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(54) **IMAGE CAPTURING SYSTEM**

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(73) Assignee: **Largan Precision Co., Ltd.**, Taichung (TW)

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See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,111,703 A 8/2000 Hozumi
6,236,522 B1 5/2001 Shimizu
7,443,610 B1 10/2008 Lin et al.
7,480,105 B2 1/2009 Mori
(Continued)

FOREIGN PATENT DOCUMENTS

CN 101710207 A 5/2010
CN 201594156 U 9/2010
(Continued)

OTHER PUBLICATIONS

Hobbs, P. C. D. Chapter 4: Lenses, Prisms, and Mirrors, in Building Electro-Optical Systems: Making it all Work, Second Edition, John Wiley & Sons, Inc., Hoboken, NJ, USA, 2009, pp. 145-179.*
(Continued)

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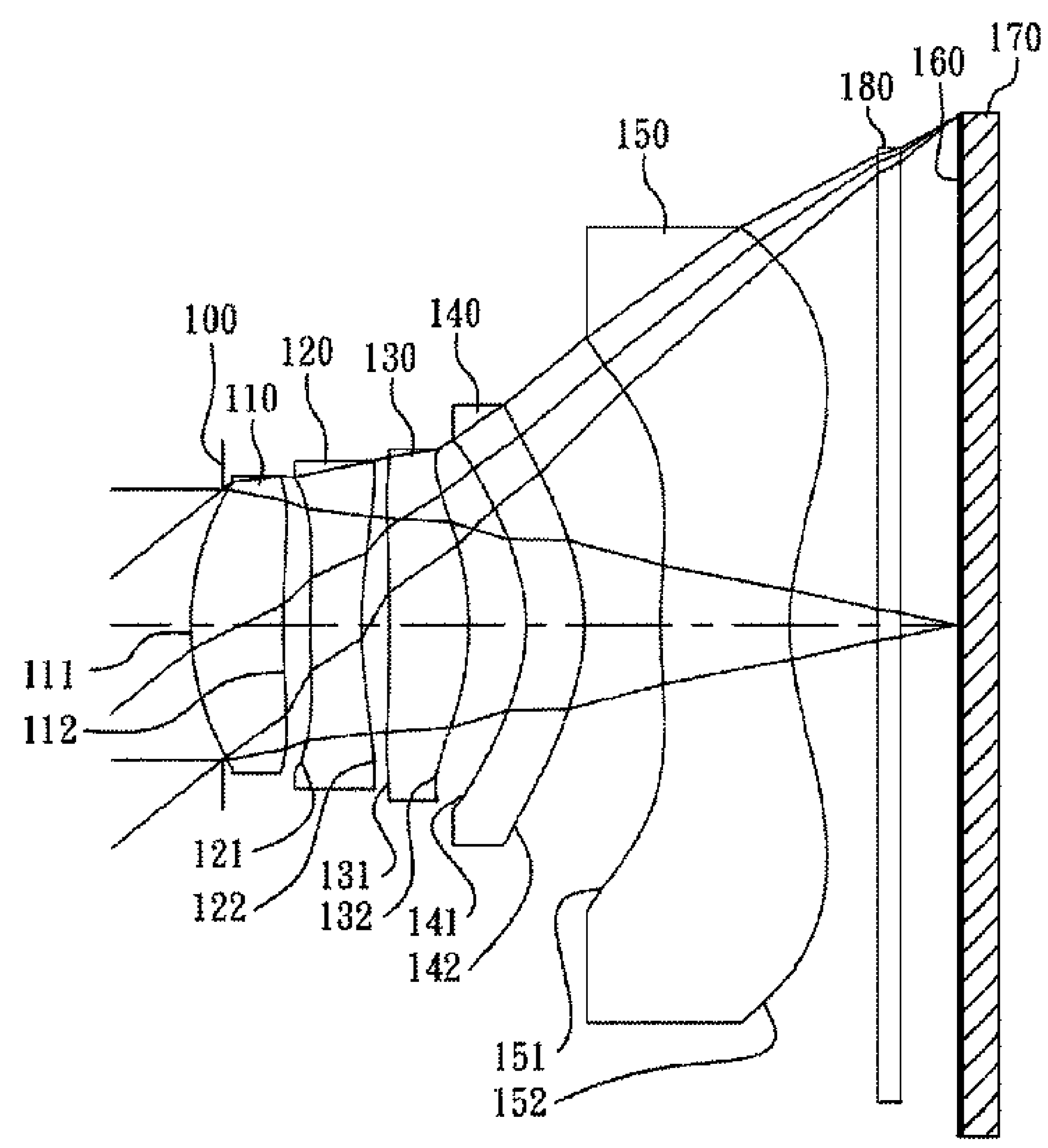
(57) **ABSTRACT**

An image capturing system includes, in order from an object side to an image side, a first lens element, a second lens element, a third lens element, a fourth lens element and a fifth lens element. The first lens element with positive refractive power has a convex object-side surface. The second lens element has negative refractive power. The third lens element has positive refractive power. The fourth lens element with negative refractive power has a concave object-side surface and a convex image-side surface, wherein at least one of the object-side surface and the image-side surface of the fourth lens element is aspheric. The fifth lens element with refractive power has a concave image-side surface, wherein at least one of an object-side surface and the image-side surface of the fifth lens element is aspheric, and the fifth lens element has at least one inflection point on the image-side surface thereof.

59 Claims, 22 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

7,502,181	B2	3/2009	Shinohara	
7,515,351	B2	4/2009	Chen et al.	
7,710,665	B2	5/2010	Park et al.	
7,826,151	B2	11/2010	Tsai	
7,864,454	B1	1/2011	Tang et al.	
7,911,711	B1	3/2011	Tang et al.	
7,965,454	B2	6/2011	Tanaka et al.	
7,969,664	B2	6/2011	Tang et al.	
8,000,030	B2	8/2011	Tang	
8,000,031	B1	8/2011	Tsai	
8,035,723	B2	10/2011	Sano et al.	
8,072,695	B1	12/2011	Lee et al.	
8,174,777	B2	5/2012	Tang et al.	
8,179,613	B2	5/2012	Sano	
8,179,614	B1	5/2012	Tsai	
8,179,615	B1 *	5/2012	Tang et al.	359/714
8,179,618	B2	5/2012	Baba	
8,189,273	B2	5/2012	Noda	
8,203,796	B2	6/2012	Ohtsu	
8,233,224	B2	7/2012	Chen	
8,248,713	B2	8/2012	Hsieh et al.	
8,264,784	B2	9/2012	You	
8,269,878	B2	9/2012	Sano et al.	
8,279,537	B2	10/2012	Sato	
8,284,291	B2	10/2012	Huang et al.	
8,305,697	B1	11/2012	Chen et al.	
8,310,768	B2	11/2012	Lin et al.	
8,325,429	B2	12/2012	Tang et al.	
8,325,430	B1	12/2012	Tsai	
8,334,922	B2	12/2012	Shinohara	
8,335,043	B2	12/2012	Huang	
8,339,718	B1	12/2012	Tang et al.	
8,345,358	B2	1/2013	Hsu et al.	
8,351,132	B2	1/2013	Uchida	
8,358,474	B2	1/2013	Kwon	
8,363,337	B2	1/2013	Tang et al.	
8,369,027	B2	2/2013	Hsu et al.	
8,369,029	B2	2/2013	Tang et al.	
8,379,324	B2	2/2013	Tsai et al.	
8,379,325	B2	2/2013	Tsai et al.	
8,390,940	B2 *	3/2013	Tsai	G02B 13/0045 359/713
8,390,941	B2	3/2013	Shinohara	
8,390,945	B2	3/2013	Yen	
8,395,851	B2	3/2013	Tang et al.	
8,395,852	B2	3/2013	Tsai et al.	
8,395,853	B2	3/2013	Chen et al.	
8,400,716	B2	3/2013	Jeong	
8,411,374	B2	4/2013	Ohtsu	
8,411,376	B2	4/2013	Kubota	
8,422,145	B2	4/2013	Ise et al.	
8,427,569	B2	4/2013	Sano	
8,437,092	B2	5/2013	Baba	
8,451,545	B2	5/2013	Hsieh et al.	
8,456,757	B2	6/2013	Tsai et al.	
8,456,758	B1 *	6/2013	Huang et al.	359/714
8,462,257	B2	6/2013	Sano et al.	
8,462,446	B2	6/2013	Tsai et al.	
8,467,137	B2	6/2013	Yonezawa et al.	
8,477,432	B2	7/2013	Huang et al.	
8,482,863	B2	7/2013	Tsai et al.	
8,488,255	B2	7/2013	Tsai	
8,488,258	B2	7/2013	Shabtay et al.	
8,488,259	B2	7/2013	Chen et al.	
8,498,061	B2	7/2013	Sano	
8,502,906	B2	8/2013	Sano et al.	
8,502,907	B2	8/2013	Sano et al.	
8,503,111	B2	8/2013	Kwon	
8,508,649	B2	8/2013	Reshidko et al.	
8,508,836	B2 *	8/2013	Ohtsu	348/340
8,508,859	B2	8/2013	Tsai et al.	
8,508,860	B2	8/2013	Tang et al.	
8,508,861	B2	8/2013	Tsai et al.	
8,514,501	B2	8/2013	Chen et al.	
8,514,502	B2	8/2013	Chen	
8,520,124	B2	8/2013	Ozaki	
8,520,322	B2	8/2013	Tang et al.	
8,520,324	B2	8/2013	Chen	
8,531,784	B2	9/2013	Hashimoto	
8,531,786	B2	9/2013	Tsai et al.	
8,537,472	B2	9/2013	Tsai et al.	
8,547,649	B2	10/2013	Lai	
8,547,650	B2	10/2013	Noda	
8,559,118	B2	10/2013	Engelhardt et al.	
8,576,497	B2	11/2013	Hsu et al.	
8,576,498	B2	11/2013	Huang	
8,593,737	B2	11/2013	Tang et al.	
8,599,498	B2	12/2013	Huang	
8,605,367	B2	12/2013	Tsai et al.	
8,611,023	B2	12/2013	Tsai et al.	
8,625,208	B2	1/2014	Abe	
8,649,112	B2	2/2014	Tsai et al.	
8,654,242	B2	2/2014	Matsusaka et al.	
8,654,458	B2	2/2014	Tsai et al.	
8,659,838	B2	2/2014	Konishi et al.	
8,670,190	B2	3/2014	Chen	
8,670,191	B2	3/2014	Chen	
8,675,288	B2	3/2014	Jung et al.	
8,687,293	B2	4/2014	Chen et al.	
8,693,111	B2	4/2014	Chen	
8,717,687	B2	5/2014	Hsu et al.	
8,736,977	B2	5/2014	Tang et al.	
8,736,981	B2	5/2014	Chen	
8,736,983	B2	5/2014	Jo	
8,743,478	B2	6/2014	Tsai et al.	
8,743,485	B2	6/2014	Hsieh et al.	
8,767,298	B2	7/2014	Suzuki et al.	
8,773,768	B2	7/2014	Jung et al.	
8,773,769	B2	7/2014	Jung et al.	
8,773,770	B2	7/2014	Jung et al.	
8,773,780	B2	7/2014	You	
8,773,781	B2	7/2014	Jo	
8,780,458	B2	7/2014	Sano et al.	
8,780,465	B2	7/2014	Chae	
8,786,962	B2	7/2014	Chen et al.	
8,786,966	B2	7/2014	You	
8,804,253	B2	8/2014	Tsai et al.	
8,810,929	B2	8/2014	You	
8,830,596	B2	9/2014	Jo	
8,842,377	B2	9/2014	Kubota et al.	
8,867,150	B2	10/2014	Sano	
8,885,270	B2	11/2014	Tanaka et al.	
8,917,457	B2	12/2014	Matsusaka et al.	
8,917,458	B2	12/2014	Tsai et al.	
9,001,438	B2	4/2015	Okano	
9,042,034	B2	5/2015	Tang et al.	
9,091,836	B2	7/2015	Jung et al.	
2003/0117722	A1	6/2003	Chen	
2004/0196571	A1	10/2004	Shinohara	
2007/0229984	A1	10/2007	Shinohara	
2007/0298572	A1	12/2007	Chen et al.	
2009/0061153	A1	3/2009	De Luca et al.	
2009/0294527	A1	12/2009	Brabson et al.	
2009/0294528	A1	12/2009	Halbur et al.	
2010/0008562	A1	1/2010	Takahashi et al.	
2010/0026434	A1	2/2010	Okamoto et al.	
2010/0048996	A1	2/2010	Makiyama	
2010/0220229	A1	9/2010	Sano	
2010/0253829	A1	10/2010	Shinohara	
2010/0254029	A1	10/2010	Shinohara	
2010/0256608	A1	10/2010	Bolmsjo et al.	
2010/0282000	A1	11/2010	Gorjanc et al.	
2011/0013069	A1	1/2011	Chen	
2011/0085733	A1	4/2011	Knee	
2011/0134305	A1	6/2011	Sano et al.	
2011/0138175	A1	6/2011	Clark et al.	
2011/0164327	A1	7/2011	Sato	
2011/0181963	A1 *	7/2011	Kwon	G02B 13/0045 359/718
2011/0188131	A1	8/2011	Sano	
2011/0209352	A1	9/2011	Affa et al.	
2011/0209554	A1	9/2011	Miyashita	
2011/0227362	A1	9/2011	Rockafellow et al.	
2011/0249346	A1 *	10/2011	Tang et al.	359/764

(56) **References Cited**

U.S. PATENT DOCUMENTS

2011/0249349	A1	10/2011	Asami	
2011/0257447	A1	10/2011	Botella-Franco et al.	
2011/0273611	A1	11/2011	Matsusaka et al.	
2012/0081595	A1	4/2012	Uchida	
2012/0087019	A1*	4/2012	Tang et al.	359/714
2012/0087020	A1*	4/2012	Tang et al.	359/714
2012/0105704	A1*	5/2012	Huang et al.	348/340
2012/0140104	A1	6/2012	Ozaki	
2012/0262806	A1	10/2012	Huang	
2012/0314301	A1	12/2012	Huang et al.	
2013/0010181	A1	1/2013	Baba	
2013/0027788	A1	1/2013	Yen	
2013/0050847	A1	2/2013	Hsu et al.	
2013/0070346	A1	3/2013	Hsu et al.	
2013/0088788	A1	4/2013	You	
2013/0093938	A1	4/2013	Otsu	
2013/0093942	A1	4/2013	Okano	
2013/0094098	A1	4/2013	Ko	
2013/0100542	A1*	4/2013	Tsai et al.	359/714
2013/0114151	A1	5/2013	Chen et al.	
2013/0120858	A1	5/2013	Sano	
2013/0170048	A1	7/2013	Lai	
2013/0201568	A1	8/2013	Tsai et al.	
2013/0208174	A1	8/2013	Tamura	
2013/0271642	A1	10/2013	Sano	
2013/0286488	A1	10/2013	Chae	
2013/0301147	A1	11/2013	Yamada	
2013/0314803	A1	11/2013	Huang et al.	
2013/0329307	A1	12/2013	Jung et al.	
2013/0335622	A1	12/2013	Kwon	
2013/0342919	A1	12/2013	Tang et al.	
2014/0015991	A1	1/2014	Yamada et al.	
2014/0036378	A1	2/2014	Huang	
2014/0085736	A1	3/2014	Chen et al.	
2014/0104704	A1	4/2014	Chae	
2014/0139935	A1	5/2014	Hsieh et al.	
2014/0146215	A1	5/2014	Chen	
2014/0146402	A1	5/2014	You	
2014/0218812	A1	8/2014	Liou et al.	
2014/0254030	A1	9/2014	Hsu et al.	
2014/0285907	A1	9/2014	Tang et al.	
2014/0293455	A1	10/2014	Chen et al.	
2014/0307149	A1	10/2014	Chen et al.	
2014/0320986	A1	10/2014	You	
2014/0368928	A1	12/2014	Jo	
2014/0368929	A1	12/2014	Chae	
2014/0368930	A1	12/2014	Jung et al.	
2014/0368932	A1	12/2014	You	
2015/0022701	A1	1/2015	Chen	

FOREIGN PATENT DOCUMENTS

JP	H09-211320		8/1997
JP	2003131136	A	5/2003
JP	2003161879	A	6/2003
JP	2003185917	A	7/2003
JP	2005266771	A	9/2005
JP	2006293042	A	10/2006
JP	2007298572	A	11/2007
JP	2009294528	A	12/2009
JP	2010256608	A	11/2010
JP	2010262218	A	11/2010
JP	2011039091	A	2/2011
JP	2011085733	A	4/2011
JP	2011138175	A	7/2011
JP	2011141396	A	7/2011
JP	2011158508	A	8/2011
JP	2011209554	A	10/2011
JP	2011237750	A	11/2011
JP	2011257448	A	12/2011
JP	2012008164	A	1/2012
JP	2012073642	A	4/2012
JP	2013011710	A	1/2013
JP	2013054099	A	3/2013
KR	100407422	B1	11/2003
KR	2007-0097369	A	10/2007
KR	100835108	B1	6/2008
KR	2009-0027330	A	3/2009
KR	2009-0055115	A	6/2009
KR	2009-0100814	A	9/2009
KR	2009-0131805	A	12/2009
KR	2010-0000132	A	1/2010
KR	2010-0001525	A	1/2010
KR	2010-0043667	A	4/2010
KR	2010-0067515	A	6/2010
KR	2011-0042382	A	4/2011
KR	2011-0042697	A	4/2011
KR	2011-0057625	A	6/2011
KR	2011-0071554	A	6/2011
KR	2011-0140040	A	12/2011
KR	2012-0018573	A	3/2012
KR	2012-0033866	A	4/2012
TW	I268360		12/2006
TW	M313246	U	6/2007
TW	M313781	U	6/2007
TW	M332199	U	5/2008
TW	201022714	A	6/2010
TW	201038966	A	11/2010
TW	M416090	U	11/2011
TW	201248187	A	12/2012
TW	201326884	A	7/2013
TW	201333517	A	8/2013
TW	201341840	A	10/2013
TW	201348732	A	12/2013
WO	WO-2010/024198	A1	3/2010
WO	WO-2011/021271	A1	2/2011
WO	WO-2011/027690	A1	3/2011

OTHER PUBLICATIONS

Notice of Allowance dated May 14, 2014 for U.S. Appl. No. 14/105,096 (now U.S. Pat. No. 8,773,768).
Non-Final Office Action dated Mar. 4, 2014 for U.S. Appl. No. 14/105,096 (now U.S. Pat. No. 8,773,768).
Notice of Allowance dated May 28, 2014 for U.S. Appl. No. 14/105,105 (now U.S. Pat. No. 8,773,769).
Final Office Action dated May 12, 2014 for U.S. Appl. No. 14/105,105 (now U.S. Pat. No. 8,773,769).
Non-Final Office Action dated Feb. 7, 2014 for U.S. Appl. No. 14/105,105 (now U.S. Pat. No. 8,773,769).
Notice of Allowance dated May 22, 2014 for U.S. Appl. No. 14/105,122 (now U.S. Pat. No. 8,773,770).
Final Office Action dated May 12, 2014 for U.S. Appl. No. 14/105,122 (now U.S. Pat. No. 8,773,770).
Non-Final Office Action dated Feb. 4, 2014 for U.S. Appl. No. 14/105,122 (now U.S. Pat. No. 8,773,770).
Office Action dated Feb. 26, 2014 and Prior Art Search Report for Korean Patent Appl. No. 10-2014-0003271 and its English translation.
Office Action dated Jul. 1, 2013 for Korean Patent Appl. No. 10-2012-0045609 and its English translation.
Office Action dated Aug. 26, 2014 for Korean Patent Appl. No. 10-2014-0097555 and its English translation.
Office Action dated Jan. 28, 2013 for Korean Patent Appl. No. 10-2011-0108128 and its English summary.
Office Action dated Nov. 26, 2014 for Taiwanese Patent Appl. No. 102144927 and its English summary.
Office Action dated Jan. 21, 2013 for Korean Patent Appl. No. 10-2011-0103101 and its English summary.
Notice of Allowance dated Mar. 27, 2014 for U.S. Appl. No. 13/533,769 (now U.S. Pat. No. 8,736,983).
Non-Final Office Action dated Sep. 5, 2013 for U.S. Appl. No. 13/533,769 (now U.S. Pat. No. 8,736,983).
Notice of Allowance dated May 30, 2014 for U.S. Appl. No. 14/135,152 (now U.S. Pat. No. 8,773,781).
Non-Final Office Action dated Apr. 3, 2014 for U.S. Appl. No. 14/135,152 (now U.S. Pat. No. 8,773,781).
Notice of Allowance dated Jul. 21, 2014 for U.S. Appl. No. 14/135,203 (now U.S. Pat. No. 8,830,596).

(56) **References Cited**

OTHER PUBLICATIONS

Non-Final Office Action dated Jun. 5, 2014 for U.S. Appl. No. 14/135,203 (now U.S. Pat. No. 8,830,596).
Non-Final Office Action dated Feb. 26, 2014 for U.S. Appl. No. 14/135,203 (now U.S. Pat. No. 8,830,596).
Notice of Allowance dated May 12, 2014 for U.S. Appl. No. 14/137,683 (now U.S. Pat. No. 8,780,465).
Non-Final Office Action dated Feb. 27, 2014 for U.S. Appl. No. 14/137,683 (now U.S. Pat. No. 8,780,465).
Non-Final Office Action dated Jul. 30, 2014 for U.S. Appl. No. 13/802,247 (now U.S. 2013/0286488).
Non-Final Office Action dated May 9, 2014 for U.S. Appl. No. 13/802,247 (now U.S. 2013/0286488).
Non-Final Office Action dated Mar. 11, 2014 for U.S. Appl. No. 13/802,247 (now U.S. 2013/0286488).
Final Office Action dated Aug. 20, 2014 for U.S. Appl. No. 14/137,795 (now U.S. 2014/0104704).
Non-Final Office Action dated Jun. 3, 2014 for U.S. Appl. No. 14/137,795 (now U.S. 2014/0104704).
Final Office Action dated May 8, 2014 for U.S. Appl. No. 14/137,795 (now U.S. 2014/0104704).
Non-Final Office Action dated Mar. 18, 2014 for U.S. Appl. No. 14/137,795 (now U.S. 2014/0104704).
Notice of Allowance dated Jan. 23, 2015 for U.S. Appl. No. 14/473,904 (now published as U.S. 2014/0368928).
Office Action dated Oct. 10, 2014 for U.S. Appl. No. 14/473,904 (now published 2014/0368928).
Office Action dated Oct. 24, 2014 for U.S. Appl. No. 14/473,938 (now published as US 2014/0368932).
Final Office Action dated Jan. 12, 2015 for U.S. Appl. No. 14/473,956 (now published as US 2014/0368929).
Non-Final Office Action dated Oct. 10, 2014 for U.S. Appl. No. 14/473,956 (now published as US 2014/0368929).
Office Action dated Sep. 2, 2014 for U.S. Appl. No. 14/324,003 (now published as U.S. 2014/0320986).
Notice of Allowance dated May 22, 2014 for U.S. Appl. No. 13/434,980 (now U.S. Pat. No. 8,773,780).
Final Office Action dated Mar. 25, 2014 for U.S. Appl. No. 13/434,980 (now U.S. Pat. No. 8,773,780).
Non-Final Office Action dated Jan. 29, 2014 for U.S. Appl. No. 13/434,980 (now U.S. Pat. No. 8,773,780).
Final Office Action dated Sep. 3, 2013 for U.S. Appl. No. 13/434,980 (now U.S. Pat. No. 8,773,780).
Non-Final Office Action dated Feb. 8, 2013 for U.S. Appl. No. 13/434,980 (now U.S. Pat. No. 8,773,780).
Notice of Allowance dated Jun. 26, 2014 for U.S. Appl. No. 14/106,578 (now U.S. Pat. No. 8,810,929).
Non-Final Office Action dated Jan. 29, 2014 for U.S. Appl. No. 14/106,578 (now U.S. Pat. No. 8,810,929).
Notice of Allowance dated Jun. 10, 2014 for U.S. Appl. No. 14/106,598 (now U.S. Pat. No. 8,786,966).
Non-Final Office Action dated Apr. 2, 2014 for U.S. Appl. No. 14/106,598 (now U.S. Pat. No. 8,786,966).
Non-Final Office Action dated May 23, 2014 for U.S. Appl. No. 14/169,121 (now U.S. 2014/0146402).
Office Action dated Aug. 27, 2014 for Korean Patent Application No. 10-2013-0065734 and its English summary.
Office Action dated Aug. 29, 2014 for Korean Patent Application No. 10-2014-0097556 and its English summary.
Pretrial Examination Report dated Jan. 26, 2015 for Japanese Patent Application No. 2012-181553 and its English summary.
Office Action dated Sep. 25, 2013 from corresponding Japanese Patent Application No. 2012-181553 and its English summary.
Office Action dated Jan. 28, 2014 and Prior Art Search Report for corresponding Korean Patent Application No. 10-2013-0150984 and its English translation.
Notice of Allowance dated Nov. 6, 2013 for U.S. Appl. No. 13/588,208 (now U.S. Pat. No. 8,675,288).

