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UTILITY PATENT APPLICATION TRANSMITTAL <i>(Only for new nonprovisional applications under 37 CFR 1.53(b))</i>	Attorney Docket No.	14970-94702
	First Named Inventor	WEI-YU CHEN
	Title	IMAGE CAPTURING LENS SYSTEM, IMAGING DEVICE AND MOBILE TERMINAL
	Express Mail Label No.	

APPLICATION ELEMENTS <i>See MPEP chapter 600 concerning utility patent application contents.</i>	Commissioner for Patents P.O. Box 1450 Alexandria, VA 22313-1450
1. <input checked="" type="checkbox"/> Fee Transmittal Form (PTO/SB/17 or equivalent) 2. <input type="checkbox"/> Applicant asserts small entity status. See 37 CFR 1.27 3. <input type="checkbox"/> Applicant certifies micro entity status. See 37 CFR 1.29. Applicant must attach form PTO/SB/15A or B or equivalent. 4. <input checked="" type="checkbox"/> Specification [Total Pages <u>56</u>] Both the claims and abstract must start on a new page. (See MPEP § 608.01(a) for information on the preferred arrangement) 5. <input checked="" type="checkbox"/> Drawing(s) (35 U.S.C. 113) [Total Sheets <u>23</u>] 6. Inventor's Oath or Declaration [Total Pages <u>1</u>] (including substitute statements under 37 CFR 1.64 and assignments serving as an oath or declaration under 37 CFR 1.63(e)) a. <input checked="" type="checkbox"/> Newly executed (original or copy) b. <input type="checkbox"/> A copy from a prior application (37 CFR 1.63(d)) 7. <input checked="" type="checkbox"/> Application Data Sheet * See note below. See 37 CFR 1.76 (PTO/AIA/14 or equivalent) 8. CD-ROM or CD-R in duplicate, large table, or Computer Program (Appendix) <input type="checkbox"/> Landscape Table on CD 9. Nucleotide and/or Amino Acid Sequence Submission (if applicable, items a. – c. are required) a. <input type="checkbox"/> Computer Readable Form (CRF) b. <input type="checkbox"/> Specification Sequence Listing on: i. <input type="checkbox"/> CD-ROM or CD-R (2 copies); or ii. <input type="checkbox"/> Paper c. <input type="checkbox"/> Statements verifying identity of above copies	ACCOMPANYING APPLICATION PAPERS 10. <input type="checkbox"/> Assignment Papers (cover sheet & document(s)) Name of Assignee _____ 11. <input type="checkbox"/> 37 CFR 3.73(c) Statement <input checked="" type="checkbox"/> Power of Attorney (when there is an assignee) 12. <input type="checkbox"/> English Translation Document (if applicable) 13. <input type="checkbox"/> Information Disclosure Statement (PTO/SB/08 or PTO-1449) <input type="checkbox"/> Copies of citations attached 14. <input type="checkbox"/> Preliminary Amendment 15. <input type="checkbox"/> Return Receipt Postcard (MPEP § 503) (Should be specifically itemized) 16. <input type="checkbox"/> Certified Copy of Priority Document(s) (if foreign priority is claimed) 17. <input type="checkbox"/> Nonpublication Request Under 35 U.S.C. 122(b)(2)(B)(i). Applicant must attach form PTO/SB/35 or equivalent. 18. <input type="checkbox"/> Other: _____ _____ _____ _____ _____

***Note:** (1) Benefit claims under 37 CFR 1.78 and foreign priority claims under 1.55 **must** be included in an Application Data Sheet (ADS).
(2) For applications filed under 35 U.S.C. 111, the application must contain an ADS specifying the applicant if the applicant is an assignee, person to whom the inventor is under an obligation to assign, or person who otherwise shows sufficient proprietary interest in the matter. See 37 CFR 1.46(b).

19. CORRESPONDENCE ADDRESS				
<input checked="" type="checkbox"/> The address associated with Customer Number: <u>24728</u> OR <input type="checkbox"/> Correspondence address below				
Name				
Address				
City	State	Zip Code		
Country	Telephone	Email		
Signature	/Tim Tingkang Xia/		Date	December 13, 2013
Name (Print/Type)	Tim Tingkang Xia		Registration No. (Attorney/Agent)	45,242

This collection of information is required by 37 CFR 1.53(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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FEE TRANSMITTAL		Complete if known	
		Application Number	
		Filing Date	December 13, 2013
<input type="checkbox"/> Applicant asserts small entity status. See 37 CFR 1.27.		First Named Inventor	WEI-YU CHEN
<input type="checkbox"/> Applicant certifies micro entity status. See 37 CFR 1.29. Form PTO/SB/15A or B or equivalent must either be enclosed or have been submitted previously.		Examiner Name	
		Art Unit	
TOTAL AMOUNT OF PAYMENT	(\$ 2080	Practitioner Docket No.	14970-94702

METHOD OF PAYMENT (check all that apply)
☐ Check ☐ Credit Card ☐ Money Order ☐ None ☐ Other (please identify): _____

☒ Deposit Account Deposit Account Number: 50-3537 Deposit Account Name: Morris, Manning & Martin, LLP

For the above-identified deposit account, the Director is hereby authorized to (check all that apply):

☒ Charge fee(s) indicated below ☐ Charge fee(s) indicated below, **except for the filing fee**
☒ Charge any additional fee(s) or underpayment of fee(s) ☒ Credit any overpayment of fee(s)
under 37 CFR 1.16 and 1.17

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FEE CALCULATION**1. BASIC FILING, SEARCH, AND EXAMINATION FEES (U = undiscounted fee; S = small entity fee; M = micro entity fee)**

Application Type	FILING FEES			SEARCH FEES			EXAMINATION FEES			Fees Paid (\$)
	U (\$)	S (\$)	M (\$)	U (\$)	S (\$)	M (\$)	U (\$)	S (\$)	M (\$)	
Utility	280	140*	70	600	300	150	720	360	180	1600
Design	180	90	45	120	60	30	460	230	115	
Plant	180	90	45	380	190	95	580	290	145	
Reissue	280	140	70	600	300	150	2,160	1,080	540	
Provisional	260	130	65	0	0	0	0	0	0	

* The \$140 small entity status filing fee for a utility application is further reduced to \$70 for a small entity status applicant who files the application via EFS-Web.

2. EXCESS CLAIM FEES

Fee Description	Undiscounted Fee (\$)	Small Entity Fee (\$)	Micro Entity Fee (\$)
Each claim over 20 (including Reissues)	80	40	20
Each independent claim over 3 (including Reissues)	420	210	105
Multiple dependent claims	780	390	195
Total Claims			
26 - 20 or HP = 6 x 80 = 480			
HP = highest number of total claims paid for, if greater than 20.			
Indep. Claims			
3 - 3 or HP = x =			
HP = highest number of independent claims paid for, if greater than 3.			

3. APPLICATION SIZE FEE

If the specification and drawings exceed 100 sheets of paper (excluding electronically filed sequence or computer listings under 37 CFR 1.52(e)), the application size fee due is \$400 (\$200 for small entity) (\$100 for micro entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

Total Sheets	Extra Sheets	Number of each additional 50 or fraction thereof	Fee (\$)	Fee Paid (\$)
79 - 100 =	/ 50 =	(round up to a whole number) x	=	

4. OTHER FEE(S)

Non-English specification, \$130 fee (no small or micro entity discount)

Non-electronic filing fee under 37 CFR 1.16(t) for a utility application, \$400 fee (\$200 small or micro entity)

Other (e.g., late filing surcharge): _____

SUBMITTED BY			
Signature	/Tim Tingkang Xia/	Registration No. (Attorney/Agent) 45,242	Telephone (404) 495-3678
Name (Print/Type)	Tim Tingkang Xia	Date December 13, 2013	

This collection of information is required by 37 CFR 1.136. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	14970-94702
		Application Number	
Title of Invention	IMAGE CAPTURING LENS SYSTEM, IMAGING DEVICE AND MOBILE TERMINAL		
<p>The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.</p> <p>This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.</p>			

Secrecy Order 37 CFR 5.2

<input type="checkbox"/>	Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)
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Inventor Information:

Inventor 1					Remove	
Legal Name						
Prefix	Given Name	Middle Name	Family Name	Suffix		
	WEI-YU		CHEN			
Residence Information (Select One) <input type="radio"/> US Residency <input checked="" type="radio"/> Non US Residency <input type="radio"/> Active US Military Service						
City	Taichung		Country of Residence i	TW		
Mailing Address of Inventor:						
Address 1		No.11, Jingke Rd., Nantun District				
Address 2						
City	Taichung		State/Province			
Postal Code	408		Country i	TW		
All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the Add button.						
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Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below. For further information see 37 CFR 1.33(a).				
<input type="checkbox"/> An Address is being provided for the correspondence information of this application.				
Customer Number	24728			
Email Address	mmmipdocket@system.foundationip.com		Add Email	Remove Email

Application Information:

Title of the Invention	IMAGE CAPTURING LENS SYSTEM, IMAGING DEVICE AND MOBILE TERMINAL		
Attorney Docket Number	14970-94702	Small Entity Status Claimed	<input type="checkbox"/>
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	23	Suggested Figure for Publication (if any)	1A

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	14970-94702
		Application Number	
Title of Invention	IMAGE CAPTURING LENS SYSTEM, IMAGING DEVICE AND MOBILE TERMINAL		

Publication Information:

<input type="checkbox"/>	Request Early Publication (Fee required at time of Request 37 CFR 1.219)
<input type="checkbox"/>	Request Not to Publish. I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application has not and will not be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

<p>Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32). Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.</p>			
Please Select One:	<input checked="" type="radio"/> Customer Number	<input type="radio"/> US Patent Practitioner	<input type="radio"/> Limited Recognition (37 CFR 11.9)
Customer Number	24728		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.			
Prior Application Status		Remove	
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the Add button.			Add

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55(d). When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX) the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(h)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).			
Remove			
Application Number	Country ⁱ	Filing Date (YYYY-MM-DD)	Access Code ^j (if applicable)
102139029	TW	2013-10-29	
Additional Foreign Priority Data may be generated within this form by selecting the Add button.			Add HP, Ex. 1002

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	14970-94702
		Application Number	
Title of Invention	IMAGE CAPTURING LENS SYSTEM, IMAGING DEVICE AND MOBILE TERMINAL		

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

<input type="checkbox"/> This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013. NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

Authorization to Permit Access:

<input checked="" type="checkbox"/> Authorization to Permit Access to the Instant Application by the Participating Offices
<p>If checked, the undersigned hereby grants the USPTO authority to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the World Intellectual Property Office (WIPO), and any other intellectual property offices in which a foreign application claiming priority to the instant patent application is filed access to the instant patent application. See 37 CFR 1.14(c) and (h). This box should not be checked if the applicant does not wish the EPO, JPO, KIPO, WIPO, or other intellectual property office in which a foreign application claiming priority to the instant patent application is filed to have access to the instant patent application.</p> <p>In accordance with 37 CFR 1.14(h)(3), access will be provided to a copy of the instant patent application with respect to: 1) the instant patent application-as-filed; 2) any foreign application to which the instant patent application claims priority under 35 U.S.C. 119(a)-(d) if a copy of the foreign application that satisfies the certified copy requirement of 37 CFR 1.55 has been filed in the instant patent application; and 3) any U.S. application-as-filed from which benefit is sought in the instant patent application.</p> <p>In accordance with 37 CFR 1.14(c), access may be provided to information concerning the date of filing this Authorization.</p>

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	14970-94702
	Application Number	
Title of Invention	IMAGE CAPTURING LENS SYSTEM, IMAGING DEVICE AND MOBILE TERMINAL	

Applicant 1				Remove	
<p>If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.</p>					
Clear					
<input checked="" type="radio"/> Assignee		<input type="radio"/> Legal Representative under 35 U.S.C. 117		<input type="radio"/> Joint Inventor	
<input type="radio"/> Person to whom the inventor is obligated to assign.			<input type="radio"/> Person who shows sufficient proprietary interest		
If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:					
Name of the Deceased or Legally Incapacitated Inventor : <input type="text"/>					
If the Applicant is an Organization check here. <input checked="" type="checkbox"/>					
Organization Name		LARGAN PRECISION CO., LTD.			
Mailing Address Information:					
Address 1		No.11, Jingke Rd., Nantun District			
Address 2					
City		Taichung	State/Province		
Country ⁱ	TW	Postal Code		408	
Phone Number			Fax Number		
Email Address					
Additional Applicant Data may be generated within this form by selecting the Add button. Add					

Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.			
Assignee 1			
<p>Complete this section only if non-applicant assignee information is desired to be included on the patent application publication in accordance with 37 CFR 1.215(b). Do not include in this section an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest), as the patent application publication will include the name of the applicant(s).</p>			
Remove			
If the Assignee is an Organization check here. <input type="checkbox"/>			

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	14970-94702
		Application Number	
Title of Invention	IMAGE CAPTURING LENS SYSTEM, IMAGING DEVICE AND MOBILE TERMINAL		

Prefix	Given Name	Middle Name	Family Name	Suffix

Mailing Address Information:

Address 1			
Address 2			
City		State/Province	
Country i		Postal Code	
Phone Number		Fax Number	
Email Address			

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Signature:

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NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications

Signature	/Tim Tingkang Xia/		Date (YYYY-MM-DD)	2013-12-13
First Name	Tim Tingkang	Last Name	Xia	Registration Number
				45242

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The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

IMAGE CAPTURING LENS SYSTEM, IMAGING DEVICE AND MOBILE TERMINAL

RELATED APPLICATIONS

5 This application claims priority to Taiwan Application Serial Number 102139029, filed October 29, 2013, which is incorporated by reference herein in its entirety.

BACKGROUND

10 Technical Field

 The present disclosure relates to an image capturing lens system. More particularly, the present disclosure relates to a compact image capturing lens system applicable to a mobile terminal.

15 Description of Related Art

 In recent years, with the popularity of mobile terminals having camera functionalities, the demand of miniaturized optical systems has been increasing. As the advanced semiconductor manufacturing technologies have allowed the pixel size of sensors to be reduced and compact optical systems have gradually
20 evolved toward the field of higher megapixels, there is an increasing demand for compact optical systems featuring better image quality.

 A conventional compact optical system in a portable electronic product typically utilizes a three-element lens structure. Due to the popularity of mobile products with high-end specifications, such as smart phones, tablet personal
25 computers, wearable apparatus and other high-end mobile terminals, the

requirements for high resolution and image quality of present compact optical systems increase significantly. However, the conventional optical systems cannot satisfy these requirements of the compact optical systems.

Another conventional compact optical system provides a four-element lens structure. However, it is hard to make a good balance between obtaining a large field of view and a short total track length. Furthermore, it is also not favorable for the resolving power and illumination in a peripheral region of an image; therefore, it cannot satisfy the requirements of the compact optical systems featuring better image quality.

SUMMARY

According to one aspect of the present disclosure, an image capturing lens system includes, in order from an object side to an image side, a first lens element, a second lens element, a third lens element and a fourth lens element.

The first lens element has refractive power. The second lens element with positive refractive power has a convex image-side surface in a paraxial region thereof. The third lens element with negative refractive power has a concave object-side surface in a paraxial region thereof and a convex image-side surface in a paraxial region thereof. The fourth lens element with refractive power has a concave image-side surface in a paraxial region thereof, wherein both of an object-side surface and the image-side surface of the fourth lens element are aspheric, and the image-side surface of the fourth lens element has at least one convex shape in an off-axis region thereof. The image capturing lens system has a total of four lens elements with refractive power. When an axial distance between an object-side surface of the first lens element and the

image-side surface of the fourth lens element is T_d , half of a maximal field of view of the image capturing lens system is HFOV, a focal length of the image capturing lens system is f , a focal length of the fourth lens element is f_4 , a focal length of the second lens element is f_2 , and a focal length of the third lens element is f_3 , the following conditions are satisfied:

$$0.5 \text{ mm} < T_d < 3.2 \text{ mm};$$

$$1.0 \text{ mm} < T_d/\tan(\text{HFOV}) < 3.75 \text{ mm};$$

$$|f/f_4| < 1.20; \text{ and}$$

$$f_2/f_3 < -0.65.$$

According to another aspect of the present disclosure, an image capturing lens system includes, in order from an object side to an image side, a first lens element, a second lens element, a third lens element and a fourth lens element. The first lens element has refractive power. The second lens element with positive refractive power has a convex image-side surface in a paraxial region thereof. The third lens element with negative refractive power has a concave object-side surface in a paraxial region thereof and a convex image-side surface in a paraxial region thereof. The fourth lens element with refractive power has a concave image-side surface in a paraxial region thereof, wherein both of an object-side surface and the image-side surface of the fourth lens element are aspheric, and the image-side surface of the fourth lens element has at least one convex shape in an off-axis region thereof. The image capturing lens system has a total of four lens elements with refractive power. When an axial distance between an object-side surface of the first lens element and the image-side surface of the fourth lens element is T_d , half of a maximal field of view of the image capturing lens system is HFOV, a focal

length of the image capturing lens system is f , a focal length of the fourth lens element is f_4 , and a focal length of the third lens element is f_3 , the following conditions are satisfied:

$$0.5 \text{ mm} < T_d < 3.2 \text{ mm};$$

5 $1.0 \text{ mm} < T_d/\tan(\text{HFOV}) < 3.75 \text{ mm};$

$$|f/f_4| < 1.20; \text{ and}$$

$$-2.0 < f/f_3 < -0.95.$$

According to still another aspect of the present disclosure, an image capturing lens system includes, in order from an object side to an image side, a first lens element, a second lens element, a third lens element and a fourth lens element. The first lens element has refractive power. The second lens element with positive refractive power has a convex image-side surface in a paraxial region thereof. The third lens element with negative refractive power has a concave object-side surface in a paraxial region thereof and a convex image-side surface in a paraxial region thereof. The fourth lens element with refractive power has a concave image-side surface in a paraxial region thereof, wherein both of an object-side surface and the image-side surface of the fourth lens element are aspheric, and the image-side surface of the fourth lens element has at least one convex shape in an off-axis region thereof. The image capturing lens system has a total of four lens elements with refractive power. When an axial distance between an object-side surface of the first lens element and the image-side surface of the fourth lens element is T_d , half of a maximal field of view of the image capturing lens system is HFOV, a focal length of the image capturing lens system is f , a focal length of the fourth lens

element is f_4 , and an f-number of the image capturing lens system is F_{no} , the following conditions are satisfied:

$$0.5 \text{ mm} < T_d < 3.2 \text{ mm};$$

$$1.0 \text{ mm} < T_d/\tan(HFOV) < 3.75 \text{ mm};$$

5 $|f/f_4| < 1.20; \text{ and}$

$$1.40 < F_{no} \leq 2.25.$$

According to yet another aspect of the present disclosure, an imaging device includes the image capturing lens system according to the aforementioned aspect and an image sensor, wherein the image sensor is
10 located on an image plane of the image capturing lens system.

According to still yet another aspect of the present disclosure, a mobile terminal includes the imaging device according to the aforementioned aspect.

BRIEF DESCRIPTION OF THE DRAWINGS

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

Fig. 1A is a schematic view of an imaging device according to the 1st embodiment of the present disclosure;

20 Fig. 1B shows spherical aberration curves, astigmatic field curves and a distortion curve of the imaging device according to the 1st embodiment;

Fig. 2A is a schematic view of an imaging device according to the 2nd embodiment of the present disclosure;

25 Fig. 2B shows spherical aberration curves, astigmatic field curves and a distortion curve of the imaging device according to the 2nd embodiment;

Fig. 3A is a schematic view of an imaging device according to the 3rd embodiment of the present disclosure;

Fig. 3B shows spherical aberration curves, astigmatic field curves and a distortion curve of the imaging device according to the 3rd embodiment;

5 Fig. 4A is a schematic view of an imaging device according to the 4th embodiment of the present disclosure;

Fig. 4B shows spherical aberration curves, astigmatic field curves and a distortion curve of the imaging device according to the 4th embodiment;

10 Fig. 5A is a schematic view of an imaging device according to the 5th embodiment of the present disclosure;

Fig. 5B shows spherical aberration curves, astigmatic field curves and a distortion curve of the imaging device according to the 5th embodiment;

Fig. 6A is a schematic view of an imaging device according to the 6th embodiment of the present disclosure;

15 Fig. 6B shows spherical aberration curves, astigmatic field curves and a distortion curve of the imaging device according to the 6th embodiment;

Fig. 7A is a schematic view of an imaging device according to the 7th embodiment of the present disclosure;

20 Fig. 7B shows spherical aberration curves, astigmatic field curves and a distortion curve of the imaging device according to the 7th embodiment;

Fig. 8A is a schematic view of an imaging device according to the 8th embodiment of the present disclosure;

Fig. 8B shows spherical aberration curves, astigmatic field curves and a distortion curve of the imaging device according to the 8th embodiment;

Fig. 9A is a schematic view of an imaging device according to the 9th embodiment of the present disclosure;

Fig. 9B shows spherical aberration curves, astigmatic field curves and a distortion curve of the imaging device according to the 9th embodiment;

5 Fig. 10A is a schematic view of an imaging device according to the 10th embodiment of the present disclosure;

Fig. 10B shows spherical aberration curves, astigmatic field curves and a distortion curve of the imaging device according to the 10th embodiment;

10 Fig. 11A shows a smart phone with an imaging device of the present disclosure installed therein;

Fig. 11B shows a tablet personal computer with an imaging device of the present disclosure installed therein; and

Fig. 11C shows a wearable device with an imaging device of the present disclosure installed therein.

15

DETAILED DESCRIPTION

An image capturing lens system includes, in order from an object side to an image side, a first lens element, a second lens element, a third lens element and a fourth lens element. The image capturing lens system has a total of four
20 lens elements with refractive power.

The first lens element can have positive refractive power, so that it provides the image capturing lens system with the positive refractive power as it needs to be so as to reduce the total track length of the image capturing lens system. The first lens element can have a convex object-side surface in a

paraxial region thereof, so that it is favorable for further reducing the total track length.

The second lens element has positive refractive power, so that it is favorable for the second lens element adjusting the light gathering ability of the first lens element. The second lens element has a convex image-side surface in a paraxial region thereof, so that it is favorable for correcting the astigmatism of the image capturing lens system.

The third lens element has negative refractive power, so that it is favorable for correcting the aberration of the image capturing lens system. The third lens element has a concave object-side surface in a paraxial region thereof and a convex image-side surface in a paraxial region thereof, so that it is favorable for correcting the astigmatism of the image capturing lens system.

The fourth lens element can have a convex object-side surface in a paraxial region thereof and has a concave image-side surface in a paraxial region thereof. Furthermore, the image-side surface of the fourth lens element has at least one convex shape in an off-axis region thereof. Therefore, it is favorable for correcting the astigmatism and aberration of the off-axis.

When an axial distance between the object-side surface of the first lens element and the image-side surface of the fourth lens element is T_d , and the following condition is satisfied: $0.5 \text{ mm} < T_d < 3.2 \text{ mm}$. Therefore, it is favorable for keeping the image capturing lens system compact. Preferably, the following condition is satisfied: $0.8 \text{ mm} < T_d < 2.5 \text{ mm}$.

When the axial distance between the object-side surface of the first lens element and the image-side surface of the fourth lens element is T_d , and half of a maximal field of view of the image capturing lens system is HFOV, the

following condition is satisfied: $1.0 \text{ mm} < Td/\tan(HFOV) < 3.75 \text{ mm}$. Therefore, it is favorable for obtaining a large field of view and short total track length for the image capturing lens system. Preferably, the following condition is satisfied: $1.2 \text{ mm} < Td/\tan(HFOV) < 2.75 \text{ mm}$.

5 When a focal length of the image capturing lens system is f , and a focal length of the fourth lens element is f_4 , the following condition is satisfied: $|f/f_4| < 1.20$. Therefore, it is favorable for the principal point of the image capturing lens system being positioned away from the image plane so as to reduce the total track length and keep the image capturing lens system compact.

10 When a focal length of the second lens element is f_2 , and a focal length of the third lens element is f_3 , the following condition is satisfied: $f_2/f_3 < -0.65$. Therefore, it is favorable for balancing the refractive powers of the second lens element and the third lens element so as to correct the aberration and reduce the photosensitivity. Preferably, the following condition is satisfied: $f_2/f_3 <$
15 -0.75 .

 When the focal length of the image capturing lens system is f , and the focal length of the third lens element is f_3 , the following condition is satisfied: $-2.0 < f/f_3 < -0.95$. Therefore, the third lens element serves as a correcting lens for balancing and correcting the aberrations of the image capturing lens
20 system so as to obtain better image quality.

 When an f-number of the image capturing lens system is F_{no} , and the following condition is satisfied: $1.40 < F_{no} \leq 2.25$. Therefore, it is favorable for improving the illumination in a peripheral region of the image capturing lens system.

When the focal length of the image capturing lens system is f , and a focal length of the first lens element is f_1 , the following condition is satisfied: $-0.25 < f/f_1 < 0.75$. Therefore, the first lens element will have a more proper refractive power so as to avoid excess photosensitivity. Preferably, the following condition is satisfied: $0.25 < f/f_1 < 0.75$.

When a curvature radius of the object-side surface of the second lens element is R_3 , and a curvature radius of the image-side surface of the second lens element is R_4 , the following condition is satisfied: $0.5 < (R_3+R_4)/(R_3-R_4) < 2.5$. Therefore, it is favorable for further correcting the aberration of the image capturing lens system.

When the focal length of the image capturing lens system is f , and the following condition is satisfied: $0.5 \text{ mm} < f < 2.0 \text{ mm}$. Therefore, it is favorable for providing a proper total track length.

When a sum of the central thicknesses of the first lens element, the second lens element, the third lens element, and the fourth lens element is ΣCT , and the axial distance between the object-side surface of the first lens element and the image-side surface of the fourth lens element is T_d , the following condition is satisfied: $0.80 < \Sigma CT/T_d < 0.95$. Therefore, it is favorable for assembling the lens elements of the image capturing lens system so as to reduce the photosensitivity.

When an Abbe number of the first lens element is V_1 , and the following condition is satisfied: $45 < V_1$. Therefore, it is favorable for correcting the chromatic aberration of the image capturing lens system.

When a central thickness of the second lens element is CT_2 , a central thickness of the first lens element is CT_1 , a central thickness of the third lens

element is CT3, and a central thickness of the fourth lens element is CT4, the following condition is satisfied: $0.65 < CT2/(CT1+CT3+CT4) < 2.0$. Therefore, the thickness of each lens element is favorable for manufacturing and assembling the lens elements.

5 When a maximal field of view of the image capturing lens system is FOV, and the following condition is satisfied: $80 \text{ degrees} < FOV < 110 \text{ degrees}$. Therefore, it is favorable for obtaining enough field of view.

 According to the image capturing lens system of the present disclosure, the lens elements thereof can be made of glass or plastic material. When the
10 lens elements are made of glass material, the distribution of the refractive power of the image capturing lens system may be more flexible to design. When the lens elements are made of plastic material, the manufacturing cost can be effectively reduced. Furthermore, surfaces of each lens element can be arranged to be aspheric, since the aspheric surface of the lens element is
15 easy to form a shape other than spherical surface so as to have more controllable variables for eliminating the aberration thereof, and to further decrease the required number of the lens elements. Therefore, the total track length of the image capturing lens system can also be reduced.

 According to the image capturing lens system of the present disclosure,
20 each of an object-side surface in a paraxial region thereof and an image-side surface has a paraxial region and an off-axis region. The paraxial region refers to the region of the surface where light rays travel close to the optical axis, and the off-axis region refers to the region of the surface where light rays travel away from the optical axis. Particularly, when the lens element has a convex
25 surface, it indicates that the surface is convex in the paraxial region thereof;

when the lens element has a concave surface, it indicates that the surface is concave in the paraxial region thereof.

According to the image capturing lens system of the present disclosure, the image capturing lens system can include at least one stop, such as an aperture stop, a glare stop or a field stop. Said glare stop or said field stop is for eliminating the stray light and thereby improving the image resolution thereof.

According to the image capturing lens system of the present disclosure, an aperture stop can be configured as a front stop or a middle stop. A front stop disposed between an imaged object and the first lens element can provide a longer distance between an exit pupil of the image capturing lens system and the image plane and thereby improves the image-sensing efficiency of an image sensor. A middle stop disposed between the first lens element and the image plane is favorable for enlarging the field of view of the image capturing lens system and thereby provides a wider field of view for the same.

The present image capturing lens system can be optionally applied to moving focus optical systems. According to the image capturing lens system of the present disclosure, the image capturing lens system is featured with good correction ability and high image quality, and can be applied to 3D (three-dimensional) image capturing applications, in products such as digital cameras, mobile devices, digital tablets, wearable devices and other mobile terminals.

According to the present disclosure, an imaging device is provided. The imaging device includes the image capturing lens system according to the aforementioned image capturing lens system of the present disclosure, and an

image sensor, wherein the image sensor is disposed on an image plane of the
aforementioned image capturing lens system. As a result, it is favorable for
reducing the total track length of the image capturing lens system while
obtaining large field of view. Furthermore, it is also favorable for improving the
5 resolving power and illumination so as to achieve the best image quality.
Preferably, the imaging device can further include a barrel member, a holding
member or a combination thereof.

According to the present disclosure, a mobile terminal is provided,
wherein the mobile terminal includes the aforementioned imaging device. The
10 imaging device includes the image capturing lens system according to the
aforementioned image capturing lens system of the present disclosure, and the
image sensor, wherein the image sensor is disposed on an image plane of the
aforementioned image capturing lens system. As a result, it is favorable for
reducing the total track length of the image capturing lens system while
15 obtaining large field of view. Furthermore, it is also favorable for improving the
resolving power and illumination so as to achieve the best image quality.

