root of teeth*, 32,500, *length of points*, 31,00. RULE.—Multiply by pitch. Ans. in 100ths.

" " " *Thickness of teeth at pitch-line for very close gear*, 49,0; *For cast gears*, *Medium* 47,5, *Very open* 48,0. RULE.—Multiply by pitch. Ans. in 100ths.

NOTE.—No teeth below fifteen in number can be strictly accurate. At three-inch pitch, the error of twelve teeth will be $\frac{1}{400}$, and ten teeth $\frac{1}{200}$ of an inch.

I disclaim any and all systems for forming the teeth of gears that are usually termed involute, in which the faces of the teeth are formed with one continuous curve from point to root, and all systems which have not the three features which have been named and described in my system.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. The teeth of cog-wheels, for gearing, constructed as hereinbefore described.

2. The thickness of the teeth spaced at right angles from the centre line of the same, substantially as set forth.

3. The meeting-point of the root and point-face circles inside of the pitch-circle, in accordance with the rules as specified.

4. The radii, for sweeping the faces of the teeth, obtained from the wheel containing the least number of teeth in a set, as so described.

Witnesses: HORACE I. CRANDALL.

JAMES LYLE,

WILLIAM E. TIRRELL.