* cited by examiner

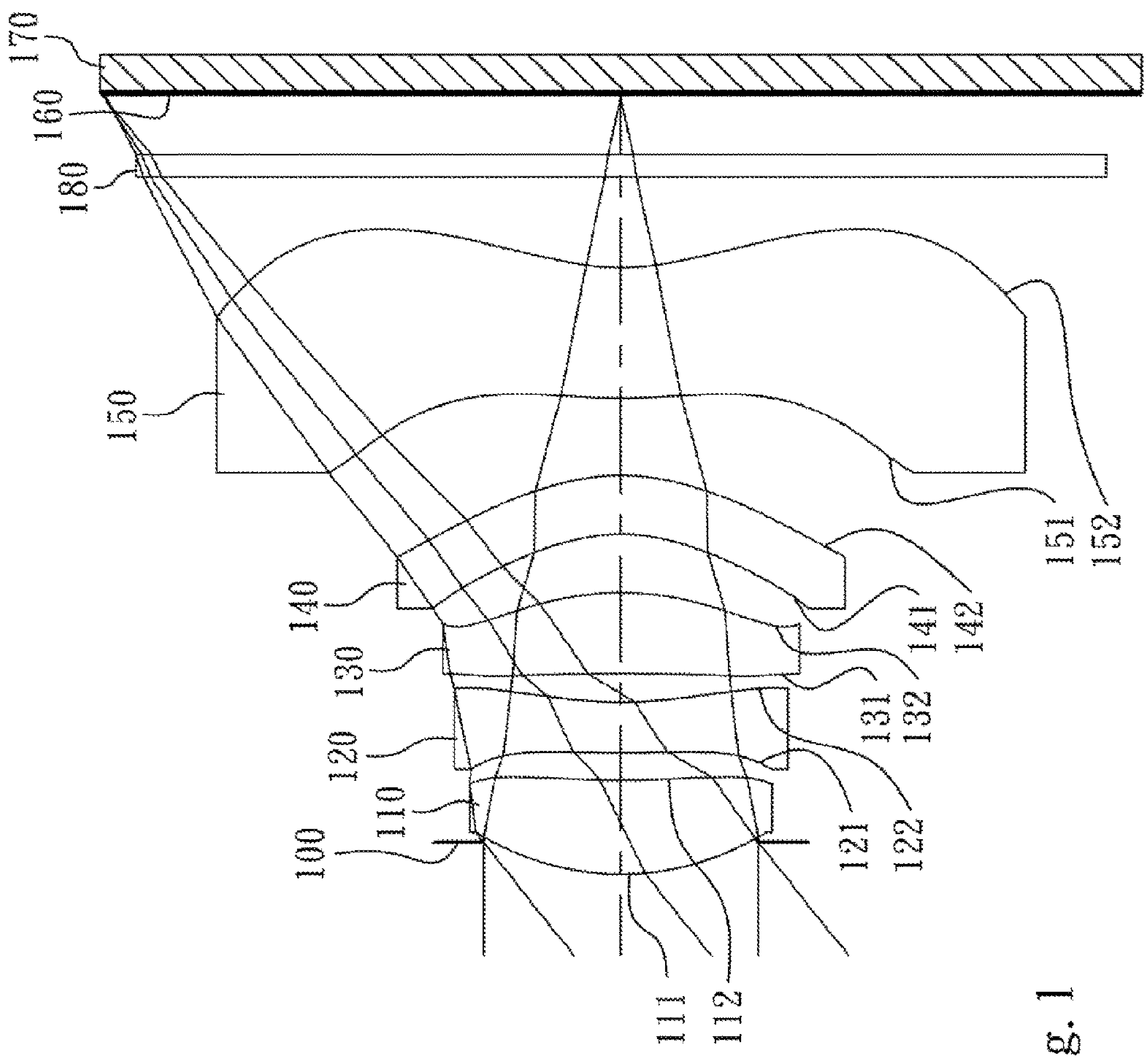

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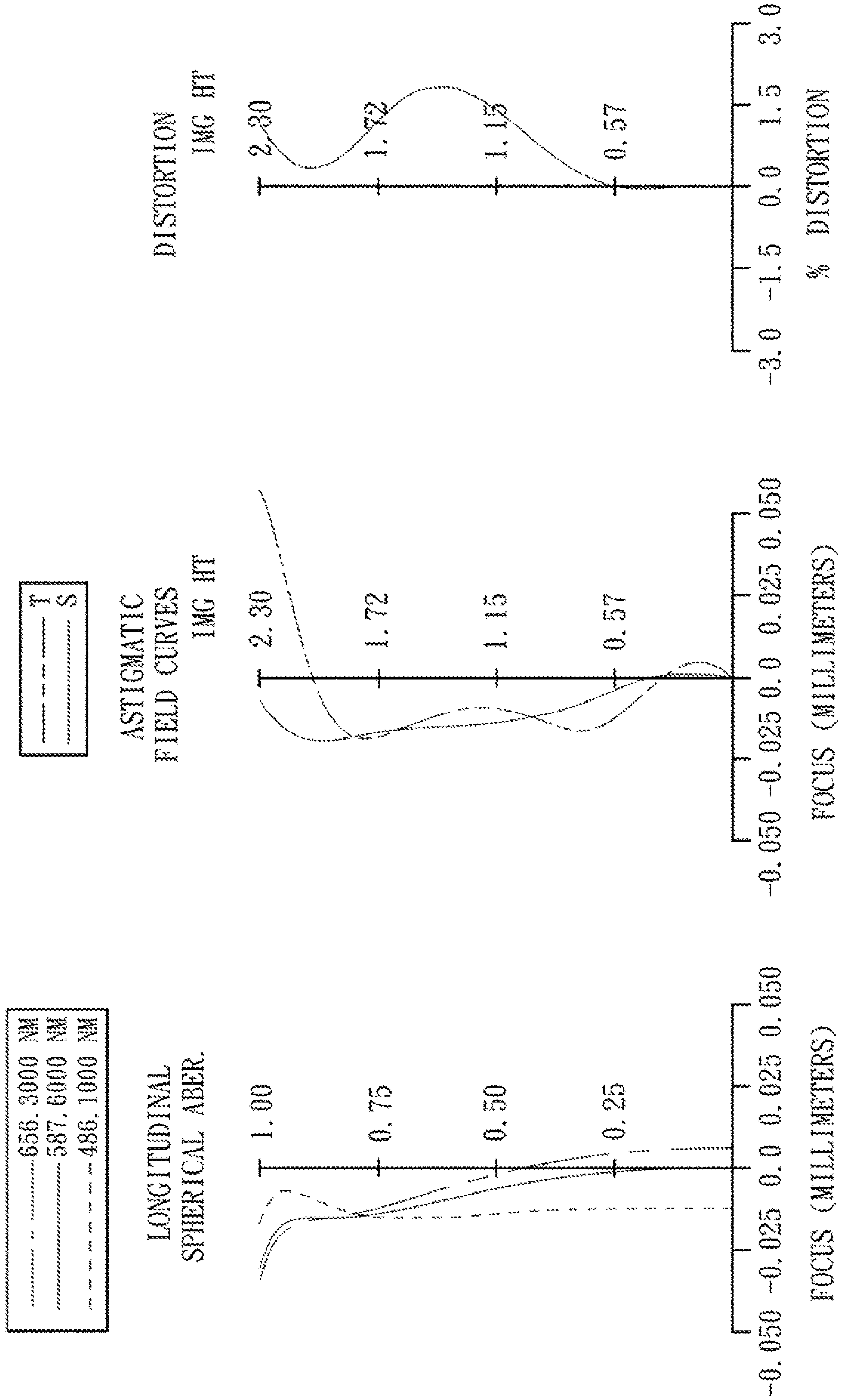
Fig. 1



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-0.050 -0.025 0.0 0.025 0.050
FOCUS (MILLIMETERS)
ASTIGMATIC FIELD CURVES
IMG HT
T
S
2.30
1.72
1.15
0.57
-0.050 -0.025 0.0 0.025 0.050
FOCUS (MILLIMETERS)
DISTORTION
IMG HT
2.30
1.72
1.15
0.57
-3.0 -1.5 0.0 1.5 3.0
% DISTORTION

Fig. 2

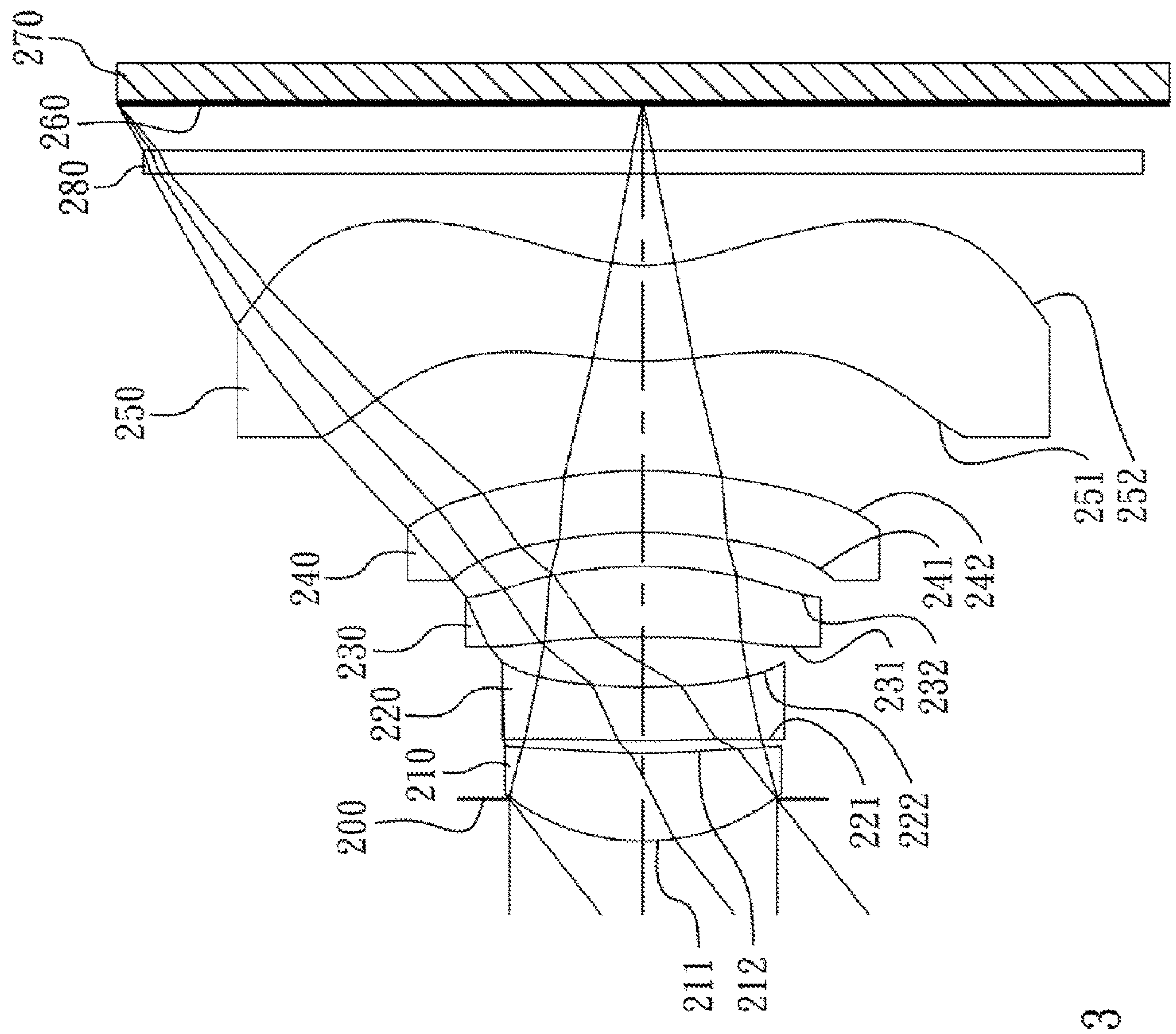

270
260
280
250
251
252
240
241
242
230
231
232
220
221
222
210
200
211
212

Fig. 3

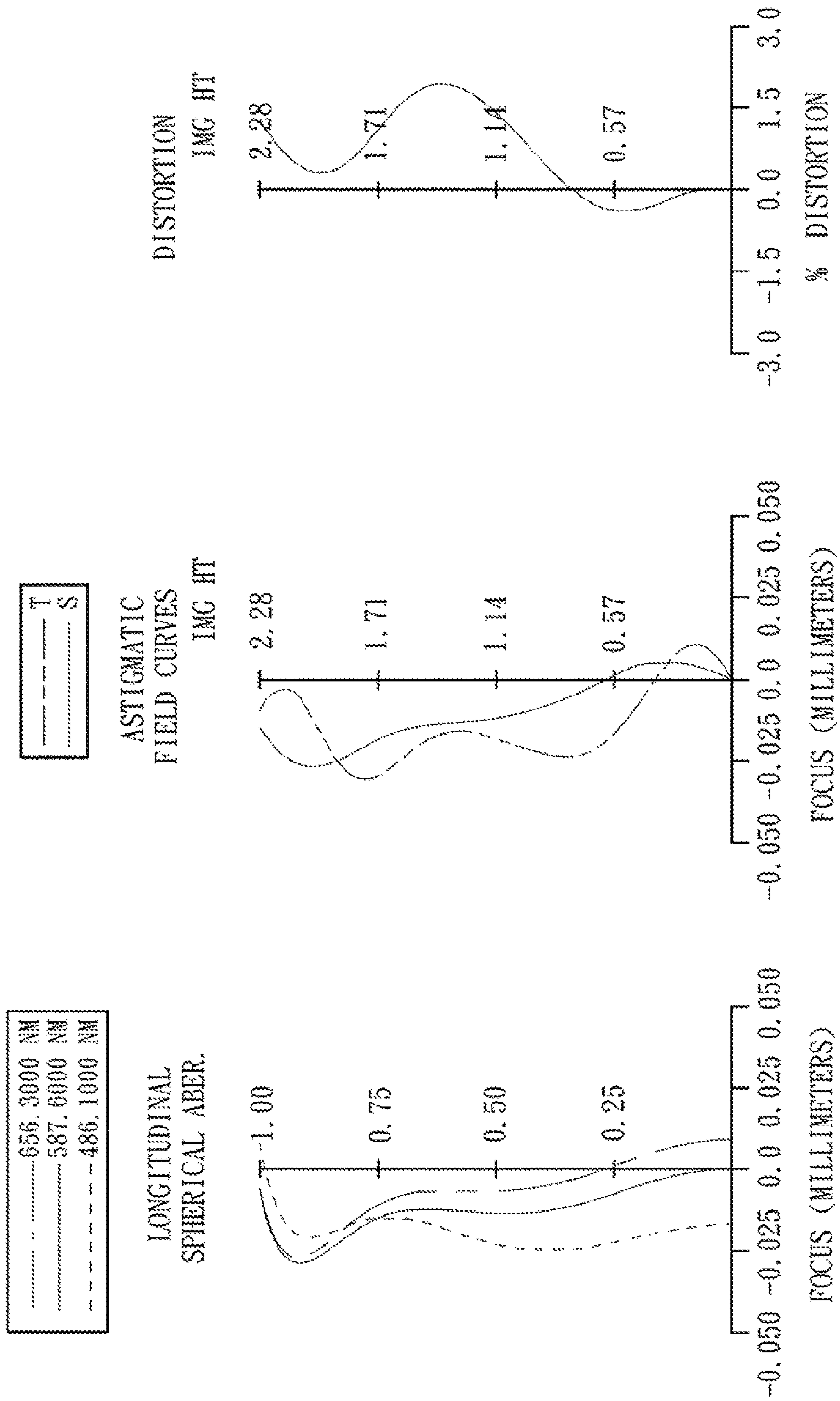

LONGITUDINAL SPHERICAL ABER.
656.3000 NM
587.6000 NM
486.1000 NM
1.00
0.75
0.50
0.25
-0.050 -0.025 0.0 0.025 0.050
FOCUS (MILLIMETERS)
ASTIGMATIC FIELD CURVES
IMG HT
T
S
2.28
1.71
1.14
0.57
-0.050 -0.025 0.0 0.025 0.050
FOCUS (MILLIMETERS)
DISTORTION
IMG HT
2.28
1.71
1.14
0.57
-3.0 -1.5 0.0 1.5 3.0
% DISTORTION

Fig. 4

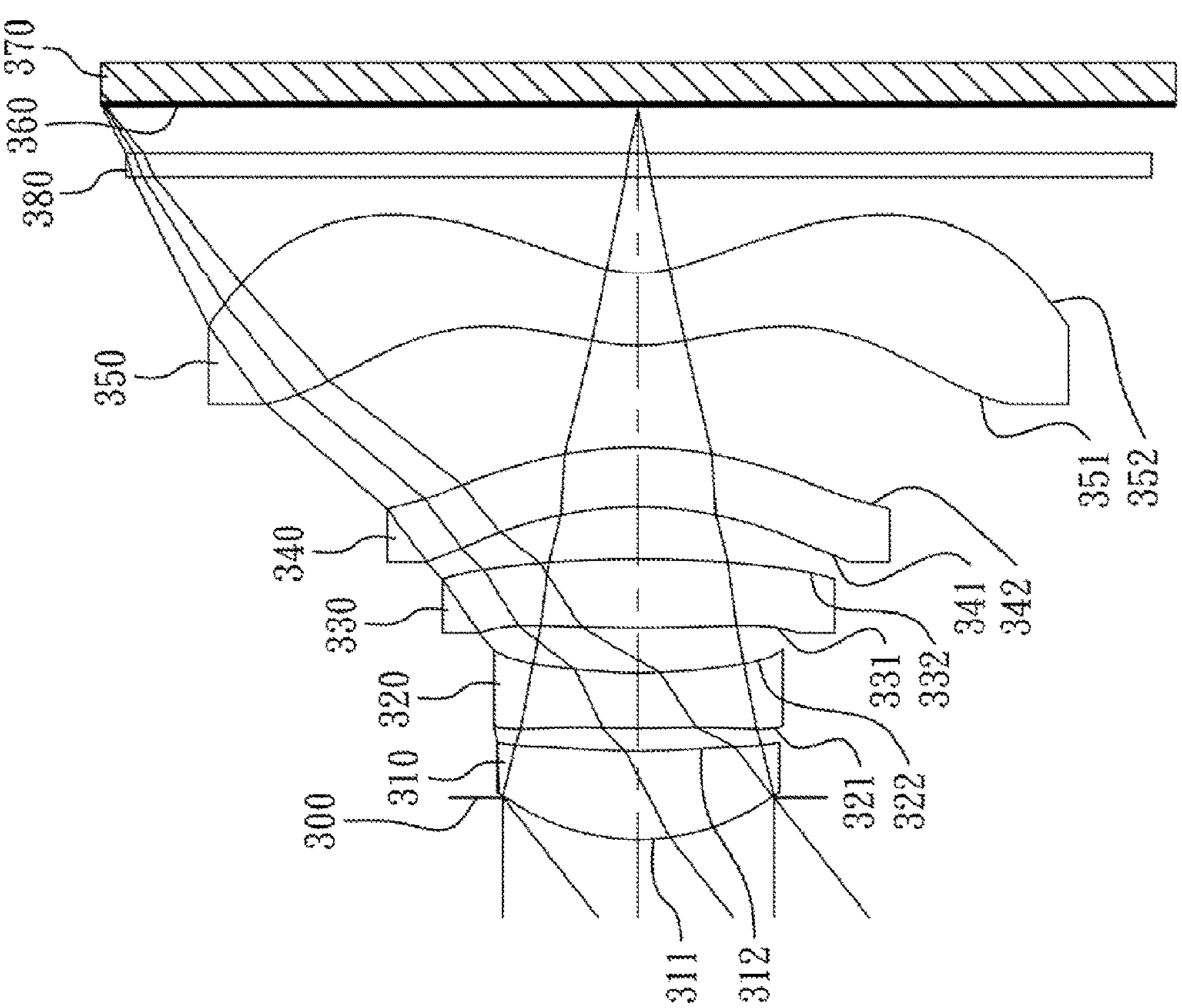

370
360
380
350
351
352
340
341
342
330
331
332
320
321
322
310
300
311
312

Fig. 5

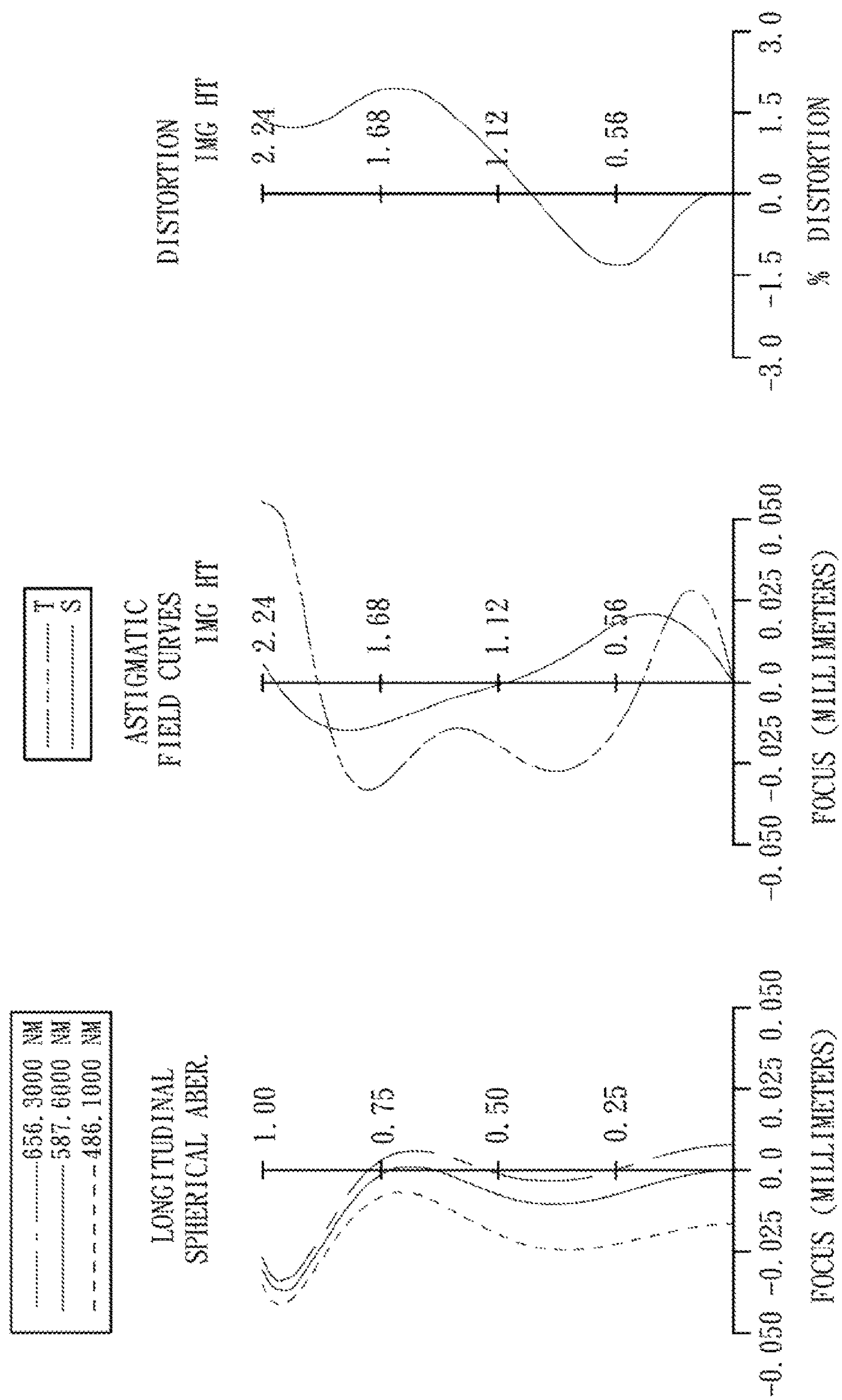

LONGITUDINAL
SPHERICAL ABER.
656.3000 NM
587.6000 NM
486.1000 NM
1.00
0.75
0.50
0.25
-0.050 -0.025 0.0 0.025 0.050
FOCUS (MILLIMETERS)
ASTIGMATIC
FIELD CURVES
IMG HT
T
S
2.24
1.68
1.12
0.56
-0.050 -0.025 0.0 0.025 0.050
FOCUS (MILLIMETERS)
DISTORTION
IMG HT
2.24
1.68
1.12
0.56
-3.0 -1.5 0.0 1.5 3.0
% DISTORTION