In Fig. 11A, Fig. 11B and Fig. 11C, an imaging device 1101 may be
installed in but not limited to a mobile terminal, including a smart phone 1110, a
tablet personal computer 1120 or a wearable device 1130. The three
20 exemplary figures of different kinds of mobile terminal are only exemplary for
showing the imaging device of present disclosure installing in a mobile terminal
and is not limited thereto. Preferably, the mobile terminal can further include
but not limited to display, control unit, random access memory unit (RAM) a
read only memory unit (ROM) or a combination thereof.

According to the above description of the present disclosure, the following 1st – 10th specific embodiments are provided for further explanation.

1st Embodiment

5 Fig. 1A is a schematic view of an imaging device according to the 1st embodiment of the present disclosure. Fig. 1B shows, in order from left to right, spherical aberration curves, astigmatic field curves and a distortion curve of the imaging device according to the 1st embodiment.

In Fig. 1A, the imaging device includes the image capturing lens system
10 (not otherwise herein labeled) of the present disclosure and an image sensor 170. The image capturing lens system includes, in order from an object side to an image side, a first lens element 110, an aperture stop 100, a second lens element 120, a third lens element 130, a fourth lens element 140, an IR-cut filter 150 and an image plane 160, wherein the image capturing lens system has a
15 total of four lens elements (110-140) with refractive power.

The first lens element 110 with positive refractive power has a convex object-side surface 111 in a paraxial region thereof and a concave image-side surface 112 in a paraxial region thereof, which are both aspheric, and the first lens element 110 is made of plastic material.

20 The second lens element 120 with positive refractive power has a convex object-side surface 121 in a paraxial region thereof and a convex image-side surface 122 in a paraxial region thereof, which are both aspheric, and the second lens element 120 is made of plastic material.

The third lens element 130 with negative refractive power has a concave
25 object-side surface 131 in a paraxial region thereof and a convex image-side

surface 132 in a paraxial region thereof, which are both aspheric, and the third lens element 130 is made of plastic material.

The fourth lens element 140 with positive refractive power has a convex object-side surface 141 in a paraxial region thereof and a concave image-side surface 142 in a paraxial region thereof, which are both aspheric, and the fourth lens element 140 is made of plastic material. Furthermore, the image-side surface 142 of the fourth lens element 140 has at least one convex shape in an off-axis region thereof.

The IR-cut filter 150 is made of glass and located between the fourth lens element 140 and the image plane 160, and will not affect the focal length of the image capturing lens system. The image sensor 170 is disposed on the image plane 160 of the image capturing lens system.

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

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

, where,

X is the relative 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 vertical distance from the point on 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 lens system of the imaging device according to the 1st embodiment, when a focal length of the image capturing lens system is f , an f-number of the image capturing lens system is Fno , and half of a maximal field of view of the image capturing lens system is $HFOV$, these parameters
 5 have the following values: $f = 1.17 \text{ mm}$; $Fno = 2.20$; and $HFOV = 46.7 \text{ degrees}$.

In the image capturing lens system of the imaging device according to the 1st embodiment, when an Abbe number of the first lens element 110 is $V1$, the following condition is satisfied: $V1 = 21.4$.

In the image capturing lens system according to the 1st embodiment,
 10 when a central thickness of the second lens element 120 is $CT2$, a central thickness of the first lens element 110 is $CT1$, 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 condition is satisfied: $CT2/(CT1+CT3+CT4) = 0.69$.

In the image capturing lens system according to the 1st embodiment,
 15 when a curvature radius of the object-side surface 121 of the second lens element 120 is $R3$, and a curvature radius of the image-side surface 122 of the second lens element 120 is $R4$, the following condition is satisfied: $(R3+R4)/(R3-R4) = 0.85$.

In the image capturing lens system of the imaging device according to
 20 the 1st embodiment, when the focal length of the image capturing lens system is f , and a focal length of the first lens element 110 is $f1$, the following condition is satisfied: $f/f1 = 0.12$.

In the image capturing lens system of the imaging device according to the 1st embodiment, when a focal length of the second lens element 120 is $f2$,

and a focal length of the third lens element 130 is f_3 , the following condition is satisfied: $f_2/f_3 = -0.77$.

In the image capturing lens system of the imaging device according to the 1st embodiment, when the focal length of the image capturing lens system is f , and a focal length of the fourth lens element 140 is f_4 , the following condition is satisfied: $|f/f_4| = 0.77$.

In the image capturing lens system of the imaging device according to the 1st embodiment, when the focal length of the image capturing lens system is f , and the focal length of the third lens element 130 is f_3 , the following condition is satisfied: $f/f_3 = -1.10$.

In the image capturing lens system according to the 1st embodiment, when an axial distance between the object-side surface 111 of the first lens element 110 and the image-side surface 142 of the fourth lens element 140 is T_d , the following condition is satisfied: $T_d = 1.850$ mm.

In the image capturing lens system according to the 1st embodiment, when a sum of the central thicknesses of the first lens element 110, the second lens element 120, the third lens element 130, and the fourth lens element 140 is ΣCT , and the axial distance between the object-side surface 111 of the first lens element 110 and the image-side surface 142 of the fourth lens element 140 is T_d , the following condition is satisfied: $\Sigma CT/T_d = 0.89$.

In the image capturing lens system according to the 1st embodiment, when the axial distance between the object-side surface 111 of the first lens element 110 and the image-side surface 142 of the fourth lens element 140 is T_d , and half of the maximal field of view of the image capturing lens system is $HFOV$, the following condition is satisfied: $T_d/\tan(HFOV) = 1.74$ mm.

In the image capturing lens system of the imaging device according to the 1st embodiment, when a maximal field of view of the image capturing lens system is FOV, the following condition is satisfied: FOV = 93.4 degrees.

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								
Embodiment 1								
f = 1.17 mm, Fno = 2.20, HFOV = 46.7 deg.								
Surface #		Curvature Radius		Thickness	Material	Index	Abbe #	Focal Length
0	Object	Plano		Infinity				
1	Lens 1	1.666	ASP	0.256	Plastic	1.650	21.4	9.56
2		2.139	ASP	0.031				
3	Ape. Stop	Plano		0.019				
4	Lens 2	5.712	ASP	0.671	Plastic	1.544	55.9	0.82
5		-0.464	ASP	0.130				
6	Lens 3	-0.228	ASP	0.230	Plastic	1.634	23.8	-1.06
7		-0.480	ASP	0.030				
8	Lens 4	0.679	ASP	0.483	Plastic	1.535	55.7	1.52
9		3.062	ASP	0.300				
10	IR-cut filter	Plano		0.145	Glass	1.517	64.2	-
11		Plano		0.204				
12	Image	Plano		-				
Note: Reference wavelength is 587.6 nm (d-line).								

TABLE 2				
Aspheric Coefficients				
Surface #	1	2	4	5
k =	1.2237E+00	1.7244E+01	9.0000E+01	-6.9311E-01
A4 =	3.1416E-01	1.1703E+00	-4.1498E-01	-6.9345E-01
A6 =	-1.0010E+00	-2.0080E+01	3.6416E+00	1.3202E+00
A8 =	4.5872E+01	5.2569E+02	4.3035E+01	1.0955E+01
A10 =	-5.9339E+02	-3.0044E+03	-7.4996E+03	-3.8285E+02
A12 =	4.0961E+03	-1.6432E+05	1.3290E+05	3.0040E+03
A14 =	-1.4631E+04	3.1882E+06	-1.1481E+06	-1.0680E+04
A16 =	2.0715E+04	-1.7563E+07	3.7732E+06	1.3826E+04
Surface #	6	7	8	9

k =	-9.8477E-01	-3.2669E+00	-6.1619E-01	-1.4636E+01
A4 =	3.5682E+00	-1.8915E+00	-1.2870E+00	1.2883E+00
A6 =	-3.7958E+00	8.7075E+00	3.1244E+00	-3.7603E+00
A8 =	-1.1135E+02	-3.6761E+01	-9.1933E+00	5.9040E+00
A10 =	1.5862E+03	1.7257E+02	1.7146E+01	-5.8521E+00
A12 =	-8.7685E+03	-4.8146E+02	-1.9850E+01	3.5356E+00
A14 =	2.3054E+04	6.7728E+02	1.2752E+01	-1.1759E+00
A16 =	-2.3557E+04	-3.6747E+02	-3.5165E+00	1.6169E-01

In Table 1, the curvature radius, the thickness and the focal length are shown in millimeters (mm). Surface numbers 0-12 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. The tables presented below for each embodiment are the corresponding schematic parameter and aberration curves, and the definitions of the tables are the same as Table 1 and Table 2 of the 1st embodiment. Therefore, an explanation in this regard will not be provided again.

2nd Embodiment

Fig. 2A is a schematic view of an imaging device according to the 2nd embodiment of the present disclosure. Fig. 2B shows, in order from left to right, spherical aberration curves, astigmatic field curves and a distortion curve of the imaging device according to the 2nd embodiment.

In Fig. 2A, the imaging device includes the image capturing lens system (not otherwise herein labeled) of the present disclosure and an image sensor 270. The image capturing lens system includes, in order from an object side to

an image side, a first lens element 210, an aperture stop 200, a second lens element 220, a third lens element 230, a fourth lens element 240, an IR-cut filter 250 and an image plane 260, wherein the image capturing lens system has a total of four lens elements (210-240) with refractive power.

5 The first lens element 210 with positive refractive power has a convex object-side surface 211 in a paraxial region thereof and a concave image-side surface 212 in a paraxial region thereof, which are both aspheric, and the first lens element 210 is made of plastic material.

10 The second lens element 220 with positive refractive power has a convex object-side surface 221 in a paraxial region thereof and a convex image-side surface 222 in a paraxial region thereof, which are both aspheric, and the second lens element 220 is made of plastic material.

15 The third lens element 230 with negative refractive power has a concave object-side surface 231 in a paraxial region thereof and a convex image-side surface 232 in a paraxial region thereof, which are both aspheric, and the third lens element 230 is made of plastic material.

20 The fourth lens element 240 with positive refractive power has a convex object-side surface 241 in a paraxial region thereof and a concave image-side surface 242 in a paraxial region thereof, which are both aspheric, and the fourth lens element 240 is made of plastic material. Furthermore, the image-side surface 242 of the fourth lens element 240 has at least one convex shape in an off-axis region thereof.

 The IR-cut filter 250 is made of glass and located between the fourth lens element 240 and the image plane 260, and will not affect the focal length of the

image capturing lens system. The image sensor 270 is disposed on the image plane 260 of the image capturing lens 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								
Embodiment 2								
f = 1.23 mm, Fno = 2.45, HFOV = 45.6 deg.								
Surface #		Curvature Radius		Thickness	Material	Index	Abbe #	Focal Length
0	Object	Plano		Infinity				
1	Lens 1	1.728	ASP	0.217	Plastic	1.640	22.0	1207.16
2		1.647	ASP	0.041				
3	Ape. Stop	Plano		0.020				
4	Lens 2	2.201	ASP	0.685	Plastic	1.544	55.9	0.78
5		-0.465	ASP	0.138				
6	Lens 3	-0.213	ASP	0.222	Plastic	1.634	23.8	-0.90
7		-0.479	ASP	0.030				
8	Lens 4	0.691	ASP	0.430	Plastic	1.535	55.7	1.40
9		7.112	ASP	0.300				
10	IR-cut filter	Plano		0.300	Glass	1.517	64.2	-
11		Plano		0.171				
12	Image	Plano		-				
Note: Reference wavelength is 587.6 nm (d-line).								

5

TABLE 4				
Aspheric Coefficients				
Surface #	1	2	4	5
k =	-7.8611E-01	2.2256E+01	4.4287E+01	-6.8249E-01
A4 =	2.7433E-01	3.5449E-01	-1.1581E+00	-5.9944E-01
A6 =	-1.5466E+00	-2.9377E+01	8.9406E-01	3.6061E-01
A8 =	4.7455E+01	6.4129E+02	4.1870E+01	1.6896E+01
A10 =	-6.0092E+02	-3.8207E+03	-7.3180E+03	-3.8194E+02
A12 =	4.0961E+03	-1.6432E+05	1.3290E+05	3.0043E+03
A14 =	-1.4631E+04	3.1882E+06	-1.1481E+06	-1.0680E+04
A16 =	2.0715E+04	-1.7563E+07	3.7732E+06	1.3826E+04
Surface #	6	7	8	9
k =	-1.0107E+00	-3.0532E+00	-7.4231E-01	2.2155E+01
A4 =	3.8803E+00	-1.7079E+00	-1.1152E+00	1.6267E+00
A6 =	-4.2860E+00	8.7245E+00	2.9613E+00	-4.5228E+00
A8 =	-1.1314E+02	-3.7291E+01	-9.2058E+00	6.4630E+00

A10 =	1.5859E+03	1.7181E+02	1.7048E+01	-5.8730E+00
A12 =	-8.7686E+03	-4.8143E+02	-1.9563E+01	3.4083E+00
A14 =	2.3054E+04	6.7878E+02	1.3110E+01	-1.1920E+00
A16 =	-2.3557E+04	-3.6776E+02	-4.1607E+00	1.9105E-01

In the 2nd embodiment, the equation of the aspheric surface profiles of the aforementioned lens elements is the same as the equation of the 1st embodiment. Also, the definitions of these parameters shown in the following table are the same as those stated in the 1st embodiment with corresponding values for the 2nd embodiment, so an explanation in this regard will not be provided again.

Moreover, these parameters can be calculated from Table 3 and Table 4 as the following values and satisfy the following conditions:

2nd Embodiment			
f [mm]	1.23	f2/f3	-0.87
Fno	2.45	f/f4	0.88
HFOV [deg.]	45.6	f/f3	-1.37
V1	22.0	Td [mm]	1.783
CT2/(CT1+CT3+CT4)	0.79	Σ CT/Td	0.87
(R3+R4)/(R3-R4)	0.65	Td/tan(HFOV) [mm]	1.75
f/f1	0.00	FOV [deg.]	91.2

10

3rd Embodiment

Fig. 3A is a schematic view of an imaging device according to the 3rd embodiment of the present disclosure. Fig. 3B shows, in order from left to right, spherical aberration curves, astigmatic field curves and a distortion curve of the imaging device according to the 3rd embodiment.

15

In Fig. 3A, the imaging device includes the image capturing lens system (not otherwise herein labeled) of the present disclosure and an image sensor

370. The image capturing lens system includes, in order from an object side to an image side, a first lens element 310, an aperture stop 300, a second lens element 320, a third lens element 330, a fourth lens element 340, an IR-cut filter 350 and an image plane 360, wherein the image capturing lens system has a
5 total of four lens elements (310-340) with refractive power.

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

10 The second lens element 320 with positive refractive power has a concave object-side surface 321 in a paraxial region thereof and a convex image-side surface 322 in a paraxial region thereof, which are both aspheric, and the second lens element 320 is made of plastic material.

The third lens element 330 with negative refractive power has a concave
15 object-side surface 331 in a paraxial region thereof and a convex image-side surface 332 in a paraxial region thereof, which are both aspheric, and the third lens element 330 is made of plastic material.

The fourth lens element 340 with positive refractive power has a convex object-side surface 341 in a paraxial region thereof and a concave image-side
20 surface 342 in a paraxial region thereof, which are both aspheric, and the fourth lens element 340 is made of plastic material. Furthermore, the image-side surface 342 of the fourth lens element 340 has at least one convex shape in an off-axis region thereof.

The IR-cut filter 350 is made of glass and located between the fourth lens
25 element 340 and the image plane 360, and will not affect the focal length of the

image capturing lens system. The image sensor 370 is disposed on the image plane 360 of the image capturing lens 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								
Embodiment 3								
f = 1.66 mm, Fno = 2.15, HFOV = 46.8 deg.								
Surface #		Curvature Radius		Thickness	Material	Index	Abbe #	Focal Length
0	Object	Plano		Infinity				
1	Lens 1	1.333	ASP	0.286	Plastic	1.544	55.9	2.50
2		59.851	ASP	0.005				
3	Ape. Stop	Plano		0.195				
4	Lens 2	-1.920	ASP	0.409	Plastic	1.544	55.9	1.60
5		-0.644	ASP	0.156				
6	Lens 3	-0.263	ASP	0.200	Plastic	1.650	21.4	-1.49
7		-0.470	ASP	0.030				
8	Lens 4	0.677	ASP	0.363	Plastic	1.535	55.7	2.33
9		1.206	ASP	0.400				
10	IR-cut filter	Plano		0.175	Glass	1.517	64.2	-
11		Plano		0.431				
12	Image	Plano		-				
Note: Reference wavelength is 587.6 nm (d-line).								
The effective radius of Surface 1 is 0.510 mm.								

5

TABLE 6				
Aspheric Coefficients				
Surface #	1	2	4	5
k =	-2.4704E+00	9.0000E+01	5.8947E+00	-3.7972E-01
A4 =	-3.4848E-02	-3.8775E-01	-9.3075E-01	-3.3741E-01
A6 =	-4.4471E-01	-2.8417E+00	3.6516E+00	9.2277E-01
A8 =	-4.9925E-01	1.8185E+01	-4.0769E+01	-3.9461E+00
A10 =	-1.2166E+01	-2.0954E+01	-4.4351E+00	-1.9037E+01
A12 =	3.9114E+01	-1.4998E+03	1.2130E+03	4.9148E+01
A14 =	-1.7950E+02	1.2389E+04	-4.4615E+03	1.0076E+02
A16 =	3.3572E+02	-2.9058E+04	6.2425E+03	8.0489E+01
Surface #	6	7	8	9
k =	-1.1491E+00	-2.3808E+00	-1.7649E+00	-1.0689E+01
A4 =	4.2079E+00	2.1562E-01	-6.9591E-01	9.1971E-01
A6 =	-2.8310E+01	-4.4239E+00	1.2041E+00	-3.0958E+00

A8 =	1.2287E+02	1.8790E+01	-2.9023E+00	4.8713E+00
A10 =	-3.9035E+02	-4.1840E+01	4.4195E+00	-4.6279E+00
A12 =	8.5064E+02	5.5883E+01	-3.7857E+00	2.6418E+00
A14 =	-9.7331E+02	-4.0255E+01	1.6532E+00	-8.3581E-01
A16 =	4.7213E+02	1.4428E+01	-2.8192E-01	1.1204E-01

In the 3rd embodiment, the equation of the aspheric surface profiles of the aforementioned lens elements is the same as the equation of the 1st embodiment. Also, the definitions of these parameters shown in the following table are the same as those stated in the 1st embodiment with corresponding values for the 3rd embodiment, so an explanation in this regard will not be provided again.

Moreover, these parameters can be calculated from Table 5 and Table 6 as the following values and satisfy the following conditions:

3rd Embodiment			
f [mm]	1.66	f2/f3	-1.07
Fno	2.15	f/f4	0.71
HFOV [deg.]	46.8	f/f3	-1.11
V1	55.9	Td [mm]	1.644
CT2/(CT1+CT3+CT4)	0.48	Σ CT/Td	0.77
(R3+R4)/(R3-R4)	2.01	Td/tan(HFOV) [mm]	1.54
f/f1	0.66	FOV [deg.]	93.6

10

4th Embodiment

Fig. 4A is a schematic view of an imaging device according to the 4th embodiment of the present disclosure. Fig. 4B shows, in order from left to right, spherical aberration curves, astigmatic field curves and a distortion curve of the imaging device according to the 4th embodiment.

15

In Fig. 4A, the imaging device includes the image capturing lens system (not otherwise herein labeled) of the present disclosure and an image sensor

470. The image capturing lens system includes, in order from an object side to an image side, a first lens element 410, an aperture stop 400, a second lens element 420, a third lens element 430, a fourth lens element 440, an IR-cut filter 450 and an image plane 460, wherein the image capturing lens system has a total of four lens elements (410-440) with refractive power.

The first lens element 410 with negative refractive power has a convex object-side surface 411 in a paraxial region thereof and a concave image-side surface 412 in a paraxial region thereof, which are both aspheric, and the first lens element 410 is made of plastic material.

The second lens element 420 with positive refractive power has a convex object-side surface 421 in a paraxial region thereof and a convex image-side surface 422 in a paraxial region thereof, which are both aspheric, and the second lens element 420 is made of plastic material.

The third lens element 430 with negative refractive power has a concave object-side surface 431 in a paraxial region thereof and a convex image-side surface 432 in a paraxial region thereof, which are both aspheric, and the third lens element 430 is made of plastic material.

The fourth lens element 440 with positive refractive power has a convex object-side surface 441 in a paraxial region thereof and a concave image-side surface 442 in a paraxial region thereof, which are both aspheric, and the fourth lens element 440 is made of plastic material. Furthermore, the image-side surface 442 of the fourth lens element 440 has at least one convex shape in an off-axis region thereof.

The IR-cut filter 450 is made of glass and located between the fourth lens element 440 and the image plane 460, and will not affect the focal length of the

image capturing lens system. The image sensor 470 is disposed on the image plane 460 of the image capturing lens 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								
Embodiment 4								
f = 1.15 mm, Fno = 2.22, HFOV = 48.5 deg.								
Surface #		Curvature Radius		Thickness	Material	Index	Abbe #	Focal Length
0	Object	Plano		Infinity				
1	Lens 1	1.999	ASP	0.200	Plastic	1.544	55.9	-46.83
2		1.789	ASP	0.021				
3	Ape. Stop	Plano		0.037				
4	Lens 2	1.606	ASP	0.471	Plastic	1.544	55.9	0.81
5		-0.543	ASP	0.184				
6	Lens 3	-0.207	ASP	0.209	Plastic	1.634	23.8	-1.22
7		-0.393	ASP	0.030				
8	Lens 4	0.747	ASP	0.319	Plastic	1.535	55.7	1.62
9		4.607	ASP	0.300				
10	IR-cut filter	Plano		0.300	Glass	1.517	64.2	-
11		Plano		0.130				
12	Image	Plano		-				

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

5

TABLE 8				
Aspheric Coefficients				
Surface #	1	2	4	5
k =	-2.2996E+01	3.4247E+01	9.8701E+00	-4.2975E-01
A4 =	-2.1353E-01	-2.0670E+00	-2.2221E+00	-6.3795E-01
A6 =	-3.6880E+00	-3.6063E+01	-8.7081E+00	-6.5092E+00
A8 =	5.2789E+01	6.9201E+02	1.4888E+02	4.6114E+01
A10 =	-6.4083E+02	-4.8238E+03	-8.2602E+03	-4.7532E+02
A12 =	4.0983E+03	-1.6432E+05	1.3290E+05	3.0044E+03
A14 =	-1.4631E+04	3.1882E+06	-1.1481E+06	-1.0679E+04
A16 =	2.0715E+04	-1.7563E+07	3.7732E+06	1.3828E+04
Surface #	6	7	8	9
k =	-1.0439E+00	-2.0056E+00	-6.4024E-01	-3.3636E+00
A4 =	4.2327E+00	-9.7476E-01	-8.3147E-01	1.0958E+00
A6 =	-3.4551E+00	1.0236E+01	2.1761E+00	-1.7086E+00
A8 =	-1.0303E+02	-3.7610E+01	-4.8336E+00	1.3575E+00

A10 =	1.5970E+03	1.6620E+02	5.0397E+00	-2.6285E+00
A12 =	-8.9315E+03	-4.9093E+02	-4.1411E+00	4.3863E+00
A14 =	2.3054E+04	6.8046E+02	3.4069E+00	-3.3963E+00
A16 =	-2.3558E+04	-3.4010E+02	-1.6576E+00	9.5967E-01

In the 4th embodiment, the equation of the aspheric surface profiles of the aforementioned lens elements is the same as the equation of the 1st embodiment. Also, the definitions of these parameters shown in the following table are the same as those stated in the 1st embodiment with corresponding values for the 4th embodiment, so an explanation in this regard will not be provided again.

Moreover, these parameters can be calculated from Table 7 and Table 8 as the following values and satisfy the following conditions:

4th Embodiment			
f [mm]	1.15	f2/f3	-0.66
Fno	2.22	f/f4	0.71
HFOV [deg.]	48.5	f/f3	-0.94
V1	55.9	Td [mm]	1.471
CT2/(CT1+CT3+CT4)	0.65	Σ CT/Td	0.82
(R3+R4)/(R3-R4)	0.49	Td/tan(HFOV) [mm]	1.30
f/f1	-0.02	FOV [deg.]	97.0

10

5th Embodiment

Fig. 5A is a schematic view of an imaging device according to the 5th embodiment of the present disclosure. Fig. 5B shows, in order from left to right, spherical aberration curves, astigmatic field curves and a distortion curve of the imaging device according to the 5th embodiment.

15

In Fig. 5A, the imaging device includes the image capturing lens system (not otherwise herein labeled) of the present disclosure and an image sensor

570. The image capturing lens system includes, in order from an object side to an image side, a first lens element 510, an aperture stop 500, a second lens element 520, a third lens element 530, a fourth lens element 540, an IR-cut filter 550 and an image plane 560, wherein the image capturing lens system has a total of four lens elements (510-540) with refractive power.

The first lens element 510 with negative refractive power has a convex object-side surface 511 in a paraxial region thereof and a concave image-side surface 512 in a paraxial region thereof, which are both aspheric, and the first lens element 510 is made of glass material.

10 The second lens element 520 with positive refractive power has a convex object-side surface 521 in a paraxial region thereof and a convex image-side surface 522 in a paraxial region thereof, which are both aspheric, and the second lens element 520 is made of glass material.

15 The third lens element 530 with negative refractive power has a concave object-side surface 531 in a paraxial region thereof and a convex image-side surface 532 in a paraxial region thereof, which are both aspheric, and the third lens element 530 is made of plastic material.

20 The fourth lens element 540 with positive refractive power has a convex object-side surface 541 in a paraxial region thereof and a concave image-side surface 542 in a paraxial region thereof, which are both aspheric, and the fourth lens element 540 is made of plastic material. Furthermore, the image-side surface 542 of the fourth lens element 540 has at least one convex shape in an off-axis region thereof.

25 The IR-cut filter 550 is made of glass and located between the fourth lens element 540 and the image plane 560, and will not affect the focal length of the

image capturing lens system. The image sensor 570 is disposed on the image plane 560 of the image capturing lens 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								
Embodiment 5								
f = 2.24 mm, Fno = 2.51, HFOV = 44.2 deg.								
Surface #		Curvature Radius		Thickness	Material	Index	Abbe #	Focal Length
0	Object	Plano		Infinity				
1	Lens 1	1.367	ASP	0.300	Glass	2.144	17.8	-13.68
2		1.110	ASP	0.144				
3	Ape. Stop	Plano		-0.015				
4	Lens 2	3.909	ASP	1.483	Glass	1.525	70.3	1.60
5		-0.932	ASP	0.325				
6	Lens 3	-0.341	ASP	0.277	Plastic	1.639	23.5	-1.72
7		-0.651	ASP	0.030				
8	Lens 4	0.897	ASP	0.606	Plastic	1.565	57.0	2.00
9		3.302	ASP	0.800				
10	IR-cut filter	Plano		0.300	Glass	1.517	64.2	-
11		Plano		0.342				
12	Image	Plano		-				

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

5

TABLE 10				
Aspheric Coefficients				
Surface #	1	2	4	5
k =	1.1992E+00	1.9195E+00	2.1734E+01	-7.2786E-01
A4 =	5.8324E-02	1.2422E-01	-9.9032E-02	-1.2252E-01
A6 =	-1.4402E-01	-5.2189E-01	5.9983E+00	5.2990E-01
A8 =	1.0028E+00	4.2713E+00	-1.1966E+02	-3.0301E+00
A10 =	-4.0021E+00	1.8016E+01	1.4083E+03	7.9248E+00
A12 =	8.9035E+00	-4.2193E+02	-9.4428E+03	-1.0795E+01
A14 =	-9.8479E+00	2.2697E+03	3.3923E+04	6.3429E+00
A16 =	3.0263E+00	-4.1004E+03	-5.0610E+04	-8.0066E-01
Surface #	6	7	8	9
k =	-9.8774E-01	-3.1767E+00	-8.3817E-01	-2.4331E+01
A4 =	2.5606E+00	-1.2881E-01	-4.2259E-01	3.5717E-01
A6 =	-7.9740E+00	-6.6170E-01	4.3675E-01	-4.5759E-01
A8 =	1.4853E+01	1.1888E+00	-4.6275E-01	2.9937E-01

A10 =	-1.1480E+01	-4.2607E-01	3.1380E-01	-1.1921E-01
A12 =	-4.4740E+00	-5.1720E-01	-1.2912E-01	2.8364E-02
A14 =	1.2594E+01	5.0722E-01	2.9275E-02	-3.7104E-03
A16 =	-5.4160E+00	-1.2485E-01	-2.8533E-03	2.0238E-04

In the 5th embodiment, the equation of the aspheric surface profiles of the aforementioned lens elements is the same as the equation of the 1st embodiment. Also, the definitions of these parameters shown in the following table are the same as those stated in the 1st embodiment with corresponding values for the 5th embodiment, so an explanation in this regard will not be provided again.