Fig. 6

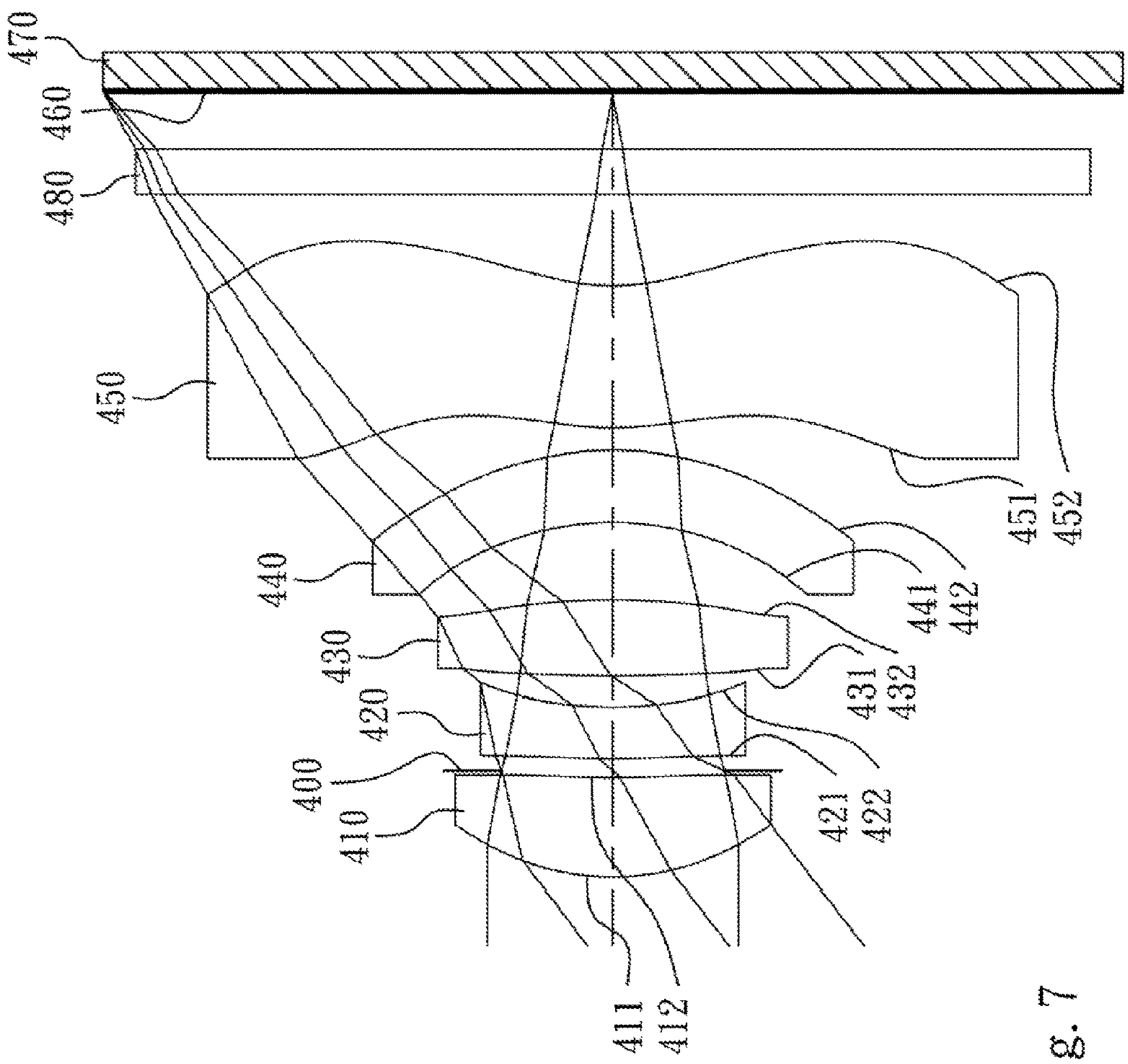

470
460
480
450
440
430
420
400
410
411
412
421
422
431
432
441
442
451
452

Fig. 7

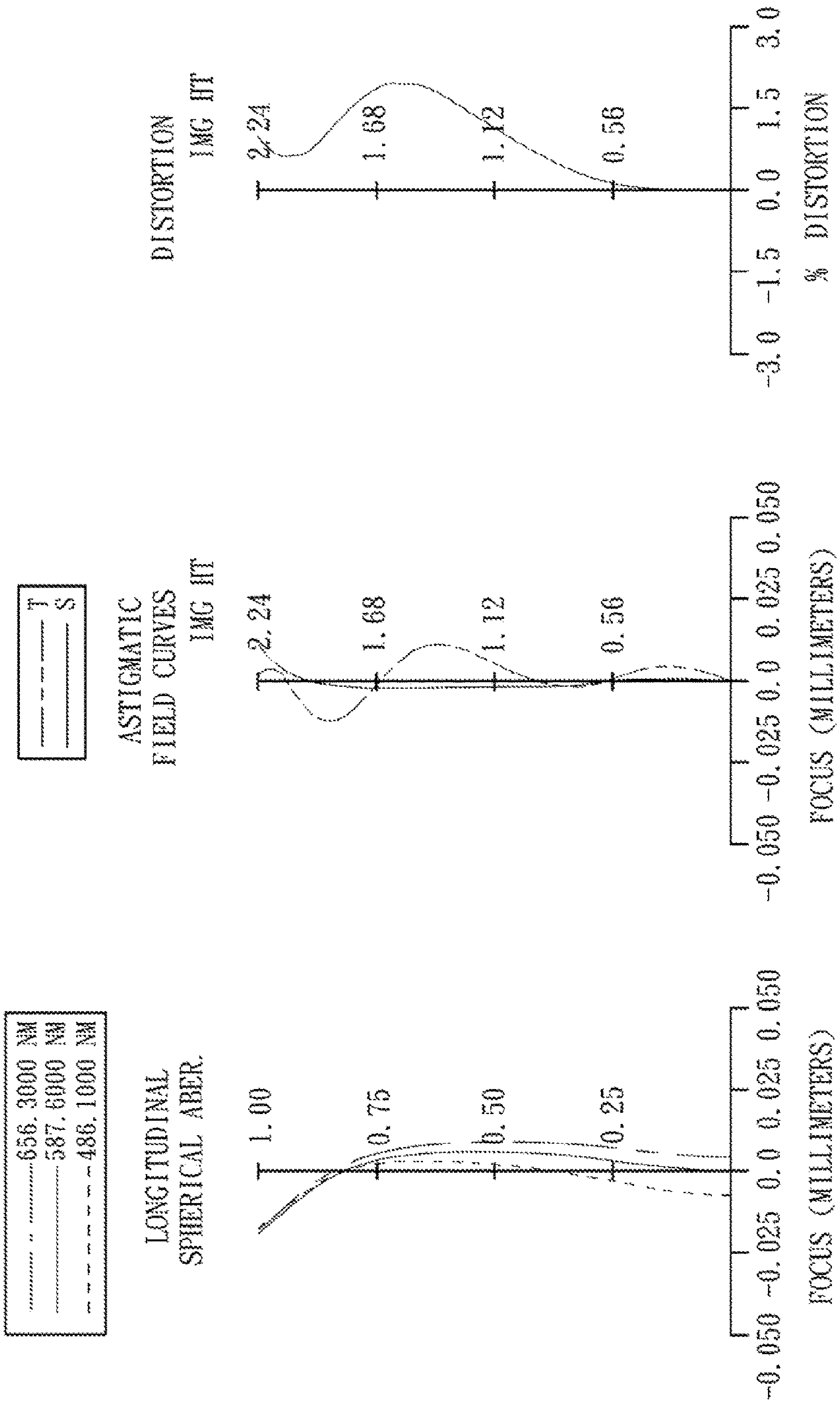

LONGITUDINAL SPHERICAL ABER.
656.3000 NM
587.6000 NM
486.1000 NM
1.00
0.75
0.50
0.25
-0.050 -0.025 0.0 0.025 0.050
FOCUS (MILLIMETERS)
ASTIGMATIC FIELD CURVES
IMG HT
T
S
2.24
1.68
1.12
0.56
-0.050 -0.025 0.0 0.025 0.050
FOCUS (MILLIMETERS)
DISTORTION
IMG HT
2.24
1.68
1.12
0.56
-3.0 -1.5 0.0 1.5 3.0
% DISTORTION

Fig. 8

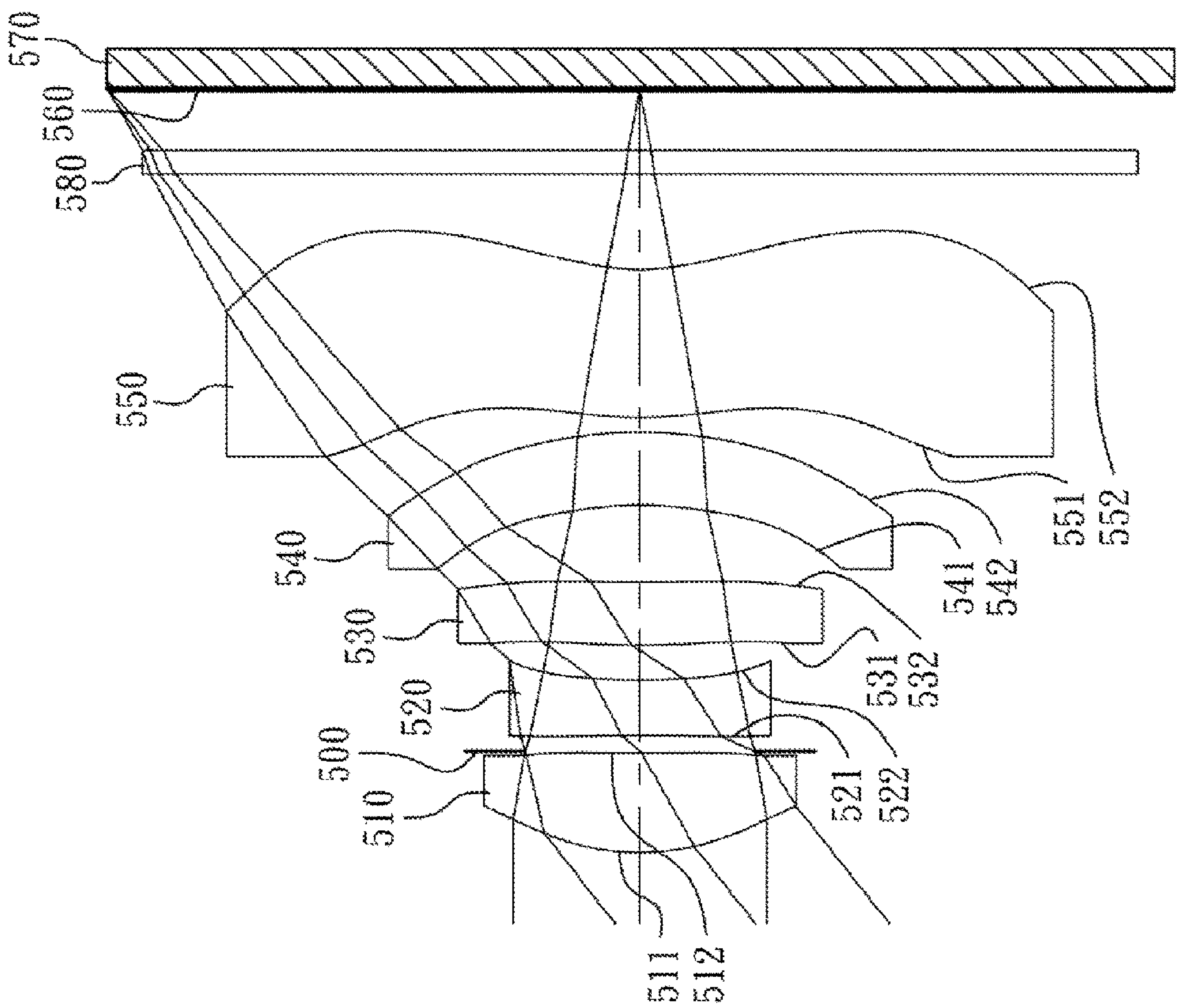

570
560
580
550
552
551
540
541
542
530
531
532
520
521
522
500
510
511
512

Fig. 9

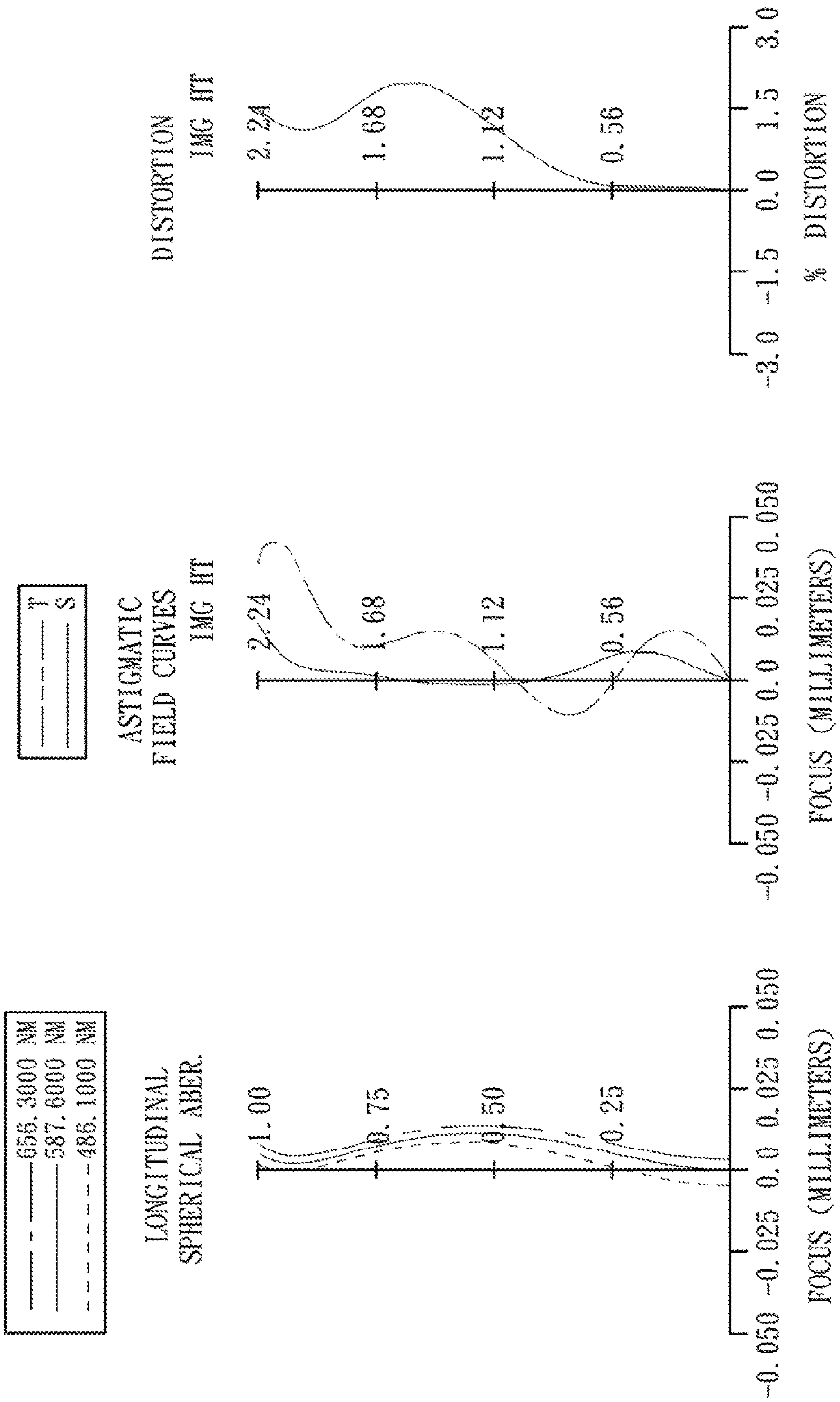

LONGITUDINAL SPHERICAL ABER.
656.3000 NM
587.6000 NM
486.1000 NM
FOCUS (MILLIMETERS)
ASTIGMATIC FIELD CURVES
IMG HT
T
S
FOCUS (MILLIMETERS)
DISTORTION
IMG HT
% DISTORTION

Fig. 10

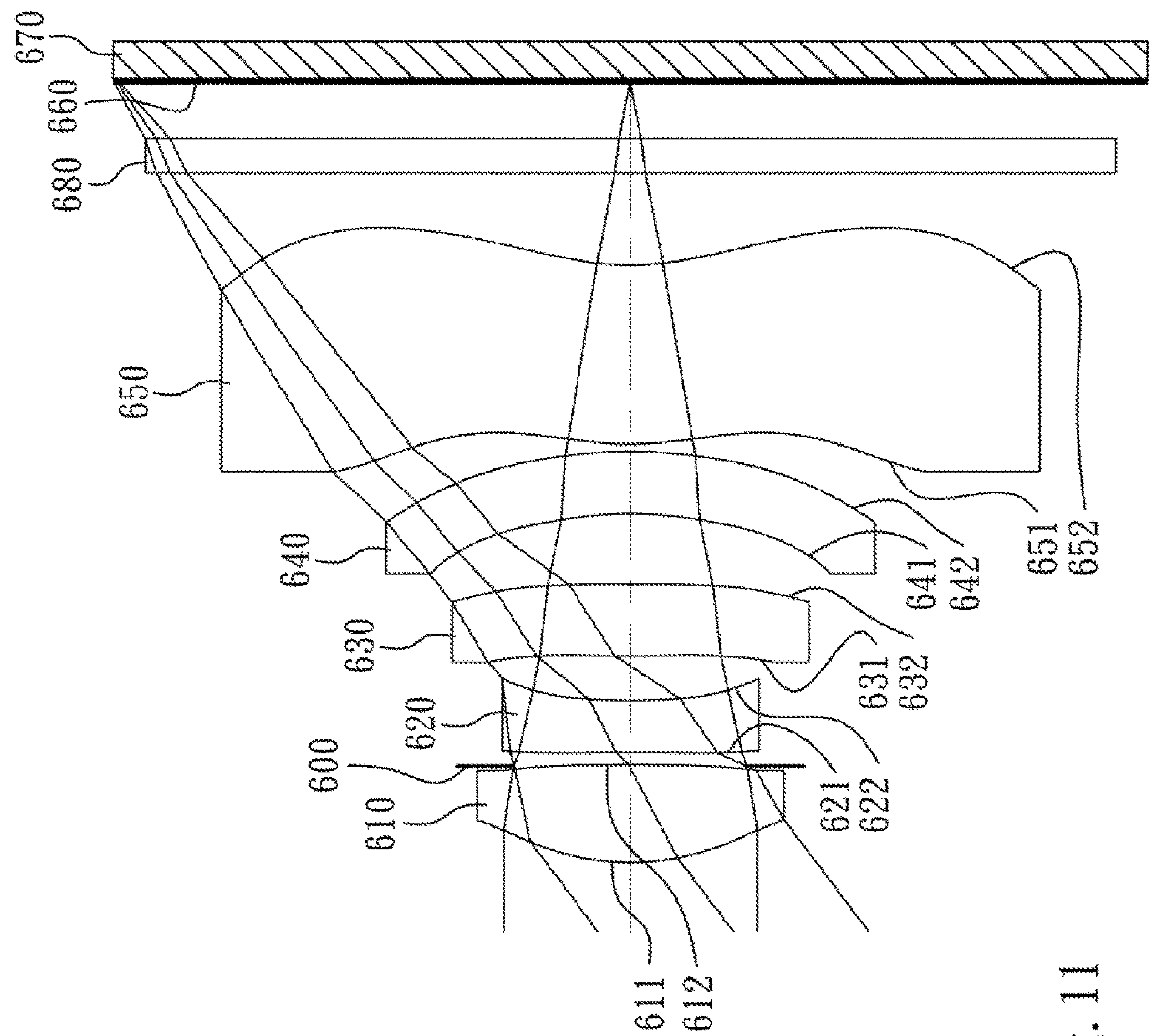
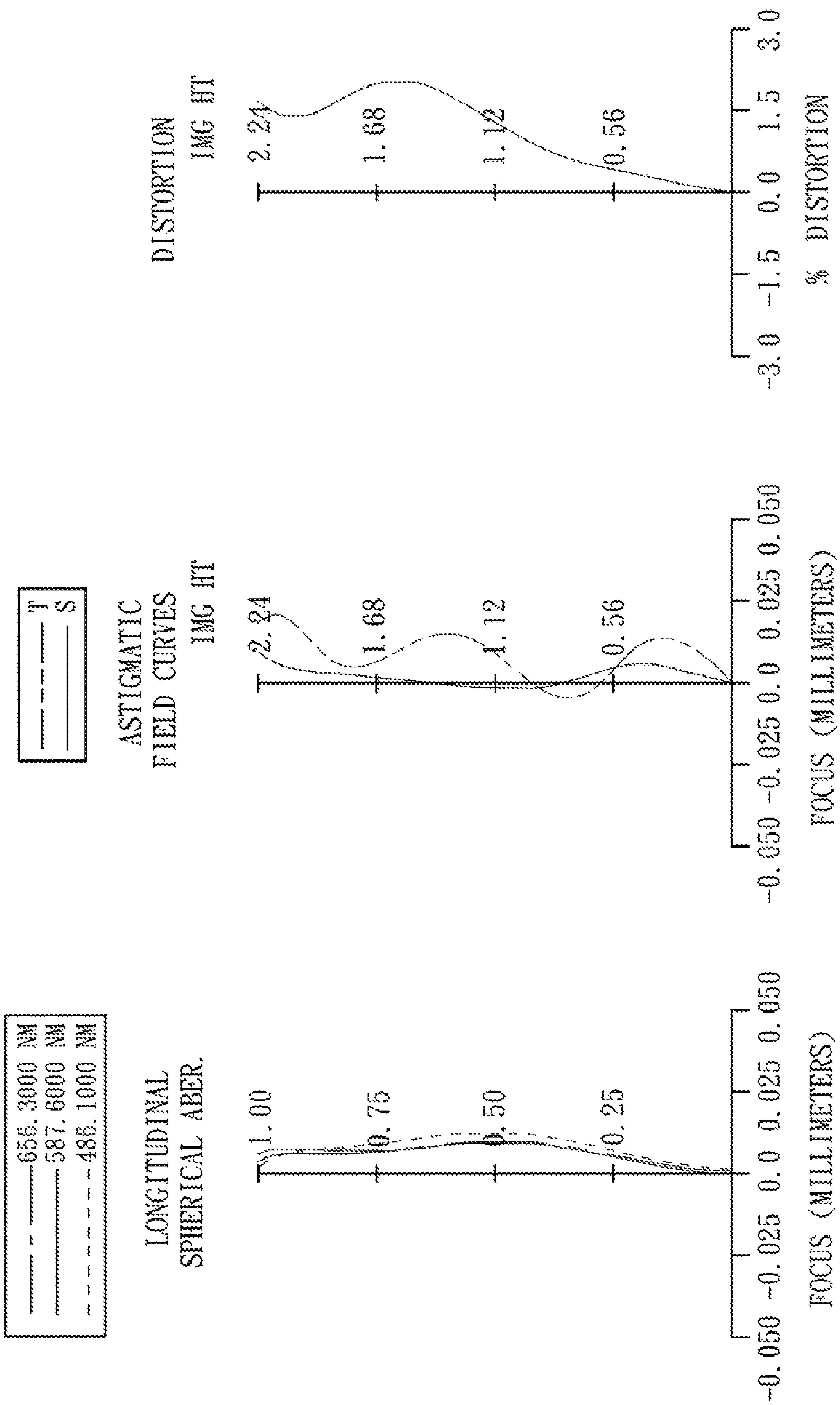

670
660
680
650
640
630
620
600
610
611
612
621
622
631
632
641
642
651
652

Fig. 11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587.6000 NM
486.1000 NM
LONGITUDINAL SPHERICAL ABER.
1.00
0.75
0.50
0.25
-0.050 -0.025 0.0 0.025 0.050
FOCUS (MILLIMETERS)
T
S
ASTIGMATIC FIELD CURVES
IMG HT
2.24
1.68
1.12
0.56
-0.050 -0.025 0.0 0.025 0.050
FOCUS (MILLIMETERS)
DISTORTION
IMG HT
2.24
1.68
1.12
0.56
-3.0 -1.5 0.0 1.5 3.0
% DISTORTION

Fig. 12

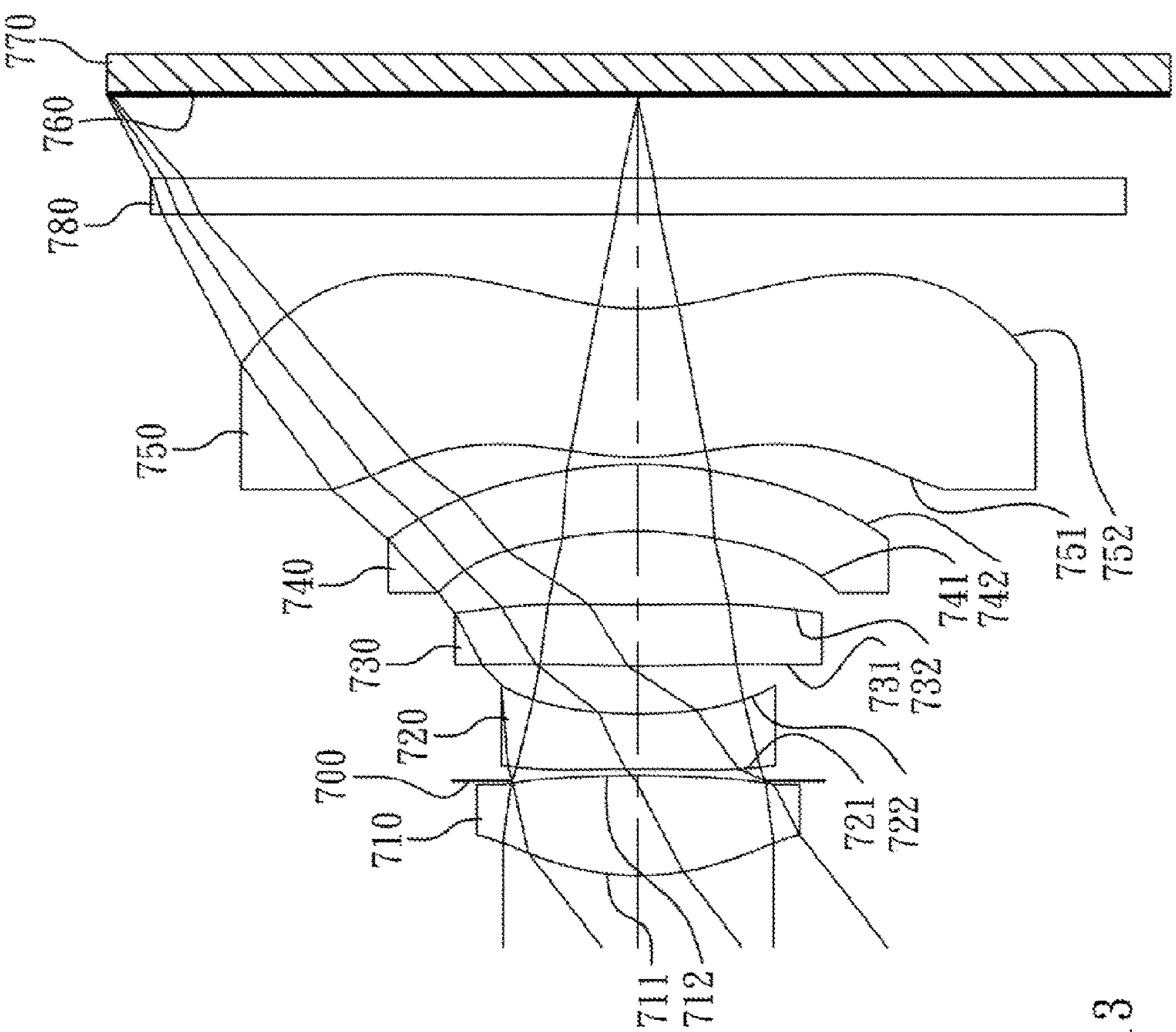

770
760
780
750
740
730
720
700
710
711
712
721
722
731
732
741
742
751
752

Fig. 13

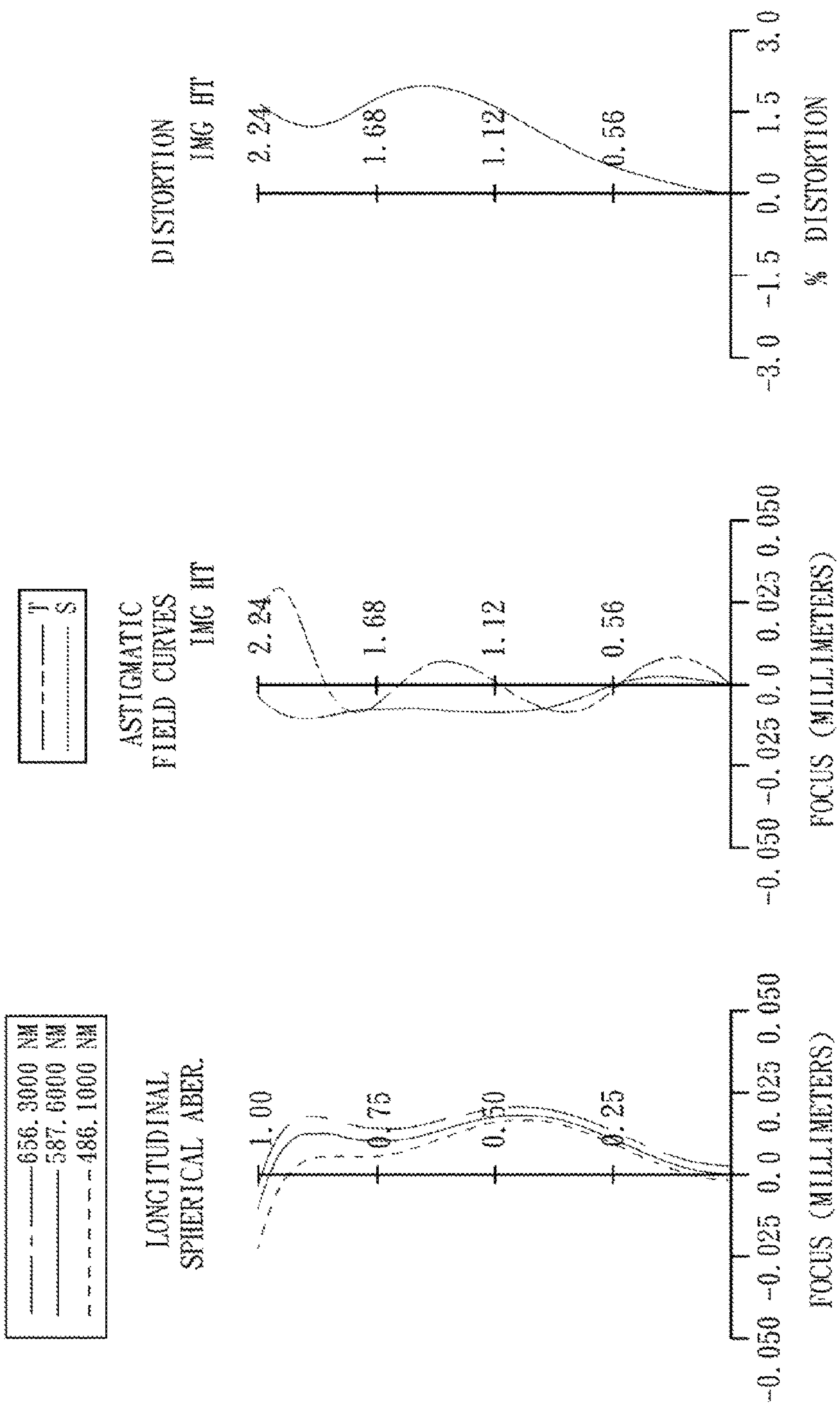

LONGITUDINAL SPHERICAL ABER.
656.3000 NM
587.6000 NM
486.1000 NM
1.00
0.75
0.50
0.25
-0.050 -0.025 0.0 0.025 0.050
FOCUS (MILLIMETERS)
ASTIGMATIC FIELD CURVES
IMG HT
T
S
2.24
1.68
1.12
0.56
-0.050 -0.025 0.0 0.025 0.050
FOCUS (MILLIMETERS)
DISTORTION
IMG HT
2.24
1.68
1.12
0.56
-3.0 -1.5 0.0 1.5 3.0
% DISTORTION