Moreover, these parameters can be calculated from Table 9 and Table 10 as the following values and satisfy the following conditions:

5th Embodiment			
f [mm]	2.24	f ₂ /f ₃	-0.93
Fno	2.51	f/f ₄	1.12
HFOV [deg.]	44.2	f/f ₃	-1.30
V1	17.8	Td [mm]	3.150
CT ₂ /(CT ₁ +CT ₃ +CT ₄)	1.25	ΣCT/Td	0.85
(R ₃ +R ₄)/(R ₃ -R ₄)	0.61	Td/tan(HFOV) [mm]	3.24
f/f ₁	-0.16	FOV [deg.]	88.4

10

6th Embodiment

Fig. 6A is a schematic view of an imaging device according to the 6th embodiment of the present disclosure. Fig. 6B shows, in order from left to right, spherical aberration curves, astigmatic field curves and a distortion curve of the imaging device according to the 6th embodiment.

15

In Fig. 6A, the imaging device includes the image capturing lens system (not otherwise herein labeled) of the present disclosure and an image sensor

670. The image capturing lens system includes, in order from an object side to an image side, a first lens element 610, an aperture stop 600, a second lens element 620, a third lens element 630, a fourth lens element 640, an IR-cut filter 650 and an image plane 660, wherein the image capturing lens system has a total of four lens elements (610-640) with refractive power.

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

The second lens element 620 with positive refractive power has a concave object-side surface 621 in a paraxial region thereof and a convex image-side surface 622 in a paraxial region thereof, which are both aspheric, and the second lens element 620 is made of plastic material.

The third lens element 630 with negative refractive power has a concave object-side surface 631 in a paraxial region thereof and a convex image-side surface 632 in a paraxial region thereof, which are both aspheric, and the third lens element 630 is made of plastic material.

The fourth lens element 640 with positive refractive power has a convex object-side surface 641 in a paraxial region thereof and a concave image-side surface 642 in a paraxial region thereof, which are both aspheric, and the fourth lens element 640 is made of plastic material. Furthermore, the image-side surface 642 of the fourth lens element 640 has at least one convex shape in an off-axis region thereof.

The IR-cut filter 650 is made of glass and located between the fourth lens element 640 and the image plane 660, and will not affect the focal length of the

image capturing lens system. The image sensor 670 is disposed on the image plane 660 of the image capturing lens 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								
Embodiment 6								
f = 1.27 mm, Fno = 2.10, HFOV = 44.4 deg.								
Surface #		Curvature Radius		Thickness	Material	Index	Abbe #	Focal Length
0	Object	Plano		Infinity				
1	Lens 1	2.393	ASP	0.280	Plastic	1.544	55.9	3.85
2		-16.057	ASP	0.017				
3	Ape. Stop	Plano		0.044				
4	Lens 2	-30.373	ASP	0.755	Plastic	1.544	55.9	0.87
5		-0.468	ASP	0.121				
6	Lens 3	-0.246	ASP	0.240	Plastic	1.639	23.5	-0.90
7		-0.594	ASP	0.030				
8	Lens 4	0.639	ASP	0.522	Plastic	1.530	55.8	1.47
9		2.521	ASP	0.400				
10	IR-cut filter	Plano		0.175	Glass	1.517	64.2	-
11		Plano		0.073				
12	Image	Plano		-				
Note: Reference wavelength is 587.6 nm (d-line).								

5

TABLE 12				
Aspheric Coefficients				
Surface #	1	2	4	5
k =	1.7241E+00	-8.9754E+01	-9.0000E+01	-7.5923E-01
A4 =	2.1410E-01	1.4516E+00	1.5168E-01	-5.4982E-01
A6 =	-2.3810E-01	-1.0826E+01	4.8929E+00	2.0791E+00
A8 =	2.3555E+01	1.9495E+02	-3.2116E+01	8.2787E-01
A10 =	-2.5034E+02	-5.1780E+02	-2.6801E+03	-1.4893E+02
A12 =	1.4357E+03	-5.7593E+04	4.6579E+04	1.0534E+03
A14 =	-4.2381E+03	9.2351E+05	-3.3256E+05	-3.0936E+03
A16 =	4.9589E+03	-4.2045E+06	9.0327E+05	3.3098E+03
Surface #	6	7	8	9
k =	-9.9704E-01	-3.7851E+00	-7.3474E-01	-2.0751E+00
A4 =	2.9255E+00	-1.3600E+00	-1.2133E+00	1.8260E+00
A6 =	-2.4852E+00	5.5927E+00	3.0817E+00	-5.9653E+00
A8 =	-5.7718E+01	-1.8755E+01	-1.0034E+01	9.6816E+00

A10 =	6.7135E+02	7.3016E+01	1.9498E+01	-9.2466E+00
A12 =	-3.0733E+03	-1.6937E+02	-2.1549E+01	5.1894E+00
A14 =	6.6780E+03	1.9522E+02	1.2590E+01	-1.5760E+00
A16 =	-5.6393E+03	-8.6932E+01	-3.0510E+00	1.9769E-01

In the 6th embodiment, the equation of the aspheric surface profiles of the aforementioned lens elements is the same as the equation of the 1st embodiment. Also, the definitions of these parameters shown in the following table are the same as those stated in the 1st embodiment with corresponding values for the 6th embodiment, so an explanation in this regard will not be provided again.

Moreover, these parameters can be calculated from Table 11 and Table 12 as the following values and satisfy the following conditions:

6th Embodiment			
f [mm]	1.27	f2/f3	-0.97
Fno	2.10	f/f4	0.86
HFOV [deg.]	44.4	f/f3	-1.41
V1	55.9	Td [mm]	2.009
CT2/(CT1+CT3+CT4)	0.72	Σ CT/Td	0.89
(R3+R4)/(R3-R4)	1.03	Td/tan(HFOV) [mm]	2.05
f/f1	0.33	FOV [deg.]	88.8

10

7th Embodiment

Fig. 7A is a schematic view of an imaging device according to the 7th embodiment of the present disclosure. Fig. 7B shows, in order from left to right, spherical aberration curves, astigmatic field curves and a distortion curve of the imaging device according to the 7th embodiment.

15

In Fig. 7A, the imaging device includes the image capturing lens system (not otherwise herein labeled) of the present disclosure and an image sensor

770. The image capturing lens system includes, in order from an object side to an image side, an aperture stop 700, a first lens element 710, a second lens element 720, a third lens element 730, a fourth lens element 740, an IR-cut filter 750 and an image plane 760, wherein the image capturing lens system has a
5 total of four lens elements (710-740) with refractive power.

The first lens element 710 with positive refractive power has a convex object-side surface 711 in a paraxial region thereof and a concave image-side surface 712 in a paraxial region thereof, which are both aspheric, and the first lens element 710 is made of plastic material.

10 The second lens element 720 with positive refractive power has a concave object-side surface 721 in a paraxial region thereof and a convex image-side surface 722 in a paraxial region thereof, which are both aspheric, and the second lens element 720 is made of plastic material.

The third lens element 730 with negative refractive power has a concave
15 object-side surface 731 in a paraxial region thereof and a convex image-side surface 732 in a paraxial region thereof, which are both aspheric, and the third lens element 730 is made of plastic material.

The fourth lens element 740 with positive refractive power has a convex object-side surface 741 in a paraxial region thereof and a concave image-side
20 surface 742 in a paraxial region thereof, which are both aspheric, and the fourth lens element 740 is made of plastic material. Furthermore, the image-side surface 742 of the fourth lens element 740 has at least one convex shape in an off-axis region thereof.

The IR-cut filter 750 is made of glass and located between the fourth
25 lens element 740 and the image plane 760, and will not affect the focal length of

the image capturing lens system. The image sensor 770 is disposed on the image plane 760 of the image capturing lens 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								
Embodiment 7								
f = 1.57 mm, Fno = 2.05, HFOV = 48.5 deg.								
Surface #		Curvature Radius		Thickness	Material	Index	Abbe #	Focal Length
0	Object	Plano		Infinity				
1	Ape. Stop	Plano		-0.052				
2	Lens 1	1.142	ASP	0.279	Plastic	1.544	55.9	2.84
3		4.008	ASP	0.159				
4	Lens 2	-4.075	ASP	0.614	Plastic	1.544	55.9	1.24
5		-0.608	ASP	0.142				
6	Lens 3	-0.255	ASP	0.230	Plastic	1.634	23.8	-1.37
7		-0.487	ASP	0.030				
8	Lens 4	0.636	ASP	0.414	Plastic	1.535	55.7	2.35
9		0.998	ASP	0.500				
10	IR-cut filter	Plano		0.175	Glass	1.517	64.2	-
11		Plano		0.141				
12	Image	Plano		-				
Note: Reference wavelength is 587.6 nm (d-line).								

5

TABLE 14				
Aspheric Coefficients				
Surface #	2	3	4	5
k =	-5.4318E-01	6.9324E+01	6.0179E+01	-4.8138E-01
A4 =	1.1275E-01	-3.4138E-01	-6.6571E-01	-8.5384E-02
A6 =	-1.4350E+00	-2.7321E+00	4.9846E-01	-6.6518E-01
A8 =	6.0529E+00	2.0740E+01	-4.5807E+00	-2.1554E-01
A10 =	4.7148E+01	-7.0776E+01	-1.7027E+02	-7.9977E+00
A12 =	-1.4571E+02	-1.4998E+03	1.2130E+03	2.5638E+01
A14 =	-3.8164E+03	1.2389E+04	-4.4615E+03	-4.3167E+01
A16 =	1.5882E+04	-2.9058E+04	6.2425E+03	7.2938E+01
Surface #	6	7	8	9
k =	-1.1103E+00	-3.0258E+00	-9.3042E-01	-5.1455E+00
A4 =	5.4423E+00	4.5345E-01	-7.7223E-01	7.0200E-01
A6 =	-3.5666E+01	-4.9768E+00	9.4468E-01	-1.5850E+00
A8 =	1.3446E+02	1.9752E+01	-1.3669E+00	1.7028E+00

A10 =	-2.5131E+02	-4.2912E+01	1.1409E+00	-1.1082E+00
A12 =	-7.3665E+01	5.3544E+01	-5.2307E-01	4.3302E-01
A14 =	1.1117E+03	-3.5702E+01	1.2365E-01	-9.2838E-02
A16 =	-1.2600E+03	1.0063E+01	-1.1645E-02	8.3092E-03

In the 7th embodiment, the equation of the aspheric surface profiles of the aforementioned lens elements is the same as the equation of the 1st embodiment. Also, the definitions of these parameters shown in the following table are the same as those stated in the 1st embodiment with corresponding values for the 7th embodiment, so an explanation in this regard will not be provided again.

Moreover, these parameters can be calculated from Table 13 and Table 14 as the following values and satisfy the following conditions:

7th Embodiment			
f [mm]	1.57	f2/f3	-0.91
Fno	2.05	f/f4	0.67
HFOV [deg.]	48.5	f/f3	-1.15
V1	55.9	Td [mm]	1.868
CT2/(CT1+CT3+CT4)	0.67	ΣCT/Td	0.82
(R3+R4)/(R3-R4)	1.35	Td/tan(HFOV) [mm]	1.65
f/f1	0.55	FOV [deg.]	97.0

10

8th Embodiment

Fig. 8A is a schematic view of an imaging device according to the 8th embodiment of the present disclosure. Fig. 8B shows, in order from left to right, spherical aberration curves, astigmatic field curves and a distortion curve of the imaging device according to the 8th embodiment.

15

In Fig. 8A, the imaging device includes the image capturing lens system (not otherwise herein labeled) of the present disclosure and an image sensor

870. The image capturing lens system includes, in order from an object side to an image side, a first lens element 810, an aperture stop 800, a second lens element 820, a third lens element 830, a fourth lens element 840, an IR-cut filter 850 and an image plane 860, wherein the image capturing lens system has a total of four lens elements (810-840) with refractive power.

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

The second lens element 820 with positive refractive power has a concave object-side surface 821 in a paraxial region thereof and a convex image-side surface 822 in a paraxial region thereof, which are both aspheric, and the second lens element 820 is made of plastic material.

The third lens element 830 with negative refractive power has a concave object-side surface 831 in a paraxial region thereof and a convex image-side surface 832 in a paraxial region thereof, which are both aspheric, and the third lens element 830 is made of plastic material.

The fourth lens element 840 with positive refractive power has a convex object-side surface 841 in a paraxial region thereof and a concave image-side surface 842 in a paraxial region thereof, which are both aspheric, and the fourth lens element 840 is made of plastic material. Furthermore, the image-side surface 842 of the fourth lens element 840 has at least one convex shape in an off-axis region thereof.

The IR-cut filter 850 is made of glass and located between the fourth lens element 840 and the image plane 860, and will not affect the focal length of

the image capturing lens system. The image sensor 870 is disposed on the image plane 860 of the image capturing lens 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								
Embodiment 8								
f = 1.68 mm, Fno = 2.10, HFOV = 46.0 deg.								
Surface #		Curvature Radius		Thickness	Material	Index	Abbe #	Focal Length
0	Object	Plano		Infinity				
1	Lens 1	1.787	ASP	0.278	Plastic	1.544	55.9	3.81
2		12.133	ASP	0.022				
3	Ape. Stop	Plano		0.145				
4	Lens 2	-3.839	ASP	0.668	Plastic	1.544	55.9	1.38
5		-0.668	ASP	0.194				
6	Lens 3	-0.273	ASP	0.230	Plastic	1.639	23.5	-1.18
7		-0.569	ASP	0.030				
8	Lens 4	0.784	ASP	0.496	Plastic	1.530	55.8	1.65
9		5.992	ASP	0.400				
10	IR-cut filter	Plano		0.175	Glass	1.517	64.2	-
11		Plano		0.472				
12	Image	Plano		-				
Note: Reference wavelength is 587.6 nm (d-line).								

5

TABLE 16				
Aspheric Coefficients				
Surface #	1	2	4	5
k =	-1.3232E+00	5.3151E+01	5.1693E+01	-5.9308E-01
A4 =	1.6281E-02	-1.2122E-02	-2.5602E-01	-1.1508E-01
A6 =	1.5823E-01	-1.1940E+00	-1.0332E+00	-6.8787E-01
A8 =	5.9941E-01	1.2093E+01	1.0464E+01	-9.7964E-02
A10 =	-1.3812E+01	-2.0003E+01	-1.9940E+02	-6.2734E+00
A12 =	4.5317E+01	-1.4998E+03	1.2130E+03	2.8529E+01
A14 =	-4.4460E+01	1.2389E+04	-4.4615E+03	-4.4589E+01
A16 =	-4.7734E+01	-2.9058E+04	6.2425E+03	2.7908E+01
Surface #	6	7	8	9
k =	-1.0578E+00	-3.0032E+00	-8.6121E-01	5.6610E+00
A4 =	4.0391E+00	9.4553E-02	-6.6716E-01	7.7788E-01
A6 =	-2.6571E+01	-4.4170E+00	1.1395E+00	-1.2944E+00
A8 =	1.2417E+02	1.9085E+01	-1.7698E+00	1.0967E+00

A10 =	-3.9394E+02	-4.1568E+01	1.6239E+00	-5.7605E-01
A12 =	8.2748E+02	5.5376E+01	-8.6944E-01	1.8609E-01
A14 =	-9.7331E+02	-4.1902E+01	2.5418E-01	-3.3617E-02
A16 =	4.7213E+02	1.3653E+01	-3.1838E-02	2.5144E-03

In the 8th embodiment, the equation of the aspheric surface profiles of the aforementioned lens elements is the same as the equation of the 1st embodiment. Also, the definitions of these parameters shown in the following table are the same as those stated in the 1st embodiment with corresponding values for the 8th embodiment, so an explanation in this regard will not be provided again.

Moreover, these parameters can be calculated from Table 15 and Table 16 as the following values and satisfy the following conditions:

8th Embodiment			
f [mm]	1.68	f2/f3	-1.17
Fno	2.10	f/f4	1.02
HFOV [deg.]	46.0	f/f3	-1.42
V1	55.9	Td [mm]	2.063
CT2/(CT1+CT3+CT4)	0.67	Σ CT/Td	0.81
(R3+R4)/(R3-R4)	1.42	Td/tan(HFOV) [mm]	1.99
f/f1	0.44	FOV [deg.]	92.0

10

9th Embodiment

Fig. 9A is a schematic view of an imaging device according to the 9th embodiment of the present disclosure. Fig. 9B shows, in order from left to right, spherical aberration curves, astigmatic field curves and a distortion curve of the imaging device according to the 9th embodiment.

15

In Fig. 9A, the imaging device includes the image capturing lens system (not otherwise herein labeled) of the present disclosure and an image sensor

970. The image capturing lens system includes, in order from an object side to an image side, a first lens element 910, an aperture stop 900, a second lens element 920, a third lens element 930, a fourth lens element 940, an IR-cut filter 950 and an image plane 960, wherein the image capturing lens system has a total of four lens elements (910-940) with refractive power.

The first lens element 910 with positive refractive power has a convex object-side surface 911 in a paraxial region thereof and a convex image-side surface 912 in a paraxial region thereof, which are both aspheric, and the first lens element 910 is made of plastic material.

The second lens element 920 with positive refractive power has a convex object-side surface 921 in a paraxial region thereof and a convex image-side surface 922 in a paraxial region thereof, which are both aspheric, and the second lens element 920 is made of plastic material.

The third lens element 930 with negative refractive power has a concave object-side surface 931 in a paraxial region thereof and a convex image-side surface 932 in a paraxial region thereof, which are both aspheric, and the third lens element 930 is made of plastic material.

The fourth lens element 940 with positive refractive power has a convex object-side surface 941 in a paraxial region thereof and a concave image-side surface 942 in a paraxial region thereof, which are both aspheric, and the fourth lens element 940 is made of plastic material. Furthermore, the image-side surface 942 of the fourth lens element 940 has at least one convex shape in an off-axis region thereof.

The IR-cut filter 950 is made of glass and located between the fourth lens element 940 and the image plane 960, and will not affect the focal length of

the image capturing lens system. The image sensor 970 is disposed on the image plane 960 of the image capturing lens 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								
Embodiment 9								
f = 0.92 mm, Fno = 2.45, HFOV = 43.9 deg.								
Surface #		Curvature Radius		Thickness	Material	Index	Abbe #	Focal Length
0	Object	Plano		Infinity				
1	Lens 1	100.000	ASP	0.205	Plastic	1.633	23.4	13.12
2		-9.046	ASP	0.017				
3	Ape. Stop	Plano		0.024				
4	Lens 2	1.695	ASP	0.475	Plastic	1.544	55.9	0.54
5		-0.319	ASP	0.100				
6	Lens 3	-0.148	ASP	0.160	Plastic	1.634	23.8	-0.65
7		-0.329	ASP	0.030				
8	Lens 4	0.595	ASP	0.239	Plastic	1.530	55.8	1.28
9		4.109	ASP	0.300				
10	IR-cut filter	Plano		0.145	Glass	1.517	64.2	-
11		Plano		0.151				
12	Image	Plano		-				
Note: Reference wavelength is 587.6 nm (d-line).								

5

TABLE 18				
Aspheric Coefficients				
Surface #	1	2	4	5
k =	-9.0000E+01	9.0000E+01	3.3243E+01	-6.6437E-01
A4 =	2.5656E-01	2.4894E+00	-1.9077E+00	-1.5093E+00
A6 =	-1.0613E+00	-9.5530E+01	-1.3506E+01	4.3096E+00
A8 =	1.6769E+02	3.0126E+03	1.0928E+01	1.6065E+02
A10 =	-3.7307E+03	-2.3016E+04	-4.4021E+04	-2.9203E+03
A12 =	3.9786E+04	-1.5960E+06	1.2908E+06	2.9181E+04
A14 =	-2.1485E+05	4.6819E+07	-1.6860E+07	-1.5683E+05
A16 =	4.5990E+05	-3.8994E+08	8.3772E+07	3.0696E+05
Surface #	6	7	8	9
k =	-1.0921E+00	-2.4247E+00	-6.0015E-01	3.3921E+01
A4 =	8.8579E+00	-1.7457E+00	-1.8642E+00	3.4965E+00
A6 =	-9.7201E+00	2.7059E+01	4.2816E+00	-1.7965E+01
A8 =	-4.6210E+02	-1.6609E+02	-3.6842E+01	3.3243E+01

A10 =	1.0079E+04	1.0699E+03	9.4802E+01	-3.1178E+01
A12 =	-8.5169E+04	-4.7330E+03	-1.9140E+02	1.8452E+01
A14 =	3.3855E+05	1.0605E+04	3.6755E+02	-3.7397E+01
A16 =	-5.2300E+05	-7.7191E+03	-9.3365E+02	3.7762E+01

In the 9th embodiment, the equation of the aspheric surface profiles of the aforementioned lens elements is the same as the equation of the 1st embodiment. Also, the definitions of these parameters shown in the following
5 table are the same as those stated in the 1st embodiment with corresponding values for the 9th embodiment, so an explanation in this regard will not be provided again.

Moreover, these parameters can be calculated from Table 17 and Table 18 as the following values and satisfy the following conditions:

9th Embodiment			
f [mm]	0.92	f2/f3	-0.83
Fno	2.45	f/f4	0.72
HFOV [deg.]	43.9	f/f3	-1.42
V1	23.4	Td [mm]	1.250
CT2/(CT1+CT3+CT4)	0.79	Σ CT/Td	0.86
(R3+R4)/(R3-R4)	0.68	Td/tan(HFOV) [mm]	1.30
f/f1	0.07	FOV [deg.]	87.8

10

10th Embodiment

Fig. 10A is a schematic view of an imaging device according to the 10th embodiment of the present disclosure. Fig. 10B shows, in order from left to
15 right, spherical aberration curves, astigmatic field curves and a distortion curve of the imaging device according to the 10th embodiment.

In Fig. 10A, the imaging device includes the image capturing lens system (not otherwise herein labeled) of the present disclosure and an image sensor

1070. The image capturing lens system includes, in order from an object side to an image side, an aperture stop 1000, a first lens element 1010, a second lens element 1020, a third lens element 1030, a fourth lens element 1040, an IR-cut filter 1050 and an image plane 1060, wherein the image capturing lens
5 system has a total of four lens elements (1010-1040) with refractive power.

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

10 The second lens element 1020 with positive refractive power has a concave object-side surface 1021 in a paraxial region thereof and a convex image-side surface 1022 in a paraxial region thereof, which are both aspheric, and the second lens element 1020 is made of plastic material.

The third lens element 1030 with negative refractive power has a
15 concave object-side surface 1031 in a paraxial region thereof and a convex image-side surface 1032 in a paraxial region thereof, which are both aspheric, and the third lens element 1030 is made of plastic material.

The fourth lens element 1040 with positive refractive power has a convex object-side surface 1041 in a paraxial region thereof and a concave image-side
20 surface 1042 in a paraxial region thereof, which are both aspheric, and the fourth lens element 1040 is made of plastic material. Furthermore, the image-side surface 1042 of the fourth lens element 1040 has at least one convex shape in an off-axis region thereof.

The IR-cut filter 1050 is made of glass and located between the fourth
25 lens element 1040 and the image plane 1060, and will not affect the focal length

of the image capturing lens system. The image sensor 1070 is disposed on the image plane 1060 of the image capturing lens 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								
Embodiment 10								
f = 1.80 mm, Fno = 2.12, HFOV = 47.2 deg.								
Surface #		Curvature Radius		Thickness	Material	Index	Abbe #	Focal Length
0	Object	Plano		Infinity				
1	Ape. Stop	Plano		-0.060				
2	Lens 1	1.246	ASP	0.289	Plastic	1.544	55.9	2.97
3		5.018	ASP	0.191				
4	Lens 2	-3.749	ASP	0.593	Plastic	1.544	55.9	1.57
5		-0.733	ASP	0.156				
6	Lens 3	-0.288	ASP	0.248	Plastic	1.634	23.8	-1.33
7		-0.584	ASP	0.030				
8	Lens 4	0.704	ASP	0.601	Plastic	1.535	55.7	2.05
9		1.382	ASP	0.500				
10	IR-cut filter	Plano		0.210	Glass	1.517	64.2	-
11		Plano		0.198				
12	Image	Plano		-				
Note: Reference wavelength is 587.6 nm (d-line).								
The effective radius of Surface 9 is 1.676 mm.								

5

TABLE 20				
Aspheric Coefficients				
Surface #	2	3	4	5
k =	-5.0585E-01	9.0000E+01	3.6143E+01	-3.9805E-01
A4 =	8.6099E-02	-2.2970E-01	-4.8540E-01	-1.5034E-01
A6 =	-9.1382E-01	-1.8900E+00	2.7508E-01	-5.1276E-01
A8 =	1.9706E+00	1.1233E+01	-2.0152E+00	-1.5742E-01
A10 =	1.9492E+01	-3.0654E+01	-6.3534E+01	-3.0117E+00
A12 =	-3.5519E+01	-4.4967E+02	3.6120E+02	7.3424E+00
A14 =	-8.0910E+02	2.9681E+03	-1.0702E+03	-1.0241E+01
A16 =	2.4600E+03	-5.5960E+03	1.2022E+03	1.7746E+01
Surface #	6	7	8	9
k =	-1.1070E+00	-2.9894E+00	-9.3316E-01	-5.2865E+00
A3 =			-1.4739E-01	5.0831E-01
A4 =	4.3809E+00	4.3352E-01	-3.5412E+00	2.6512E+00

A5 =			2.4672E-02	1.3099E-01
A6 =	-2.6437E+01	-3.7903E+00	1.0303E+01	-3.1255E+01
A7 =			3.7082E-02	2.0652E-01
A8 =	9.1296E+01	1.0965E+01	-3.1616E+01	1.1148E+02
A9 =			-2.2687E-03	-9.0797E-01
A10 =	-1.5853E+02	-1.4675E+01	6.3626E+01	-2.2327E+02
A11 =			-2.3794E-03	3.6058E-01
A12 =	8.3141E+00	7.7310E+00	-7.5604E+01	2.6201E+02
A13 =			8.0966E-03	1.7201E-01
A14 =	3.8963E+02	1.2159E+00	4.7652E+01	-1.7041E+02
A15 =			-5.5857E-02	1.0396E-01
A16 =	-3.9976E+02	-1.8447E+00	-1.2153E+01	4.7523E+01

In the 10th embodiment, the equation of the aspheric surface profiles of the aforementioned lens elements is the same as the equation of the 1st embodiment. Also, the definitions of these parameters shown in the following table are the same as those stated in the 1st embodiment with corresponding values for the 10th embodiment, so an explanation in this regard will not be provided again.

Moreover, these parameters can be calculated from Table 19 and Table 20 as the following values and satisfy the following conditions:

10th Embodiment			
f [mm]	1.80	f2/f3	-1.18
Fno	2.12	f/f4	0.88
HFOV [deg.]	47.2	f/f3	-1.35
V1	55.9	Td [mm]	2.108
CT2/(CT1+CT3+CT4)	0.52	Σ CT/Td	0.82
(R3+R4)/(R3-R4)	1.49	Td/tan(HFOV) [mm]	1.95
f/f1	0.61	FOV [deg.]	94.4

10

The foregoing description, for purpose of explanation, has been described with reference to specific embodiments. It is to be noted that

TABLES 1-20 show different data of the different embodiments; however, the data of the different embodiments are obtained from experiments. The embodiments were chosen and described in order to best explain the principles of the disclosure and its practical applications, to thereby enable others skilled
5 in the art to best utilize the disclosure and various embodiments with various modifications as are suited to the particular use contemplated. The embodiments depicted above and the appended drawings are exemplary and are not intended to be exhaustive or to limit the scope of the present disclosure to the precise forms disclosed. Many modifications and variations are possible
10 in view of the above teachings.

CLAIMS

WHAT IS CLAIMED IS:

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

a first lens element having refractive power;

a second lens element with positive refractive power having a convex image-side surface in a paraxial region thereof;

a third lens element with negative refractive power having a concave object-side surface in a paraxial region thereof and a convex image-side surface in a paraxial region thereof; and

a fourth lens element with refractive power having a concave image-side surface in a paraxial region thereof, wherein both of an object-side surface and the image-side surface of the fourth lens element are aspheric, and the image-side surface of the fourth lens element has at least one convex shape in an off-axis region thereof;

wherein the image capturing lens system has a total of four lens elements with refractive power, an axial distance between an object-side surface of the first lens element and the image-side surface of the fourth lens element is T_d , half of a maximal field of view of the image capturing lens system is HFOV, a focal length of the image capturing lens system is f , a focal length of the fourth lens element is f_4 , a focal length of the second lens element is f_2 , a focal length of the third lens element is f_3 , and the following conditions are satisfied:

$0.5 \text{ mm} < T_d < 3.2 \text{ mm}$;

$1.0 \text{ mm} < T_d/\tan(\text{HFOV}) < 3.75 \text{ mm}$;

$$|f/f_4| < 1.20; \text{ and}$$

$$f_2/f_3 < -0.65.$$

2. The image capturing lens system of claim 1, wherein the fourth lens element has the object-side surface being convex in a paraxial region thereof.

3. The image capturing lens system of claim 2, wherein the focal length of the image capturing lens system is f , a focal length of the first lens element is f_1 , and the following condition is satisfied:

$$-0.25 < f/f_1 < 0.75.$$

4. The image capturing lens system of claim 2, wherein the axial distance between the object-side surface of the first lens element and the image-side surface of the fourth lens element is T_d , and the following condition is satisfied:

$$0.8 \text{ mm} < T_d < 2.5 \text{ mm}.$$

5. The image capturing lens system of claim 2, wherein an f-number of the image capturing lens system is F_{no} , and the following condition is satisfied:

$$1.40 < F_{no} \leq 2.25.$$

6. The image capturing lens system of claim 2, wherein a curvature radius of the object-side surface of the second lens element is R_3 , a curvature radius of the image-side surface of the second lens element is R_4 , and the following condition is satisfied:

$$0.5 < (R3+R4)/(R3-R4) < 2.5.$$

7. The image capturing lens system of claim 2, wherein the focal length of the image capturing lens system is f , and the following condition is satisfied:

$$0.5 \text{ mm} < f < 2.0 \text{ mm}.$$

8. The image capturing lens system of claim 1, wherein the first lens element has a convex object-side surface in a paraxial region thereof.