Fig. 14

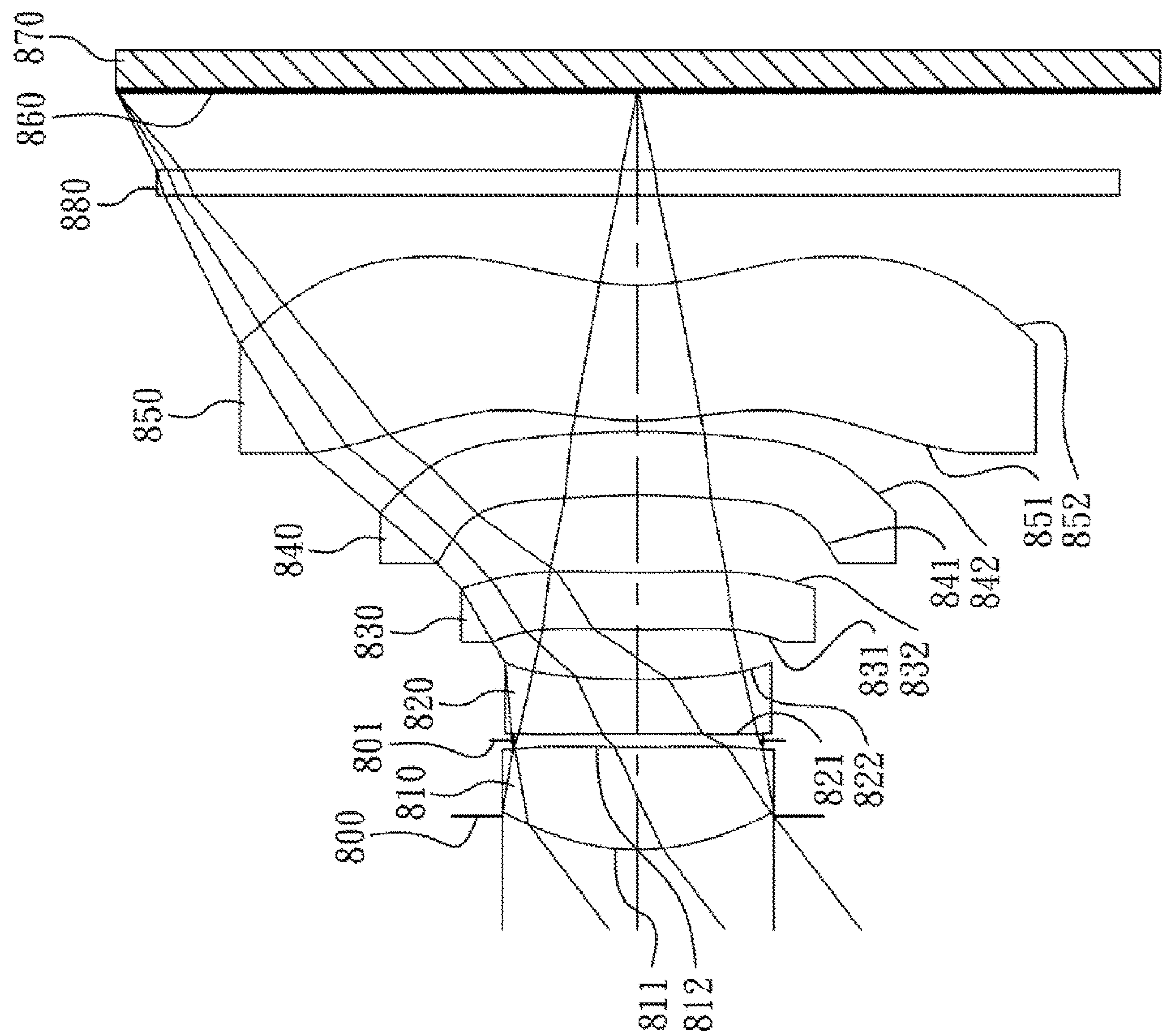
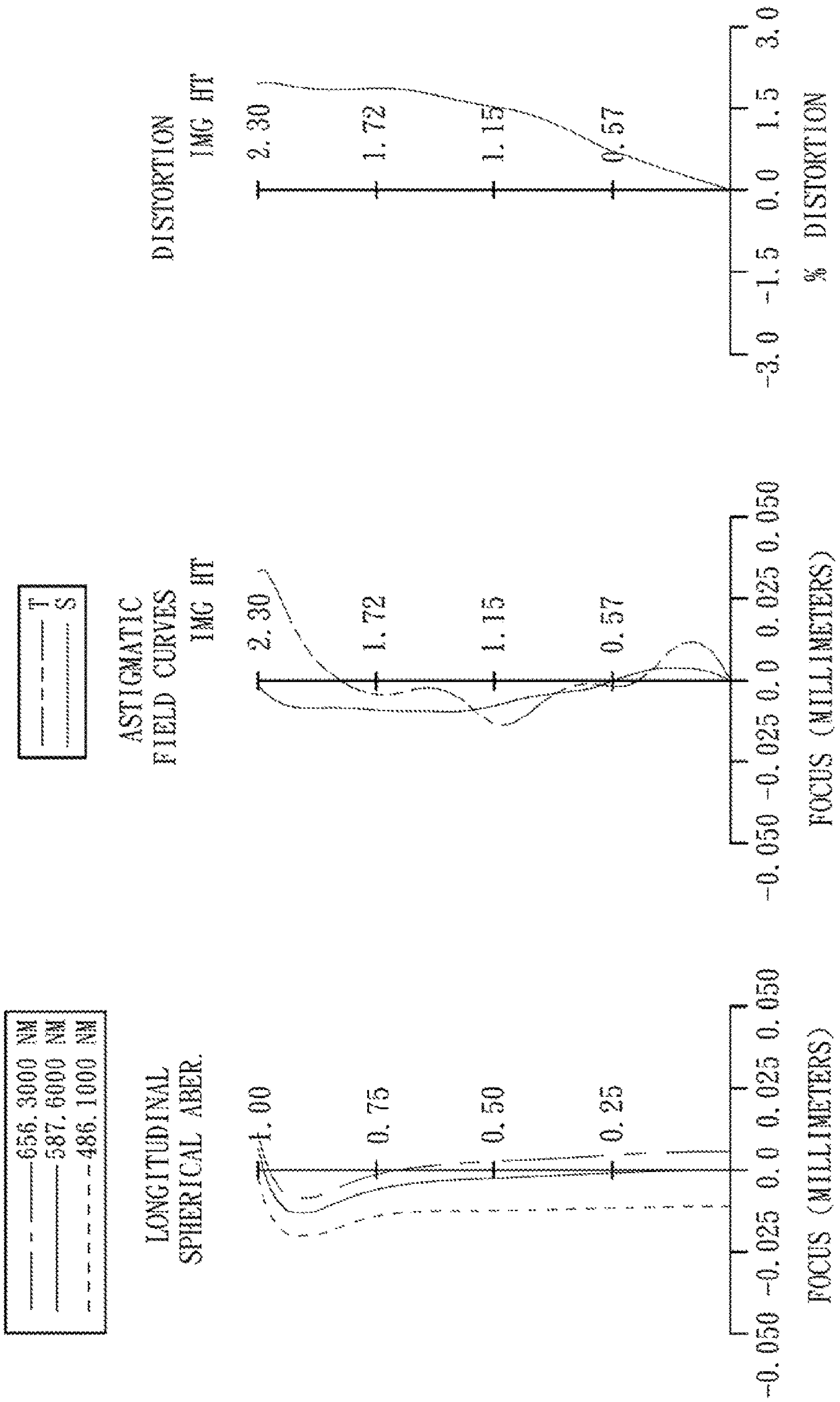
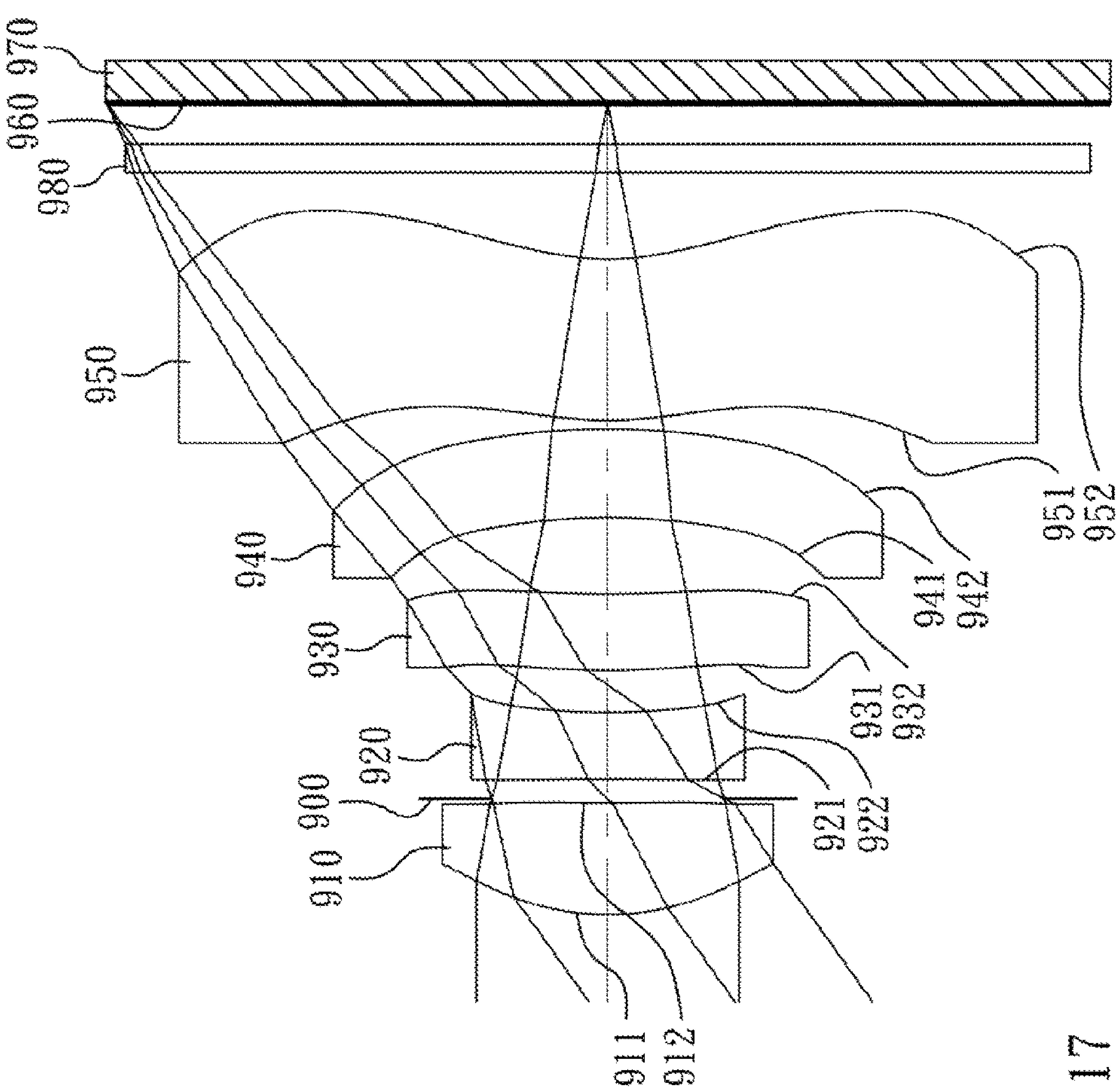

870
860
880
850
840
830
820
801
810
800
811
812
821
822
831
832
841
842
851
852

Fig. 15



LONGITUDINAL SPHERICAL ABER.
656.3000 NM
587.6000 NM
486.1000 NM
1.00
0.75
0.50
0.25
-0.050 -0.025 0.0 0.025 0.050
FOCUS (MILLIMETERS)
ASTIGMATIC FIELD CURVES
IMG HT
T
S
2.30
1.72
1.15
0.57
-0.050 -0.025 0.0 0.025 0.050
FOCUS (MILLIMETERS)
DISTORTION
IMG HT
2.30
1.72
1.15
0.57
-3.0 -1.5 0.0 1.5 3.0
% DISTORTION

Fig. 16


970
960
980
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940
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930
931
932
920
921
922
900
910
911
912

Fig. 17

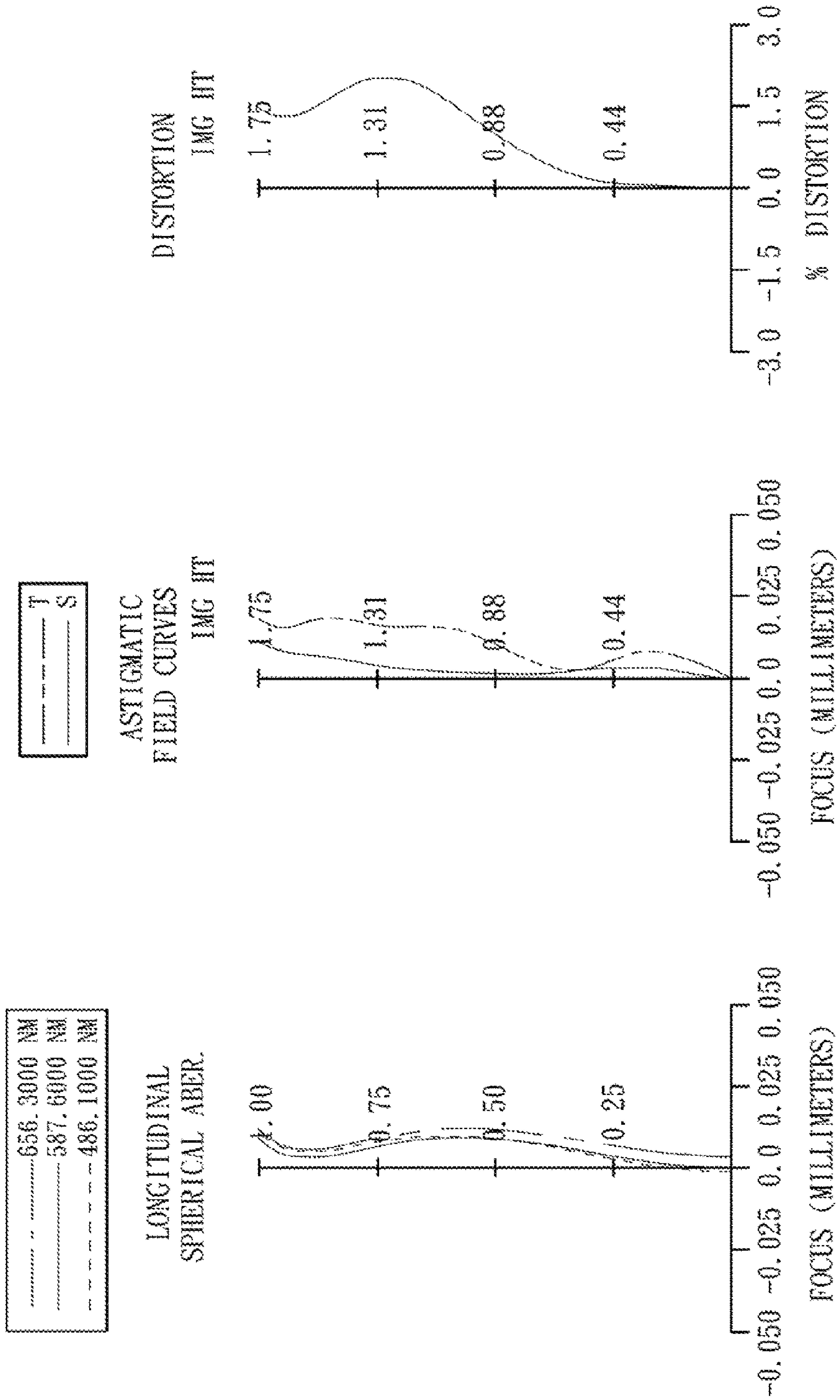
LONGITUDINAL SPHERICAL ABER.
656.3000 NM
587.6000 NM
486.1000 NM
FOCUS (MILLIMETERS)
ASTIGMATIC FIELD CURVES
IMG HT
T
S
FOCUS (MILLIMETERS)
DISTORTION
IMG HT
% DISTORTION

Fig. 18

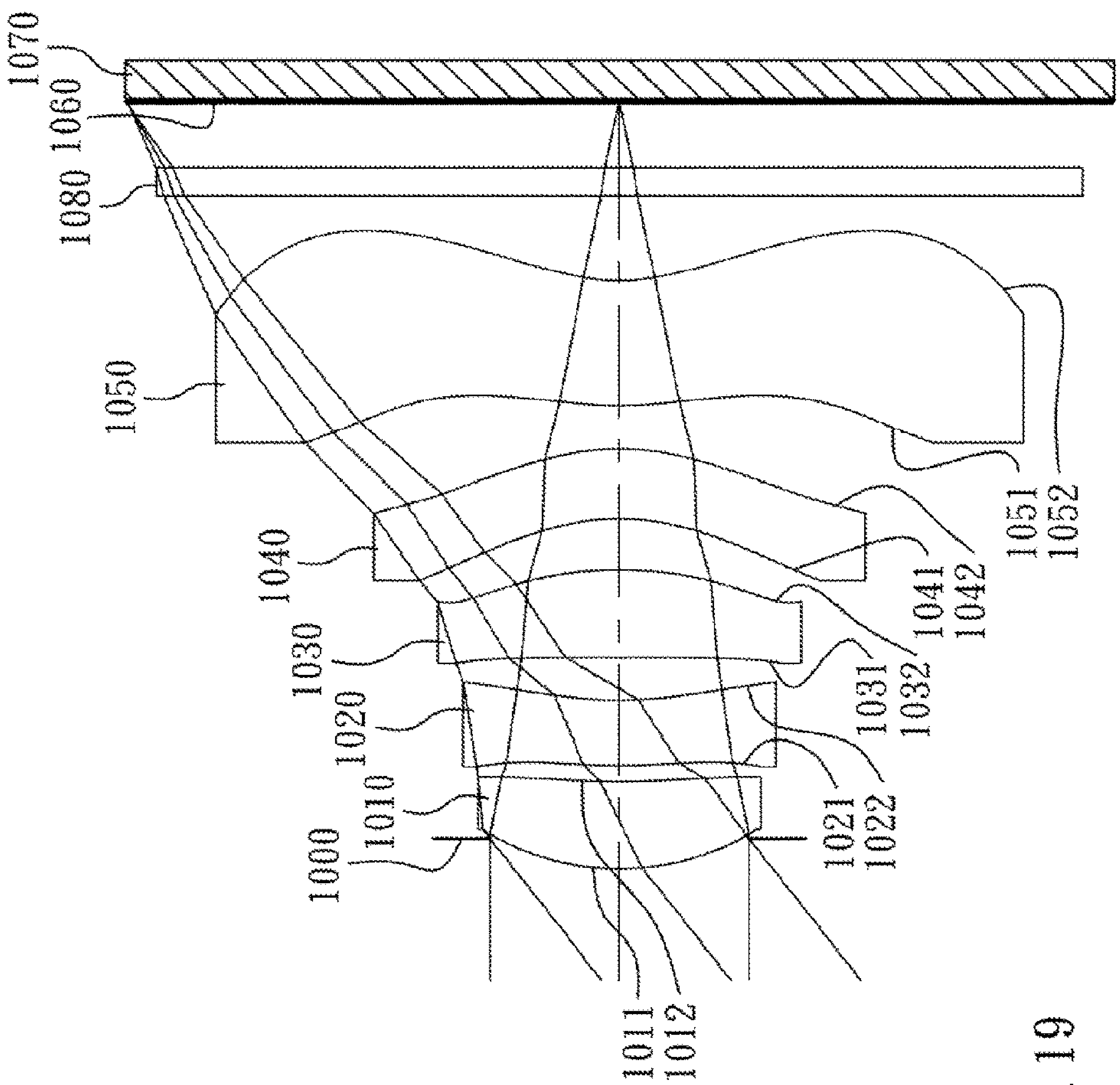
1070
1060
1080
1050
1040
1030
1020
1010
1000
1011
1012
1021
1022
1031
1032
1041
1042
1051
1052

Fig. 19

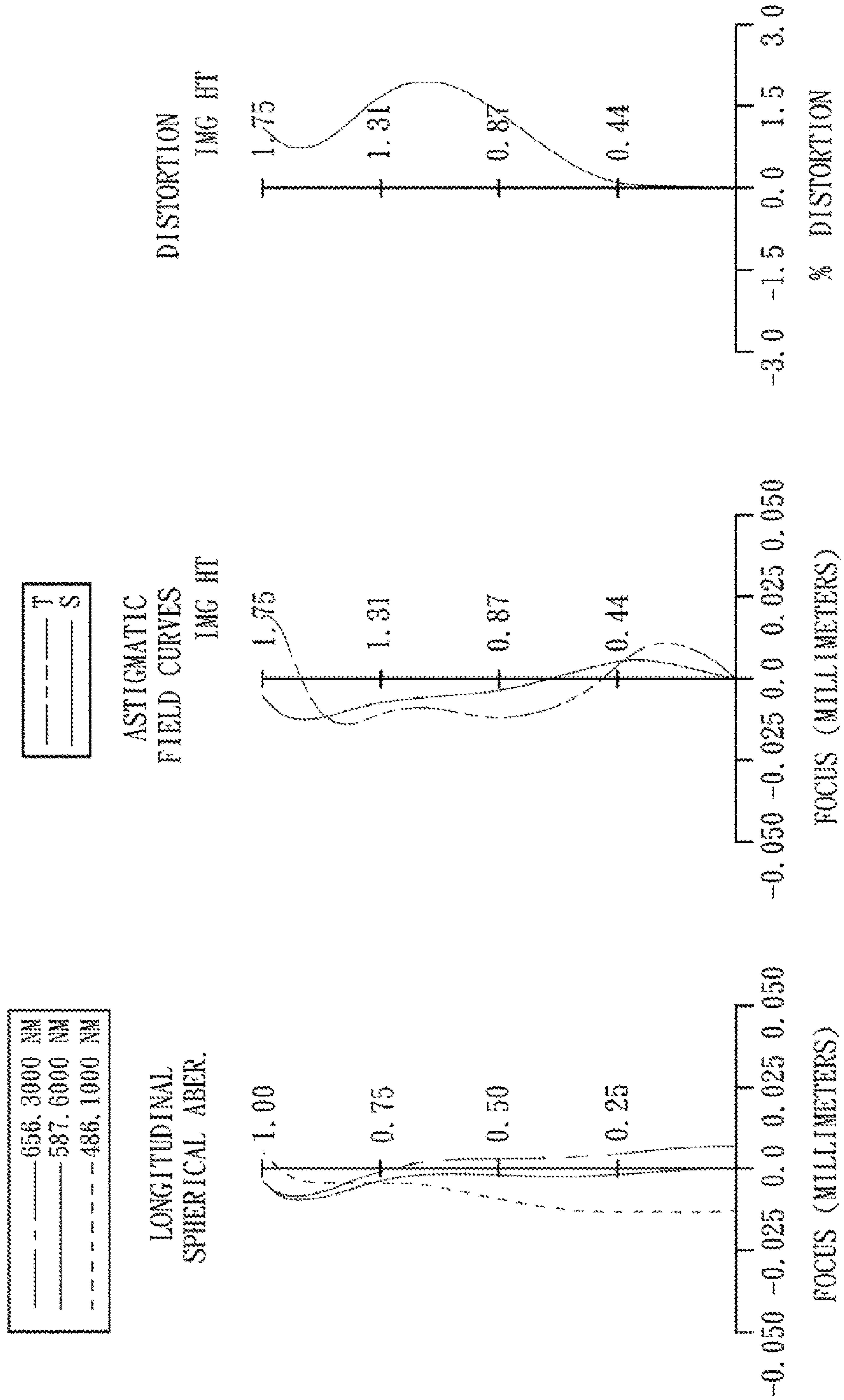
656.3000 NM
587.6000 NM
486.1000 NM
LONGITUDINAL
SPHERICAL ABER.
1.00
0.75
0.50
0.25
-0.050 -0.025 0.0 0.025 0.050
FOCUS (MILLIMETERS)
T
S
ASTIGMATIC
FIELD CURVES
IMG HT
1.75
1.31
0.87
0.44
-0.050 -0.025 0.0 0.025 0.050
FOCUS (MILLIMETERS)
DISTORTION
IMG HT
1.75
1.31
0.87
0.44
-3.0 -1.5 0.0 1.5 3.0
% DISTORTION

Fig. 20

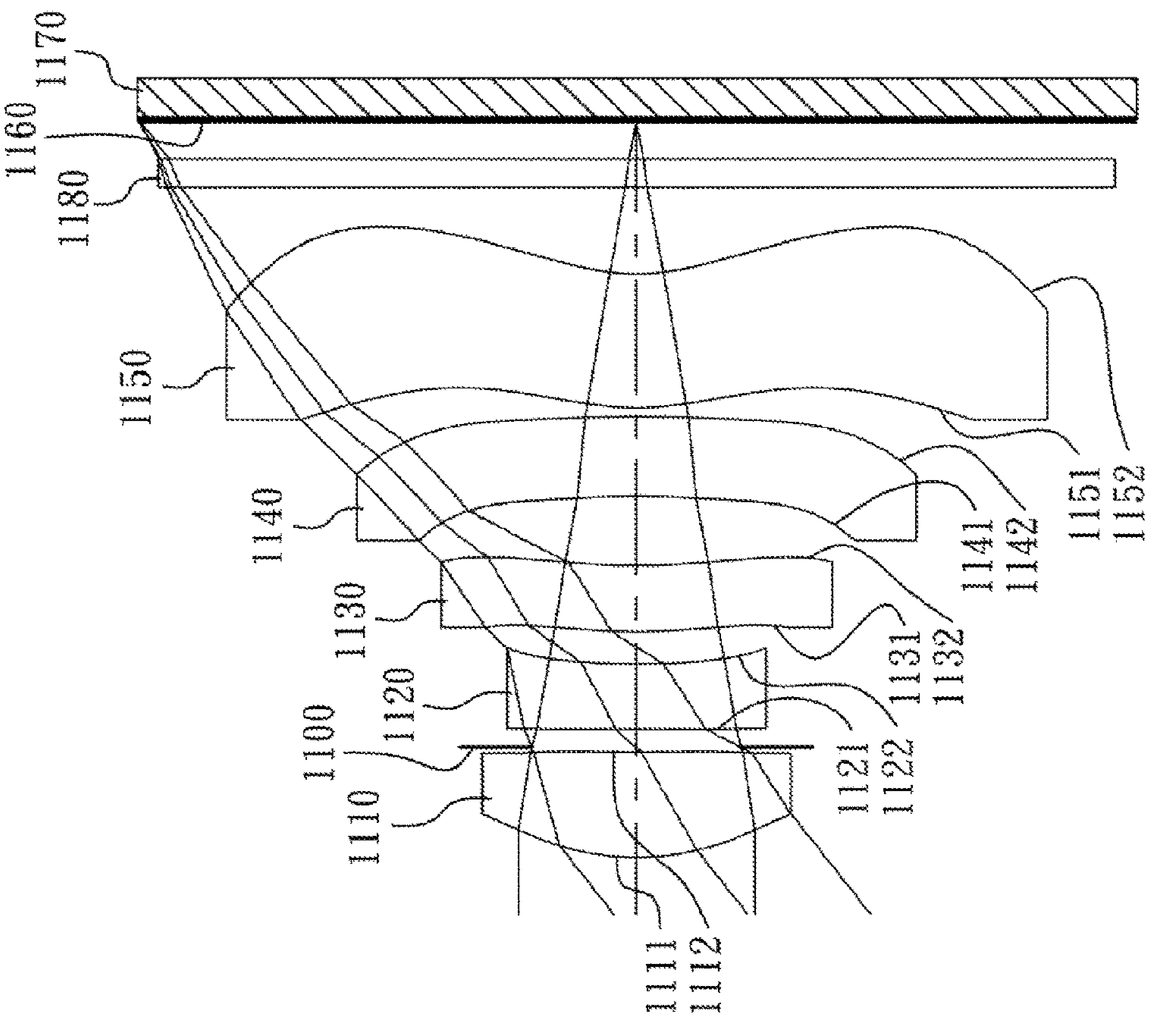
1170
1160
1180
1150
1140
1130
1120
1100
1110
1111
1112
1121
1122
1131
1132
1141
1142
1151
1152

Fig. 21

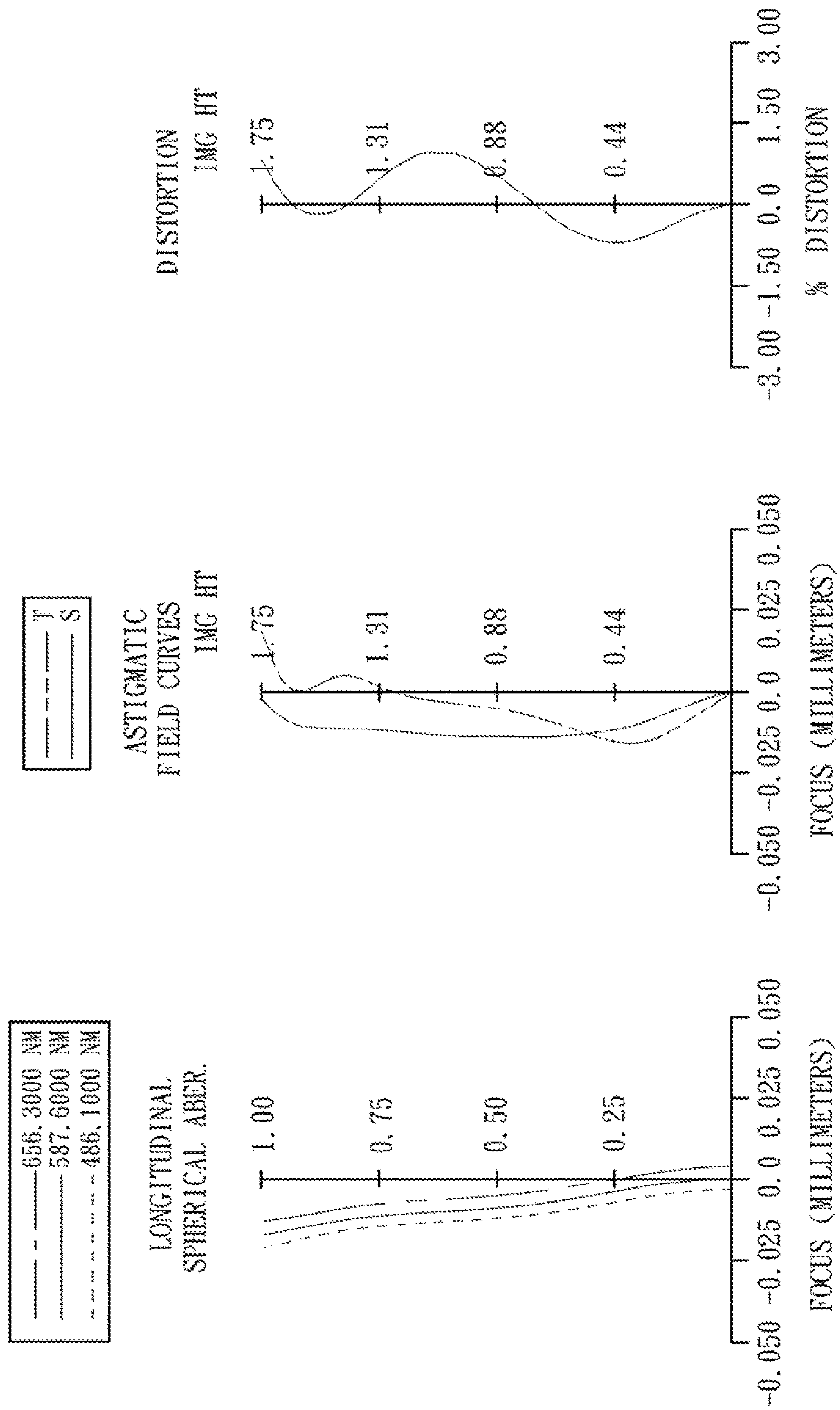
DISTORTION
IMG HT
1.75
1.31
0.88
0.44
-3.00 -1.50 0.0 1.50 3.00
% DISTORTION
T
S
ASTIGMATIC
FIELD CURVES
IMG HT
1.75
1.31
0.88
0.44
-0.050 -0.025 0.0 0.025 0.050
FOCUS (MILLIMETERS)
656.3000 NM
587.6000 NM
486.1000 NM
LONGITUDINAL
SPHERICAL ABER.
1.00
0.75
0.50
0.25
-0.050 -0.025 0.0 0.025 0.050
FOCUS (MILLIMETERS)

Fig. 22

IMAGE CAPTURING SYSTEM

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.

RELATED APPLICATIONS

[The**]** *This* application *is a broadening reissue application of U.S. Pat. No. 8,705,181 B2 issued to Assignee Largan Precision Col, Ltd. on Apr. 22, 2014 from U.S. patent application Ser. No. 13/615,568 filed on Sep. 13, 2012 which* claims priority to Taiwan Application Serial Number 101101276, filed Jan. 12, 2012, which is herein incorporated by reference.

BACKGROUND

1. Technical Field

The present invention relates to an image capturing system. More particularly, the present invention relates to a compact image capturing system applicable to electronic products.

2. Description of Related Art

In recent years, with the popularity of mobile products with camera functionalities, the demand for miniaturizing an optical lens system is increasing. The sensor of a conventional photographing camera is typically a CCD (Charge-Coupled Device) or a CMOS (Complementary Metal-Oxide-Semiconductor) sensor. As advanced semiconductor manufacturing technologies have allowed the pixel size of sensors to be reduced and compact optical lens systems have gradually evolved toward the field of higher megapixels, there is an increasing demand for compact optical lens systems featuring better image quality.

A conventional compact optical lens system employed in a portable electronic product mainly adopts a four-element lens structure. Due to the popularity of mobile products with high-end specifications, such as smart phones and PDAs (Personal Digital Assistants), the pixel and image-quality requirements of the compact optical lens system have increased rapidly. However, the conventional four-element lens structure cannot satisfy the requirements of the compact optical lens system.

Another conventional compact optical lens system with five-element lens structure enhances image quality and resolving power. However, the total track length of the optical lens system cannot be reduced easily. Therefore, a need exists in the art for providing an optical lens system for use in a mobile electronic product that has excellent imaging quality without excessive total track length.

SUMMARY

According to one aspect of the present disclosure, an image capturing system includes, in order from an object side to an image side, a first lens element, a second lens element, a third lens element, a fourth lens element and a fifth lens element. The first lens element with positive refractive power has a convex object-side surface. The second lens element has negative refractive power. The third lens element has positive refractive power. The fourth lens element with negative refractive power has a concave object-side surface and a convex image-side surface, wherein at least one of the object-side surface and the image-side surface of the fourth lens element is aspheric. The fifth lens element with refractive power has a concave image-side surface, wherein at least one of an object-side surface and the image-side surface of the fifth lens element is aspheric, and the fifth lens element has at least one inflection point on the image-side surface thereof. The first through fifth lens elements are five independent and non-cemented lens elements. When a maximum image height of the image capturing system is ImgH an axial distance between the object-side surface of the first lens element and an image plane is TTL, and a focal length of the image capturing system is f, the following relationship is satisfied:

$$2.8\ \text{mm}<(f/ImgH)\times TTL<4.6\ \text{mm}.$$

According to another aspect of the present disclosure, an image capturing system includes, in order from an object side to an image side, a first lens element, a second lens element, a third lens element, a fourth lens element to and a fifth lens element. The first lens element with positive refractive power has a convex object-side surface. The second lens element has negative refractive power. The third lens element has refractive power. The fourth lens element with negative refractive power has a concave object-side surface and a convex image-side surface, wherein at least one of the object-side surface and the image-side surface of the fourth lens element is aspheric. The fifth lens element with refractive power has a concave image-side surface, wherein at least one of an object-side surface and the image-side surface of the fifth lens element is aspheric, and the fifth lens element has at least one inflection point on the image-side surface thereof. When an axial distance between the object-side surface of the first lens element and an image plane is TTL, a focal length of the image capturing system is f, a half of the maximal field of view of the image capturing system is HFOV, an Abbe number of the third lens element is V3, and an Abbe number of the fourth lens element is V4, the following relationships are satisfied:

$$6.0\ \text{mm}^2<TTL\times f/\tan(HFOV)<16.0\ \text{mm}^2;\ \text{and}$$

$$27<V3-V4<45.$$

According to yet another aspect of the present disclosure, an image capturing system includes, in order from an object side to an image side, a first lens element, a second lens element, a third lens element, a fourth lens element and a fifth lens element. The first lens element with positive refractive power has a convex object-side surface. The second lens element has negative refractive power. The third lens element has refractive power. The fourth lens element with negative refractive power has a concave object-side surface and a convex image-side surface, wherein at least one of the object-side surface and the image-side surface of the fourth lens element is aspheric. The fifth lens element with refractive power has a concave image-side surface, wherein at least one of an object-side surface and the image-side surface of the fifth lens element is aspheric, and the fifth lens element has at least one inflection point on the image-side surface thereof. The first through fifth lens elements are five independent and non-cemented lens elements. When an axial distance between the object-side surface of the first lens element and an image plane is TTL, the following relationship is satisfied:

$$2.2\ \text{mm}<TTL<3.5\ \text{mm}.$$

BRIEF DESCRIPTION OF THE DRAWINGS

The invention can be more fully understood by reading the following detailed description of the embodiment, with reference made to the accompanying drawings as follows:

FIG. **1** is a schematic view of an image capturing system according to the 1st embodiment of the present disclosure;

FIG. **2** shows spherical aberration curves, astigmatic field curves and a distortion curve of the image capturing system according to the 1st embodiment;

FIG. **3** is a schematic view of an image capturing system according to the 2nd embodiment of the present disclosure;

FIG. **4** shows spherical aberration curves, astigmatic field curves and a distortion curve of the image capturing system according to the 2nd embodiment;

FIG. **5** is a schematic view of an image capturing system according to the to 3rd embodiment of the present disclosure;

FIG. **6** shows spherical aberration curves, astigmatic field curves and a distortion curve of the image capturing system according to the 3rd embodiment;

FIG. **7** is a schematic view of an image capturing system according to the 4th embodiment of the present disclosure;

FIG. **8** shows spherical aberration curves, astigmatic field curves and a distortion curve of the image capturing system according to the 4th embodiment;

FIG. **9** is a schematic view of an image capturing system according to the 5th embodiment of the present disclosure;

FIG. **10** shows spherical aberration curves, astigmatic field curves and a distortion curve of the image capturing system according to the 5th embodiment;

FIG. **11** is a schematic view of an image capturing system according to the 6th embodiment of the present disclosure;

FIG. **12** shows spherical aberration curves, astigmatic field curves and a distortion curve of the image capturing system according to the 6th embodiment;

FIG. **13** is a schematic view of an image capturing system according to the 7th embodiment of the present disclosure;

FIG. **14** shows spherical aberration curves, astigmatic field curves and a distortion curve of the image capturing system according to the 7th embodiment;

FIG. **15** is a schematic view of an image capturing system according to the 8th embodiment of the present disclosure;

FIG. **16** shows spherical aberration curves, astigmatic field curves and a distortion curve of the image capturing system according to the 8th embodiment;

FIG. **17** is a schematic view of an image capturing system according to the 9th embodiment of the present disclosure;

FIG. **18** shows spherical aberration curves, astigmatic field curves and a distortion curve of the image capturing system according to the 9th embodiment;

FIG. **19** is a schematic view of an image capturing system according to the 10th embodiment of the present disclosure;

FIG. **20** shows spherical aberration curves, astigmatic field curves and a distortion curve of the image capturing system according to the 10th embodiment;

FIG. **21** is a schematic view of an image capturing system according to the 11th embodiment of the present disclosure; and

FIG. **22** shows spherical aberration curves, astigmatic field curves and a distortion curve of the image capturing system according to the 11th embodiment.

DETAILED DESCRIPTION

An image capturing system includes, in order from an object side to an image side, a first lens element, a second

lens element, a third lens element, a fourth lens element and a fifth lens element. The image capturing system further includes an image sensor located on an image plane.

The first through fifth lens elements are five independent and non-cemented lens elements. That is, any two lens elements adjacent to each other are not cemented, and there is an air space between the two lens elements. The manufacture of the cemented lenses is more complex than the manufacture of the non-cemented lenses. Especially, the cemented surfaces of the two lens elements should have accurate curvatures for ensuring a precise bonding between the two lens elements, or else an undesirable gap between the cemented surfaces of the two lens elements created during the cementing process may affect the optical quality of the image capturing system. Therefore, the image capturing system of the present disclosure provides five independent and non-cemented lens elements for improving the problem generated by the cemented lens elements.

The first lens element with positive refractive power has a convex object-side surface, so that the positive refractive power of the first lens element can be enhanced for further reducing the total track length thereof.

The second lens element with negative refractive power corrects the aberration generated from the first lens element with positive refractive power. The second lens element has a concave image-side surface, so that the refractive power of the second lens element is proper by adjusting the curvature of the image-side surface of the second lens element, and the aberration of the image capturing system can be further corrected.

The third lens element with positive refractive power can reduce the sensitivity of the image capturing system by balancing the distribution of the positive refractive power of the image capturing system.

The fourth lens element with negative refractive power has a concave object-side surface and a convex image-side surface, so that the astigmatism and the high-order aberration of the image capturing system can be corrected.

The fifth lens element with refractive power has a convex object-side surface and a concave image-side surface, so that the principal point of the image capturing system can be positioned away from the image plane, and the total track length of the image capturing system can be reduced so as to maintain the compact size of the image capturing system. Furthermore, the fifth lens element has at least one inflection point on at least one of the object-side surface and the image-side surface thereof, so that the incident angle of the off-axis field on the image sensor can be effectively reduced and the aberration can be corrected as well.

When a maximum image height of the image capturing system is ImgH, an axial distance between the object-side surface of the first lens element and an image plane is TTL, and a focal length of the image capturing system is f, the following relationship is satisfied:

$$2.8\text{ mm}<(f/ImgH)\times TTL<4.6\text{ mm}.$$

Therefore, the image capturing system with short total track length is applicable to the ultra-thin electronic products. Moreover, the optimized arrangement of the maximum image height of the image capturing system can provide the excellent image capture of the compact electronic products.

When the focal length of the image capturing system is f, and a focal length of the second lens element is f2, the following relationship is satisfied:

$$-1.4<f/f2<-0.18.$$

Therefore, the negative refractive power of the second lens element can to correct the aberration generated from the first lens element with positive refractive power.

When a central thickness of the second lens element is CT2, a central thickness of the third lens element is CT3, and acentral thickness of the fourth lens element is CT4, the following relationship is satisfied:

$$0.20\text{ mm}<(CT2+CT3+CT4)/3<0.31\text{ mm}.$$

Therefore, the thickness of the second lens element, the third lens element and the fourth lens element are proper for enhancing the yield of the manufacture and fabrication of the lens elements.

When an Abbe number of the first lens element is V1, an Abbe number of the second lens element is V2, an Abbe number of the third lens element is V3, and an Abbe number of the fourth lens element is V4, the following relationships are satisfied:

$$20<V1-V2<50;\text{ and}$$

$$27<V3-V4<45.$$

Therefore, the chromatic aberration of the image capturing system can be corrected.

When the axial distance between the object-side surface of the first lens element and an image plane is TTL, the focal length of the image capturing system is f, and a half of the maximal field of view of the image capturing system is HFOV, the following relationship is satisfied:

$$6.0\text{ mm}^2<TTL\times f/\tan(HFOV)<16.0\text{ mm}^2.$$

Therefore, the short total track length of the image capturing system is applicable to the ultra-thin electronic product, and the field of view of the image to capturing system is proper for the image capture of the compact electronic product.

TTL, f, and HFOV can further satisfy the following relationship:

$$6.5\text{ mm}^2<TTL\times f/\tan(HFOV)<13.4\text{ mm}^2.$$

When a maximal field of view of the image capturing system is FOV, the following relationship is satisfied:

$$70\text{ degrees}<FOV<90\text{ degrees}.$$

Therefore, the proper range of the image can be captured by the image capturing system with larger field of view.

When the focal length of the image capturing system is f, the following relationship is satisfied:

$$1.8\text{ mm}<f<3.2\text{ mm}.$$

Therefore, the proper focal length of the image capturing system can maintain the compact size of the image capturing system.

When the maximum image height of the image capturing system is ImgH, and the axial distance between the object-side surface of the first lens element and an image plane is TTL, the following relationships are satisfied:

$$2.2\text{ mm}<TTL<3.5\text{ mm};\text{ and}$$

$$TTL/ImgH<<1.55.$$

Therefore, the image capturing system with short total track length can maintain the compact size for portable electronic products.

According to the image capturing system of the present disclosure, the lens elements thereof can be made of glass or plastic material. When the lens elements are made of glass material, the distribution of the refractive power of the image capturing system may be more flexible to design. When the lens elements are made of plastic material, the cost of manufacture can be effectively reduced. Furthermore, the surface of each lens element can be aspheric, so that it is easier to make the surface into non-spherical shapes. As a result, more controllable variables are obtained, and the aberration is reduced, as well as the number of required lens elements can be reduced while constructing an optical system. Therefore, the total track length of the image capturing system can also be reduced.

According to the image capturing system of the present disclosure, when the lens element has a convex surface, it indicates that the paraxial region of the surface is convex; and when the lens element has a concave surface, it indicates that the paraxial region of the surface is concave.

According to the image capturing system of the present disclosure, the image capturing system can include at least one stop, such as an aperture stop, glare stop, field stop, etc. Said glare stop or said field stop is allocated for reducing stray light while retaining high image quality. Furthermore, when a stop is an aperture stop, the position of the aperture stop within an optical system can be arbitrarily placed in front of the entire lens assembly, within the lens assembly, or in front of the image plane in accordance with the preference of the optical designer, in order to achieve the desirable optical features or higher image quality produced from the optical system.

According to the above description of the present disclosure, the following 1st-11th specific embodiments are provided for further explanation.

1st Embodiment

FIG. **1** is a schematic view of an image capturing system according to the 1st embodiment of the present disclosure, FIG. **2** shows spherical aberration curves, astigmatic field curves and a distortion curve of the image capturing system according to the 1st embodiment. In FIG. **1**, the image capturing system includes, in order from an object side to an image side, an aperture stop **100**, the first lens element **110**, the second lens element **120**, the third lens element **130**, the fourth lens element **140**, the fifth lens element **150**, an IR-cut filter **180**, an image plane **160** and an image sensor **170**.

The first lens element **110** with positive refractive power has a convex object-side surface **111** and a concave image-side surface **112**, and is made of plastic material. The object-side surface **111** and the mage-side surface **112** of the first lens element **110** are aspheric.

The second lens element **120** with negative refractive power has a convex object-side surface **121** and a concave image-side surface **122**, and is made of plastic material. The object-side surface **121** and the image-side surface **122** of the second lens element **120** are aspheric.

The third lens element **130** with positive refractive power has a concave object-side surface **131** and a convex image-side surface **132**, and is made of plastic material. The object-side surface **131** and the image-side surface **132** of the third lens element **130** are aspheric.

The fourth lens element **140** with negative refractive power has a concave object-side surface **141** and a convex image-side surface **142**, and is made of plastic material. The object-side surface **141** and the image-side surface **142** of the fourth lens element **140** are aspheric.

The fifth lens element **150** with negative refractive power has a convex object-side surface **151** and a concave image-side surface **152**, and is made of plastic material. The object-side surface **151** and the image-side surface **152** of the fifth lens element **150** are aspheric. Furthermore, the fifth lens element **150** has inflection points on the object-side surface **151** and the image-side surface **152** thereof.

The IR-cut filter **180** is made of glass, and located between the fifth lens element **150** and the image plane **160**, and will not affect the focal length of the image capturing system.

The equation of the aspheric surface profiles of the aforementioned lens elements of the 1st embodiment is expressed as follows:

$$X(Y) = (Y^2/R)/(1+\mathrm{sqrt}(1-(1+k)\times(Y/R)^2)) + \sum_i (Ai)\times(Y^i),$$

wherein,

X is the distance between a point on the aspheric surface spaced at a distance Y from the optical axis and the tangential plane at the aspheric surface vertex on the optical axis;

Y is the distance from the point on the curve of the aspheric surface to the optical axis;

R is the curvature radius;

k is the conic coefficient; and

Ai is the i-th aspheric coefficient.

In the image capturing system according to the 1st embodiment, when a focal length of the image capturing system is f, an f-number of the image capturing system is Fno, and half of the maximal field of view is HFOV, these parameters have the following values:

f=2.85 mm;

Fno=2.35; and

HFOV=38.6 degrees.

In the image capturing system according to the 1st embodiment, when an Abbe number of the first lens element **110** is V1, an Abbe number of the second lens element **120** is V2, an Abbe number of the third lens element **130** is V3, and an Abbe number of the fourth lens element **140** is V4, the following relationships are satisfied:

$V1-V2=32.6$; and

$V3-V4=32.6$.

In the image capturing system according to the 1st embodiment, when a central thickness of the second lens element **120** is CT2, a central thickness of the third lens element **130** is CT3, and a central thickness of the fourth lens element **140** is CT4, the following relationship is satisfied:

$(CT2+CT3+CT4)/3=0.28$ mm.

In the image capturing system according to the 1st embodiment, when the focal length of the image capturing system is f, and a focal length of the second lens element **120** is f2, the following relationship is satisfied:

$f/f2=-0.53$.

In the image capturing system according to the 1st embodiment, when a maximal field of view of the image capturing system is FOV, the following relationship is satisfied:

FOV=77.2 degrees.

In the image capturing system according to the 1st embodiment, when a to maximum image height of the image capturing system is ImgH which here is a half of the diagonal length of the photosensitive area of the image sensor **170** on the image plane **160**, an axial distance between the object-side surface **111** of the first lens element **110** and the image plane **160** is TTL, the focal length of the image capturing system is f, and the half of the maximal field of view of the image capturing system is HFOV, the following relationships are satisfied:

TTL=3.45 mm;

TTL/ImgH=1.50;

$(f/ImgH)\times TTL=4.28$ mm; and

$TTL\times f/\tan(HFOV)=12.32\ mm^2$.

The detailed optical data of the 1st embodiment are shown in Table 1 and the aspheric surface data are shown in Table 2 below.