9. The image capturing lens system of claim 8, wherein the axial distance between the object-side surface of the first lens element and the image-side surface of the fourth lens element is T_d , half of the maximal field of view of the image capturing lens system is $HFOV$, and the following condition is satisfied:

$$1.2 \text{ mm} < T_d/\tan(HFOV) < 2.75 \text{ mm}.$$

10. The image capturing lens system of claim 8, wherein a sum of the central thicknesses of the first lens element, the second lens element, the third lens element, and the fourth lens element is ΣCT , the axial distance between the object-side surface of the first lens element and the image-side surface of the fourth lens element is T_d , and the following condition is satisfied:

$$0.80 < \Sigma CT/T_d < 0.95.$$

11. The image capturing lens system of claim 8, wherein an Abbe number of the first lens element is V_1 , and the following condition is satisfied:

$$45 < V1.$$

12. The image capturing lens system of claim 8, wherein a central thickness of the second lens element is CT2, a central thickness of the first lens element is CT1, a central thickness of the third lens element is CT3, a central thickness of the fourth lens element is CT4, and the following condition is satisfied:

$$0.65 < CT2/(CT1+CT3+CT4) < 2.0.$$

13. An imaging device, comprising:
the image capturing lens system of claim 1; and
an image sensor.

14. A mobile terminal, comprising:
the imaging device of claim 13.

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

a first lens element having refractive power;

a second lens element with positive refractive power having a convex image-side surface in a paraxial region thereof;

a third lens element with negative refractive power having a concave object-side surface in a paraxial region thereof and a convex image-side surface in a paraxial region thereof; and

a fourth lens element with refractive power having a concave image-side surface in a paraxial region thereof, wherein both of an object-side surface and the image-side surface of the fourth lens element are aspheric, and the image-side surface of the fourth lens element has at least one convex shape in an off-axis region thereof;

wherein the image capturing lens system has a total of four lens elements with refractive power, an axial distance between an object-side surface of the first lens element and the image-side surface of the fourth lens element is T_d , half of a maximal field of view of the image capturing lens system is HFOV, a focal length of the image capturing lens system is f , a focal length of the fourth lens element is f_4 , a focal length of the third lens element is f_3 , and the following conditions are satisfied:

$$0.5 \text{ mm} < T_d < 3.2 \text{ mm};$$

$$1.0 \text{ mm} < T_d/\tan(\text{HFOV}) < 3.75 \text{ mm};$$

$$|f/f_4| < 1.20; \text{ and}$$

$$-2.0 < f/f_3 < -0.95.$$

16. The image capturing lens system of claim 15, wherein an Abbe number of the first lens element is V_1 , and the following condition is satisfied:

$$45 < V_1.$$

17. The image capturing lens system of claim 15, wherein the focal length of the image capturing lens system is f , a focal length of the first lens element is f_1 , and the following condition is satisfied:

$$-0.25 < f/f_1 < 0.75.$$

18. The image capturing lens system of claim 15, wherein a maximal field of view of the image capturing lens system is FOV, and the following condition is satisfied:

$$80 \text{ degrees} < \text{FOV} < 110 \text{ degrees.}$$

19. The image capturing lens system of claim 15, wherein the axial distance between the object-side surface of the first lens element and the image-side surface of the fourth lens element is Td, and the following condition is satisfied:

$$0.8 \text{ mm} < Td < 2.5 \text{ mm.}$$

20. The image capturing lens system of claim 15, wherein a focal length of the second lens element is f2, the focal length of the third lens element is f3, and the following condition is satisfied:

$$f2/f3 < -0.75.$$

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

a first lens element having refractive power;

a second lens element with positive refractive power having a convex image-side surface in a paraxial region thereof;

a third lens element with negative refractive power having a concave object-side surface in a paraxial region thereof and a convex image-side surface in a paraxial region thereof; and

a fourth lens element with refractive power having a concave image-side surface in a paraxial region thereof, wherein both of an object-side surface and the image-side surface of the fourth lens element are aspheric, and the image-side surface of the fourth lens element has at least one convex shape in an off-axis region thereof;

wherein the image capturing lens system has a total of four lens elements with refractive power, an axial distance between the object-side surface of the first lens element and the image-side surface of the fourth lens element is T_d , half of a maximal field of view of the image capturing lens system is HFOV, a focal length of the image capturing lens system is f , a focal length of the fourth lens element is f_4 , an f-number of the image capturing lens system is F_{no} , and the following conditions are satisfied:

$$0.5 \text{ mm} < T_d < 3.2 \text{ mm};$$

$$1.0 \text{ mm} < T_d/\tan(\text{HFOV}) < 3.75 \text{ mm};$$

$$|f/f_4| < 1.20; \text{ and}$$

$$1.40 < F_{no} \leq 2.25.$$

22. The image capturing lens system of claim 21, wherein a focal length of the second lens element is f_2 , a focal length of the third lens element is f_3 , and the following condition is satisfied:

$$f_2/f_3 < -0.65.$$

23. The image capturing lens system of claim 21, wherein an Abbe number of the first lens element is V_1 , and the following condition is satisfied:

$$45 < V_1.$$

24. The image capturing lens system of claim 21, wherein the first lens element has positive refractive power, the focal length of the image capturing lens system is f , a focal length of the first lens element is f_1 , and the following condition is satisfied:

$$0.25 < f/f_1 < 0.75.$$

25. The image capturing lens system of claim 21, wherein a maximal field of view of the image capturing lens system is FOV, and the following condition is satisfied:

$$80 \text{ degrees} < \text{FOV} < 110 \text{ degrees}.$$

26. The image capturing lens system of claim 21, wherein a central thickness of the second lens element is CT_2 , a central thickness of the first lens element is CT_1 , a central thickness of the third lens element is CT_3 , a central thickness of the fourth lens element is CT_4 , and the following condition is satisfied:

$$0.65 < CT_2/(CT_1+CT_3+CT_4) < 2.0.$$

ABSTRACT OF THE DISCLOSURE

An image capturing lens system includes, in order from an object side to an image side, a first lens element, a second lens element, a third lens element and a fourth lens element. The first lens element has refractive power. The
5 second lens element with positive refractive power has a convex image-side surface in a paraxial region thereof. The third lens element with negative refractive power has a concave object-side surface in a paraxial region thereof and a convex image-side surface in a paraxial region thereof. The fourth lens
10 element with refractive power has a concave image-side surface in a paraxial region thereof, wherein both of an object-side surface and the image-side surface thereof are aspheric, and the image-side surface thereof has at least one convex shape in an off-axis region thereof. The image capturing lens system has a total of four lens elements with refractive power.

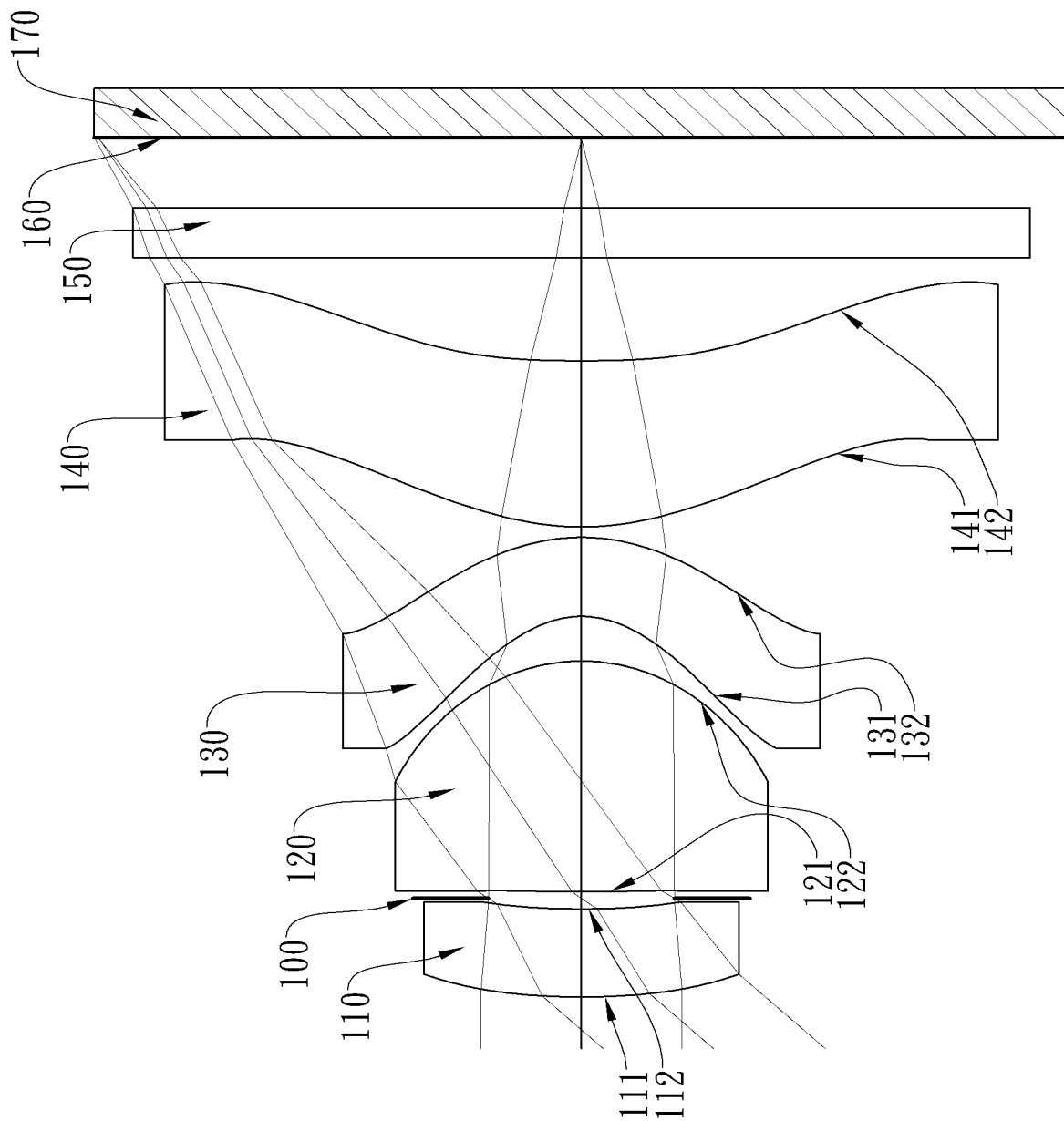


Fig. 1A

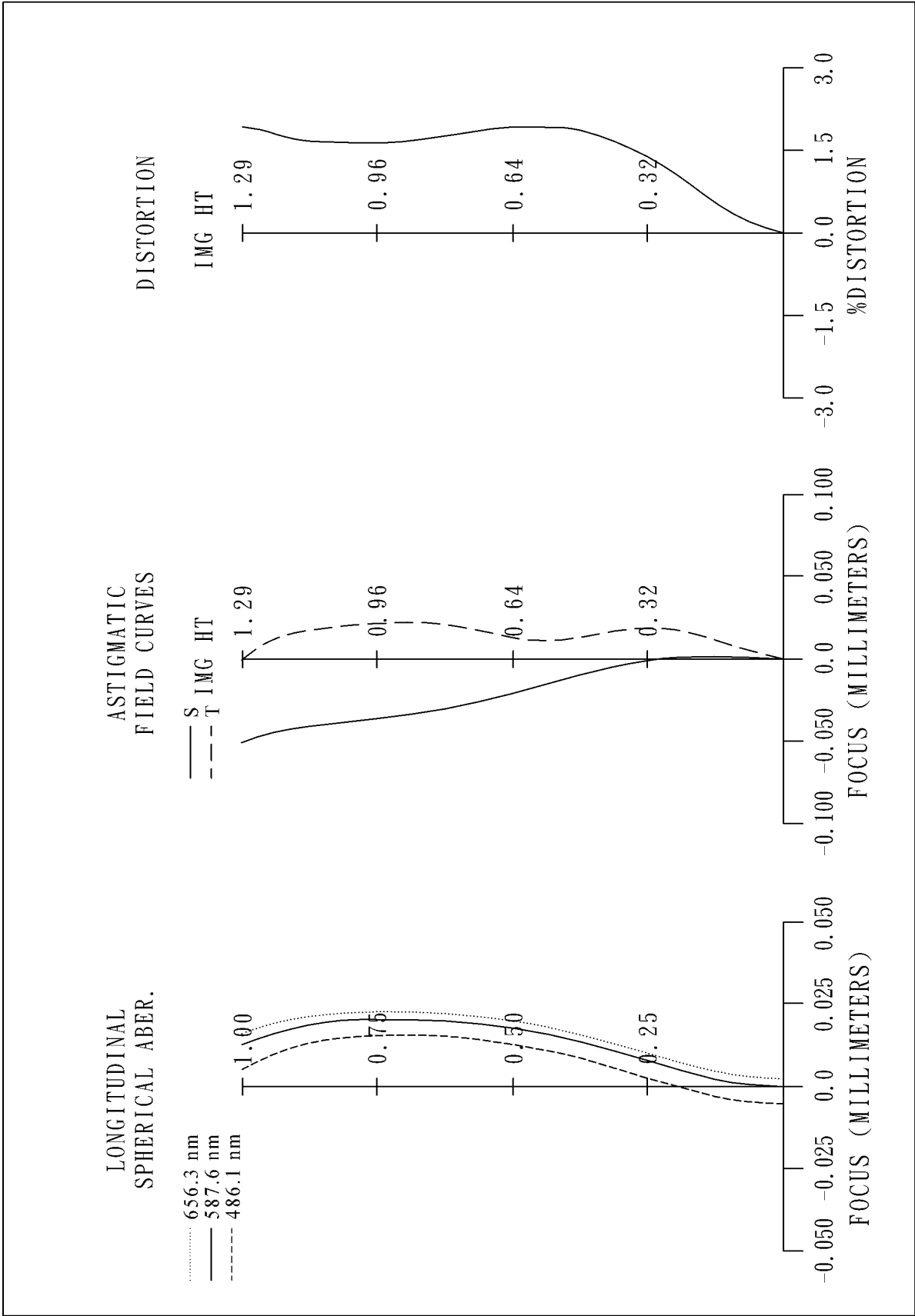


Fig. 1B

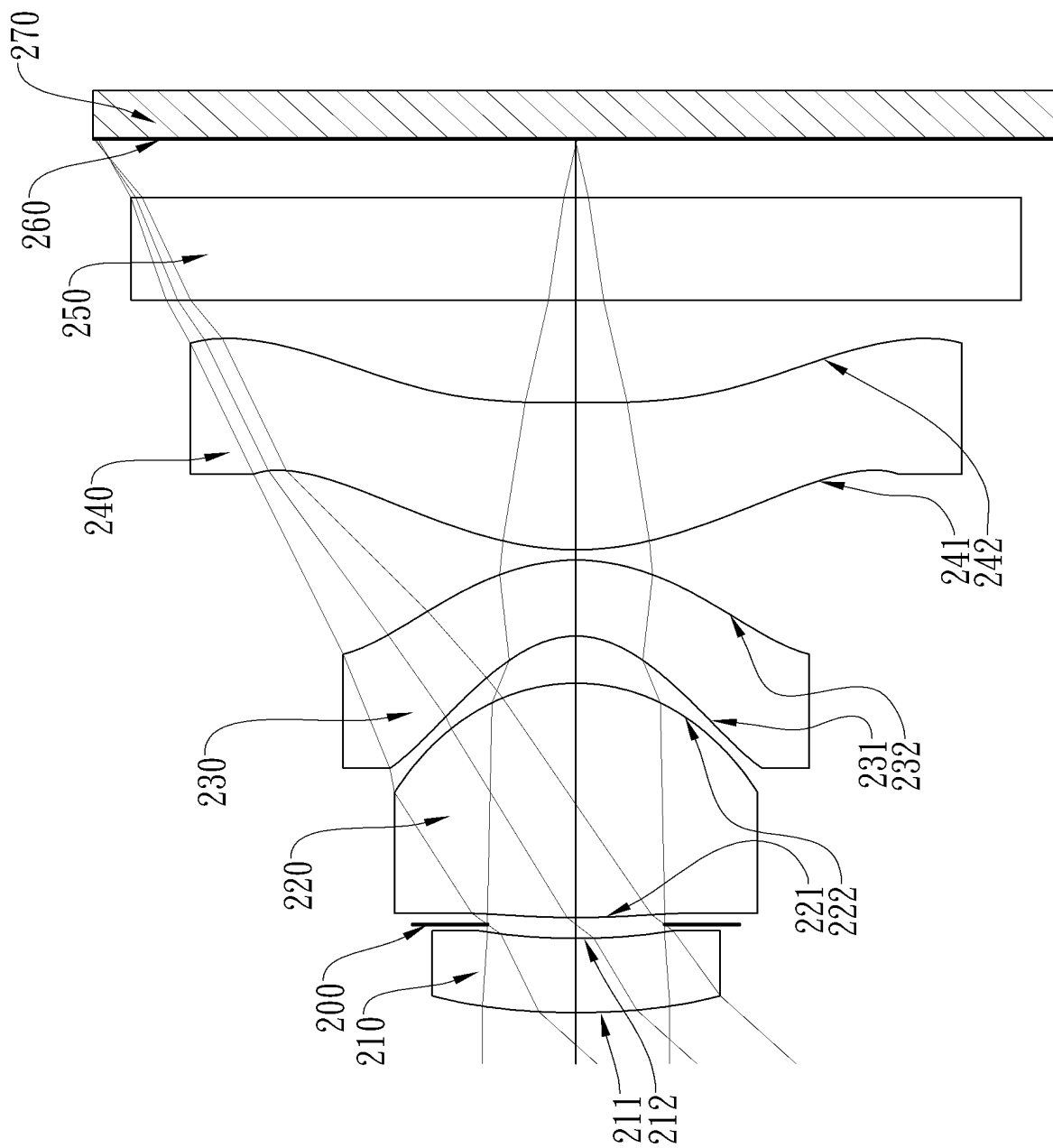


Fig. 2A

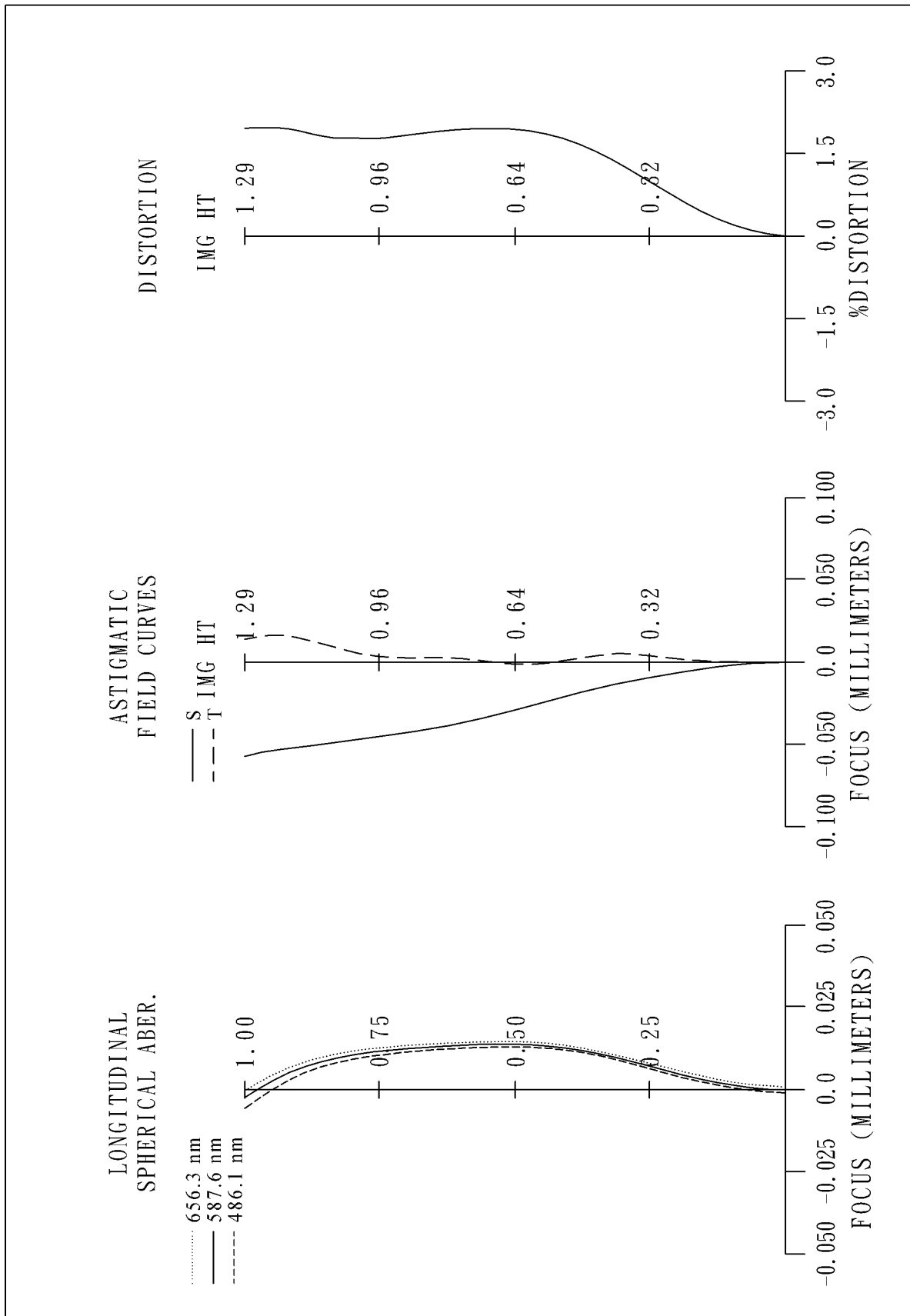


Fig. 2B

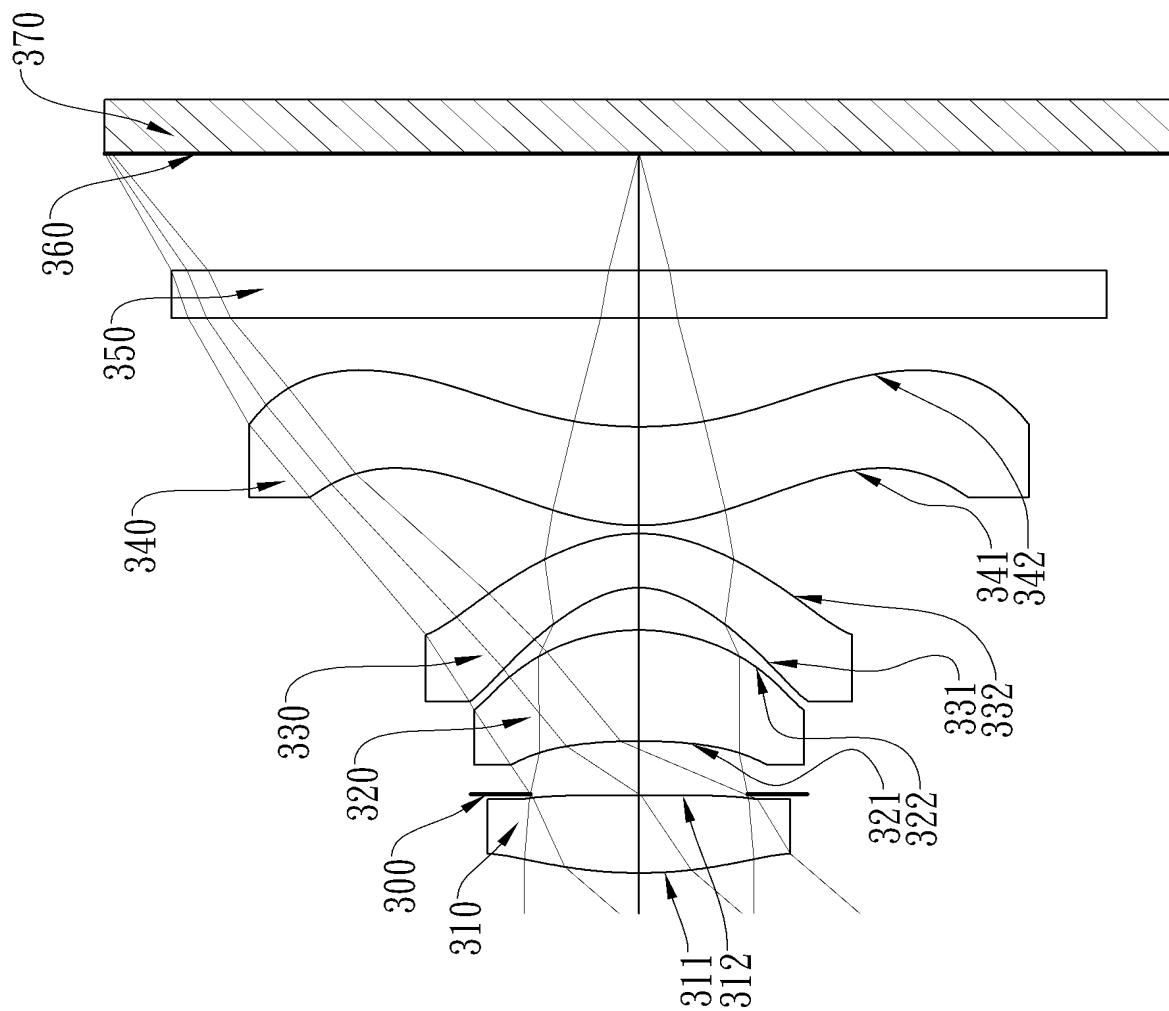


Fig. 3A

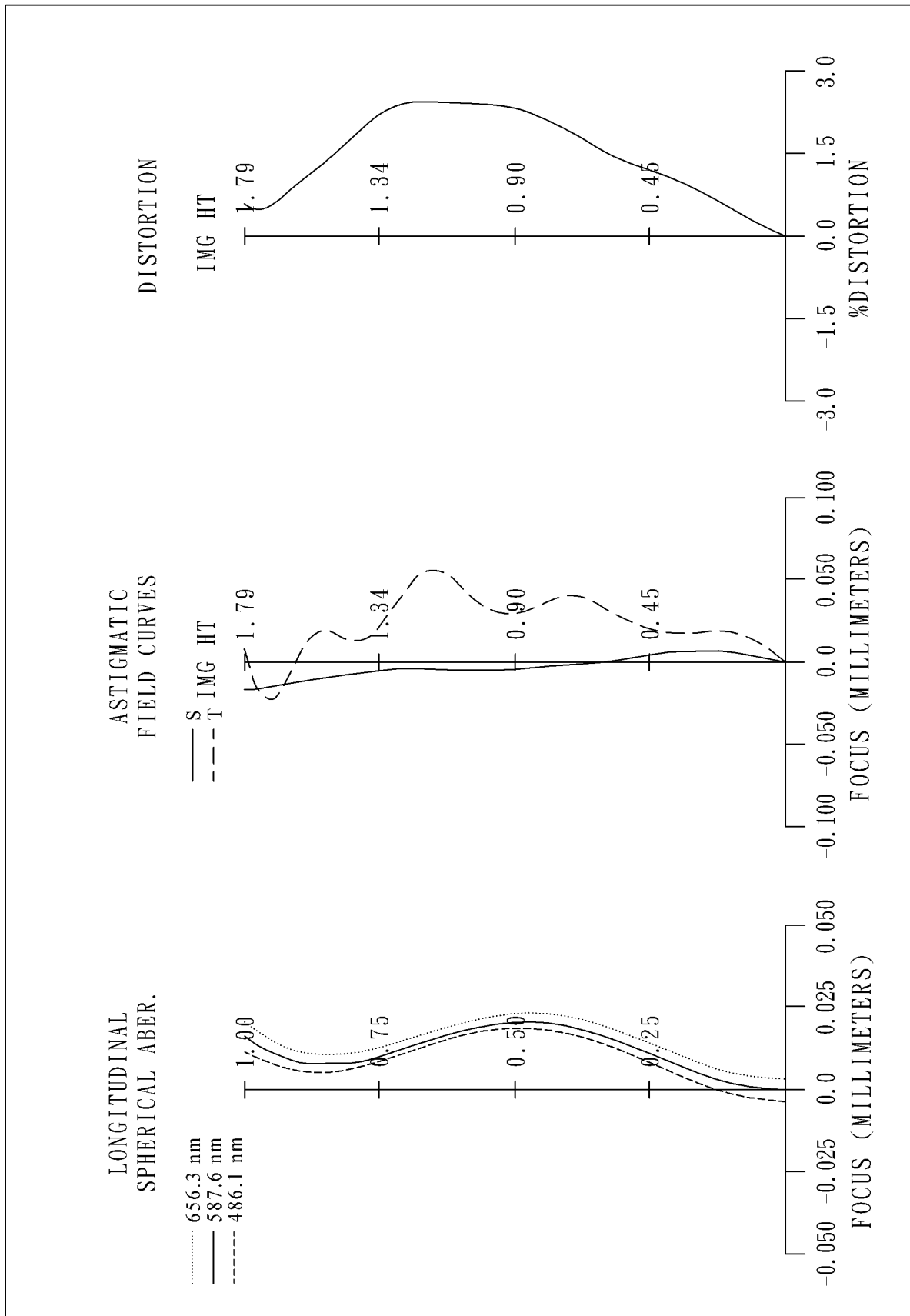


Fig. 3B

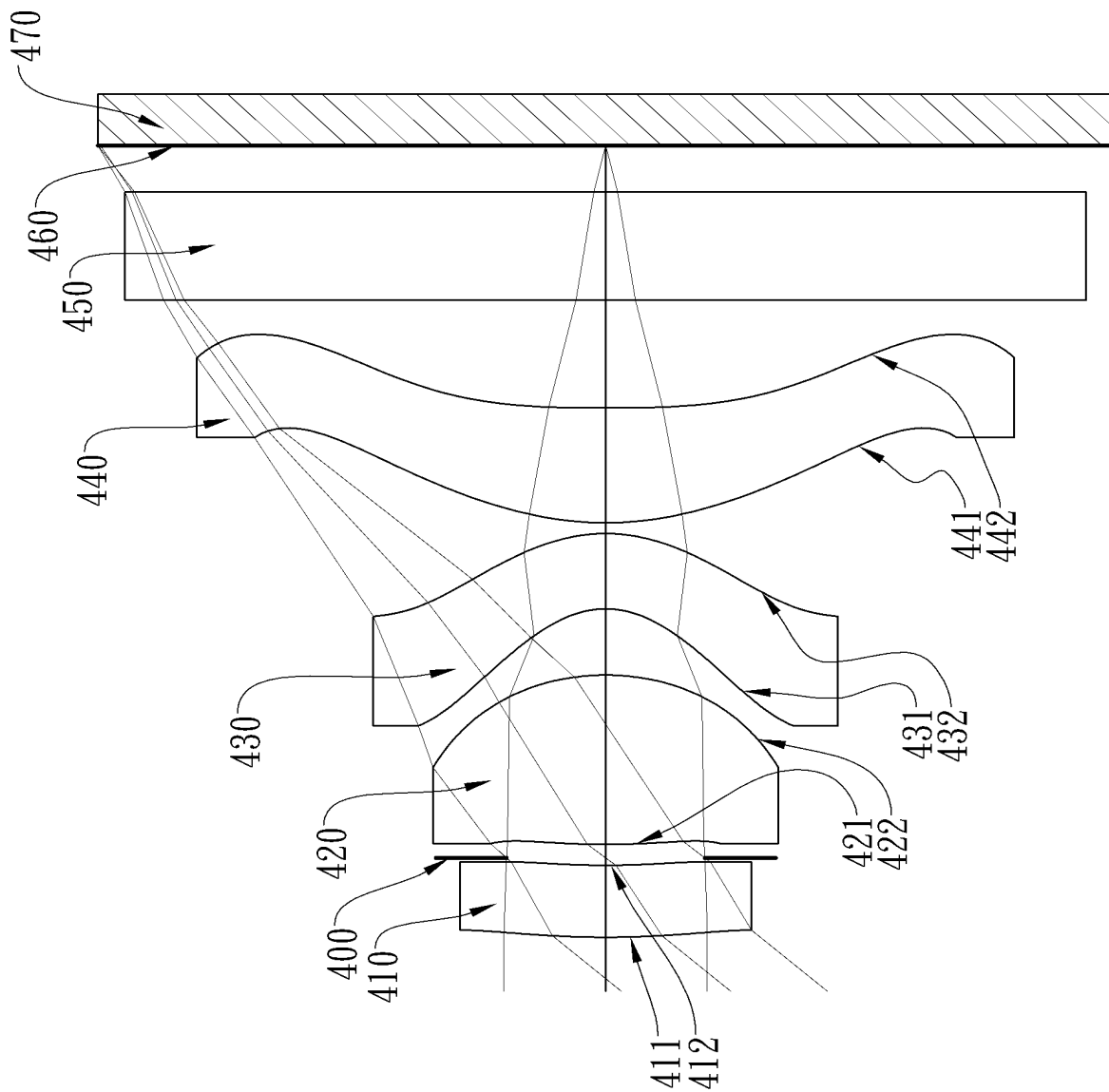


Fig. 4A

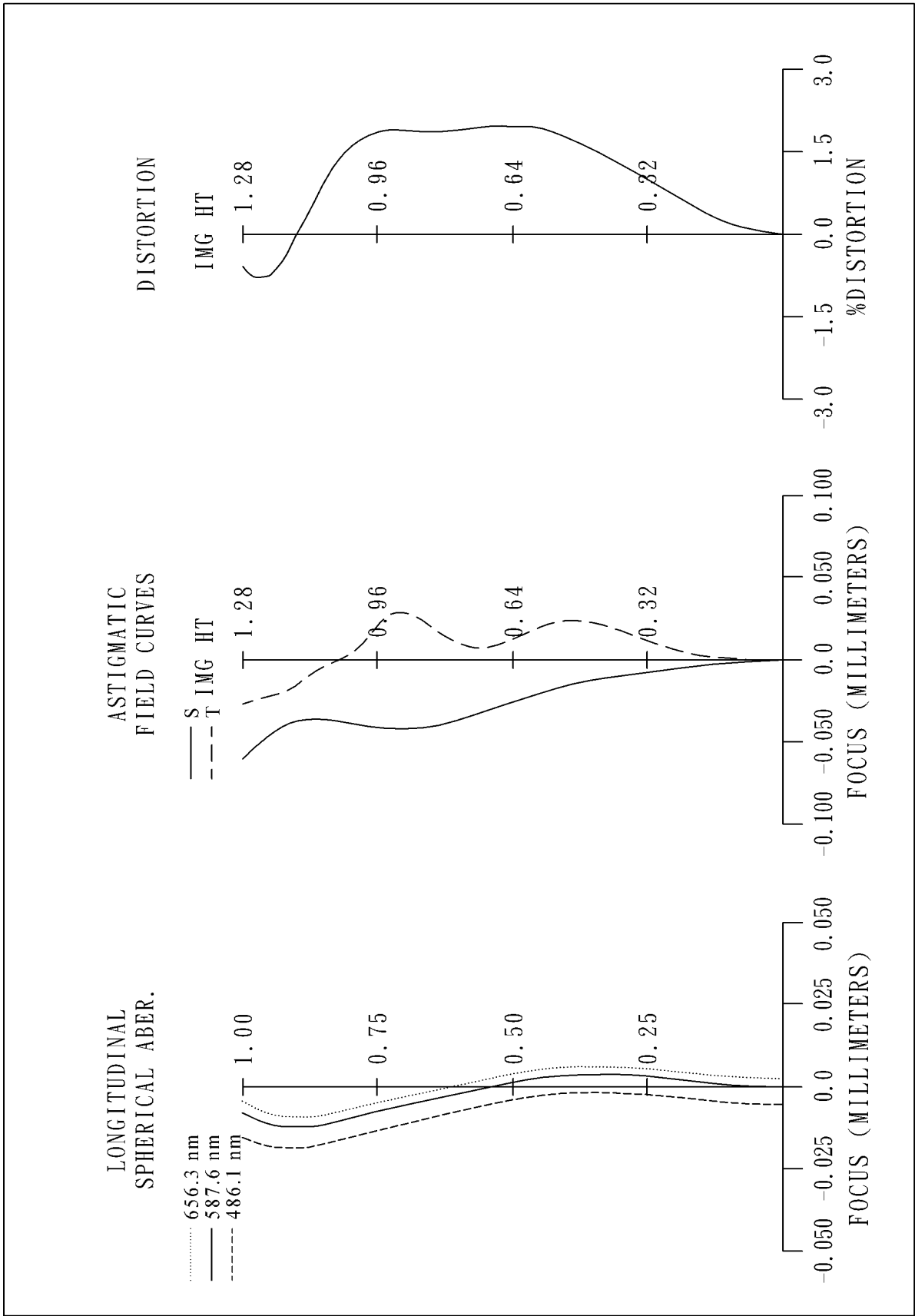


Fig. 4B

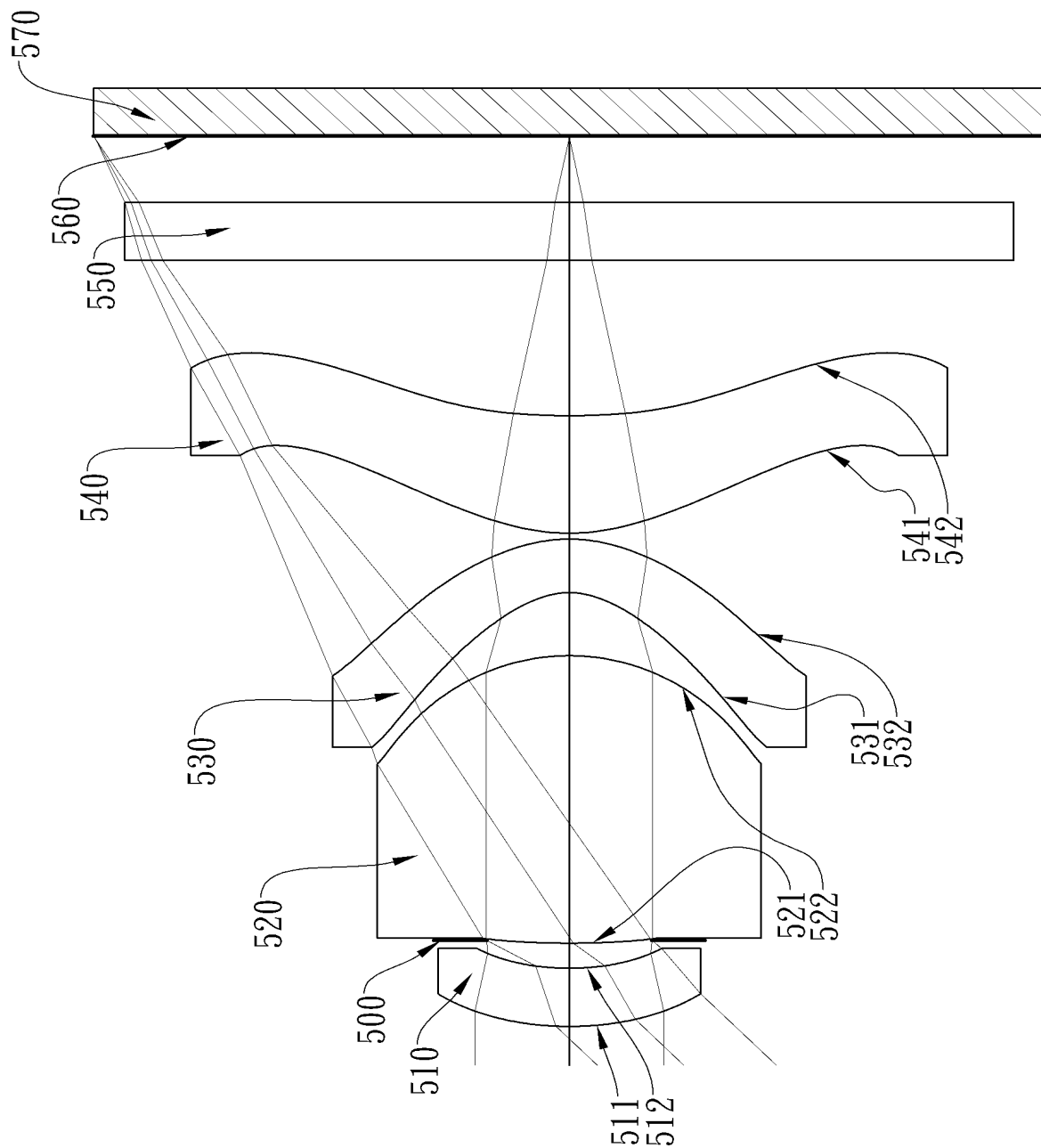


Fig. 5A

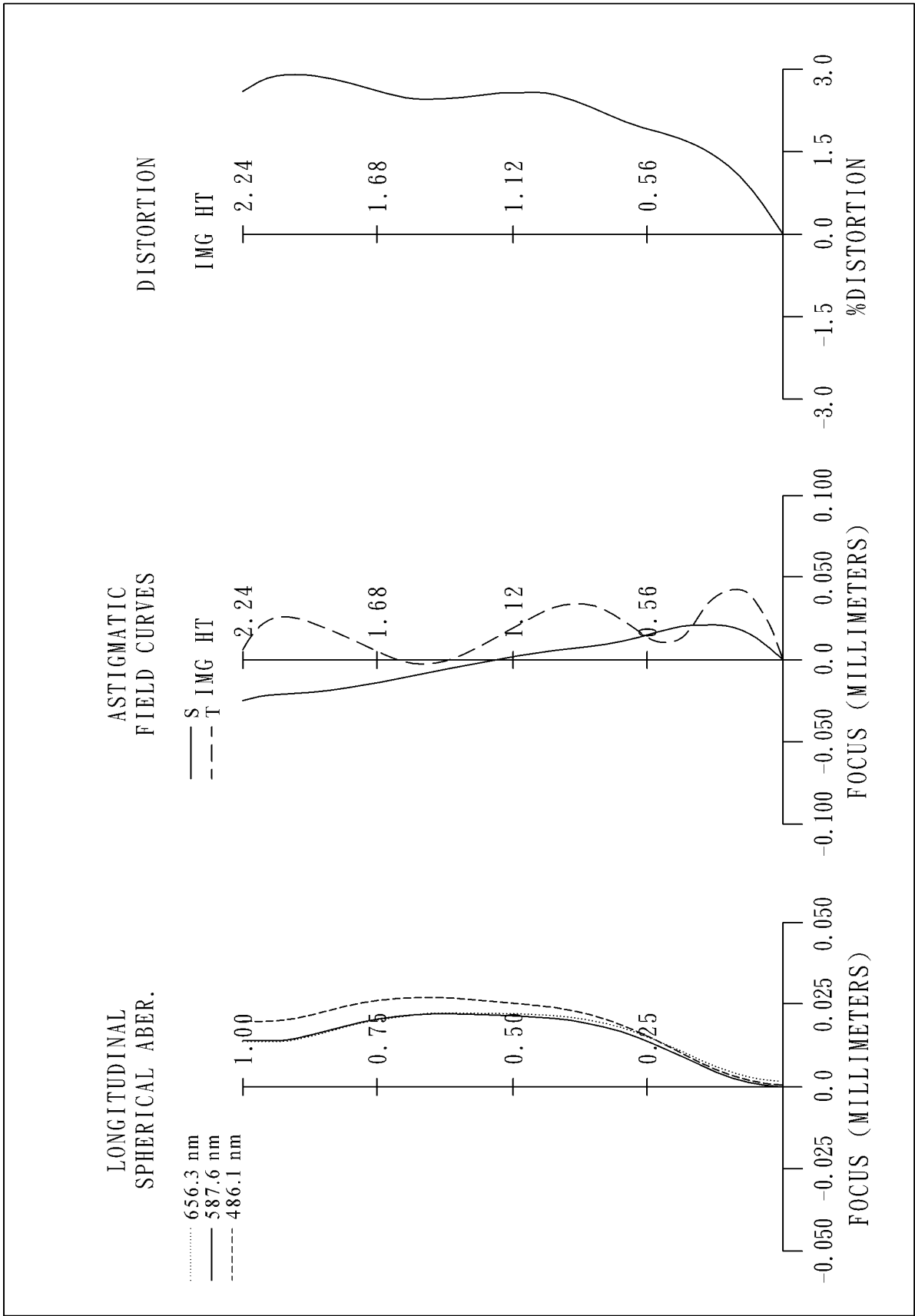


Fig. 5B

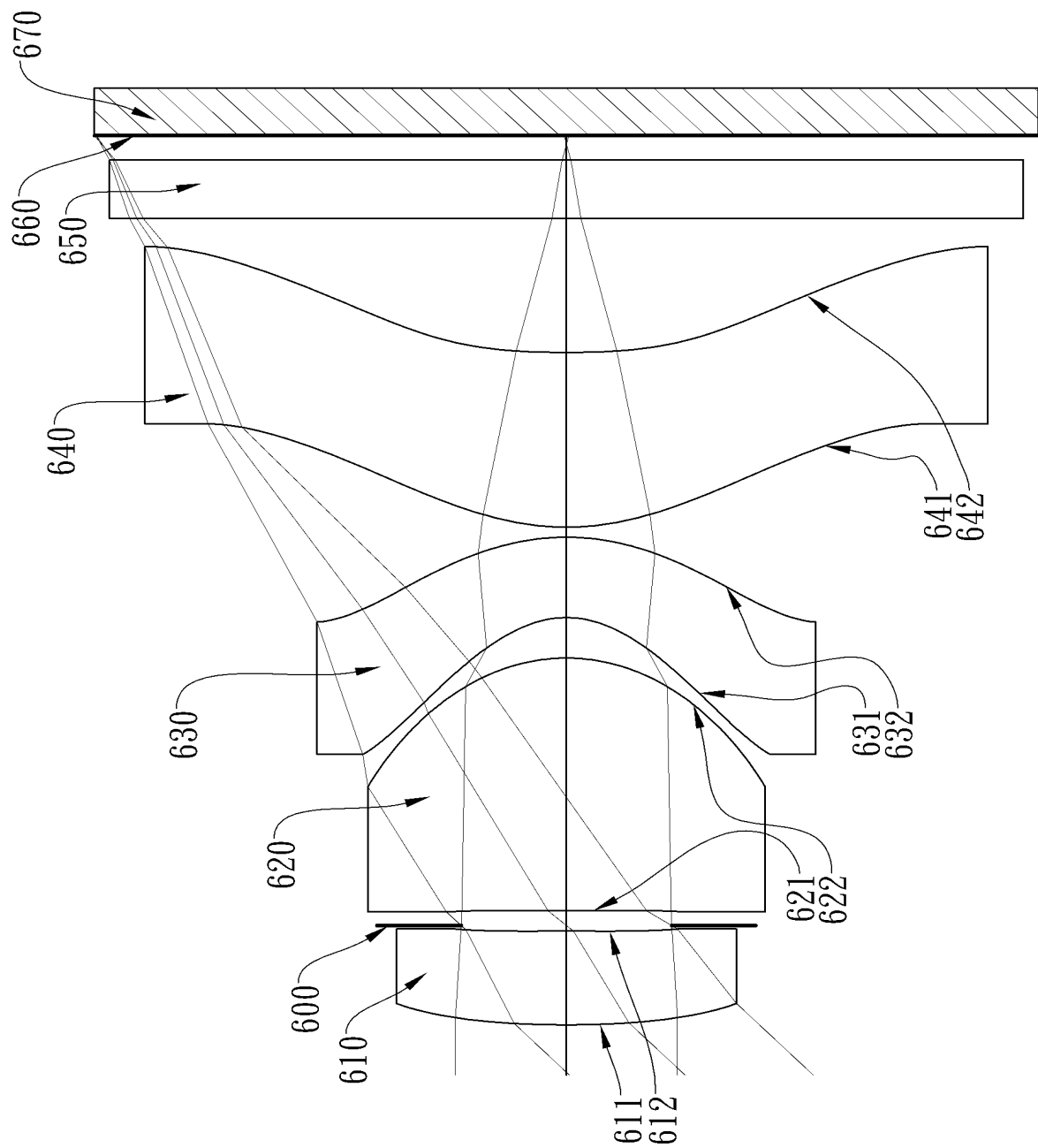


Fig. 6A

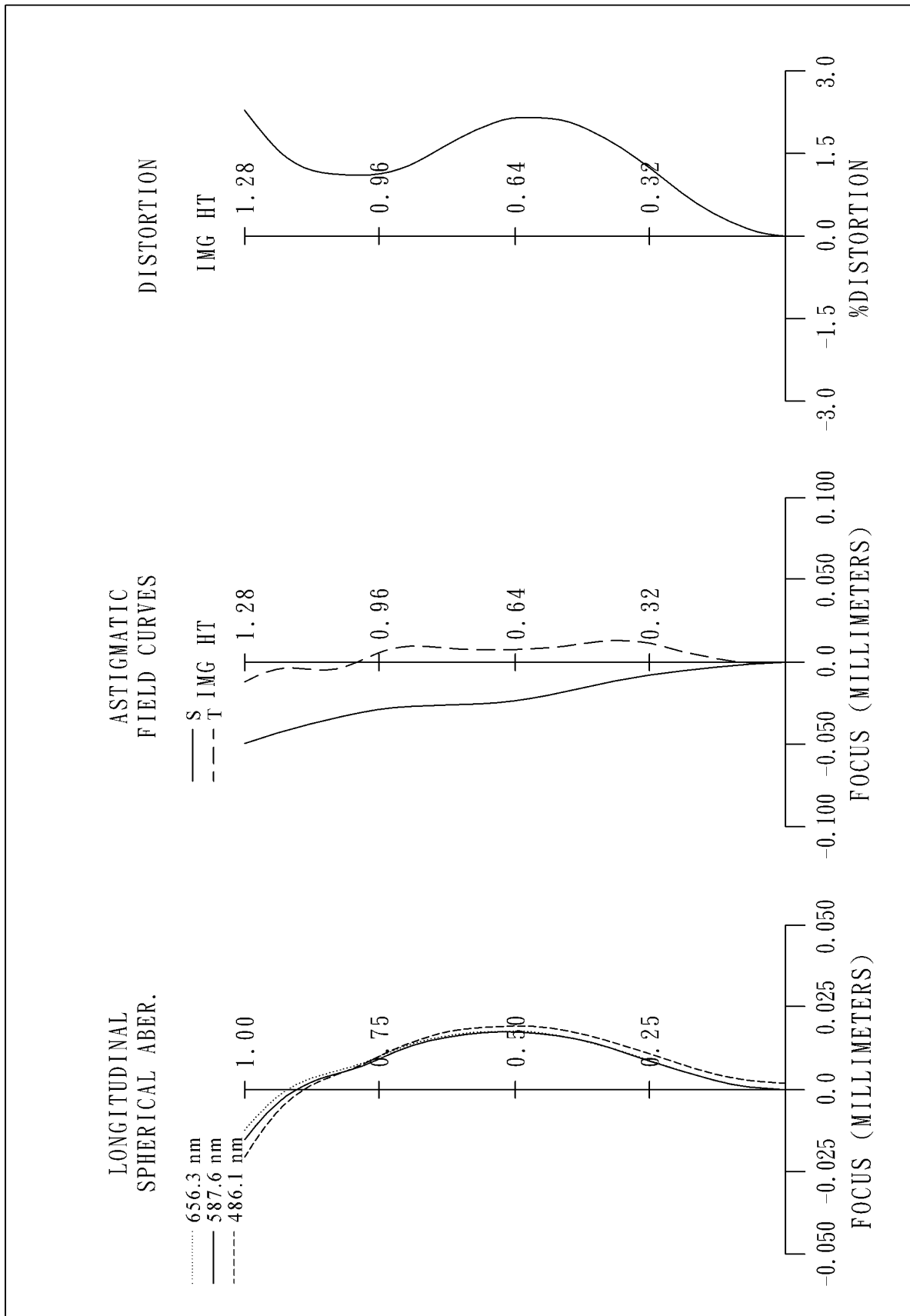


Fig. 6B

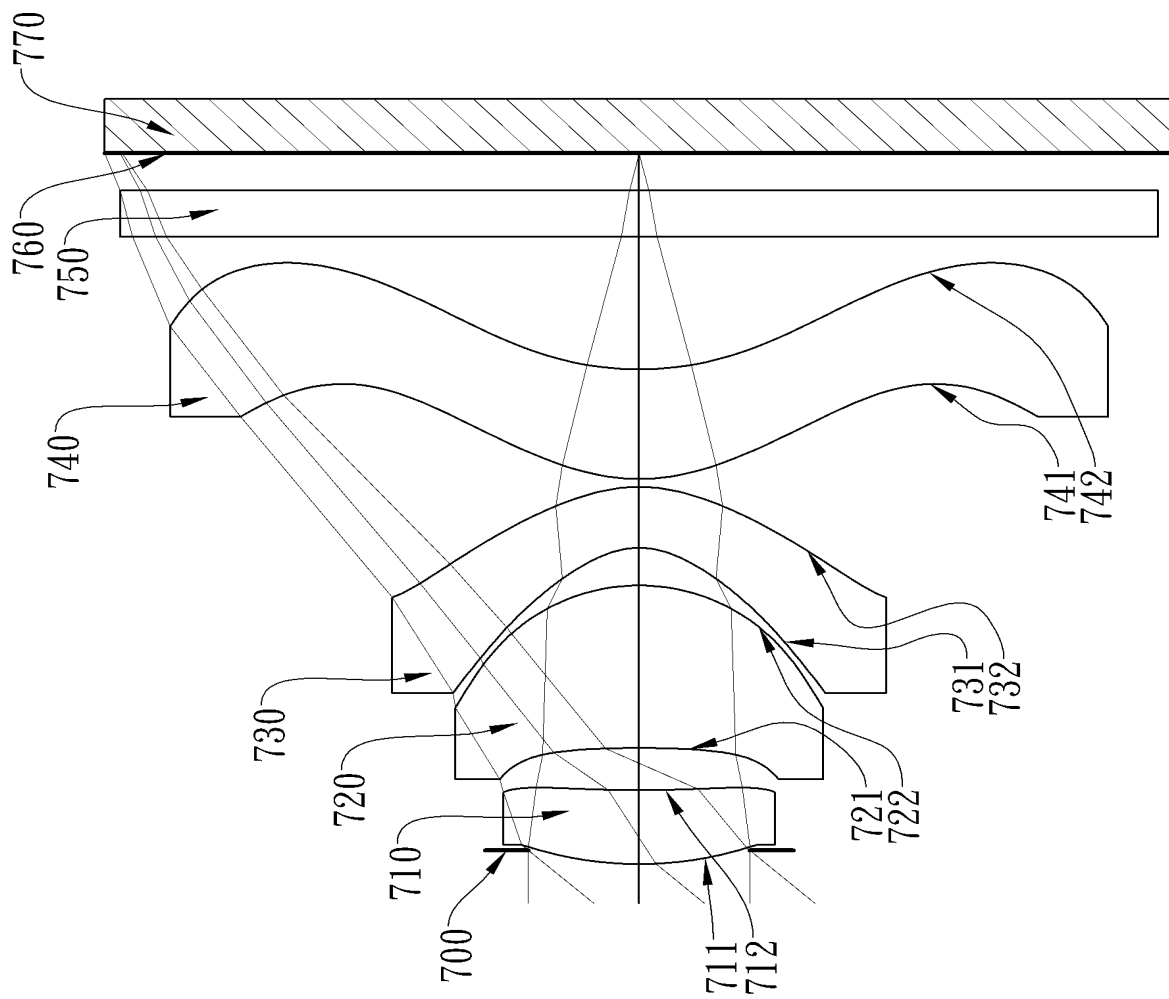


Fig. 7A

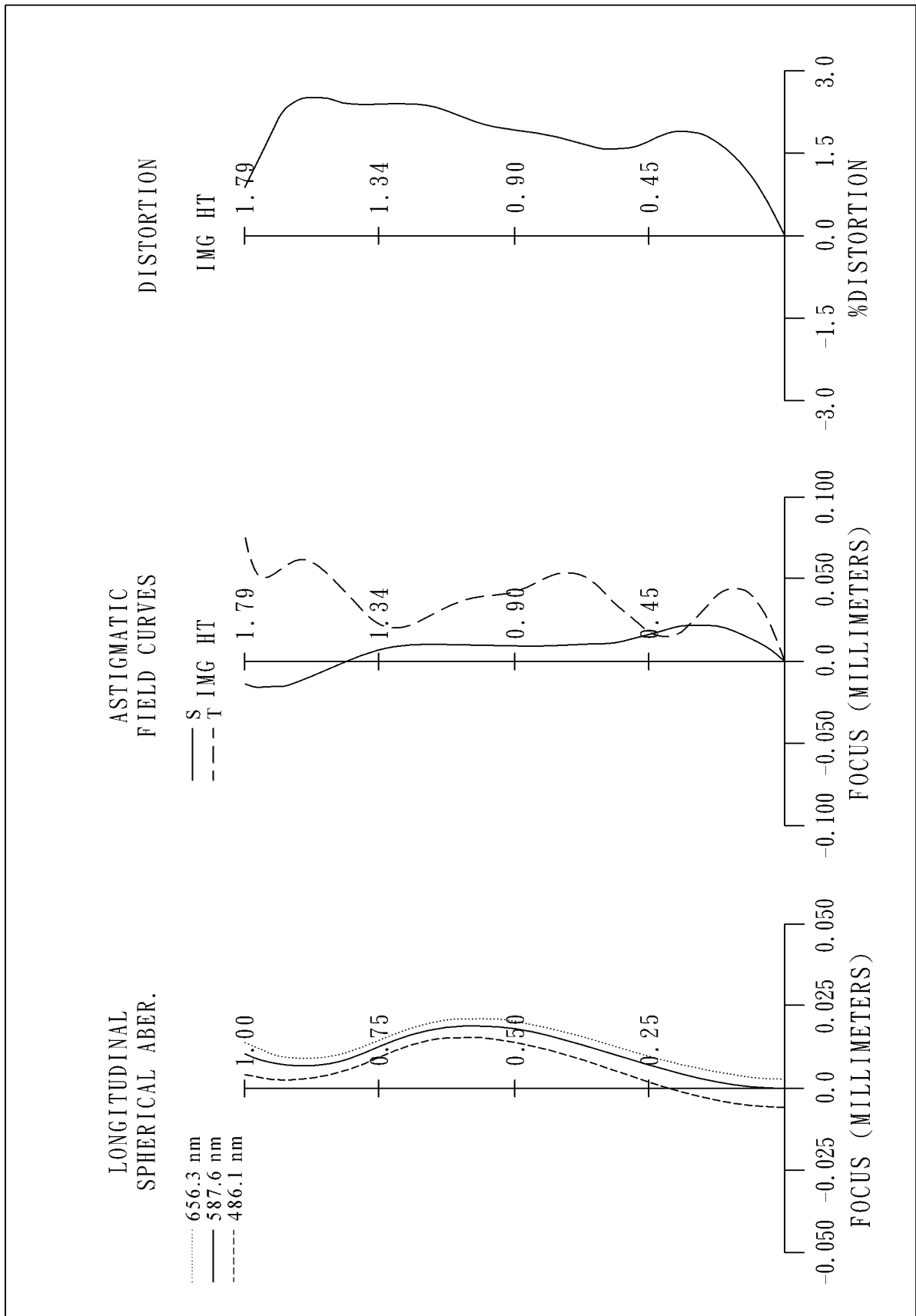


Fig. 7B

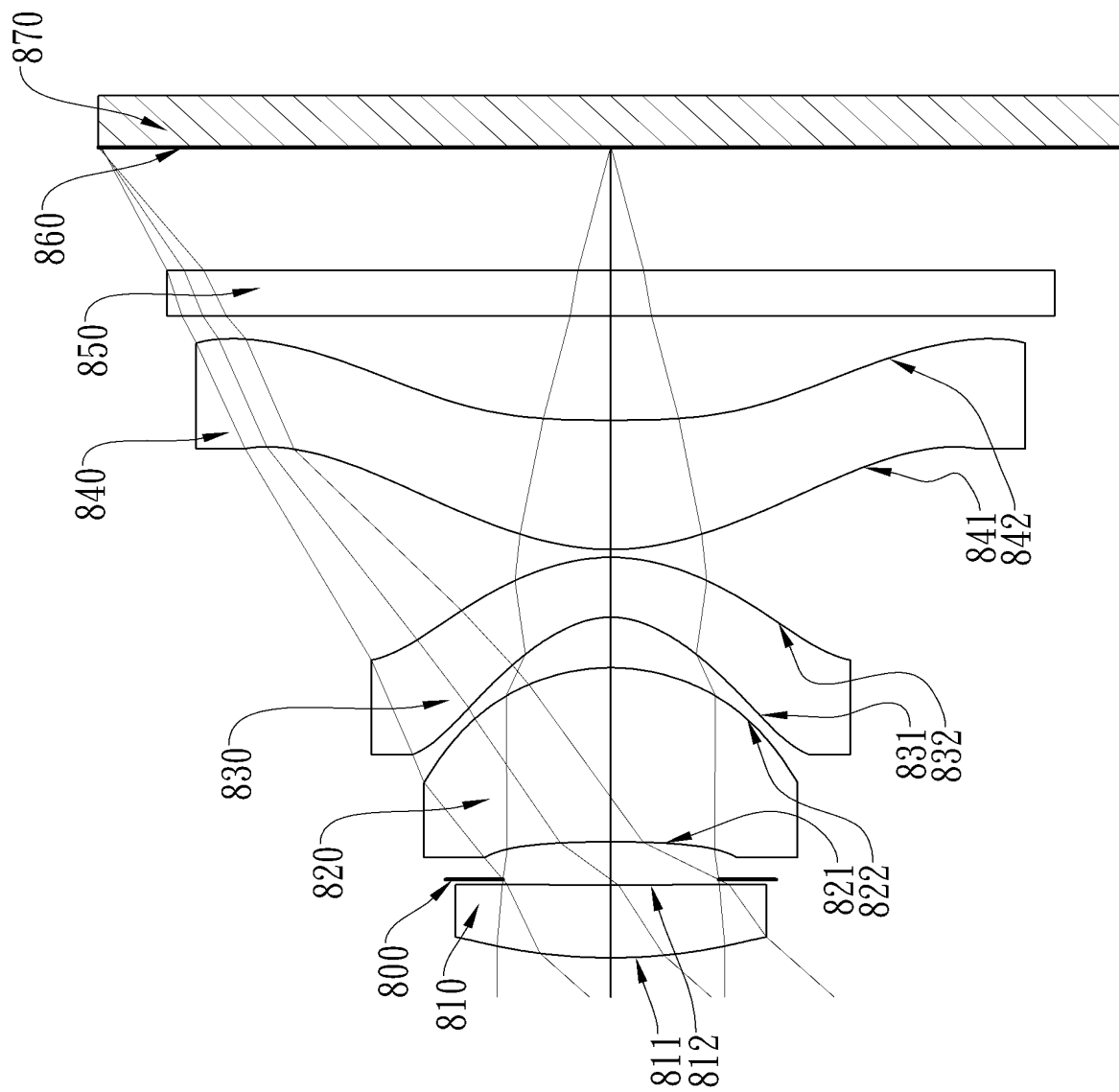


Fig. 8A

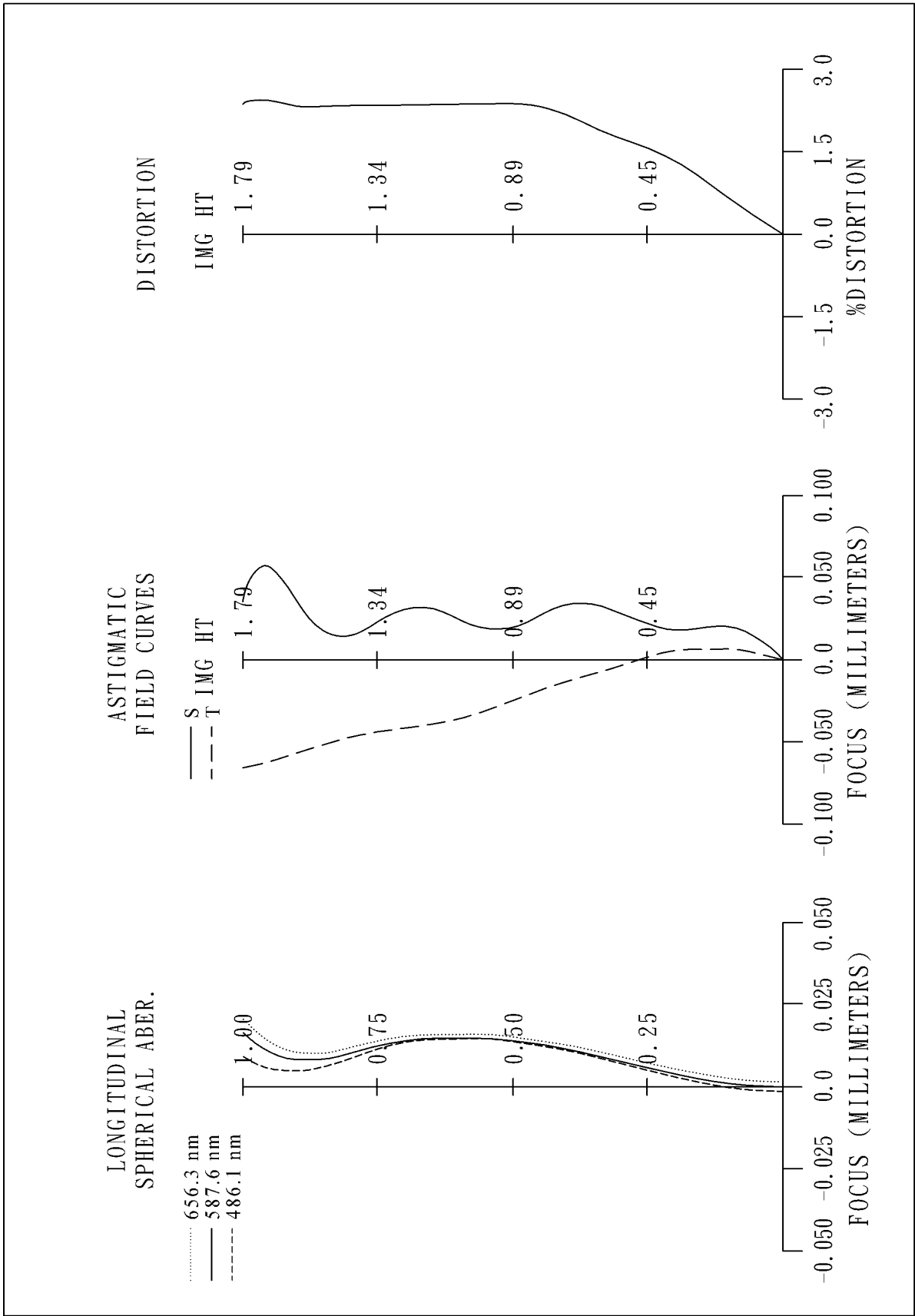


Fig. 8B