TABLE 1

1st Embodiment f = 2.85 mm, Fno = 2.35, HFOV = 38.6 deg.							
Surface #		Curvature Radius	Thickness	Material	Index	Abbe #	Focal length
0	Object	Plano	Infinity				
1	Ape. Stop	Plano	−0.140				
2	Lens 1	1.203440 (ASP)	0.415	Plastic	1.544	55.9	2.90
3		4.431400 (ASP)	0.120				
4	Lens 2	4.333300 (ASP)	0.230	Plastic	1.640	23.3	−5.39
5		1.881120 (ASP)	0.123				
6	Lens 3	−15.082100 (ASP)	0.359	Plastic	1.544	55.9	2.59
7		−1.299460 (ASP)	0.256				
8	Lens 4	−0.795830 (ASP)	0.262	Plastic	1.640	23.3	−27.33
9		−0.940880 (ASP)	0.342				
10	Lens 5	2.634130 (ASP)	0.574	Plastic	1.544	55.9	−3.41
11		1.004370 (ASP)	0.400				
12	IR-cut filter	Plano	0.100	Glass	1.516	64.1	—
13		Plano	0.271				
14	Image	Plano	—				

Note:
Reference wavelength (d-line) is 587.6 nm.

TABLE 2

Aspheric Coefficients					
	Surface #				
	2	3	4	5	6
k =	−1.03755E−01	−5.97353E+01	−6.29980E+01	−1.60475E+01	3.00000E+00
A4 =	1.24646E−02	−1.76708E−01	−6.10000E−01	−2.24518E−01	−1.39865E−01
A6 =	2.60307E−02	1.27409E−01	6.33182E−01	4.69619E−01	2.35312E−01
A8 =	−1.39140E−02	−3.71507E−01	−1.67746E+00	−6.26812E−01	1.03273E+00
A10 =	1.99378E−01	−1.07462E+00	9.26878E−01	1.65426E−02	−1.12583E+00
A12 =	−1.10184E+00	2.45859E−02	−3.52174E−02	−3.96623E−02	−1.70242E+00
A14 =	8.55180E−02	−1.22676E−01	7.84949E−02	2.46417E−02	2.93705E+00
A16=					−1.81800E+00
	Surface #				
	7	8	9	10	11
k=	−2.85316E+00	−3.25701E+00	−6.60101E−01	−7.00000E+01	−8.28107E+00
A4 =	−7.48994E−02	1.39780E−01	3.97380E−01	−2.87804E−01	−1.16665E−01
A6 =	1.35837E−04	−7.34782E−01	−3.80411E−01	9.50200E−02	4.81401E−02
A8 =	2.93692E−01	1.41788E+00	1.47130E−01	−4.76421E−02	−2.20238E−02
A10 =	8.90463E−01	−1.25174E+00	2.38860E−01	1.47559E−02	5.86354E−03
A12 =	−5.25061E−01	1.86592E−01	−1.08667E−01	7.14737E−03	−1.17427E−03
A14 =	2.55746E−03	3.94098E−01	−1.58481E−01	4.31432E−04	1.34176E−04
A16 =		−4.24467E−01	8.98673E−02	−1.42169E−03	

In Table 1, the curvature radius, the thickness and the focal length are shown in millimeters (mm). Surface numbers 0-14 represent the surfaces sequentially arranged from the object-side to the image-side along the optical axis. In Table 2, k represents the conic coefficient of the equation of the aspheric surface profiles. A1-A16 represent the aspheric coefficients ranging from the 1st order to the 16th order. This information related to Table 1 and Table 2 applies also to the Tables for the remaining embodiments, and so an explanation in this regard will not be provided again.

2nd Embodiment

FIG. **3** is a schematic view of an image capturing system according to the 2nd embodiment of the present disclosure. FIG. **4** shows spherical aberration curves, astigmatic field curves and a distortion curve of the image capturing system according to the 2nd embodiment. In FIG. **3**, the image capturing system includes, in order from an object side to an image side, an aperture stop **200**, the first lens element **210**, the second lens element **220**, the third lens element **230**, the fourth lens element **240**, the fifth lens element **250**, an IR-cut filter **280**, an image plane **260** and an image sensor **270**.

The first lens element **210** with positive refractive power has a convex object-side surface **211** and a concave image-side surface **212**, and is made of plastic material. The object-side surface **211** and the mage-side surface **212** of the first lens element **210** are aspheric.

The second lens element **220** with negative refractive power has a convex object-side surface **221** and a concave image-side surface **222**, and is made of plastic material. The object-side surface **221** and the image-side surface **222** of the second lens element **220** are aspheric.

The third lens element **230** with positive refractive power has a concave object-side surface **231** and a convex image-side surface **232**, and is made of plastic material. The object-side surface **231** and the image-side surface **232** of the third lens element **230** are aspheric.

The fourth lens element **240** with negative refractive power has a concave object-side surface **241** and a convex-image-side surface **242**, and is made of plastic material. The object-side surface **241** and the image-side surface **242** of the fourth lens element **240** are aspheric.

The fifth lens element **250** with negative refractive power has a convex to object-side surface **251** and a concave image-side surface **252**, and is made of plastic material. The object-side surface **251** and the image-side surface **252** of the fifth lens element **250** are aspheric. Furthermore, the fifth lens element **250** has inflection points on the object-side surface **251** and the image-side surface **252** thereof.

The IR-cut filter **280** is made of glass, and located between the fifth lens element **250** and the image plane **260**, and will not affect the focal length of the image capturing system.

The detailed optical data of the 2nd embodiment are shown in Table 3 and the aspheric surface data are shown in Table 4 below.

TABLE 3

2nd Embodiment f = 2.85 mm, Fno = 2.45, HFOV = 38.5 deg.							
Surface #		Curvature Radius	Thickness	Material	Index	Abbe #	Focal length
0	Object	Plano	Infinity				
1	Ape. Stop	Plano	−0.183				
2	Lens 1	0.995170 (ASP)	0.384	Plastic	1.544	55.9	2.56
3		3.001200 (ASP)	0.053				
4	Lens 2	4.463000 (ASP)	0.230	Plastic	1.650	21.4	−8.44

TABLE 3-continued

2nd Embodiment f = 2.85 mm, Fno = 2.45, HFOV = 38.5 deg.							
Surface #		Curvature Radius	Thickness	Material	Index	Abbe #	Focal length
5		2.410910 (ASP)	0.219				
6	Lens 3	−5.577900 (ASP)	0.308	Plastic	1.544	55.9	5.57
7		−2.001630 (ASP)	0.148				
8	Lens 4	−1.723240 (ASP)	0.269	Plastic	1.650	21.4	−81.09
9		−1.891030 (ASP)	0.474				
10	Lens 5	1.441430 (ASP)	0.413	Plastic	1.544	55.9	−3.53
11		0.740770 (ASP)	0.400				
12	IR-cut filter	Plano	0.100	Glass	1.516	64.1	—
13		Plano	0.205				
14	Image	Plano	—				

Note:
Reference wavelength (d-line) is 587.6 nm.

TABLE 4

Aspheric Coefficients					
	Surface #				
	2	3	4	5	6
k =	−6.88502E−02	−3.00000E+01	3.00000E+00	−1.60883E+01	2.43205E+00
A4 =	2.58920E−02	−3.13122E−01	−5.79512E−01	−2.97877E−02	−2.49204E−01
A6 =	2.22230E−02	4.83341E−01	9.15215E−01	1.03649E+00	2.78333E−01
A8 =	6.60918E−02	−5.98899E−01	−6.28339E−03	−1.11360E+00	7.77147E−01
A10 =	6.19733E−01	1.79077E+00	−4.38440E−01	2.05247E+00	−2.23445E−01
A12 =	−9.41374E−01	−2.68994E−01	7.57127E−02	−3.71567E−02	−1.59406E+00
A14 =	8.55178E−02	−1.22676E−01	7.84947E−02	8.06883E−01	2.80195E+00
A16=					−1.81800E+00
	Surface #				
	7	8	9	10	11
k =	−2.28263E+00	−1.88163E+01	2.84586E−01	−3.00000E+01	−7.45249E+00
A4 =	−7.02749E−02	1.08745E−01	3.18903E−01	−2.94009E−01	−1.27522E−01
A6 =	−2.40392E−01	−7.85078E−01	−4.20075E−01	1.17479E−01	4.66619E−02
A8 =	6.28421E−01	1.16013E+00	1.06162E−01	−5.13621E−02	−1.82663E−02
A10 =	4.12552E−01	−1.10042E+00	2.16320E−01	1.18668E−02	3.99323E−03
A12 =	−5.30755E−01	2.36807E−01	−1.16204E−01	4.58634E−03	−1.25535E−03
A14 =	−1.96983E−02	4.20670E−01	−1.40508E−01	−8.02211E−04	2.35232E−04
A16 =		−6.20491E−01	9.50575E−02	−2.82421E−04	

In the image capturing system according to the 2nd embodiment, the definitions of f Fno, HFOV, V1, V2, V3, V4, CT2, CT3, CT4, f2, FOV, TTL and ImgH are the same as those stated in the 1st embodiment with corresponding values for the 2nd embodiment. Moreover, these parameters can be calculated from Table 3 and Table 4 as the following values and satisfy the following relationships:

f (mm)	2.85
Fno	2.45
HFOV (deg.)	38.5
V1 − V2	34.5
V3 − V4	34.5
(CT2 + CT3 + CT4)/3 (mm)	0.27
f/f2	−0.34
FOV (deg.)	77.0
TTL (mm)	3.20
TTL/ImgH	1.41
(f/ImgH) × TTL (mm)	4.00
TTL × f/tan(HFOV) (mm^2)	11.46

3rd Embodiment

FIG. **5** is a schematic view of an image capturing system according to the 3rd embodiment of the present disclosure. FIG. **6** shows spherical aberration curves, astigmatic field curves and a distortion curve of the image capturing system according to the 3rd embodiment. In FIG. **5** the image capturing to system includes, in order from an object side to an image side, an aperture stop **300**, the first lens element **310**, the second lens element **320**, the third lens element **330**, the fourth lens element **340**, the fifth lens element **350**, an IR-cut filter **380**, an image plane **360** and an image sensor **370**.

The first lens element **310** with positive refractive power has a convex object-side surface **311** and a concave image-side surface **312**, and is made of plastic material. The object-side surface **311** and the image-side surface **312** of the first lens element **310** are aspheric.

The second lens element **320** with negative refractive power has a convex object-side surface **321** and a concave image-side surface **322**, and is made of plastic material. The object-side surface **321** and the image-side surface **322** of the second lens element **320** are aspheric.

The third lens element **330** with positive refractive power has a convex object-side surface **331** and a convex image-side surface **332**, and is made of plastic material. The object-side surface **331** and the image-side surface **332** of the third lens element **330** are aspheric.

The fourth lens element **340** with negative refractive power has a concave object-side surface **341** and a convex image-side surface **342**, and is made of plastic material. The object-side surface **341** and the image-side surface **342** of the fourth lens element **340** are aspheric.

The fifth lens element **350** with negative refractive power has a convex object-side surface **351** and a concave image-side surface **352**, and is made of plastic material. The object-side surface **351** and the image-side surface **352** of the fifth lens element **350** are aspheric. Furthermore, the fifth lens element **350** has inflection points on the object-side surface **351** and the image-side surface **352** thereof.

The IR-cut filter **380** is made of glass, and located between the fifth lens element **350** and the image plane **360**, and will not affect the focal length of the image capturing system.

The detailed optical data of the 3rd embodiment are shown in Table 5 and the aspheric surface data are shown in Table 6 below.

TABLE 5

3rd Embodiment f = 2.79 mm, Fno = 2.46, HFOV = 38.5 deg.							
Surface #		Curvature Radius	Thickness	Material	Index	Abbe #	Focal length
0	Object	Plano	Infinity				
1	Ape. Stop	Plano	−0.175				
2	Lens 1	0.965900 (ASP)	0.372	Plastic	1.544	55.9	2.50
3		2.880820 (ASP)	0.094				
4	Lens 2	5.297100 (ASP)	0.230	Plastic	1.634	23.8	−5.59
5		2.088420 (ASP)	0.189				
6	Lens 3	5.634600 (ASP)	0.288	Plastic	1.544	55.9	4.91
7		−4.988600 (ASP)	0.222				
8	Lens 4	−1.383080 (ASP)	0.246	Plastic	1.634	23.8	−79.45
9		−1.520270 (ASP)	0.424				
10	Lens 5	0.766890 (ASP)	0.306	Plastic	1.535	56.3	−3.66
11		0.474360 (ASP)	0.400				
12	IR-cut filter	Plano	0.100	Glass	1.516	64.1	—
13		Plano	0.203				
14	Image	Plano	—				

Note:
Reference wavelength (d-line) is 587.6 nm.

TABLE 6

Aspheric Coefficients					
	Surface #				
	2	3	4	5	6
k =	−1.52053E−01	−2.27286E+01	−2.95852E+01	−2.61302E+01	−1.38343E+01
A4 =	1.50035E−02	−3.72892E−01	−8.14815E−01	−2.44773E−01	−1.74641E−01
A6 =	3.07480E−02	5.50794E−01	1.11088E+00	1.36473E+00	−2.75602E−01
A8 =	−1.47997E−01	−1.12422E+00	2.23095E+00	−1.91585E+00	9.60878E−01
A10 =	1.07999E+00	4.61048E+00	−1.35747E+00	5.41594E+00	−1.67591E+00
A12 =	−2.11199E+00	−4.21752E−01	−4.30110E−01	−1.71019E−01	−3.03776E+00
A14=	6.57100E−01	−1.61825E−01	2.70840E−01	1.98721E−01	5.86560E+00
A16 =					−3.70216E+00
	Surface #				
	7	8	9	10	11
k =	−2.86726E+01	−9.73941E+00	−1.33029E−01	−1.32978E+01	−6.01898E+00
A4 =	4.94268E−02	9.63340E−02	2.40380E−01	−3.73738E−01	−1.78979E−01
A6 =	−4.38237E−01	−1.30494E+00	−4.26133E−01	1.85615E−01	8.53388E−02
A8 =	7.70590E−01	2.12276E+00	1.74055E−01	−5.36970E−02	−3.49683E−02
A10 =	−3.49464E−01	−9.31429E−01	4.09076E−01	9.10557E−03	9.87231E−03
A12 =	−2.54616E−01	2.45176E−01	−9.46190E−02	4.96456E−03	−2.30035E−03
A14 =	1.61846E−03	−1.92494E−01	−3.27985E−01	−3.14677E−03	2.73973E−04
A16 =		−2.26714E−01	1.51163E−01	4.64500E−04	

In the image capturing system according to the 3rd embodiment, the definitions of f, Fno, HFOV, V1, V2, V3, V4, CT2, CT3, CT4, f2 FOV, TTL and ImgH are the same as those stated in the t embodiment with corresponding values for the 3rd embodiment. Moreover, these parameters can be calculated from Table 5 and Table 6 as the following values and satisfy the following relationships:

f (mm)	2.79
Fno	2.46
HFOV (deg.)	38.5
V1 − V2	32.1
V3 − V4	32.1
(CT2 + CT3 + CT4)/3 (mm)	0.25
f/f2	−0.50
FOV (deg.)	77.0
TTL (mm)	3.07
TTL/ImgH	1.37
(f/ImgH) × TTL (mm)	3.83
TTL × f/tan(HFOV) (mm^2)	10.80

4th Embodiment

FIG. **7** is a schematic view of an image capturing system according to the 4th embodiment of the present disclosure. FIG. **8** shows spherical aberration curves, astigmatic field curves and a distortion curve of the image capturing system according to the 4th embodiment. In FIG. **7**, the image capturing system includes, in order from an object side to an image side, the first lens element **410**, an aperture stop **400**, the second lens element **420**, the third lens element **430**, the fourth lens element **440**, the fifth lens element **450**, an IR-cut filter **480**, an image plane **460** and an image sensor **470**.

The first lens element **410** with positive refractive power has a convex object-side surface **411** and a concave image-side surface **412**, and is made of plastic material. The object-side surface **411** and the image-side surface **412** of the first lens element **410** are aspheric.

The second lens element **420** with negative refractive power has a convex object-side surface **421** and a concave image-side surface **422**, and is made of plastic material. The object-side surface **421** and the image-side surface **422** of the second lens element **420** are aspheric.

The third lens element **430** with positive refractive power has a convex object-side surface **431** and a convex image-side surface **432**, and is made of plastic material. The object-side surface **431** and the image-side surface **432** of the third lens element **430** are aspheric.

The fourth lens element **440** with negative refractive power has a concave object-side surface **441** and a convex image-side surface **442**, and is made of plastic material. The object-side surface **441** and the image-side surface **442** of the fourth lens element **440** are aspheric.

The fifth lens element **450** with negative refractive power has a convex to object-side surface **451** and a concave image-side surface **452**, and is made of plastic material. The object-side surface **451** and the image-side surface **452** of the fifth lens element **450** are aspheric. Furthermore, the fifth lens element **450** has inflection points on the object-side surface **451** and the image-side surface **452** thereof.

The IR-cut filter **480** is made of glass, and located between the fifth lens element **450** and the image plane **460**, and will not affect the focal length of the image capturing system.

The detailed optical data of the 4th embodiment are shown in Table 7 and the aspheric surface data are shown in Table 8 below.

TABLE 7

4th Embodiment f = 2.87 mm, Fno = 2.60, HFOV = 37.7 deg.							
Surface #		Curvature Radius	Thickness	Material	Index	Abbe #	Focal length
0	Object	Plano	infinity				
1	Lens 1	1.114520 (ASP)	0.437	Plastic	1.544	55.9	2.52
2		5.165400 (ASP)	0.030				
3	Ape. Stop	Plano	0.052				
4	Lens 2	3.794800 (ASP)	0.230	Plastic	1.634	23.8	−4.26
5		1.539850 (ASP)	0.137				
6	Lens 3	5.963700 (ASP)	0.335	Plastic	1.544	55.9	4.03
7		−3.406000 (ASP)	0.339				
8	Lens 4	−1.077800 (ASP)	0.316	Plastic	1.634	23.8	−12.26
9		−1.393740 (ASP)	0.098				
10	Lens 5	1.407860 (ASP)	0.626	Plastic	1.535	56.3	−10.96
11		0.959250 (ASP)	0.400				
12	IR-cut filter	Plano	0.200	Glass	1.516	64.1	—
13		Plano	0.253				
14	Image	Plano	—				

Note:
Reference wavelength (d-line) is 587.6 nm.

TABLE 8

Aspheric Coefficients					
	Surface #				
	1	2	4	5	6
k =	−1.61279E−01	−3.14814E+01	3.00000E+00	−6.34695E+00	−3.00000E+01
A4 =	−1.53435E−02	−3.57102E−01	−6.60714E−01	−2.08486E−01	−1.35553E−01
A6 =	1.13129E−01	8.64537E−01	1.74149E+00	1.41973E+00	3.27963E−02

TABLE 8-continued

Aspheric Coefficients					
A8 =	−6.60537E−01	−1.01259E+00	−1.45754E+00	−1.55368E+00	1.16148E+00
A10 =	1.63677E+00	3.18301E−01	−5.04256E−01	8.23901E−01	−7.76417E−01
A12 =	−2.11418E+00	−4.24485E−01	−4.21846E−01	−1.72997E−01	−3.03822E+00
A14 =	6.59149E−01	−1.61830E−01	2.70835E−01	1.92076E−01	5.86313E+00
A16 =					−3.70015E+00

	Surface #				
	7	8	9	10	11
k =	−1.86859E+01	−8.00378E+00	2.07442E−02	−1.46002E+01	−6.42227E+00
A4 =	−3.15658E−02	9.47128E−02	2.17568E−01	−3.47865E−01	−1.48268E−01
A6 =	−4.49228E−01	−1.37174E+00	−4.34101E−01	1.86086E−01	8.08642E−02
A8 =	1.02300E+00	2.03618E+00	1.49949E−01	−5.32172E−02	−3.56870E−02
A10 =	−4.79755E−02	−1.01710E+00	3.94520E−01	9.23622E−03	1.02191E−02
A12 =	2.07706E−02	1.96202E−01	−9.53889E−02	4.93759E−03	−2.22584E−03
A14 =	−7.69161E−01	−1.66874E−01	−3.22708E−01	−3.18512E−03	2.67199E−04
A16 =		−1.13257E−01	1.59175E−01	4.72235E−04	

In the image capturing system according to the 4th embodiment, the definitions of f, Fno, HFOV, V1, V2, V3, V4, CT2, CT3, CT4, f2 FOV, TTL and ImgH are the same as those stated in the t embodiment with corresponding values for the 4th embodiment. Moreover, these parameters can be calculated from Table 7 and Table 8 as the following values and satisfy the following relationships:

f (mm)	2.87
Fno	2.60
HFOV (deg.)	37.7
V1 − V2	32.1
V3 − V4	32.1
(CT2 + CT3 + CT4)/3 (mm)	0.29
f/f2	−0.68
FOV (deg.)	75.4
TTL (mm)	3.45
TTL/ImgH	1.54
(f/ImgH) × TTL (mm)	4.43
TTL × f/tan(HFOV) (mm^2)	12.84

5th Embodiment

FIG. **9** is a schematic view of an image capturing system according to the 5th embodiment of the present disclosure. FIG. **10** shows spherical aberration curves, astigmatic field curves and a distortion curve of the image capturing system according to the 5th embodiment. In FIG. **9**, the image capturing to system includes, in order from an object side to an image side, the first lens element **510**, an aperture stop **500**, the second lens element **520**, the third lens element **530**, the fourth lens element **540**, the fifth lens element **550**, an IR-cut filter **580**, an image plane **560** and an image sensor **570**.

The first lens element **510** with positive refractive power has a convex object-side surface **511** and a concave image-side surface **512**, and is made of plastic material. The object-side surface **511** and the image-side surface **512** of the first lens element **510** are aspheric.

The second lens element **520** with negative refractive power has a concave object-side surface **521** and a concave image-side surface **522**, and is made of plastic material. The object-side surface **521** and the image-side surface **522** of the second lens element **520** are aspheric.

The third lens element **530** with positive refractive power has a convex object-side surface **531** and a concave image-side surface **532**, and is made of plastic material. The object-side surface **531** and the image-side surface **532** of the third lens element **530** are aspheric.

The fourth lens element **540** with negative refractive power has a concave object-side surface **541** and a convex image-side surface **542**, and is made of plastic material. The object-side surface **541** and the image-side surface **542** of the fourth lens element **540** are aspheric.

The fifth lens element **550** with negative refractive power has a convex object-side surface **551** and a concave image-side surface **552**, and is made of plastic material. The object-side surface **551** and the image-side surface **552** of the fifth lens element **550** are aspheric. Furthermore, the fifth lens element **550** has inflection points on the object-side surface **551** and the image-side surface **552** thereof.

The IR-cut filter **580** is made of glass, and located between the fifth lens element **550** and the image plane **560**, and will not affect the focal length of the image capturing system.

The detailed optical data of the 5th embodiment are shown in Table 9 and the aspheric surface data are shown in Table 10 below.

TABLE 9

5th Embodiment f = 2.77 mm, Fno = 2.60, HFOV = 38.5 deg.							
Surface #		Curvature Radius	Thickness	Material	Index	Abbe #	Focal length
0	Object	Plano	Infinity				
1	Lens 1	1.027520 (ASP)	0.422	Plastic	1.544	55.9	2.04
2		11.920400 (ASP)	0.007				
3	Ape. Stop	Plano	0.067				
4	Lens 2	−27.933000 (ASP)	0.230	Plastic	1.640	23.3	−3.85

TABLE 9-continued

5th Embodiment f = 2.77 mm, Fno = 2.60, HFOV = 38.5 deg.							
Surface #		Curvature Radius	Thickness	Material	Index	Abbe #	Focal length
5		2.713100 (ASP)	0.146				
6	Lens 3	3.015100 (ASP)	0.264	Plastic	1.544	55.9	7.90
7		9.771000 (ASP)	0.326				
8	Lens 4	−1.367900 (ASP)	0.303	Plastic	1.640	23.3	−14.98
9		−1.733630 (ASP)	0.062				
10	Lens 5	1.359220 (ASP)	0.623	Plastic	1.544	55.9	−10.88
11		0.928940 (ASP)	0.400				
12	IR-cut filter	Plano	0.100	Glass	1.516	64.1	—
13		Plano	0.254				
14	Image	Plano	—				

Note:
Reference wavelength (d-line) is 587.6 nm.

TABLE 10

Aspheric Coefficients					
	Surface #				
	1	2	4	5	6
k =	−3.43318E−01	−3.84768E+02	0.00000E+00	−5.47436E+00	−2.69833E+01
A4 =	−3.36501E−02	−3.92263E−01	−3.52197E−01	−1.60611E−01	−3.70184E−01
A6 =	2.50508E−02	7.14730E−01	2.11016E+00	1.97313E+00	5.45888E−03
A8 =	−8.11433E−01	−1.10836E+00	−2.30435E+00	−1.90023E+00	1.28146E+00
A10 =	7.34044E−01	1.56618E−01	6.30659E−01	1.77306E+00	−1.48368E+00
A12 =	−2.11137E+00	−4.24482E−01	−4.21843E−01	−1.72994E−01	−3.03682E+00
A14 =	6.59420E−01	−1.61826E−01	2.70839E−01	1.92080E−01	5.86777E+00
A16 =					−3.70015E+00
	Surface #				
	7	8	9	10	11
k =	−3.00000E+01	−1.82327E+01	2.71553E−01	−2.33863E+01	−8.44770E+00
A4 =	−1.70307E−01	1.26110E−01	2.38866E−01	−3.52152E−01	−1.46856E−01
A6 =	−4.48634E−01	−1.41052E+00	−4.98677E−01	1.87769E−01	7.75380E−02
A8 =	1.00739E+00	1.88321E+00	1.32517E−01	−5.29516E−02	−3.62970E−02
A10 =	−1.30601E−01	−1.09476E+00	3.93077E−01	9.35449E−03	1.01599E−02
A12 =	−8.70973E−02	2.38898E−01	−9.29186E−02	4.99858E−03	−2.20638E−03
A14 =	−6.63675E−01	−2.35952E−02	−3.18795E−01	−3.13159E−03	2.80074E−04
A16 =		1.00283E−01	1.66194E−01	4.31560E−04	

In the image capturing system according to the 5th embodiment, the definitions of f Fno, HFOV, V1, V2, V3, V4, CT2, CT3, CT4, f2, FOV, TTL and ImgH are the same as those stated in the 1st embodiment with corresponding values for the 5th embodiment. Moreover, these parameters can be calculated from Table 9 and Table 10 as the following values and satisfy the following relationships:

f (mm)	2.77
Fno	2.60
HFOV (deg.)	38.5
V1 − V2	32.6
V3 − V4	32.6
(CT2 + CT3 + CT4)/3 (mm)	0.27
f/f2	−0.72
FOV (deg.)	77.0
TTL (mm)	3.20
TTL/ImgH	1.43
(f/ImgH) × TTL (mm)	3.96
TTL × f/tan(HFOV) (mm^2)	11.17

6th Embodiment

FIG. **11** is a schematic view of an image capturing system according to the 6th embodiment of the present disclosure. FIG. **12** shows spherical aberration curves, astigmatic field curves and a distortion curve of the image capturing system according to the 6th embodiment. In FIG. **11**, the image to capturing system includes, in order from an object side to an image side, the first lens element **610**, an aperture stop **600**, the second lens element **620**, the third lens element **630**, the fourth lens element **640**, the fifth lens element **650**, an IR-cut filter **680**, an image plane **660** and an image sensor **670**.

The first lens element **610** with positive refractive power has a convex object-side surface **611** and a convex image-side surface **612**, and is made of plastic material. The object-side surface **611** and the image-side surface **612** of the first lens element **610** are aspheric.

The second lens element **620** with negative refractive power has a concave object-side surface **621** and a concave image-side surface **622**, and is made of plastic material. The object-side surface **621** and the image-side surface **622** of the second lens element **620** are aspheric.

The third lens element **630** with positive refractive power has a convex object-side surface **631** and a convex image-side surface **632**, and is made of plastic material. The object-side surface **631** and the image-side surface **632** of the third lens element **630** are aspheric.

The fourth lens element **640** with negative refractive power has a concave object-side surface **641** and a convex-image-side surface **642**, and is made of plastic material. The object-side surface **641** and the image-side surface **642** of the fourth lens element **640** are aspheric.

The fifth lens element **650** with positive refractive power has a convex object-side surface **651** and a concave image-side surface **652**, and is made of plastic material. The object-side surface **651** and the image-side surface **652** of the fifth lens element **650** are aspheric. Furthermore, the fifth lens element **650** has inflection points on the object-side surface **651** and the image-side surface **652** thereof.

The IR-cut filter **680** is made of glass, and located between the fifth lens element **650** and the image plane **660**, and will not affect the focal length of the image capturing system.

The detailed optical data of the 6th embodiment are shown in Table 11 and the aspheric surface data are shown in Table 12 below.

TABLE 11

6th Embodiment
f = 2.87 mm, Fno = 2.60, HFOV = 37.4 deg.

Surface #		Curvature Radius	Thickness	Material	Index	Abbe #	Focal length
0	Object	Plano	infinity				
1	Lens 1	1.078690 (ASP)	0.424	Plastic	1.544	55.9	1.93
2		−32.975000 (ASP)	−0.006				
3	Ape. Stop	Plano	0.060				
4	Lens 2	−71.428600 (ASP)	0.230	Plastic	1.640	23.3	−3.59
5		2.374170 (ASP)	0.192				
6	Lens 3	8.407000 (ASP)	0.314	Plastic	1.544	55.9	12.45
7		−34.393600 (ASP)	0.305				
8	Lens 4	−1.300330 (ASP)	0.272	Plastic	1.640	23.3	−6.74
9		−2.013250 (ASP)	0.030				
10	Lens 5	1.314500 (ASP)	0.780	Plastic	1.544	55.9	24.75
11		1.152080 (ASP)	0.400				
12	IR-cut filter	Plano	0.150	Glass	1.516	64.1	—
13		Plano	0.250				
14	Image	Plano	—				

Note:
Reference wavelength (d-line) is 587.6 nm.

TABLE 12

Aspheric Coefficients

Surface #	1	2	4	5	6
k =	−3.59454E−01	−1.00000E+00	0.00000E+00	2.32370E+00	−3.00000E+01
A4 =	−3.42040E−02	−3.59393E−01	−2.61149E−01	−9.54178E−02	−4.07777E−01
A6 =	2.76864E−02	1.06309E+00	2.20847E+00	1.69539E+00	−4.62508E−03
A8 =	−8.20722E−01	−2.68042E+00	−4.60080E+00	−3.04730E+00	1.23933E+00
A10 =	7.92109E−01	2.18211E+00	5.04622E+00	4.14315E+00	−1.24872E+00
A12 =	−2.11137E+00	−4.24482E−01	−4.21843E−01	−1.72994E−01	−3.03682E+00
A14 =	6.59420E−01	−1.61826E−01	2.70839E−01	1.92080E−01	5.86777E+00
A16 =					−3.70015E+00

Surface #	7	8	9	10	11
k =	3.00000E+00	−1.86979E+01	3.46619E−01	−1.92615E+01	−7.83557E+00
A4 =	−1.66431E−01	2.73519E−01	2.23431E−01	−3.53679E−01	−1.33232E−01
A6 =	−5.15883E−01	−1.53053E+00	−4.85894E−01	1.91012E−01	7.22731E−02
A8 =	1.03001E+00	1.85234E+00	1.23076E−01	−5.24341E−02	−3.47368E−02
A10 =	−1.01121E−01	−9.12899E−01	3.83642E−01	9.74909E−03	1.05131E−02
A12 =	−8.08239E−02	2.74680E−01	−9.03108E−02	5.16568E−03	−2.16016E−03
A14 =	−6.63675E−01	−2.77521E−01	−3.17706E−01	−3.02811E−03	2.27599E−04
A16 =		2.36114E−02	1.68134E−01	3.15619E−04	

In the image capturing system according to the 6th embodiment, the definitions of f Fno, HFOV, V1, V2, V3, V4, CT2, CT3, CT4, f2, FOV, TTL and ImgH are the same as those stated in the 1st embodiment with corresponding values for the 6th embodiment. Moreover, these parameters can be calculated from Table 11 and Table 12 as the following values and satisfy the following relationships:

f (mm)	2.87
Fno	2.60
HFOV (deg.)	37.4
V1 − V2	32.6
V3 − V4	32.6
(CT2 + CT3 + CT4)/3 (mm)	0.27
f/f2	−0.80
FOV (deg.)	74.8
TTL (mm)	3.40
TTL/ImgH	1.52
(f/ImgH) × TTL (mm)	4.36
TTL × f/tan(HFOV) (mm^2)	12.75

7th Embodiment

FIG. **13** is a schematic view of an image capturing system according to the 7th embodiment of the present disclosure. FIG. **14** shows spherical aberration curves, astigmatic field curves and a distortion curve of the image capturing system according to the 7th embodiment. In FIG. **13**, the image to capturing system includes, in order from an object side to an image side, the first lens element **710**, an aperture stop **700**, the second lens element **720**, the third lens element **730**, the fourth lens element **740**, the fifth lens element **750**, an IR-cut filter **780**, an image plane **760** and an image sensor **770**.

The first lens element **710** with positive refractive power has a convex object-side surface **711** and a convex image-side surface **712**, and is made of plastic material. The object-side surface **711** and the image-side surface **712** of the first lens element **710** are aspheric.

The second lens element **720** with negative refractive power has a concave object-side surface **721** and a concave image-side surface **722**, and is made of plastic material. The object-side surface **721** and the image-side surface **722** of the second lens element **720** are aspheric.

The third lens element **730** with positive refractive power has a convex object-side surface **731** and a concave image-side surface **732**, and is made of plastic material. The object-side surface **731** and the image-side surface **732** of the third lens element **730** are aspheric.

The fourth lens element **740** with negative refractive power has a concave object-side surface **741** and a convex image-side surface **742**, and is made of plastic material. The object-side surface **741** and the image-side surface **742** of the fourth lens element **740** are aspheric.

The fifth lens element **750** with positive refractive power has a convex object-side surface **751** and a concave image-side surface **752**, and is made of plastic material. The object-side surface **751** and the image-side surface **752** of the fifth lens element **750** are aspheric. Furthermore, the fifth lens element **750** has inflection points on the object-side surface **751** and the image-side surface **752** thereof.

The IR-cut filter **780** is made of glass, and located between the fifth lens element **750** and the image plane **760**, and will not affect the focal length of the image capturing system.

The detailed optical data of the 7th embodiment are shown in Table 13 and the aspheric surface data are shown in Table 14 below.

TABLE 13

7th Embodiment f = 2.80 mm, Fno = 2.45, HFOV = 38.1 deg.							
Surface #		Curvature Radius	Thickness	Material	Index	Abbe #	Focal length
0	Object	Plano	Infinity				
1	Lens 1	1.119890 (ASP)	0.426	Plastic	1.544	55.9	1.76
2		−5.821200 (ASP)	−0.023				
3	Ape. Stop	Plano	0.052				
4	Lens 2	−26.089800 (ASP)	0.230	Plastic	1.607	28.6	−2.83
5		1.842810 (ASP)	0.202				
6	Lens 3	4.144500 (ASP)	0.263	Plastic	1.544	55.9	11.35
7		12.308100 (ASP)	0.308				
8	Lens 4	−1.255580 (ASP)	0.281	Plastic	1.607	26.6	−10.46
9		−1.697400 (ASP)	0.030				
10	Lens 5	1.205780 (ASP)	0.630	Plastic	1.535	56.3	44.00
11		1.035950 (ASP)	0.400				
12	IR-cut filter	Plano	0.150	Glass	1.516	64.1	—
13		Plano	0.354				
14	Image	Plano	—				

Note:
Reference wavelength (d-line) is 587.6 nm.

TABLE 14

Aspheric Coefficients					
	Surface #				
	1	2	4	5	6
k =	−4.89422E−01	−1.00000E+00	0.00000E+00	1.47669E+00	−3.17412E+00
A4 =	−4.78999E−02	−2.54940E−01	−1.94436E−01	−1.12985E−01	−3.85344E−01
A6 =	6.66855E−02	1.32984E+00	2.66460E+00	1.58624E+00	8.02814E−02

TABLE 14-continued

Aspheric Coefficients					
A8 =	−1.21705E+00	−3.89996E+00	−6.65036E+00	−2.91786E+00	1.13524E+00
A10 =	1.43194E+00	3.47957E+00	7.47017E+00	3.51316E+00	−7.14912E−01
A12 =	−2.11137E+00	−4.24481E−01	−4.21842E−01	−1.72993E−01	−3.03682E+00
A14 =	6.59418E−01	−1.61826E−01	2.70839E−01	1.92080E−01	5.86777E+00
A16 =					−3.70015E+00
	Surface #				
	7	8	9	10	11
k =	−1.00000E+00	−2.00369E+01	−3.33565E−01	−1.62425E+01	−7.88149E+00
A4 =	−1.73728E−01	2.59742E−01	3.01686E−01	−3.62768E−01	−1.64726E−01
A6 =	−5.35306E−01	−1.44905E+00	−5.22751E−01	1.90515E−01	8.05776E−02
A8 =	1.10409E+00	1.65899E+00	1.12120E−01	−5.29520E−02	−3.72522E−02
A10 =	−3.78156E−02	−1.00404E+00	3.82854E−01	9.38154E−03	1.00866E−02
A12 =	−4.14795E−02	3.05325E−01	−8.90255E−02	4.86369E−03	−2.07221E−03
A14 =	−6.63675E−01	−1.76754E−01	−3.15349E−01	−3.22899E−03	2.57944E−04
A16 =		7.54633E−02	1.67192E−01	5.03307E−04	

In the image capturing system according to the 7th embodiment, the definitions of f, Fno, HFOV, V1, V2, V3, V4, CT2, CT3, CT4, f2 FOV, TTL and ImgH are the same as those stated in the t embodiment with corresponding values for the 7th embodiment. Moreover, these parameters can be calculated from Table 13 and Table 14 as the following values and satisfy the following relationships:

f (mm)	2.80
Fno	2.45
HFOV (deg.)	38.1
V1 − V2	29.3
V3 − V4	29.3
(CT2 + CT3 + CT4)/3 (mm)	0.26
f/f2	−0.99
FOV (deg.)	76.2
TTL (mm)	3.30
TTL/ImgH	1.48
(f/ImgH) × TTL (mm)	4.13
TTL × f/tan(HFOV) (mm^2)	11.82

8th Embodiment

FIG. **15** is a schematic view of an image capturing system according to the 8th embodiment of the present disclosure. FIG. **16** shows spherical aberration curves, astigmatic field curves and a distortion curve of the image capturing system according to the 8th embodiment. In FIG. **15**, the image capturing system includes, in order from an object side to an image side, an aperture stop **800**, the first lens element **810**, a stop **801**, the second lens element **820**, the third lens element **830**, the fourth lens element **840**, the fifth lens element **850**, an IR-cut filter **880**, an image plane **860** and an image sensor **870**.

The first lens element **810** with positive refractive power has a convex object-side surface **811** and a concave image-side surface **812**, and is made of plastic material. The object-side surface **811** and the image-side surface **812** of the first lens element **810** are aspheric.

The second lens element **820** with negative refractive power has a convex object-side surface **821** and a concave image-side surface **822**, and is made of plastic material. The object-side surface **821** and the image-side surface **822** of the second lens element **820** are aspheric.

The third lens element **830** with positive refractive power has a convex object-side surface **831** and a concave image-side surface **832**, and is made of plastic material. The object-side surface **831** and the image-side surface **832** of the third lens element **830** are aspheric.

The fourth lens element **840** with negative refractive power has a concave object-side surface **841** and a convex image-side surface **842**, and is made of plastic material. The object-side surface **841** and the image-side surface **842** of the fourth lens element **840** are aspheric.

The fifth lens element **850** with positive refractive power has a convex object-side surface **851** and a concave image-side surface **852**, and is made of plastic material. The object-side surface **851** and the image-side surface **852** of the fifth lens element **850** are aspheric. Furthermore, the fifth lens element **850** has inflection points on the object-side surface **851** and the image-side surface **852** thereof.

The IR-cut filter **880** is made of glass, and located between the fifth lens element **850** and the image plane **860**, and will not affect the focal length of the image capturing system.

The detailed optical data, of the 8th embodiment are shown in Table 15 and the aspheric surface data are shown in Table 16 below.

TABLE 15

8th Embodiment f = 2.94 mm, Fno = 2.46, HFOV = 37.5 deg.							
Surface #		Curvature Radius	Thickness	Material	Index	Abbe #	Focal length
0	Object	Plano	Infinity				
1	Ape. Stop	Plano	−0.148				
2	Lens 1	1.070080 (ASP)	0.449	Plastic	1.544	55.9	2.18
3		9.388500 (ASP)	0.030				
4	Stop	Plano	0.030				

TABLE 15-continued

8th Embodiment f = 2.94 mm, Fno = 2.46, HFOV = 37.5 deg.							
Surface #		Curvature Radius	Thickness	Material	Index	Abbe #	Focal length
5	Lens 2	84.652700 (ASP)	0.240	Plastic	1.640	23.3	−5.34
6		3.277500 (ASP)	0.219				
7	Lens 3	6.451000 (ASP)	0.256	Plastic	1.544	55.9	167.33
8		6.845800 (ASP)	0.337				
9	Lens 4	−2.568740 (ASP)	0.282	Plastic	1.640	23.3	−13.91
10		−3.765400 (ASP)	0.047				
11	Lens 5	1.238030 (ASP)	0.593	Plastic	1.544	55.9	97.18
12		1.053730 (ASP)	0.400				
13	IR-cut filter	Plano	0.110	Glass	1.516	64.1	—
14		Plano	0.350				
15	Image	Plano	—				

Note:
Reference wavelength (d-line) is 587.6 nm.
Effective radius of Surface 4 is 0.55 mm.

TABLE 16

Aspheric Coefficients					
	Surface #				
	2	3	5	6	7
k =	−1.25115E−01	1.43813E+01	−9.00000E+01	−9.00000E+01	−1.62971E+01
A4 =	−3.24904E−02	−3.46578E−01	−2.71748E−01	2.01805E−01	−5.12661E−01
A6 =	8.31961E−02	8.25956E−01	1.45537E+00	3.91515E−01	−2.18390E−01
A8 =	−9.69593E−01	−2.88251E+00	−2.81983E+00	−7.55601E−01	2.80932E+00
A10 =	1.70029E+00	1.72981E+00	−9.98196E−01	5.89497E+00	−8.73332E+00
A12 =	−1.95301E+00	8.05134E+00	1.77489E+01	−2.12222E+01	1.29551E+00
A14 =	−1.40784E+00	−1.02407E+01	−1.73755E+01	3.13853E+01	3.83345E+01
A16 =					−5.53900E+01
	Surface #				
	8	9	10	11	12
k =	−1.00000E+02	−9.00000E+01	−2.07918E+01	−2.13912E+01	−7.68740E+00
A4 =	−2.44016E−01	3.33352E−01	−1.26866E−01	−4.00253E−01	−2.16002E−01
A6 =	−8.78370E−01	−1.51045E+00	1.52241E+00	2.66439E−01	1.10894E−01
A8 =	2.90423E+00	4.50617E+00	−5.54351E+00	−6.98977E−02	−3.63247E−02
A10 =	−5.31890E+00	−1.73903E+01	8.99824E+00	1.61916E−03	4.72950E−03
A12 =	4.94594E+00	3.73070E+01	−8.05875E+00	3.70311E−03	9.41363E−05
A14 =	−9.45588E−01	−4.09507E+01	3.84242E+00	−8.23655E−04	−4.20686E−05
A16 =		1.77252E+01	−7.54720E−01	3.85845E−05	

In the image capturing system according to the 8th embodiment, the definitions of f, Fno, HFOV, V1, V2, V3, V4, CT2, CT3, CT4, f2, FOV, TTL and ImgH are the same as those stated in the 1st embodiment with corresponding values for the 8th embodiment. Moreover, these parameters can be calculated from Table 15 and Table 16 as the following values and satisfy the following relationships:

f (mm)	2.94
Fno	2.46
HFOV (deg.)	37.5
V1 − V2	32.6
V3 − V4	32.6
(CT2 + CT3 + CT4)/3 (mm)	0.26
f/f2	−0.55
FOV (deg.)	75.0
TTL (mm)	3.34
TTL/ImgH	1.46
(f/ImgH) × TTL (mm)	4.28
TTL × f/tan(HFOV) (mm^2)	12.84

9th Embodiment

FIG. **17** is a schematic view of an image capturing system according to to the 9th embodiment of the present disclosure. FIG. **18** shows spherical aberration curves, astigmatic field curves and a distortion curve of the image capturing system according to the 9th embodiment. In FIG. **17**, the image capturing system includes, in order from an object side to an image side, the first lens element **910**, an aperture stop **900**, the second lens element **920**, the third lens element **930**, the fourth lens element **940**, the fifth lens element **950**, an IR-cut filter **980**, an image plane **960** and an image sensor **970**.

The first lens element **910** with positive refractive power has a convex object-side surface **911** and a concave image-side surface **912**, and is made of plastic material. The object-side surface **911** and the image-side surface **912** of the first lens element **910** are aspheric.

The second lens element **920** with negative refractive power has a concave object-side surface **921** and a concave image-side surface **922**, and is made of plastic material. The object-side surface **921** and the image-side surface **922** of the second lens element **920** are aspheric.

The third lens element **930** with positive refractive power has a convex object-side surface **931** and a concave image-side surface **932**, and is made of plastic material. The object-side surface **931** and the image-side surface **932** of the third lens element **930** are aspheric.

The fourth lens element **940** with negative refractive power has a concave object-side surface **941** and a convex image-side surface **942**, and is made of plastic material. The object-side surface **941** and the image-side surface **942** of the fourth lens element **940** are aspheric.

The fifth lens element **950** with negative refractive power has a convex object-side surface **951** and a concave image-side surface **952**, and is made of plastic material. The object-side surface **951** and the image-side surface **952** of the fifth lens element **950** are aspheric. Furthermore, the fifth lens element **950** has inflection points on the object-side surface **951** and the image-side surface **952** thereof.

The IR-cut filter **980** is made of glass, and located between the fifth lens element **950** and the image plane **960**, and will not affect the focal length of the image capturing system.

The detailed optical data of the 9th embodiment are shown in Table 17 and the aspheric surface data are shown in Table 18 below.

TABLE 17

9th Embodiment f = 2.38 mm, Fno = 2.60, HFOV = 35.9 deg.							
Surface #		Curvature Radius	Thickness	Material	Index	Abbe #	Focal length
0	Object	Plano	Infinity				
1	Lens 1	0.910190 (ASP)	0.392	Plastic	1.544	55.9	1.80
2		11.313700 (ASP)	0.016				
3	Ape. Stop	Plano	0.068				
4	Lens 2	−33.134500 (ASP)	0.230	Plastic	1.650	21.4	−3.53
5		2.469650 (ASP)	0.147				
6	Lens 3	2.314550 (ASP)	0.266	Plastic	1.544	55.9	9.12
7		4.160700 (ASP)	0.268				
8	Lens 4	−1.755140 (ASP)	0.308	Plastic	1.650	21.4	−12.57
9		−2.390230 (ASP)	0.030				
10	Lens 5	1.255930 (ASP)	0.562	Plastic	1.544	55.9	−11.19
11		0.876950 (ASP)	0.300				
12	IR-cut filter	Plano	0.100	Glass	1.516	64.1	—
13		Plano	0.144				
14	Image	Plano	—				

Note:
Reference wavelength (d-line) is 587.6 nm.

TABLE 18

Aspheric Coefficients					
Surface #	1	2	4	5	6
k =	−3.37216E−01	−4.07406E+02	0.00000E+00	−4.79097E+00	−2.91430E+01
A4 =	−3.62588E−02	−3.94009E−01	−3.32289E−01	−1.34179E−01	−3.65687E−01
A6 =	−1.51795E−02	6.52326E−01	2.37826E+00	2.46088E+00	−1.04338E−01
A8 =	−8.63759E−01	−1.62143E+00	−1.78763E+00	−1.32037E+00	7.47909E−01
A10 =	−4.00602E−01	1.12390E+00	−2.19380E+00	2.15610E+00	−1.82371E+00
A12 =	−2.54805E+00	−4.24483E−01	−4.21844E−01	−1.72995E−01	−3.03682E+00
A14 =	6.59349E−01	−1.61831E−01	2.70834E−01	1.92075E−01	5.86777E+00
A16 =					−3.70003E+00
Surface #	7	8	9	10	11
k =	−2.88995E+01	−3.77337E+01	9.87418E−01	−2.01461E+01	−7.79639E+00
A4 =	−1.86869E−01	1.04720E−01	2.29860E−01	−3.57140E−01	−1.65451E−01
A6 =	−5.11383E−01	−1.39831E+00	−5.76255E−01	2.08575E−01	9.20261E−02
A8 =	8.66303E−01	1.57904E+00	9.49921E−02	−5.40809E−02	−4.21111E−02
A10 =	−5.16631E−01	−1.45564E+00	3.75014E−01	1.86384E−03	9.48995E−03
A12 =	−8.70992E−02	1.45266E−01	−1.00134E−01	8.92986E−04	−3.25113E−03
A14 =	−6.63679E−01	2.30884E−01	−3.12969E−01	−1.54282E−03	7.90432E−04
A16 =		7.68932E−01	1.88572E−01	1.46481E−03	

In the image capturing system according to the 9th embodiment, the definitions of f, Fno, HFOV, V1, V2, V3, V4, CT2, CT3, CT4, f2, FOV, TTL and ImgH are the same as those stated in the 1st embodiment with corresponding values for the 9th embodiment. Moreover, these parameters can be calculated from Table 17 and Table 18 as the following values and satisfy the following relationships:

f (mm)	2.38
Fno	2.60
HFOV (deg.)	35.9
V1 − V2	34.5
V3 − V4	34.5
(CT2 + CT3 + CT4)/3 (mm)	0.27
f/f2	−0.68
FOV (deg.)	71.8
TTL (mm)	2.83
TTL/ImgH	1.62
(f/ImgH) × TTL (mm)	3.85
TTL × f/tan(HFOV) (mm^2)	9.32

10th Embodiment

FIG. **19** is a schematic view of an image capturing system according to the 10th embodiment of the present disclosure. FIG. **20** shows spherical aberration curves, astigmatic field curves and a distortion curve of the image capturing system according to the 10th embodiment. In FIG. **19**, the image capturing system includes, in order from an object side to an image side, an aperture stop **1000**, the first lens element **1010**, the second lens element **1020**, the third lens element **1030**, the fourth lens element **1040**, the fifth lens element **1050**, an IR-cut filter **1080**, an image plane **1060** and an image sensor **1070**.

The first lens element **1010** with positive refractive power has a convex object-side surface **1011** and a concave image-side surface **1012**, and is made of plastic material. The object-side surface **1011** and the image-side surface **1012** of the first lens element **1010** are aspheric.

The second lens element **1020** with negative refractive power has a convex object-side surface **1021** and a concave image-side surface **1022**, and is made of plastic material. The object-side surface **1021** and the image-side surface **1022** of the second lens element **1020** are aspheric.

The third lens element **1030** with positive refractive power has a convex object-side surface **1031** and a convex image-side surface **1032**, and is made of plastic material. The object-side surface **1031** and the image-side surface **1032** of the third lens element **1030** are aspheric.

The fourth lens element **1040** with negative refractive power has a concave object-side surface **1041** and a convex image-side surface **1042**, and is made of plastic material. The object-side surface **1041** and the image-side surface **1042** of the fourth lens element **1040** are aspheric.

The fifth lens element **1050** with negative refractive power has a convex object-side surface **1051** and a concave image-side surface **1052**, and is made of plastic material. The object-side surface **1051** and the image-side surface **1052** of the fifth lens element **1050** are aspheric. Furthermore, the fifth lens element **1050** has inflection points on the object-side surface **1051** and the image-side surface **1052** thereof.

The IR-cut filter **1080** is made of glass, and located between the fifth lens element **1050** and the image plane **1060**, and will not affect the focal length of the image capturing system.

The detailed optical data of the 10th embodiment are shown in Table 19 and the aspheric surface data are shown in Table 20 below.