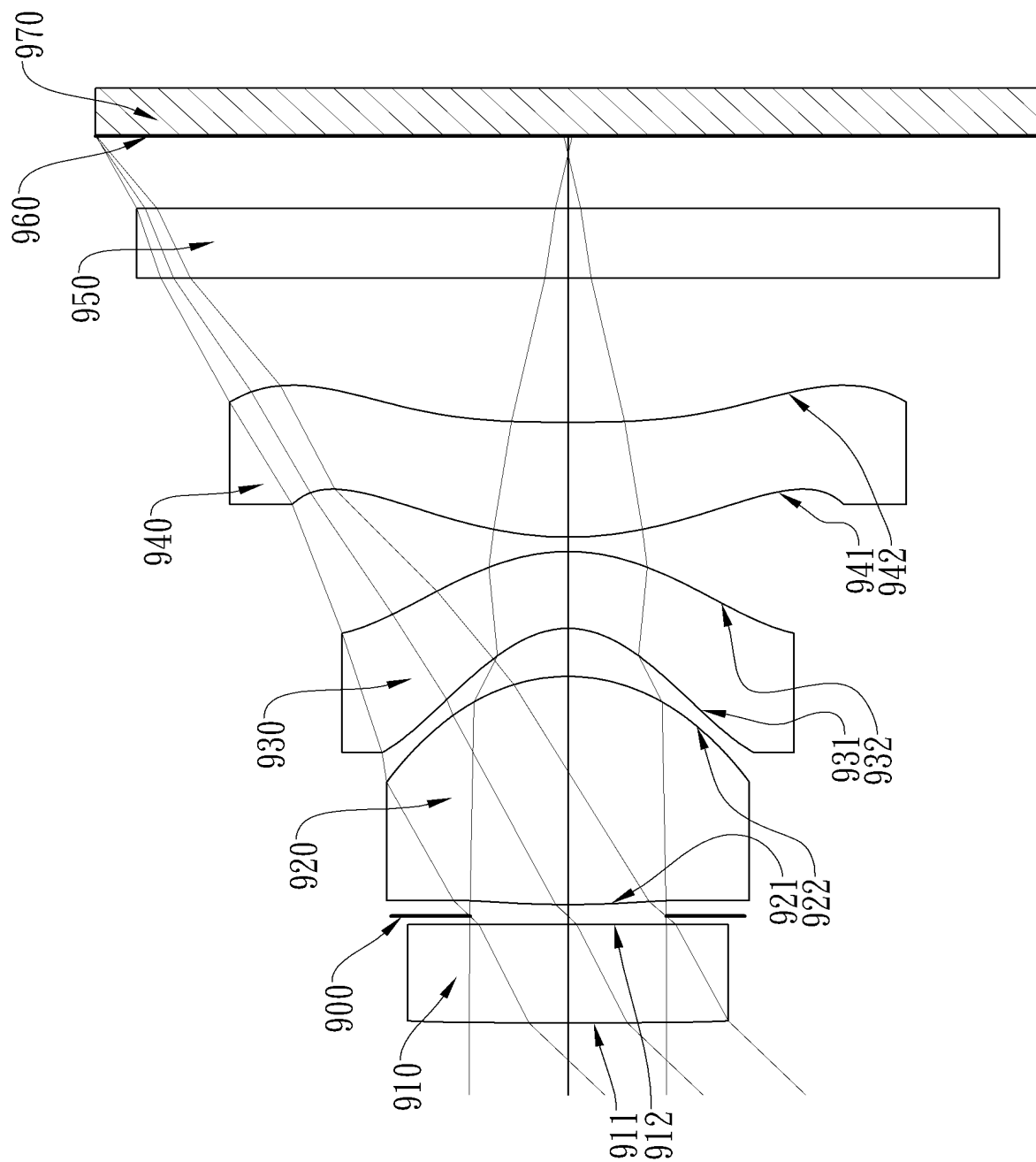


Fig. 9A

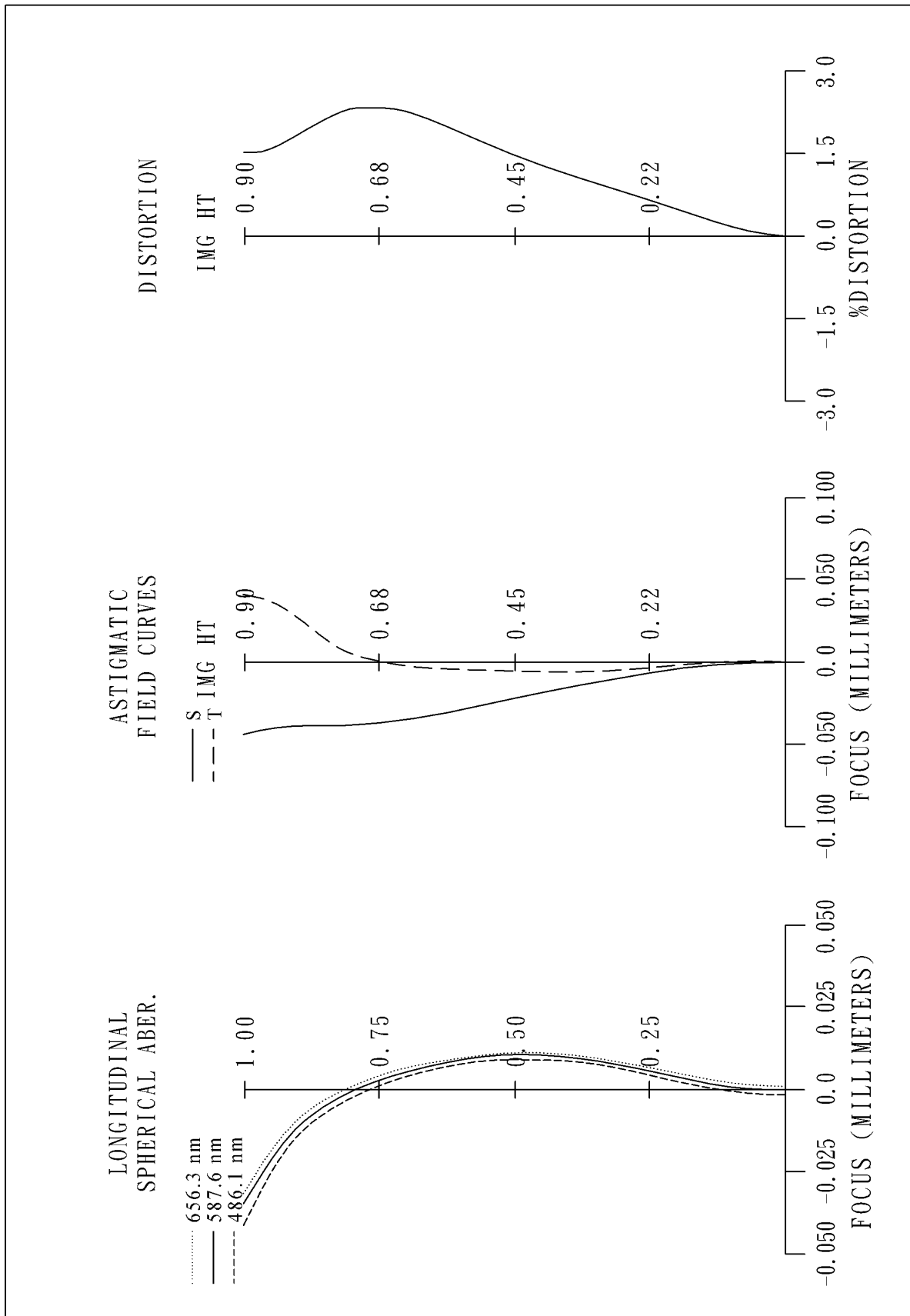


Fig. 9B

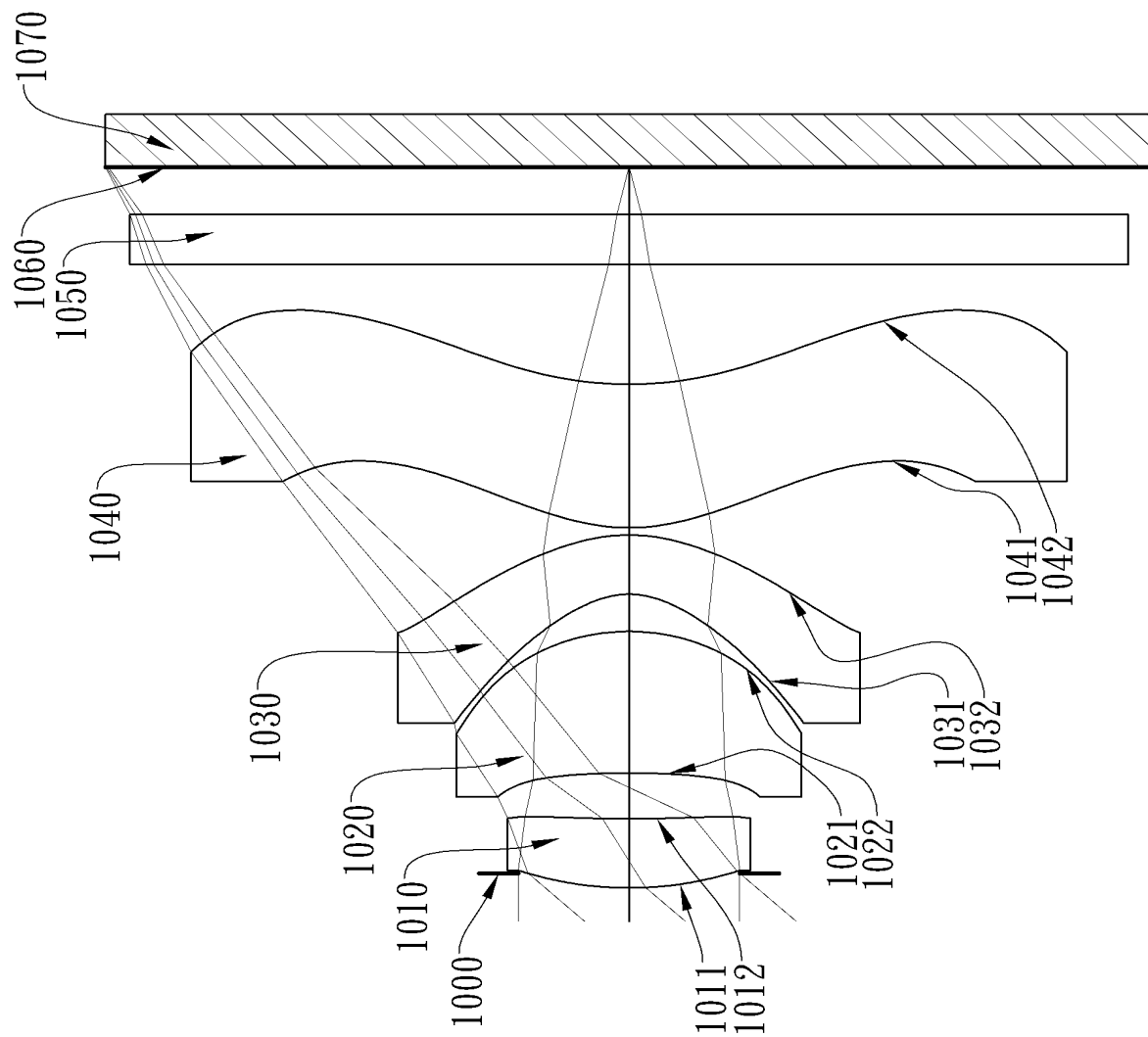


Fig. 10A

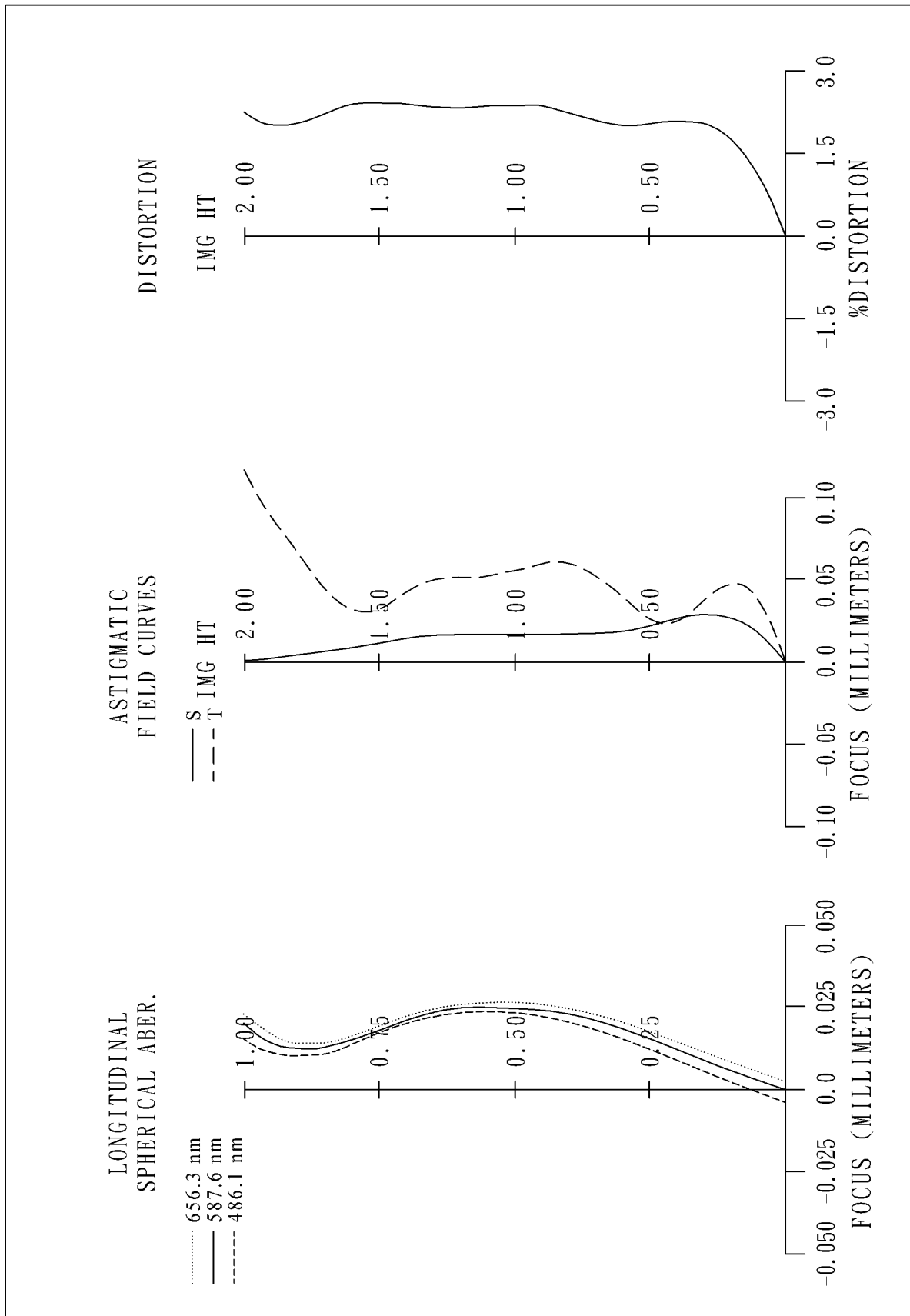


Fig. 10B

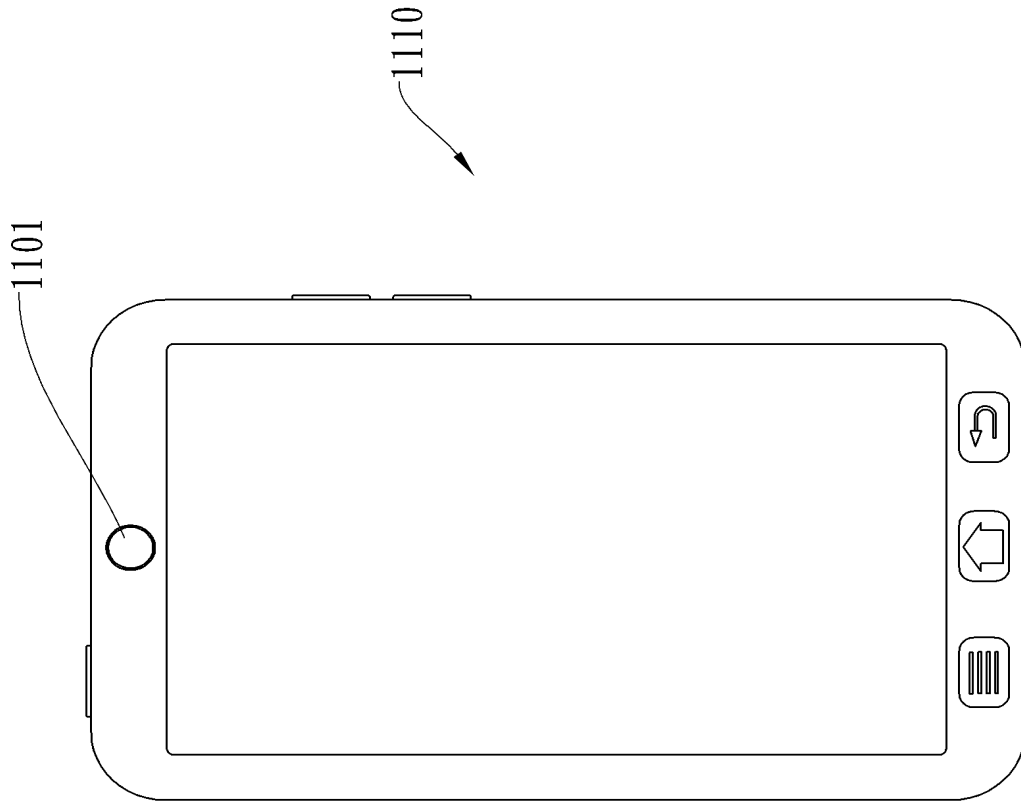


Fig. 11A

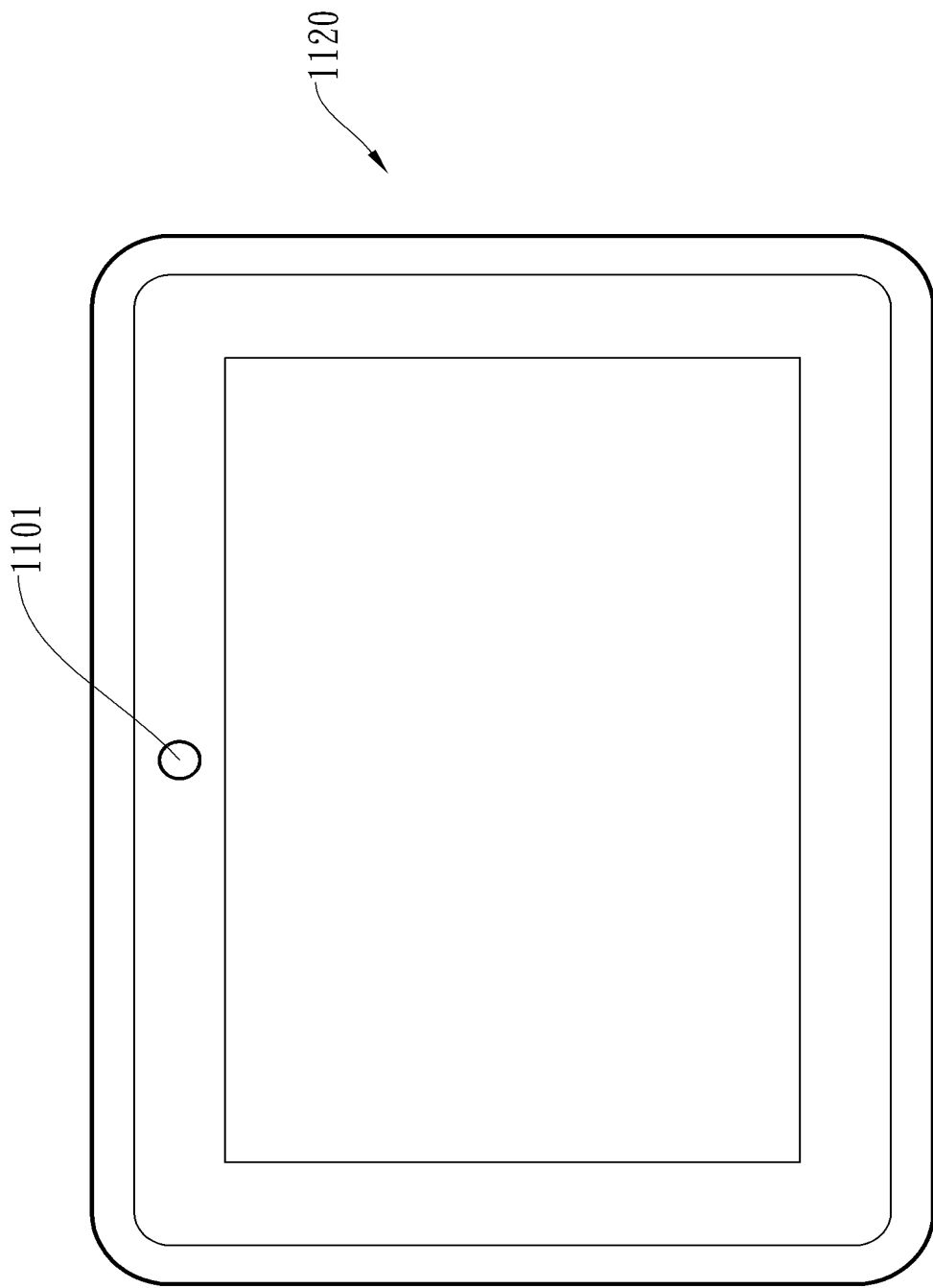


Fig. 11B

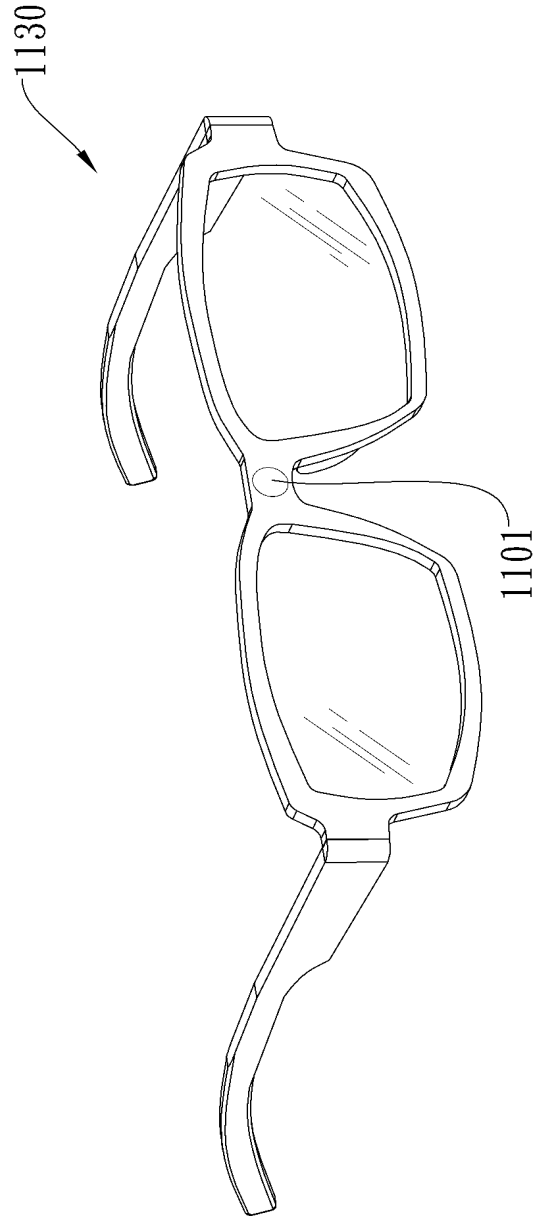


Fig. 11C

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Application Number	
Filing Date	December 13, 2013
First Named Inventor	WEI-YU CHEN
Title	IMAGE CAPTURING LENS SYSTEM, IMAGING DEVICE AND MOBILE TERMINAL
Art Unit	
Examiner Name	
Attorney Docket Number	14970-94702

SIGNATURE of Applicant or Patent Practitioner

Signature	/Tim Tingkang Xia/	Date	December 13, 2013
Name	Tim Tingkang Xia	Telephone	4044953678
Registration Number	45242		

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications.



*Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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PTO/AIA/825(07-12)

Approved for use through 11/30/2014. OMB 0851-0035

U.S. Patent and Trademark Office, U.S. DEPARTMENT OF COMMERCE

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24728

OR

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I am the Applicant:

- ☐ Inventor or Joint Inventor
☐ Legal Representative of a Deceased or Legally Incapacitated Inventor
☒ Assignee or Person to Whom the inventor is Under an Obligation to Assign
☐ Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document)

SIGNATURE of Applicant for Patent

Signature	CHEN, CHUN-SHAN	Date	10/9/12
Name	CHEN, CHUN-SHAN	Telephone	886-04-3600-2345
Title and Company	Manager, LARGAN PRECISION CO. LTD		

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. Submit multiple forms for more than one signature, see below.

- ☒ *Total of 1 forms are submitted.

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**DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN
APPLICATION DATA SHEET (37 CFR 1.76)**

Title of Invention	IMAGE CAPTURING LENS SYSTEM, IMAGING DEVICE AND MOBILE TERMINAL
-------------------------------	--

As the below named inventor, I hereby declare that:

This declaration is directed to: ☒ The attached application, or
☐ United States application or PCT international application number _____
filed on _____.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

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LEGAL NAME OF INVENTOR

Inventor: Chen, Wei-Yu

Date (Optional): 21st Nov 2013

Signature: Wei-Yu Chen

Note: An application data sheet (PTO/AIA/14 or equivalent), including naming the entire inventive entity, must accompany this form. Use an additional PTO/SB/AIA01 form for each additional inventor.

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1300339

Electronic Patent Application Fee Transmittal

Application Number:				
Filing Date:				
Title of Invention:	IMAGE CAPTURING LENS SYSTEM, IMAGING DEVICE AND MOBILE TERMINAL			
First Named Inventor/Applicant Name:	WEI-YU CHEN			
Filer:	Tim Tingkang Xia/Debby Yew			
Attorney Docket Number:	14970-94702			
Filed as Large Entity				
Utility under 35 USC 111(a) Filing Fees				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Utility application filing	1011	1	280	280
Utility Search Fee	1111	1	600	600
Utility Examination Fee	1311	1	720	720
Pages:				
Claims:				
Claims in Excess of 20	1202	6	80	480
Miscellaneous-Filing:				
Petition:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				2080

Electronic Acknowledgement Receipt

EFS ID:	17655791
Application Number:	14105811
International Application Number:	
Confirmation Number:	5836
Title of Invention:	IMAGE CAPTURING LENS SYSTEM, IMAGING DEVICE AND MOBILE TERMINAL
First Named Inventor/Applicant Name:	WEI-YU CHEN
Customer Number:	24728
Filer:	Tim Tingkang Xia/Debby Yew
Filer Authorized By:	Tim Tingkang Xia
Attorney Docket Number:	14970-94702
Receipt Date:	13-DEC-2013
Filing Date:	
Time Stamp:	14:55:47
Application Type:	Utility under 35 USC 111(a)

Payment information:

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Payment Type	Deposit Account
Payment was successfully received in RAM	\$ 2080
RAM confirmation Number	1437
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HP, Ex. 1002

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1	Transmittal of New Application	1497094702Trans.pdf	191208	no	1
			c911943ffb92207dc234e0ab91fe63eb9832931f		
Warnings:					
Information:					
2	Fee Worksheet (SB06)	1497094702FeeTrans.pdf	169762	no	1
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Warnings:					
Information:					
3	Application Data Sheet	1497094702ADS.pdf	1505518	no	6
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Warnings:					
Information:					
4		1497094702Spec.pdf	296526	yes	56
			832ad976d3e8915629b09063f87e1e982584299f		
	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Specification		1	47	
	Claims		48	55	
	Abstract		56	56	
Warnings:					
Information:					
5	Drawings-only black and white line drawings	1497094702Drawings.pdf	619675	no	23
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Information:					
6	Power of Attorney	1497094702POA.pdf	374075	no	2
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Warnings:					
Information:					

7	Oath or Declaration filed	1497094702Dec.pdf	442888 acf5d5ef1ae069bf729dd454b2bc3aa80d36b133	no	1
Warnings:					
Information:					
8	Fee Worksheet (SB06)	fee-info.pdf	37137 ce80c93b35e126b657e711b774b52e7114277f93	no	2
Warnings:					
Information:					
Total Files Size (in bytes):			3636789		
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875						Application or Docket Number 14/105,811			
APPLICATION AS FILED - PART I									
(Column 1)		(Column 2)		SMALL ENTITY		OR OTHER THAN SMALL ENTITY			
FOR	NUMBER FILED	NUMBER EXTRA	RATE(\$)	FEE(\$)		RATE(\$)	FEE(\$)		
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	280		
SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A	N/A			N/A	600		
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	720		
TOTAL CLAIMS (37 CFR 1.16(j))	26	minus 20 = * 6				x 80 =	480		
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3	minus 3 = *				x 420 =	0.00		
APPLICATION SIZE FEE (37 CFR 1.16(s))			If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$310 (\$155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			0.00			
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00		
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL		TOTAL	2080		
APPLICATION AS AMENDED - PART II									
(Column 1)		(Column 2)		(Column 3)		SMALL ENTITY		OR OTHER THAN SMALL ENTITY	
AMENDMENT A	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)	RATE(\$)	ADDITIONAL FEE(\$)		
	Total (37 CFR 1.16(i))	*	Minus **	=	x =	OR	x =		
	Independent (37 CFR 1.16(h))	*	Minus ***	=	x =	OR	x =		
	Application Size Fee (37 CFR 1.16(s))					OR			
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					OR			
				TOTAL ADD'L FEE		TOTAL ADD'L FEE			
AMENDMENT B	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)	RATE(\$)	ADDITIONAL FEE(\$)		
	Total (37 CFR 1.16(i))	*	Minus **	=	x =	OR	x =		
	Independent (37 CFR 1.16(h))	*	Minus ***	=	x =	OR	x =		
	Application Size Fee (37 CFR 1.16(s))					OR			
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					OR			
				TOTAL ADD'L FEE		TOTAL ADD'L FEE			
* If the entry in column 1 is less than the entry in column 2, write "0" in column 3. ** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20". *** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3". The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.									



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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY. DOCKET NO	TOT CLAIMS	IND CLAIMS
14/105,811	12/13/2013	2872	2080	14970-94702	26	3

CONFIRMATION NO. 5836

24728
MORRIS MANNING MARTIN LLP
3343 PEACHTREE ROAD, NE
1600 ATLANTA FINANCIAL CENTER
ATLANTA, GA 30326

FILING RECEIPT



Date Mailed: 01/08/2014

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)

WEI-YU CHEN, Taichung, TAIWAN;

Applicant(s)

LARGAN PRECISION CO., LTD., Taichung, TAIWAN

Assignment For Published Patent Application

LARGAN PRECISION CO., LTD., Taichung, TAIWAN

Power of Attorney: The patent practitioners associated with Customer Number 24728

Domestic Applications for which benefit is claimed - None.

A proper domestic benefit claim must be provided in an Application Data Sheet in order to constitute a claim for domestic benefit. See 37 CFR 1.76 and 1.78.

Foreign Applications (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see <http://www.uspto.gov> for more information.)
TAIWAN 102139029 10/29/2013

Permission to Access - A proper **Authorization to Permit Access to Application by Participating Offices** (PTO/SB/39 or its equivalent) has been received by the USPTO.

If Required, Foreign Filing License Granted: 01/02/2014

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 14/105,811**

Projected Publication Date: 04/30/2015

Non-Publication Request: No

Early Publication Request: No

Title

IMAGE CAPTURING LENS SYSTEM, IMAGING DEVICE AND MOBILE TERMINAL

Preliminary Class

359

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

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Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
14/105,811	12/13/2013	WEI-YU CHEN	14970-94702

24728
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CONFIRMATION NO. 5836
POA ACCEPTANCE LETTER



Date Mailed: 01/08/2014

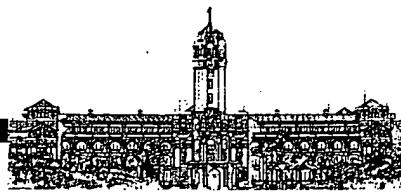
NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 12/13/2013.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

/hnguyen/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101



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茲證明所附文件，係本局存檔中原申請案的副本，正確無訛，
其申請資料如下：

This is to certify that annexed is a true copy from the records of this office of
the application as originally filed which is identified hereunder：

申 請 日：西元 2013 年 10 月 29 日
Application Date Oct. 29, 2013

申 請 案 號：102139029
Application No.

申 請 人：大立光電股份有限公司
Applicant(s)

發 明 人：陳緯彧
Inventor(s)

局 長

Director General

王美花

西元 2013 年 11 月 11 日
Nov. 11, 2013



發明摘要

※ 申請案號：

※ 申請日：

※IPC 分類：

5 **【發明名稱】(中文/英文)**

影像拾取系統透鏡組、取像裝置及可攜裝置/ Image Capturing Lens System, Imaging Device and Mobile Terminal

10 **【中文】**

本發明提供一種影像拾取系統透鏡組，由物側至像側依序包含：一具屈折力的第一透鏡；一具正屈折力的第二透鏡，其像側面於近光軸處為凸面；一具負屈折力的第三透鏡，其物側面於近光軸處為凹面，其像側面於近光軸處為凸面；及一具屈折力的第四透
15 鏡，其像側面於近光軸處為凹面，其物側面及像側面皆為非球面，且其像側面於離軸處具有至少一凸面。藉由上述結構，在滿足特定條件下，可有利於具備大視角及縮短系統總長度，並提升周邊解像力和照度。

20

【英文】



This invention provides an image capturing lens system comprising from object-side to image-side: a first lens element with refractive power; a positive second lens element having a convex image-side surface in a paraxial region; a negative third lens element having a concave object-side surface in a paraxial region and a convex image-side surface in a paraxial region; and a fourth lens element with refractive power having a concave image-side surface in a paraxial region, both of the object-side and image-side surfaces being aspheric, and the image-side surface has at least a convex shape at an off-axis region thereof. When particular relations are satisfied with the aforesaid structure configuration, wide field of view can be obtained, the total track length can be favorably reduced and the resolution for peripheral image and illumination can be improved.

15



【代表圖】

【本案指定代表圖】：第（一A）圖。

【本代表圖之符號簡單說明】：

5	光圈	100		
	第一透鏡	110		
	物側面	111	像側面	112
	第二透鏡	120		
	物側面	121	像側面	122
10	第三透鏡	130		
	物側面	131	像側面	132
	第四透鏡	140		
	物側面	141	像側面	142
	紅外線濾除濾光元件	150		
15	成像面	160		
	電子感光元件	170		

【本案若有化學式時，請揭示最能顯示發明特徵的化學式】：

20 無

25

發明專利說明書

(本說明書格式、順序，請勿任意更動)

【發明名稱】(中文/英文)

5 影像拾取系統透鏡組、取像裝置及可攜裝置 / Image
Capturing Lens System, Imaging Device and Mobile Terminal

【技術領域】

10 本發明係關於一種影像拾取系統透鏡組，特別是關於一種應
用於可攜式電子產品的影像拾取系統透鏡組。

【先前技術】

15 隨著個人電子產品逐漸輕薄化，電子產品內部各零組件被要求具有更小的尺寸。攝影鏡頭的尺寸在這個趨勢下同樣面臨著小型化的要求。除了小型化的要求之外，因為半導體製程技術的進步使得感光元件的畫素面積縮小，攝影鏡頭逐漸往高畫素領域發展，因此，對成像品質的要求也日益增加。

20 傳統搭載於可攜式電子產品上的小型化光學系統，多採用三片式透鏡結構為主，但由於智慧型手機(Smart Phone)、平板電腦(Tablet PC)與可穿戴式設備(Wearable Apparatus)等高規格可攜裝置(Mobile Terminal)的盛行，使得攝影鏡頭在畫素與成像品質上的迅速攀升，習知的三片式攝影鏡頭已無法滿足更高階的攝影需求。

25 領域中亦提出四片式透鏡組，期能提供更優異的成像品質。然而，習用四片式透鏡組往往未能在大視角及鏡頭總長度之間取得良好的平衡，且對於周邊影像的解像力與照度也不甚理想，尚未能滿足領域中所要求的高階成像品質。

 因此，領域中急需一種在滿足小型化的條件下，具有良好之

周邊解像力與照度的攝影鏡頭。

【發明內容】

本發明提供一種影像拾取系統透鏡組，由物側至像側依序包含：一具屈折力的第一透鏡；一具正屈折力的第二透鏡，其像側面於近光軸處為凸面；一具負屈折力的第三透鏡，其物側面於近光軸處為凹面，其像側面於近光軸處為凸面；及一具屈折力的第四透鏡，其像側面於近光軸處為凹面，其物側面及像側面皆為非球面，且其像側面於離軸處具有至少一凸面；其中，該影像拾取系統透鏡組中具有屈折力的透鏡為四片；其中，該第一透鏡物側面至該第四透鏡像側面於光軸上的距離為 T_d ，該影像拾取系統透鏡組中最大視角的一半為 $HFOV$ ，該影像拾取系統透鏡組的焦距為 f ，該第四透鏡的焦距為 f_4 ，該第二透鏡的焦距為 f_2 ，該第三透鏡的焦距為 f_3 ，係滿足下列關係式： $0.5\text{ mm} < T_d < 3.2\text{ mm}$ ； $1.0\text{ mm} < T_d / \tan(HFOV) < 3.75\text{ mm}$ ； $|f / f_4| < 1.20$ ；及 $f_2 / f_3 < -0.65$ 。

另一方面，本發明提供一種影像拾取系統透鏡組，由物側至像側依序包含：一具屈折力的第一透鏡；一具正屈折力的第二透鏡，其像側面於近光軸處為凸面；一具負屈折力的第三透鏡，其物側面於近光軸處為凹面，其像側面於近光軸處為凸面；及一具屈折力的第四透鏡，其像側面於近光軸處為凹面，其物側面及像側面皆為非球面，且其像側面於離軸處具有至少一凸面；其中，該影像拾取系統透鏡組中具有屈折力的透鏡為四片；其中，該第一透鏡物側面至該第四透鏡像側面於光軸上的距離為 T_d ，該影像拾取系統透鏡組中最大視角的一半為 $HFOV$ ，該影像拾取系統透鏡組的焦距為 f ，該第四透鏡的焦距為 f_4 ，該第三透鏡的焦距為 f_3 ，係滿足下列關係式： $0.5\text{ mm} < T_d < 3.2\text{ mm}$ ； $1.0\text{ mm} < T_d / \tan(HFOV) < 3.75\text{ mm}$ ； $|f / f_4| < 1.20$ ；及 $-2.0 < f / f_3 < -0.95$ 。

又一方面，本發明提供一種影像拾取系統透鏡組，由物側至像側依序包含：一具屈折力的第一透鏡；一具正屈折力的第二透鏡，其像側面於近光軸處為凸面；一具負屈折力的第三透鏡，其物側面於近光軸處為凹面，其像側面於近光軸處為凸面；及一具
5 屈折力的第四透鏡，其像側面於近光軸處為凹面，其物側面及像側面皆為非球面，且其像側面於離軸處具有至少一凸面；其中，該影像拾取系統透鏡組中具有屈折力的透鏡為四片；其中，該第一透鏡物側面至該第四透鏡像側面於光軸上的距離為 T_d ，該影像拾取系統透鏡組中最大視角的一半為 HFOV，該影像拾取系統透
10 鏡組的焦距為 f ，該第四透鏡的焦距為 f_4 ，該影像拾取系統透鏡組的光圈值為 F_{no} ，係滿足下列關係式： $0.5\text{ mm} < T_d < 3.2\text{ mm}$ ； $1.0\text{ mm} < T_d / \tan(\text{HFOV}) < 3.75\text{ mm}$ ； $|f / f_4| < 1.20$ ；及 $1.40 < F_{no} \leq 2.25$ 。

再一方面，本發明提供一種取像裝置，包含如前述的影像拾
15 取系統透鏡組及一電子感光元件。

更一方面，本發明提供一種可攜裝置，包含如前述的取像裝置。

當 T_d 滿足上述條件時，有利於維持系統的小型化。

當 $T_d / \tan(\text{HFOV})$ 滿足上述條件時，有助於使該影像拾取系
20 統透鏡組同時具備大視角及短總長的特性。

當 $|f / f_4|$ 滿足上述條件時，可使系統的主點更遠離成像面，有利於縮短系統的光學總長度，以維持鏡頭的小型化。

當 f_2 / f_3 滿足上述條件時，該第二透鏡與該第三透鏡的屈折力配置較為平衡，可有助於像差的修正與敏感度的降低。

25 當 f / f_3 滿足上述條件時，該第三透鏡的作用如同補正透鏡，其功能為平衡及修正系統所產生的各項像差，進而可使系統獲得更高的成像品質。

當 F_{no} 滿足上述條件時，有助於提升系統的周邊照度。

【圖式簡單說明】

- 第一 A 圖係本發明第一實施例的取像裝置示意圖。
第一 B 圖係本發明第一實施例的像差曲線圖。
第二 A 圖係本發明第二實施例的取像裝置示意圖。
5 第二 B 圖係本發明第二實施例的像差曲線圖。
第三 A 圖係本發明第三實施例的取像裝置示意圖。
第三 B 圖係本發明第三實施例的像差曲線圖。
第四 A 圖係本發明第四實施例的取像裝置示意圖。
第四 B 圖係本發明第四實施例的像差曲線圖。
10 第五 A 圖係本發明第五實施例的取像裝置示意圖。
第五 B 圖係本發明第五實施例的像差曲線圖。
第六 A 圖係本發明第六實施例的取像裝置示意圖。
第六 B 圖係本發明第六實施例的像差曲線圖。
第七 A 圖係本發明第七實施例的取像裝置示意圖。
15 第七 B 圖係本發明第七實施例的像差曲線圖。
第八 A 圖係本發明第八實施例的取像裝置示意圖。
第八 B 圖係本發明第八實施例的像差曲線圖。
第九 A 圖係本發明第九實施例的取像裝置示意圖。
第九 B 圖係本發明第九實施例的像差曲線圖。
20 第十 A 圖係本發明第十實施例的取像裝置示意圖。
第十 B 圖係本發明第十實施例的像差曲線圖。
第十一 A 圖係示意裝設有本發明之取像裝置的智慧型手機。
第十一 B 圖係示意裝設有本發明之取像裝置的平板電腦。
25 第十一 C 圖係示意裝設有本發明之取像裝置的可穿戴式設備。

【實施方式】

本發明提供一種影像拾取系統透鏡組，由物側至像側依序包含具屈折力的第一透鏡、第二透鏡、第三透鏡、及第四透鏡。

該第一透鏡可具有正屈折力，可提供系統所需的正屈折力，有助於縮短系統的總長度。該第一透鏡物側面可為凸面，可有效加強縮短光學總長度的功效。

5 該第二透鏡具正屈折力，有助於利用第二透鏡調和第一透鏡的匯聚能力。該第二透鏡的像側面於近光軸處為凸面，有助於修正系統的像散。

該第三透鏡具負屈折力，有助於系統的像差修正。該第三透鏡物側面近光軸處為凹面，其像側面近光軸處為凸面，可有助於修正系統的像散。

10 該第四透鏡物側面近光軸處可為凸面，其像側面近光軸處為凹面，且其像側面於離軸處具有至少一凸面，有助於修正系統非點收差(Astigmatism)，並可有效修正離軸像差。

該第一透鏡物側面至該第四透鏡像側面於光軸上的距離為 T_d ，當影像拾取系統透鏡組滿足下列關係式： $0.5 \text{ mm} < T_d < 3.2$
15 mm 時，有利於維持系統的小型化；較佳地，滿足下列關係式： $0.8 \text{ mm} < T_d < 2.5 \text{ mm}$ 。

該第一透鏡物側面至該第四透鏡像側面於光軸上的距離為 T_d ，該影像拾取系統透鏡組中最大視角的一半為 $HFOV$ ，當影像拾取系統透鏡組滿足下列關係式： $1.0 \text{ mm} < T_d / \tan(HFOV) <$
20 3.75 mm 時，有助於使該影像拾取系統透鏡組同時具備大視角及短總長的特性；較佳地，滿足下列關係式： $1.2 \text{ mm} < T_d / \tan(HFOV) < 2.75 \text{ mm}$ 。

該影像拾取系統透鏡組的焦距為 f ，該第四透鏡的焦距為 f_4 ，當影像拾取系統透鏡組滿足下列關係式： $|f / f_4| < 1.20$ 時，
25 可使系統的主點更遠離成像面，有利於縮短系統的光學總長度，以維持鏡頭的小型化。

該第二透鏡的焦距為 f_2 ，該第三透鏡的焦距為 f_3 ，當影像拾取系統透鏡組滿足下列關係式： $f_2 / f_3 < -0.65$ 時，該第二透鏡與該第三透鏡的屈折力配置較為平衡，可有助於像差的修正與敏感

度的降低；較佳地，滿足下列關係式： $f_2 / f_3 < -0.75$ 。

該影像拾取系統透鏡組的焦距為 f ，該第三透鏡的焦距為 f_3 ，當影像拾取系統透鏡組滿足下列關係式： $-2.0 < f / f_3 < -0.95$ 時，該第三透鏡的作用如同補正透鏡，其功能為平衡及修正系統所產生的各項像差，進而可使系統獲得更高的成像品質。

該影像拾取系統透鏡組的光圈值為 F_{no} ，當影像拾取系統透鏡組滿足下列關係式： $1.40 < F_{no} \leq 2.25$ 時，有助於提升系統的周邊照度。

該影像拾取系統透鏡組的焦距為 f ，該第一透鏡的焦距為 f_1 ，當影像拾取系統透鏡組滿足下列關係式： $-0.25 < f / f_1 < 0.75$ 時，該第一透鏡的屈折力較為合適，避免敏感度過高；較佳地，滿足下列關係式： $0.25 < f / f_1 < 0.75$ 。

該第二透鏡物側面的曲率半徑為 R_3 ，該第二透鏡像側面的曲率半徑為 R_4 。當影像拾取系統透鏡組滿足下列關係式： $0.5 < (R_3 + R_4) / (R_3 - R_4) < 2.5$ 時，有助於加強像差的修正。

該影像拾取系統透鏡組的焦距為 f ，當影像拾取系統透鏡組滿足下列關係式： $0.5 \text{ mm} < f < 2.0 \text{ mm}$ 時，有助於提供適當的光學總長度。

該第一透鏡、該第二透鏡、該第三透鏡、及該第四透鏡於光軸上之厚度的總合為 ΣCT ，該第一透鏡物側面至該第四透鏡像側面於光軸上的距離為 T_d ，當影像拾取系統透鏡組滿足下列關係式： $0.80 < \Sigma CT / T_d < 0.95$ 時，有利於該影像拾取系統透鏡組的組裝，並降低敏感度。

該第一透鏡的色散係數為 V_1 ，當影像拾取系統透鏡組滿足下列關係式： $45 < V_1$ 時，可有效修正系統色差。

該第二透鏡於光軸上的厚度為 CT_2 ，該第一透鏡於光軸上的厚度為 CT_1 ，該第三透鏡於光軸上的厚度為 CT_3 ，該第四透鏡於光軸上的厚度為 CT_4 ，當影像拾取系統透鏡組滿足下列關係式： $0.65 < CT_2 / (CT_1 + CT_3 + CT_4) < 2.0$ 時，各透鏡的厚度較為合適，

有助於鏡片的製作及組裝。

該影像拾取系統透鏡組的最大視角為 FOV，當影像拾取系統透鏡組滿足下列關係式： $80^\circ < \text{FOV} < 110^\circ$ 時，有利於取得足夠的視場角。

- 5 本發明的影像拾取系統透鏡組中，透鏡的材質可為玻璃或塑膠，若透鏡的材質為玻璃，則可以增加該影像拾取系統透鏡組屈折力配置的自由度，若透鏡材質為塑膠，則可以有效降低生產成本。此外，可於鏡面上設置非球面(ASP)，非球面可以容易製作成球面以外的形狀，獲得較多的控制變數，用以消減像差，進而
- 10 縮減透鏡使用的數目，因此可以有效降低本發明的影像拾取系統透鏡組的總長度。

本發明的影像拾取系統透鏡組中，可至少設置一光闌，如孔徑光闌(Aperture Stop)、耀光光闌(Glare Stop)或視場光闌(Field Stop)等。

- 15 本發明影像拾取系統透鏡組中，光圈配置可為前置或中置，其中前置光圈意即光圈設置於被攝物與第一透鏡間，中置光圈則表示光圈設置於第一透鏡與成像面間，前置光圈可使影像拾取系統透鏡組的出射瞳(Exit Pupil)與成像面產生較長的距離，使之具有遠心(Telecentric)效果，可增加電子感光元件如 CCD 或 CMOS
- 20 接收影像的效率；中置光圈則有助於擴大系統的視場角，使影像拾取系統透鏡組具有廣角鏡頭之優勢。

- 本發明影像拾取系統透鏡組中，就以具有屈折力的透鏡而言，若透鏡表面係為凸面且未界定該凸面位置時，則表示該透鏡表面於近光軸處為凸面；若透鏡表面係為凹面且未界定該凹面位置時，則表示該透鏡表面於近光軸處為凹面。
- 25

本發明的影像拾取系統透鏡組更可視需求應用於變焦的光學系統中，並兼具優良像差修正與良好成像品質的特色可多方面應用於 3D(三維)影像擷取、數位相機、行動裝置、數位平板與可穿戴式設備等可攜裝置中。

● 本發明更提供一種取像裝置，其包含前述影像拾取系統透鏡組以及電子感光元件，其中該電子感光元件設置於該影像拾取系統透鏡組的成像面，因此取像裝置可藉由影像拾取系統透鏡組的系統設計，有利於縮短大視角的系統總長，並提升周
5 邊解像力與照度，進而達到最佳成像效果。較佳地，該取像裝置可進一步包含鏡筒(Barrel Member)、支持裝置(Holder Member)或其組合。

請參第十一 A 圖、第十一 B 圖、第十一 C 圖，該取像裝置(1101)可搭載於可攜裝置，其包括，但不限於：智慧型手機(1110)、
10 平板電腦(1120)、或可穿戴式設備(1130)。前揭可攜裝置僅是示範性地說明本發明之取像裝置的實際運用例子，並非限制本發明之取像裝置的運用範圍。較佳地，該可攜裝置可進一步包含控制單元(Control Unit)、顯示單元(Display)、儲存單元(ROM)、暫儲存單元(RAM)或其組合。