TABLE 19

10th Embodiment f = 2.18 mm, Fno = 2.37, HFOV = 38.5 deg.							
Surface #		Curvature Radius	Thickness	Material	Index	Abbe #	Focal length
0	Object	Plano	Infinity				
1	Ape. Stop	Plano	−0.106				
2	Lens 1	0.946220 (ASP)	0.311	Plastic	1.544	55.9	2.55
3		2.621460 (ASP)	0.059				
4	Lens 2	2.202410 (ASP)	0.230	Plastic	1.650	21.4	−7.42
5		1.449830 (ASP)	0.152				
6	Lens 3	107.605400 (ASP)	0.309	Plastic	1.544	55.9	2.57
7		−1.413960 (ASP)	0.184				
8	Lens 4	−0.770590 (ASP)	0.245	Plastic	1.650	21.4	−60.83
9		−0.884320 (ASP)	0.156				
10	Lens 5	1.340890 (ASP)	0.443	Plastic	1.544	55.9	−3.31
11		0.678840 (ASP)	0.300				
12	IR-cut filter	Plano	0.100	Glass	1.516	64.1	—
13		Plano	0.235				
14	Image	Plano	—				

Note:
Reference wavelength (d-line) is 587.6 nm.

TABLE 20

Aspheric Coefficients					
	Surface #				
	2	3	4	5	6
k =	1.46061E−02	−7.00000E+01	−3.96271E+01	−1.02906E+01	3.00000E+00
A4 =	3.37599E−02	−3.03077E−01	−7.77909E−01	−2.14063E−01	−2.28979E−01

TABLE 20-continued

Aspheric Coefficients					
A6 =	7.78434E−02	3.05948E−01	−1.95684E−02	2.35089E−01	6.69017E−02
A8 =	7.69186E−01	−1.97098E+00	−2.03011E−01	−1.58080E+00	1.28600E+00
A10 =	−9.98338E−01	6.04596E+00	4.23651E+00	2.91597E+00	−3.37515E+00
A12 =	−1.10184E+00	2.45861E−02	−3.52173E−02	−3.96619E−02	−1.70242E+00
A14 =	8.55183E−02	−1.22676E−01	7.84952E−02	2.46422E−02	2.93705E+00
A16 =					−1.81800E+00

	Surface #				
	7	8	9	10	11
k =	2.70188E−01	−4.14893E+00	−1.20712E+00	−2.48815E+01	−6.63032E+00
A4 =	−1.70333E−01	2.04663E−02	5.18742E−01	−4.22592E−01	−2.00639E−01
A6 =	2.19899E−01	−6.09374E−01	−4.22724E−01	1.69210E−01	9.10051E−02
A8 =	7.98596E−01	1.78921E+00	1.40891E−01	−1.70236E−02	−3.93732E−02
A10 =	2.51173E+00	−1.13233E+00	2.88751E−01	2.11530E−02	3.33614E−03
A12 =	8.92554E−01	−2.91155E−02	−8.26757E−02	1.00165E−02	−9.89022E−04
A14 =	2.55808E−03	−1.18708E−01	−1.96880E−01	−2.06915E−03	6.25253E−04
A16 =		−4.65095E−01	−5.67914E−02	−6.01017E−03	

In the image capturing system according to the 10th embodiment, the definitions of f Fno, HFOV, V1, V2, V3, V4, CT2, CT3, CT4, f2, FOV, TTL and ImgH are the same as those stated in the 1st embodiment with corresponding values for the 10th embodiment. Moreover, these parameters can be calculated from Table 19 and Table 20 as the following values and satisfy the following relationships:

f (mm)	2.18
Fno	2.37
HFOV (deg.)	38.5
V1 − V2	34.5
V3 − V4	34.5
(CT2 + CT3 + CT4)/3 (mm)	0.26
f/f2	−0.29
FOV (deg.)	77.0
TTL (mm)	2.72
TTL/ImgH	1.56
(f/ImgH) × TTL (mm)	3.39
TTL × f/tan(HFOV) (mm^2)	7.47

11th Embodiment

FIG. **21** is a schematic view of an image capturing system according to the 11th embodiment of the present disclosure. FIG. **22** shows spherical aberration curves, astigmatic field curves and a distortion curve of the image capturing system according to the 11th embodiment. In FIG. **21**, the image capturing system includes, in order from an object side to an image side, the first lens element **1110**, an aperture stop **1100**, the second lens element **1120**, the third lens element **1130**, the fourth lens element **1140**, the fifth lens element **1150**, an IR-cut filter **1180**, an image plane **1160** and an image sensor **1170**.

The first lens element **1110** with positive refractive power has a convex object-side surface **1111** and a concave image-side surface **1112**, and is made of plastic material. The object-side surface **1111** and the image-side surface **1112** of the first lens element **1110** are aspheric.

The second lens element **1120** with negative refractive power has a convex object-side surface **1121** and a concave image-side surface **1122**, and is made of plastic material. The object-side surface **1121** and the image-side surface **1122** of the second lens element **1120** are aspheric.

The third lens element **1130** with positive refractive power has a convex object-side surface **1131** and a concave image-side surface **1132**, and is made of plastic material. The object-side surface **1131** and the image-side surface **1132** of the third lens element **1130** are aspheric.

The fourth lens element **1140** with negative refractive power has a concave object-side surface **1141** and a convex image-side surface **1142**, and is made of plastic material. The object-side surface **1141** and the image-side surface **1142** of the fourth lens element **1140** are aspheric.

The fifth lens element **1150** with positive refractive power has a convex object-side surface **1151** and a concave image-side surface **1152**, and is made of plastic material. The object-side surface **1151** and the image-side surface **1152** of the fifth lens element **1150** are aspheric. Furthermore, the fifth lens element **1150** has inflection points on the object-side surface **1151** and the image-side surface **1152** thereof.

The IR-cut filter **1180** is made of glass, and located between the fifth lens element **1150** and the image plane **1160**, and will not affect the focal length of the image capturing system.

The detailed optical data of the 11th embodiment are shown in Table 21 and the aspheric surface data are shown in Table 22 below

TABLE 21

11th Embodiment f = 2.20 mm, Fno = 2.65, HFOV = 38.4 deg.							
Surface #		Curvature Radius	Thickness	Material	Index	Abbe #	Focal length
0	Object	Plano	Infinity				
1	Lens 1	0.889320 (ASP)	0.372	Plastic	1.544	55.9	1.78
2		9.563700 (ASP)	0.015				
3	Ape. Stop	Plano	0.064				

TABLE 21-continued

11th Embodiment f = 2.20 mm, Fno = 2.65, HFOV = 38.4 deg.							
Surface #		Curvature Radius	Thickness	Material	Index	Abbe #	Focal length
4	Lens 2	76.383800 (ASP)	0.230	Plastic	1.650	21.4	−3.94
5		2.474210 (ASP)	0.111				
6	Lens 3	1.872980 (ASP)	0.232	Plastic	1.544	55.9	12.23
7		2.489220 (ASP)	0.242				
8	Lens 4	−2.258450 (ASP)	0.283	Plastic	1.650	21.4	−6.79
9		−4.854200 (ASP)	0.030				
10	Lens 5	0.846250 (ASP)	0.469	Plastic	1.535	56.3	127.74
11		0.689370 (ASP)	0.300				
12	IR-cut filter	Plano	0.100	Glass	1.516	64.1	—
13		Plano	0.136				
14	Image	Plano	—				

Note:
Reference wavelength (d-line) is 587.6 nm.

TABLE 22

Aspheric Coefficients					
	Surface #				
	1	2	4	5	6
k =	−4.48548E−01	−8.94672E+02	0.00000E+00	−7.95290E+00	−2.74951E+01
A4 =	−5.85059E−02	−4.26459E−01	−3.11702E−01	−1.49839E−01	−3.80038E−01
A6 =	−1.42851E−01	5.02376E−01	2.58544E+00	2.70971E+00	−2.10773E−01
A8 =	−1.21959E+00	−2.34036E+00	−1.27936E+00	−3.42914E−01	3.40313E−01
A10 =	−1.23231E+00	3.86129E+00	−6.54714E−01	1.97696E+00	−3.19399E+00
A12 =	−2.54808E+00	−4.24481E−01	−4.21842E−01	−1.72993E−01	−3.03682E+00
A14 =	6.59331E−01	−1.61828E−01	2.70837E−01	1.92078E−01	5.86777E+00
A16 =					−3.70004E+00
	Surface #				
	7	8	9	10	11
k =	−2.10141E+01	−2.52088E+02	−1.64555E+00	−1.64652E+01	−8.24454E+00
A4 =	−1.49837E−01	1.89162E−01	2.50407E−01	−3.60422E−01	−1.78572E−01
A6 =	−4.63623E−01	−1.37577E+00	−6.15990E−01	2.16730E−01	8.25622E−02
A8 =	8.18347E−01	1.51214E+00	7.90312E−02	−5.17629E−02	−4.49105E−02
A10 =	−7.14987E−01	−1.55392E+00	3.76885E−01	2.74577E−03	9.02979E−03
A12 =	−7.60853E−02	9.52445E−02	−9.78978E−02	8.79829E−04	−2.94899E−03
A14 =	−6.63676E−01	3.07718E−01	−3.09399E−01	−1.82048E−03	1.03242E−03
A16 =		1.02469E+00	1.92688E−01	9.96584E−04	

In the image capturing system according to the 11th embodiment, the definitions of f, Fno, HFOV, V1, V2, V3, V4, CT2, CT3, CT4, f2, FOV, TTL and ImgH are the same as those stated in the 1st embodiment with corresponding values for the 11th embodiment. Moreover, these parameters can be calculated from Table 21 and Table 22 as the following values and satisfy the following relationships:

f (mm)	2.20
Fno	2.65
HFOV (deg.)	38.4
V1 − V2	34.5
V3 − V4	34.5
(CT2 + CT3 + CT4)/3 (mm)	0.25
f/f2	−0.56
FOV (deg.)	76.8
TTL (mm)	2.58
TTL/ImgH	1.48
(f/ImgH) × TTL (mm)	3.24
TTL × f/tan(HFOV) (mm^2)	7.15

It will be apparent to those skilled in the art that various modifications and variations can be made to the structure of the present invention without departing from the scope or spirit of the invention. In view of the foregoing, it is intended that the present invention cover modifications and variations of this invention provided they fall within the scope of the following claims.

What is claimed is:

1. An image capturing system comprising, in order from an object side to an image side:

a first lens element with positive refractive power having a convex object-side surface;

a second lens element with negative refractive power;

a third lens element with positive refractive power;

a fourth lens element with negative refractive power having a concave object-side surface and a convex image-side surface, wherein at least one of the object-side surface and the image-side surface of the fourth lens element is aspheric; and

a fifth lens element with refractive power having a concave image-side surface, wherein at least one of an object-side surface and the image-side surface of the fifth lens element is aspheric, and the fifth lens element has at least one inflection point on the image-side surface thereof;

wherein the first through fifth lens elements are five independent and non-cemented lens elements, a maximum image height of the image capturing system is ImgH, an axial distance between the object-side surface of the first lens element and an image plane is TTL, a focal length of the image capturing system is f, and the following relationship is satisfied:

$$2.8\ \text{mm} < (f/ImgH) \times TTL < 4.6\ \text{mm}.$$

2. The image capturing system of claim **1**, wherein the focal length of the image capturing system is f, a focal length of the second lens element is f2, and the following relationship is satisfied:

$$-1.4 < f/f2 < -0.18.$$

3. The image capturing system of claim **1**, wherein a central thickness of the second lens element is CT2, a central thickness of the third lens element is CT3, a central thickness of the fourth lens element is CT4, and the following relationship is satisfied:

$$0.20\ \text{mm} < (CT2+CT3+CT4)/3 < 0.31\ \text{mm}.$$

4. The image capturing system of claim **1**, wherein an Abbe number of the first lens element is V1, an Abbe number of the second lens element is V2, and the following relationship is satisfied:

$$20 < V1-V2 < 50.$$

5. The image capturing system of claim **1**, wherein an Abbe number of the third lens element is V3, an Abbe number of the fourth lens element is V4, and the following relationship is satisfied:

$$27 < V3-V4 < 45.$$

6. The image capturing system of claim **1**, wherein the axial distance between the object-side surface of the first lens element and an image plane is TTL, the focal length of the image capturing system is f, a half of the maximal field of view of the image capturing system is HFOV, and the following relationship is satisfied:

$$6.5\ \text{mm}^2 < TTL \times f/\tan(HFOV) < 13.4\ \text{mm}^2.$$

7. The image capturing system of claim **1**, wherein at least one of the object-side surface and the image-side surface of the first through third lens elements respectively is aspheric, and the first through fifth lens elements are made of plastic material.

8. The image capturing system of claim **7**, wherein a maximal field of view of the image capturing system is FOV, and the following relationship is satisfied:

$$70\ \text{degrees} < FOV < 90\ \text{degrees}.$$

9. The image capturing system of claim **7**, wherein the second lens element has a concave image-side surface.

10. The image capturing system of claim **7**, wherein the fifth lens element has a convex object-side surface.

11. The image capturing system of claim **1**, wherein the focal length of the image capturing system is f, and the following relationship is satisfied:

$$1.8\ \text{mm} < f < 3.2\ \text{mm}.$$

12. An image capturing system comprising, in order from an object side to an image side:

a first lens element with positive refractive power having a convex object-side surface;

a second lens element with negative refractive power;

a third lens element with refractive power;

a fourth lens element with negative refractive power having a concave object-side surface and a convex image-side surface, wherein at least one of the object-side surface and the image-side surface of the fourth lens element is aspheric; and

a fifth lens element with refractive power having a concave image-side surface, wherein at least one of an object-side surface and the image-side surface of the fifth lens element is aspheric, and the fifth lens element has at least one inflection point on the image-side surface thereof;

wherein an axial distance between the object-side surface of the first lens element and an image plane is TTL, a focal length of the image capturing system is f, a half of the maximal field of view of the image capturing system is HFOV, an Abbe number of the third lens element is V3, an Abbe number of the fourth lens element is V4, and the following relationships are satisfied:

$$6.0\ \text{mm}^2 < TTL \times f/\tan(HFOV) < 16.0\ \text{mm}^2;\ \text{and}$$

$$27 < V3-V4 < 45.$$

13. The image capturing system of claim **12**, wherein the second lens element has a concave image-side surface.

14. The image capturing system of claim **12**, wherein a central thickness of the second lens element is CT2, a central thickness of the third lens element is CT3, a central thickness of the fourth lens element is CT4, and the following relationship is satisfied:

$$0.2\ \text{mm} < (CT2+CT3+CT4)/3 < 0.31\ \text{mm}.$$

15. The image capturing system of claim **12**, wherein an Abbe number of the first lens element is V1, an Abbe number of the second lens element is V2, and the following relationship is satisfied:

$$20 < V1-V2 < 50.$$

16. The image capturing system of claim **12**, wherein the axial distance between the object-side surface of the first lens element and the image plane is TTL, the focal length of the image capturing system is f, the half of the maximal field of view of the image capturing system is HFOV, and the following relationship is satisfied:

$$6.5\ \text{mm}^2 < TTL \times f/\tan(HFOV) < 13.4\ \text{mm}^2.$$

17. The image capturing system of claim **12**, wherein a maximal field of view of the image capturing system is FOV, and the following relationship is satisfied:

$$70\ \text{degrees} < FOV < 90\ \text{degrees}.$$

18. The image capturing system of claim **12**, wherein the focal length of the image capturing system is f, and the following relationship is satisfied:

$$1.8\ \text{mm} < f < 3.2\ \text{mm}.$$

19. The image capturing system of claim **12**, wherein at least one of the object-side surface and the image-side surface of the first through third lens elements respectively is aspheric, and the first through fifth lens elements are made of plastic material.

20. The image capturing system of claim **12**, wherein a maximum image height of the image capturing system is ImgH, the axial distance between the object-side surface of the first lens element and the image plane is TTL, and the following relationship is satisfied:

$$TTL/ImgH<1.55.$$

21. An image capturing system comprising, in order from an object side to an image side:

a first lens element with positive refractive power having a convex object-side surface;

a second lens element with negative refractive power;

a third lens element with refractive power;

a fourth lens element with negative refractive power having a concave object-side surface and a convex image-side surface, wherein at least one of the object-side surface and the image-side surface of the fourth lens element is aspheric; and

a fifth lens element with refractive power having a concave image-side surface, wherein at least one of an object-side surface and the image-side surface of the fifth lens element is aspheric, and the fifth lens element has at least one inflection point on the image-side surface thereof;

wherein the first through fifth lens elements are five independent and non-cemented lens elements, an axial distance between the object-side surface of the first lens element and an image plane is TTL, and the following relationship is satisfied:

$$2.2\ mm<TTL<3.5\ mm.$$

22. The image capturing system of claim **21**, wherein a central thickness of the second lens element is CT2, a central thickness of the third lens element is CT3, a central thickness of the fourth lens element is CT4, and the following relationship is satisfied:

$$0.2\ mm<(CT2+CT3+CT4)/3<0.31\ mm.$$

23. The image capturing system of claim **21**, wherein a maximum image height of the image capturing system is ImgH, the axial distance between the object-side surface of the first lens element and the image plane is TTL, and the following relationship is satisfied:

$$TTL/ImgH<1.55.$$

24. The image capturing system of claim **21**, wherein a maximal field of view of the image capturing system is FOV, and the following relationship is satisfied:

$$70\ degrees<FOV<90\ degrees.$$

25. The image capturing system of claim **21**, wherein at least one of the object-side surface and the image-side surface of the first through third lens elements respectively is aspheric, and the first through fifth lens elements are made of plastic material.

26. The image capturing system of claim **21**, wherein a focal length of the image capturing system is f, and the following relationship is satisfied:

$$1.8\ mm<f<3.2\ mm.$$

27. An image capturing system for imaging an object on an object side to an image plane on an image side opposite of the object side, comprising:

a first lens element structured to exhibit positive refractive power and to include a convex object-side surface and a concave image-side surface and positioned as an optical input of the image capturing system to receive light from the object to be imaged by the image capturing system onto the image plane;

a second lens element positioned next to the first lens element to receive light from the first lens element, the second lens element structured to exhibit negative refractive power and to include a convex object-side surface and a concave image-side surface;

a third lens element positioned next to the second lens element to receive light from the second lens element, and structured to exhibit positive refractive power and to include a convex image-side surface, the third lens element being thinner than the first lens element and thicker than the second lens element;

a fourth lens element positioned next to the third lens element to receive light from the third lens element, and structured to exhibit negative refractive power and to include a concave object-side surface and a convex image-side surface, the fourth lens element being thinner than the first lens element and thicker than the second lens element; and

a fifth lens element positioned next to the fourth lens element to receive light from the fourth lens element and to image onto the image plane, and structured to exhibit refractive power and to include an object-side surface that is convex on an optical axis of the fifth lens element and concave off the optical axis, and an image-side surface that is concave on the optical axis and convex off the optical axis, wherein the fifth lens element is shaped to include at least one inflection point is formed on each of the object-side and image-side surfaces and is thicker than the first lens element,

wherein the first, the second, the third, the fourth and the fifth lens elements are sequentially arranged from the object side toward the image side of the image capturing system.

28. The image capturing system of claim 27, wherein each of the first, the second, the third, the fourth and the fifth lens elements is a non-cemented lens element.

29. The image capturing system of claim 27, wherein the third lens element includes a concave object-side surface facing the second lens element.

30. The image capturing system of claim 27, wherein the second, the third and the fourth lens elements are structured to have central thickness values of CT2, CT3 and CT4, respectively, so that a total thickness of the three lens elements satisfies:

$$0.20\ mm<(CT2+CT3+CT4)/3<0.31\ mm.$$

31. The image capturing system of claim 27, wherein the third and the fourth lens elements are structured to have Abbe numbers of V3 and V4, respectively, to cause a difference of the Abbe numbers V3 and V4 to be between 27 and 45:

$$27<V3-V4<45.$$

32. The image capturing system of claim 27, wherein the first, the second, the third, the fourth and the fifth lens elements are structured and arranged so that a ratio of an axial distance, TTL, between the object-side surface of the first lens element and the image plane of the image capturing system and a maximum image height, ImgH, of the image capturing system is less than 1.55:

$$TTL/ImgH<1.55.$$

33. The image capturing system of claim 27, wherein the first, the second, the third, the fourth and the fifth lens elements are structured and arranged to effectuate a focal length, f, of the image capturing system between 1.8 mm and 3.2 mm:

$$1.8\ mm<f<3.2\ mm.$$

34. An image capturing system for imaging an object on an object side to an image plane on an image side opposite of the object side, comprising:

a first lens element structured to exhibit positive refractive power and to include a convex object-side surface facing the object side to direct light from the object into the image capturing system;

a second lens element positioned on an image side of the first lens element and structured to exhibit negative refractive power and to include a convex object-side surface facing the first lens element and a concave image-side surface;

a third lens element positioned on an image side of the second lens element and structured to exhibit positive refractive power and to include a convex image-side surface facing the fourth lens element, the third lens element being thinner than the first lens element;

a fourth lens element positioned on an image side of the third lens element and structured to exhibit negative refractive power and to include a concave object-side surface facing the third lens element and a convex image-side surface; and

a fifth lens element positioned on an image side of the fourth lens element and structured to exhibit refractive power and to project the image onto the image plane, the fifth lens element including an object-side surface that is convex on an optical axis of the fifth lens element and concave off the optical axis and an image-side surface that is concave on the optical axis and convex off the optical axis, wherein at least one inflection point is formed on each of the object-side and image-side surfaces of the fifth lens element,

wherein the first, the second, the third, the fourth and the fifth lens elements are structured and arranged to have a maximal field of view, FOV, of the image capturing system between 70 degrees and 90 degrees:

$$70\ \text{degrees} < FOV < 90\ \text{degrees}.$$

35. The image capturing system of claim 34, wherein the first through fifth lens elements are each non-cemented lens elements.

36. The image capturing system of claim 34, wherein the first lens element has a concave image-side surface facing the image side of the second lens element.

37. The image capturing system of claim 34, wherein the third lens element has a concave object-side surface facing the image side of the second lens element.

38. The image capturing system of claim 34, wherein an Abbe number, V3, of the third lens element and an Abbe number, V4, of the fourth lens element have a difference between 27 and 45:

$$27 < V3 - V4 < 45.$$

39. The image capturing system of claim 34, wherein a ratio of an axial distance, TTL, between the object-side surface of the first lens element and the image plane of the image capturing system and a maximum image height, ImgH, of the image capturing system is less than 1.55:

$$TTL/ImgH < 1.55.$$

40. The image capturing system of claim 34, wherein the first, the second, the third, the fourth and the fifth lens elements are structured and arranged to effectuate an axial distance, TTL, between the object-side surface of the first lens element and the image, a focal length, f, of the image capturing system, a half of the maximal field of view, HFOV, of the image capturing system to have a relation of:

$$6.0\ mm^2 < TTL \times f/\tan(HFOV) < 16.0\ mm^2.$$

41. An image capturing system, comprising:

a first lens having positive refractive power and being convex toward an object side;

a second lens having negative refractive power and being convex toward the object side and concave toward an image side;

a third lens having positive refractive power and being concave toward the object side and convex toward the image side;

a fourth lens having negative refractive power and being concave toward the object side and convex toward the image side; and

a fifth lens having a refractive power and comprising:

an object-side surface being convex in the center and concave at the periphery; and

an image-side surface being concave in the center and convex at the periphery, wherein:

at least one inflection point is formed on the object-side and image-side surfaces of the fifth lens,

the first lens is thicker than the third lens and the fourth lens is thicker than the second lens, and

the first lens, the second lens, the third lens, the fourth lens and the fifth lens are sequentially arranged from the object side toward the image side.

42. The image capturing system of claim 41, wherein the first lens is concave toward the image side.

43. The image capturing system of claim 41, wherein the second lens, the third lens, the fourth lens and the fifth lens are made of plastic.

44. The image capturing system of claim 43, wherein the first lens is made of plastic.

45. The image capturing system of claim 41, wherein the first and second lenses comprise at least one aspherical surface.

46. The image capturing system of claim 41, further comprising an aperture disposed in front of the first lens.

47. The image capturing system of claim 41, wherein

a focal length of the second lens is greater than a focal length of the fourth lens, and

a focal length of the third lens is greater than the focal length of the second lens.

48. The image capturing system of claim 47, wherein a focal length of the first lens is greater than the focal length of the second lens and shorter than the focal length of the third lens.

49. The image capturing system of claim 41, wherein

a radius of curvature of an object-side surface of the second lens is greater than a radius of curvature of an image-side surface of the second lens,

a radius of curvature of the object-side surface of the fifth lens is greater than a radius of curvature of the image-side surface of the fifth lens, and

a radius of curvature of an object-side surface of the fourth lens is greater than a radius of curvature of an image-side surface of the fourth lens.

50. The image capturing system of claim 49, wherein a radius of curvature of an image-side surface of the first lens is greater than a radius of curvature of an object-side surface of the first lens.

51. The image capturing system of claim 47, wherein the third lens is thicker than the second lens, and the first lens is thicker than the fourth lens.

52. The image capturing system of claim 51, wherein the fifth lens is thicker than the first lens.

53. An image capturing system, comprising:

a first lens having positive refractive power and being convex toward an object side and concave toward an image side;

a second lens having negative refractive power and being convex toward the object side and concave toward the image side;

a third lens having positive refractive power and being concave toward the object side and convex toward the image side;

a fourth lens having negative refractive power and being concave toward the object side and convex toward the image side; and

a fifth lens having refractive power and comprising:

an object-side surface being convex in the center and concave at the periphery; and

an image-side surface being concave in the center and convex at the periphery, wherein:

at least one inflection point is formed on the object-side and image-side surfaces of the fifth lens, and

the first lens, the second lens, the third lens, the fourth lens and the fifth lens are sequentially arranged from the object side toward the image side.

54. The image capturing system of claim 53, wherein the first lens, the second lens, the third lens, the fourth lens and the fifth lens are made of plastic.

55. The image capturing system of claim 53, wherein the first and second lenses comprise at least one aspherical surface.

56. The image capturing system of claim 53, further comprising an aperture disposed in front of the first lens.

57. The image capturing system of claim 53, wherein

a focal length of the second lens is greater than a focal length of the fourth lens,

a focal length of the first lens is greater than the focal length of the second lens, and

a focal length of the third lens is greater than the focal length of the first lens.

58. The image capturing system of claim 53, wherein

a radius of curvature of an image-side surface of the first lens is greater than a radius of curvature of an object-side surface of the first lens,

a radius of curvature of an object-side surface of the second lens is greater than a radius of curvature of an image-side surface of the second lens,

a radius of curvature of an object-side surface of the fourth lens is greater than a radius of curvature of an image-side surface of the fourth lens, and

a radius of curvature of the object-side surface of the fifth lens is greater than a radius of curvature of the image-side surface of the fifth lens.

59. The image capturing system of claim 53, wherein

the third and fourth lenses are thicker than the second lens,

the first lens is thicker than the third and fourth lenses, and

the fifth lens is thicker than the first lens.

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