15 本發明的取像裝置及影像拾取系統透鏡組將藉由以下具體實施例配合所附圖式予以詳細說明。

《第一實施例》

本發明第一實施例請參閱第一 A 圖，第一實施例的像差曲線請參閱第一 B 圖。第一實施例的取像裝置包含影像拾取系統透鏡
20 組與一電子感光元件(170)，該影像拾取系統透鏡組主要由四片具屈折力的透鏡構成，由物側至像側依序包含：

一具正屈折力的第一透鏡(110)，其材質為塑膠，其物側面(111)於近光軸處為凸面，其像側面(112)於近光軸處為凹面，且其兩面皆為非球面；

25 一具正屈折力的第二透鏡(120)，其材質為塑膠，其物側面(121)於近光軸處為凸面，其像側面(122)於近光軸處為凸面，且其兩面皆為非球面；

一具負屈折力的第三透鏡(130)，其材質為塑膠，其物側面(131)於近光軸處為凹面，其像側面(132)於近光軸處為凸面，且其兩面皆為非球面；及

- 5 一具正屈折力的第四透鏡(140)，其材質為塑膠，其物側面(141)於近光軸處為凸面，其像側面(142)於近光軸處為凹面，其兩面皆為非球面，且其像側面(142)於離軸處具有至少一凸面；

10 其中，該影像拾取系統透鏡組另設置有一光圈(100)，置於該第一透鏡(110)與該第二透鏡(120)間；另包含有一紅外線濾除濾光元件(IR-cut filter)(150)置於該第四透鏡(140)與一成像面(160)間，其材質為玻璃且不影響焦距。

其中，該電子感光元件(170)設置於該成像面(160)上。

第一實施例詳細的光學數據如表一所示，其非球面數據如表二所示，其中曲率半徑、厚度及焦距的單位為毫米，HFOV 定義為最大視角的一半。

15

表一								
(第一實施例)								
$f = 1.17 \text{ mm}$, $Fno = 2.20$, $HFOV = 46.7 \text{ deg.}$								
表面 #		曲率半徑		厚度	材質	折射率	色散係數	焦距
0	被攝物	平面		無限				
1	第一透鏡	1.666	ASP	0.256	塑膠	1.650	21.4	9.56
2		2.139	ASP	0.031				
3	光圈	平面		0.019				
4	第二透鏡	5.712	ASP	0.671	塑膠	1.544	55.9	0.82
5		-0.464	ASP	0.130				
6	第三透鏡	-0.228	ASP	0.230	塑膠	1.634	23.8	-1.06
7		-0.480	ASP	0.030				
8	第四透鏡	0.679	ASP	0.483	塑膠	1.535	55.7	1.52
9		3.062	ASP	0.300				
10	紅外線濾除	平面		0.145	玻璃	1.517	64.2	-
11	濾光片	平面		0.204				
12	成像面	平面		-				

註：參考波長為 d-line 587.6 nm

表二				
非球面係數				
表面 #	1	2	4	5
k =	1.2237E+00	1.7244E+01	9.0000E+01	-6.9311E-01
A4 =	3.1416E-01	1.1703E+00	-4.1498E-01	-6.9345E-01
A6 =	-1.0010E+00	-2.0080E+01	3.6416E+00	1.3202E+00
A8 =	4.5872E+01	5.2569E+02	4.3035E+01	1.0955E+01
A10 =	-5.9339E+02	-3.0044E+03	-7.4996E+03	-3.8285E+02
A12 =	4.0961E+03	-1.6432E+05	1.3290E+05	3.0040E+03
A14 =	-1.4631E+04	3.1882E+06	-1.1481E+06	-1.0680E+04
A16 =	2.0715E+04	-1.7563E+07	3.7732E+06	1.3826E+04
表面 #	6	7	8	9
k =	-9.8477E-01	-3.2669E+00	-6.1619E-01	-1.4636E+01
A4 =	3.5682E+00	-1.8915E+00	-1.2870E+00	1.2883E+00
A6 =	-3.7958E+00	8.7075E+00	3.1244E+00	-3.7603E+00
A8 =	-1.1135E+02	-3.6761E+01	-9.1933E+00	5.9040E+00
A10 =	1.5862E+03	1.7257E+02	1.7146E+01	-5.8521E+00
A12 =	-8.7685E+03	-4.8146E+02	-1.9850E+01	3.5356E+00
A14 =	2.3054E+04	6.7728E+02	1.2752E+01	-1.1759E+00
A16 =	-2.3557E+04	-3.6747E+02	-3.5165E+00	1.6169E-01

上述的非球面曲線的方程式表示如下：

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

其中：

5 X：非球面上距離光軸為 Y 的點，其與相切於非球面光軸上頂點之切面的相對距離；

Y：非球面曲線上的點與光軸的垂直距離；

R：曲率半徑；

k：錐面係數；

10 Ai：第 i 階非球面係數。

影像拾取系統透鏡組的焦距為 f，影像拾取系統透鏡組的光圈值為 Fno，影像拾取系統透鏡組中最大視角的一半為 HFOV，其數值為：f = 1.17 (毫米)，Fno = 2.20，HFOV = 46.7 (度)。

該第一透鏡(110)的色散係數為 V1，其關係式為：V1 = 21.4。

該第二透鏡(120)於光軸上的厚度為 CT2，該第一透鏡(110)於光軸上的厚度為 CT1，該第三透鏡(130)於光軸上的厚度為 CT3，該第四透鏡(140)於光軸上的厚度為 CT4，其關係式為： $CT2 / (CT1+CT3+CT4) = 0.69$ 。

5 該第二透鏡物側面(121)的曲率半徑為 R3，該第二透鏡像側面(122)的曲率半徑為 R4，其關係式為： $(R3+R4) / (R3-R4) = 0.85$ 。

該影像拾取系統透鏡組的焦距為 f，該第一透鏡(110)的焦距為 f1，其關係式為： $f / f1 = 0.12$ 。

10 該第二透鏡(120)的焦距為 f2，該第三透鏡(130)的焦距為 f3，其關係式為： $f2 / f3 = -0.77$ 。

該影像拾取系統透鏡組的焦距為 f，該第四透鏡(140)的焦距為 f4，其關係式為： $|f / f4| = 0.77$ 。

該影像拾取系統透鏡組的焦距為 f，該第三透鏡(130)的焦距為 f3，其關係式為： $f / f3 = -1.10$ 。

15 該第一透鏡物側面(111)至該第四透鏡像側面(142)於光軸上的距離為 Td，其關係式為： $Td = 1.850$ (毫米)。

該第一透鏡(110)、該第二透鏡(120)、該第三透鏡(130)、及該第四透鏡(140)於光軸上之厚度的總合為 ΣCT ，該第一透鏡物側面(111)至該第四透鏡像側面(142)於光軸上的距離為 Td，其關係式為： $\Sigma CT / Td = 0.89$ 。

20 該第一透鏡物側面(111)至該第四透鏡像側面(142)於光軸上的距離為 Td，該影像拾取系統透鏡組中最大視角的一半為 HFOV，其關係式為： $Td / \tan(HFOV) = 1.74$ (毫米)。

25 該影像拾取系統透鏡組的最大視角為 FOV，其關係式為： $FOV = 93.4$ (度)。

《第二實施例》

本發明第二實施例請參閱第二 A 圖，第二實施例的像差曲線請參閱第二 B 圖。第二實施例的取像裝置包含影像拾取系統透鏡

組與一電子感光元件(270)，該影像拾取系統透鏡組主要由四片具屈折力的透鏡構成，由物側至像側依序包含：

一具正屈折力的第一透鏡(210)，其材質為塑膠，其物側面(211)於近光軸處為凸面，其像側面(212)於近光軸處為凹面，且其兩面皆為非球面；

一具正屈折力的第二透鏡(220)，其材質為塑膠，其物側面(221)於近光軸處為凸面，其像側面(222)於近光軸處為凸面，且其兩面皆為非球面；

一具負屈折力的第三透鏡(230)，其材質為塑膠，其物側面(231)於近光軸處為凹面，其像側面(232)於近光軸處為凸面，且其兩面皆為非球面；及

一具正屈折力的第四透鏡(240)，其材質為塑膠，其物側面(241)於近光軸處為凸面，其像側面(242)於近光軸處為凹面，其兩面皆為非球面，且其像側面(242)於離軸處具有至少一凸面；

其中，該影像拾取系統透鏡組另設置有一光圈(200)，置於該第一透鏡(210)與該第二透鏡(220)間；另包含有一紅外線濾除濾光元件(250)置於該第四透鏡(240)與一成像面(260)間，其材質為玻璃且不影響焦距。

其中，該電子感光元件(270)設置於該成像面(260)上。

第二實施例詳細的光學數據如表三所示，其非球面數據如表四所示，其中曲率半徑、厚度及焦距的單位為毫米，HFOV 定義為最大視角的一半。

表三								
(第二實施例)								
$f = 1.23 \text{ mm}$, $Fno = 2.45$, $HFOV = 45.6 \text{ deg.}$								
表面 #		曲率半徑		厚度	材質	折射率	色散係數	焦距
0	被攝物	平面		無限				
1	第一透鏡	1.728	ASP	0.217	塑膠	1.640	22.0	1207.16
2		1.647	ASP	0.041				
3	光圈	平面		0.020				

4	第二透鏡	2.201	ASP	0.685	塑膠	1.544	55.9	0.78
5		-0.465	ASP	0.138				
6	第三透鏡	-0.213	ASP	0.222	塑膠	1.634	23.8	-0.90
7		-0.479	ASP	0.030				
8	第四透鏡	0.691	ASP	0.430	塑膠	1.535	55.7	1.40
9		7.112	ASP	0.300				
10	紅外線濾除	平面		0.300	玻璃	1.517	64.2	-
11	濾光片	平面		0.171				
12	成像面	平面		-				

註：參考波長為 d-line 587.6 nm

表四				
非球面係數				
表面 #	1	2	4	5
k =	-7.8611E-01	2.2256E+01	4.4287E+01	-6.8249E-01
A4 =	2.7433E-01	3.5449E-01	-1.1581E+00	-5.9944E-01
A6 =	-1.5466E+00	-2.9377E+01	8.9406E-01	3.6061E-01
A8 =	4.7455E+01	6.4129E+02	4.1870E+01	1.6896E+01
A10 =	-6.0092E+02	-3.8207E+03	-7.3180E+03	-3.8194E+02
A12 =	4.0961E+03	-1.6432E+05	1.3290E+05	3.0043E+03
A14 =	-1.4631E+04	3.1882E+06	-1.1481E+06	-1.0680E+04
A16 =	2.0715E+04	-1.7563E+07	3.7732E+06	1.3826E+04
表面 #	6	7	8	9
k =	-1.0107E+00	-3.0532E+00	-7.4231E-01	2.2155E+01
A4 =	3.8803E+00	-1.7079E+00	-1.1152E+00	1.6267E+00
A6 =	-4.2860E+00	8.7245E+00	2.9613E+00	-4.5228E+00
A8 =	-1.1314E+02	-3.7291E+01	-9.2058E+00	6.4630E+00
A10 =	1.5859E+03	1.7181E+02	1.7048E+01	-5.8730E+00
A12 =	-8.7686E+03	-4.8143E+02	-1.9563E+01	3.4083E+00
A14 =	2.3054E+04	6.7878E+02	1.3110E+01	-1.1920E+00
A16 =	-2.3557E+04	-3.6776E+02	-4.1607E+00	1.9105E-01

第二實施例非球面曲線方程式的表示如同第一實施例的形式。此外，各個關係式的參數係如同第一實施例所闡釋，惟各個關係式的數值係如表五中所列。

表五			
第二實施例			
f [mm]	1.23	Ω/Ω	-0.87
Fno	2.45	$ f/f_4 $	0.88
HFOV [deg.]	45.6	f/f_3	-1.37

V1	22.0	Td [mm]	1.783
CT2/(CT1+CT3+CT4)	0.79	$\Sigma CT/Td$	0.87
(R3+R4)/(R3-R4)	0.65	Td/tan(HFOV) [mm]	1.75
f/f1	0.00	FOV [deg.]	91.2

《第三實施例》

本發明第三實施例請參閱第三 A 圖，第三實施例的像差曲線請參閱第三 B 圖。第三實施例的取像裝置包含影像拾取系統透鏡組與一電子感光元件(370)，該影像拾取系統透鏡組主要由四片具屈折力的透鏡構成，由物側至像側依序包含：

一具正屈折力的第一透鏡(310)，其材質為塑膠，其物側面(311)於近光軸處為凸面，其像側面(312)於近光軸處為凹面，且其兩面皆為非球面；

一具正屈折力的第二透鏡(320)，其材質為塑膠，其物側面(321)於近光軸處為凹面，其像側面(322)於近光軸處為凸面，且其兩面皆為非球面；

一具負屈折力的第三透鏡(330)，其材質為塑膠，其物側面(331)於近光軸處為凹面，其像側面(332)於近光軸處為凸面，且其兩面皆為非球面；及

一具正屈折力的第四透鏡(340)，其材質為塑膠，其物側面(341)於近光軸處為凸面，其像側面(342)於近光軸處為凹面，其兩面皆為非球面，且其像側面(342)於離軸處具有至少一凸面；

其中，該影像拾取系統透鏡組另設置有一光圈(300)，置於該第一透鏡(310)與該第二透鏡(320)間；另包含有一紅外線濾除濾光元件(350)置於該第四透鏡(340)與一成像面(360)間，其材質為玻璃且不影響焦距。

其中，該電子感光元件(370)設置於該成像面(360)上。

第三實施例詳細的光學數據如表六所示，其非球面數據如表七所示，其中曲率半徑、厚度及焦距的單位為毫米，HFOV 定義為最大視角的一半。

表六								
(第三實施例)								
$f = 1.66 \text{ mm}$, $Fno = 2.15$, $HFOV = 46.8 \text{ deg.}$								
表面 #		曲率半徑		厚度	材質	折射率	色散係數	焦距
0	被攝物	平面		無限				
1	第一透鏡	1.333	ASP	0.286	塑膠	1.544	55.9	2.50
2		59.851	ASP	0.005				
3	光圈	平面		0.195				
4	第二透鏡	-1.920	ASP	0.409	塑膠	1.544	55.9	1.60
5		-0.644	ASP	0.156				
6	第三透鏡	-0.263	ASP	0.200	塑膠	1.650	21.4	-1.49
7		-0.470	ASP	0.030				
8	第四透鏡	0.677	ASP	0.363	塑膠	1.535	55.7	2.33
9		1.206	ASP	0.400				
10	紅外線濾除	平面		0.175	玻璃	1.517	64.2	-
11	濾光片	平面		0.431				
12	成像面	平面		-				
註：參考波長為 d-line 587.6 nm								
第 1 面有效半徑為 0.510 mm								

表七				
非球面係數				
表面 #	1	2	4	5
k =	-2.4704E+00	9.0000E+01	5.8947E+00	-3.7972E-01
A4 =	-3.4848E-02	-3.8775E-01	-9.3075E-01	-3.3741E-01
A6 =	-4.4471E-01	-2.8417E+00	3.6516E+00	9.2277E-01
A8 =	-4.9925E-01	1.8185E+01	-4.0769E+01	-3.9461E+00
A10 =	-1.2166E+01	-2.0954E+01	-4.4351E+00	-1.9037E+01
A12 =	3.9114E+01	-1.4998E+03	1.2130E+03	4.9148E+01
A14 =	-1.7950E+02	1.2389E+04	-4.4615E+03	1.0076E+02
A16 =	3.3572E+02	-2.9058E+04	6.2425E+03	8.0489E+01
表面 #	6	7	8	9
k =	-1.1491E+00	-2.3808E+00	-1.7649E+00	-1.0689E+01
A4 =	4.2079E+00	2.1562E-01	-6.9591E-01	9.1971E-01
A6 =	-2.8310E+01	-4.4239E+00	1.2041E+00	-3.0958E+00
A8 =	1.2287E+02	1.8790E+01	-2.9023E+00	4.8713E+00
A10 =	-3.9035E+02	-4.1840E+01	4.4195E+00	-4.6279E+00
A12 =	8.5064E+02	5.5883E+01	-3.7857E+00	2.6418E+00
A14 =	-9.7331E+02	-4.0255E+01	1.6532E+00	-8.3581E-01
A16 =	4.7213E+02	1.4428E+01	-2.8192E-01	1.1204E-01

第三實施例非球面曲線方程式的表示如同第一實施例的形式。此外，各個關係式的參數係如同第一實施例所闡釋，惟各個關係式的數值係如表八中所列。

表八			
第三實施例			
f [mm]	1.66	φ_2/φ_3	-1.07
Fno	2.15	$ f/f_4 $	0.71
HFOV [deg.]	46.8	f/φ_3	-1.11
V1	55.9	Td [mm]	1.644
$CT_2/(CT_1+CT_3+CT_4)$	0.48	$\Sigma CT/Td$	0.77
$(R_3+R_4)/(R_3-R_4)$	2.01	$Td/\tan(HFOV)$ [mm]	1.54
f/φ_1	0.66	FOV [deg.]	93.6

5

《第四實施例》

本發明第四實施例請參閱第四 A 圖，第四實施例的像差曲線請參閱第四 B 圖。第四實施例的取像裝置包含影像拾取系統透鏡組與一電子感光元件(470)，該影像拾取系統透鏡組主要由四片具屈折力的透鏡構成，由物側至像側依序包含：

10

一具負屈折力的第一透鏡(410)，其材質為塑膠，其物側面(411)於近光軸處為凸面，其像側面(412)於近光軸處為凹面，且其兩面皆為非球面；

一具正屈折力的第二透鏡(420)，其材質為塑膠，其物側面(421)於近光軸處為凸面，其像側面(422)於近光軸處為凸面，且其兩面皆為非球面；

15

一具負屈折力的第三透鏡(430)，其材質為塑膠，其物側面(431)於近光軸處為凹面，其像側面(432)於近光軸處為凸面，且其兩面皆為非球面；及

一具正屈折力的第四透鏡(440)，其材質為塑膠，其物側面(441)於近光軸處為凸面，其像側面(442)於近光軸處為凹面，其兩面皆為非球面，且其像側面(442)於離軸處具有至少一凸面；

20

其中，該影像拾取系統透鏡組另設置有一光圈(400)，置於該第一透鏡(410)與該第二透鏡(420)間；另包含有一紅外線濾除濾光元件(450)置於該第四透鏡(440)與一成像面(460)間，其材質為玻璃且不影響焦距。

5 其中，該電子感光元件(470)設置於該成像面(460)上。

第四實施例詳細的光學數據如表九所示，其非球面數據如表十所示，其中曲率半徑、厚度及焦距的單位為毫米，HFOV 定義為最大視角的一半。

表九								
(第四實施例)								
$f = 1.15 \text{ mm}$, $Fno = 2.22$, $HFOV = 48.5 \text{ deg.}$								
表面 #		曲率半徑		厚度	材質	折射率	色散係數	焦距
0	被攝物	平面		無限				
1	第一透鏡	1.999	ASP	0.200	塑膠	1.544	55.9	-46.83
2		1.789	ASP	0.021				
3	光圈	平面		0.037				
4	第二透鏡	1.606	ASP	0.471	塑膠	1.544	55.9	0.81
5		-0.543	ASP	0.184				
6	第三透鏡	-0.207	ASP	0.209	塑膠	1.634	23.8	-1.22
7		-0.393	ASP	0.030				
8	第四透鏡	0.747	ASP	0.319	塑膠	1.535	55.7	1.62
9		4.607	ASP	0.300				
10	紅外線濾除	平面		0.300	玻璃	1.517	64.2	-
11	濾光片	平面		0.130				
12	成像面	平面		-				

註：參考波長為 d-line 587.6 nm

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表十				
非球面係數				
表面 #	1	2	4	5
k =	-2.2996E+01	3.4247E+01	9.8701E+00	-4.2975E-01
A4 =	-2.1353E-01	-2.0670E+00	-2.2221E+00	-6.3795E-01
A6 =	-3.6880E+00	-3.6063E+01	-8.7081E+00	-6.5092E+00
A8 =	5.2789E+01	6.9201E+02	1.4888E+02	4.6114E+01
A10 =	-6.4083E+02	-4.8238E+03	-8.2602E+03	-4.7532E+02
A12 =	4.0983E+03	-1.6432E+05	1.3290E+05	3.0044E+03

A14 =	-1.4631E+04	3.1882E+06	-1.1481E+06	-1.0679E+04
A16 =	2.0715E+04	-1.7563E+07	3.7732E+06	1.3828E+04
表面 #	6	7	8	9
k =	-1.0439E+00	-2.0056E+00	-6.4024E-01	-3.3636E+00
A4 =	4.2327E+00	-9.7476E-01	-8.3147E-01	1.0958E+00
A6 =	-3.4551E+00	1.0236E+01	2.1761E+00	-1.7086E+00
A8 =	-1.0303E+02	-3.7610E+01	-4.8336E+00	1.3575E+00
A10 =	1.5970E+03	1.6620E+02	5.0397E+00	-2.6285E+00
A12 =	-8.9315E+03	-4.9093E+02	-4.1411E+00	4.3863E+00
A14 =	2.3054E+04	6.8046E+02	3.4069E+00	-3.3963E+00
A16 =	-2.3558E+04	-3.4010E+02	-1.6576E+00	9.5967E-01

第四實施例非球面曲線方程式的表示如同第一實施例的形式。此外，各個關係式的參數係如同第一實施例所闡釋，惟各個關係式的數值係如表十一中所列。

表十一			
第四實施例			
f [mm]	1.15	Ω/Ω_3	-0.66
Fno	2.22	$ f/f_4 $	0.71
HFOV [deg.]	48.5	f/Ω_3	-0.94
V1	55.9	Td [mm]	1.471
CT2/(CT1+CT3+CT4)	0.65	$\Sigma CT/Td$	0.82
(R3+R4)/(R3-R4)	0.49	Td/tan(HFOV) [mm]	1.30
f/f_1	-0.02	FOV [deg.]	97.0

5

《第五實施例》

本發明第五實施例請參閱第五 A 圖，第五實施例的像差曲線請參閱第五 B 圖。第五實施例的取像裝置包含該影像拾取系統透鏡組與一電子感光元件(570)，該影像拾取系統透鏡組主要由四片具屈折力的透鏡構成，由物側至像側依序包含：

10

一具負屈折力的第一透鏡(510)，其材質為玻璃，其物側面(511)於近光軸處為凸面，其像側面(512)於近光軸處為凹面，且其兩面皆為非球面；

一具正屈折力的第二透鏡(520)，其材質為玻璃，其物側面(521)於近光軸處為凸面，其像側面(522)於近光軸處為凸面，且

15

其兩面皆為非球面；

一具負屈折力的第三透鏡(530)，其材質為塑膠，其物側面(531)於近光軸處為凹面，其像側面(532)於近光軸處為凸面，且其兩面皆為非球面；及

- 5 一具正屈折力的第四透鏡(540)，其材質為塑膠，其物側面(541)於近光軸處為凸面，其像側面(542)於近光軸處為凹面，其兩面皆為非球面，且其像側面(542)於離軸處具有至少一凸面；

- 10 其中，該影像拾取系統透鏡組另設置有一光圈(500)，置於該第一透鏡(510)與該第二透鏡(520)間；另包含有一紅外線濾除濾光元件(550)置於該第四透鏡(540)與一成像面(560)間，其材質為玻璃且不影響焦距。

其中，該電子感光元件(570)設置於該成像面(560)上。

- 15 第五實施例詳細的光學數據如表十二所示，其非球面數據如表十三所示，其中曲率半徑、厚度及焦距的單位為毫米，HFOV定義為最大視角的一半。

表十二								
(第五實施例)								
$f = 2.24 \text{ mm}$, $Fno = 2.51$, $HFOV = 44.2 \text{ deg.}$								
表面 #		曲率半徑		厚度	材質	折射率	色散係數	焦距
0	被攝物	平面		無限				
1	第一透鏡	1.367	ASP	0.300	玻璃	2.144	17.8	-13.68
2		1.110	ASP	0.144				
3	光圈	平面		-0.015				
4	第二透鏡	3.909	ASP	1.483	玻璃	1.525	70.3	1.60
5		-0.932	ASP	0.325				
6	第三透鏡	-0.341	ASP	0.277	塑膠	1.639	23.5	-1.72
7		-0.651	ASP	0.030				
8	第四透鏡	0.897	ASP	0.606	塑膠	1.565	57.0	2.00
9		3.302	ASP	0.800				
10	紅外線濾除	平面		0.300	玻璃	1.517	64.2	-
11	濾光片	平面		0.342				
12	成像面	平面		-				
註：參考波長為 d-line 587.6 nm								

表十三				
非球面係數				
表面 #	1	2	4	5
k =	1.1992E+00	1.9195E+00	2.1734E+01	-7.2786E-01
A4 =	5.8324E-02	1.2422E-01	-9.9032E-02	-1.2252E-01
A6 =	-1.4402E-01	-5.2189E-01	5.9983E+00	5.2990E-01
A8 =	1.0028E+00	4.2713E+00	-1.1966E+02	-3.0301E+00
A10 =	-4.0021E+00	1.8016E+01	1.4083E+03	7.9248E+00
A12 =	8.9035E+00	-4.2193E+02	-9.4428E+03	-1.0795E+01
A14 =	-9.8479E+00	2.2697E+03	3.3923E+04	6.3429E+00
A16 =	3.0263E+00	-4.1004E+03	-5.0610E+04	-8.0066E-01
表面 #	6	7	8	9
k =	-9.8774E-01	-3.1767E+00	-8.3817E-01	-2.4331E+01
A4 =	2.5606E+00	-1.2881E-01	-4.2259E-01	3.5717E-01
A6 =	-7.9740E+00	-6.6170E-01	4.3675E-01	-4.5759E-01
A8 =	1.4853E+01	1.1888E+00	-4.6275E-01	2.9937E-01
A10 =	-1.1480E+01	-4.2607E-01	3.1380E-01	-1.1921E-01
A12 =	-4.4740E+00	-5.1720E-01	-1.2912E-01	2.8364E-02
A14 =	1.2594E+01	5.0722E-01	2.9275E-02	-3.7104E-03
A16 =	-5.4160E+00	-1.2485E-01	-2.8533E-03	2.0238E-04

第五實施例非球面曲線方程式的表示如同第一實施例的形式。此外，各個關係式的參數係如同第一實施例所闡釋，惟各個關係式的數值係如表十四中所列。

表十四			
第五實施例			
f [mm]	2.24	ℓ_2/ℓ_3	-0.93
Fno	2.51	$ \ell/\ell_4 $	1.12
HFOV [deg.]	44.2	ℓ/ℓ_3	-1.30
V1	17.8	Td [mm]	3.150
CT2/(CT1+CT3+CT4)	1.25	$\Sigma CT/Td$	0.85
(R3+R4)/(R3-R4)	0.61	Td/tan(HFOV) [mm]	3.24
ℓ/ℓ_1	-0.16	FOV [deg.]	88.4

《第六實施例》

本發明第六實施例請參閱第六 A 圖，第六實施例的像差曲線請參閱第六 B 圖。第六實施例的取像裝置包含影像拾取系統透鏡

組與一電子感光元件(670)，該影像拾取系統透鏡組主要由四片具屈折力的透鏡構成，由物側至像側依序包含：

一具正屈折力的第一透鏡(610)，其材質為塑膠，其物側面(611)於近光軸處為凸面，其像側面(612)於近光軸處為凸面，且其兩面皆為非球面；

一具正屈折力的第二透鏡(620)，其材質為塑膠，其物側面(621)於近光軸處為凹面，其像側面(622)於近光軸處為凸面，且其兩面皆為非球面；

一具負屈折力的第三透鏡(630)，其材質為塑膠，其物側面(631)於近光軸處為凹面，其像側面(632)於近光軸處為凸面，且其兩面皆為非球面；及

一具正屈折力的第四透鏡(640)，其材質為塑膠，其物側面(641)於近光軸處為凸面，其像側面(642)於近光軸處為凹面，其兩面皆為非球面，且其像側面(642)於離軸處具有至少一凸面；

其中，該影像拾取系統透鏡組另設置有一光圈(600)，置於該第一透鏡(610)與該第二透鏡(620)間；另包含有一紅外線濾除濾光元件(650)置於該第四透鏡(640)與一成像面(660)間，其材質為玻璃且不影響焦距。

其中，該電子感光元件(670)設置於該成像面(660)上。

第六實施例詳細的光學數據如表十五所示，其非球面數據如表十六所示，其中曲率半徑、厚度及焦距的單位為毫米，HFOV定義為最大視角的一半。

表十五								
(第六實施例)								
$f = 1.27 \text{ mm}$, $Fno = 2.10$, $HFOV = 44.4 \text{ deg.}$								
表面 #		曲率半徑		厚度	材質	折射率	色散係數	焦距
0	被攝物	平面		無限				
1	第一透鏡	2.393	ASP	0.280	塑膠	1.544	55.9	3.85
2		-16.057	ASP	0.017				
3	光圈	平面		0.044				

4	第二透鏡	-30.373	ASP	0.755	塑膠	1.544	55.9	0.87
5		-0.468	ASP	0.121				
6	第三透鏡	-0.246	ASP	0.240	塑膠	1.639	23.5	-0.90
7		-0.594	ASP	0.030				
8	第四透鏡	0.639	ASP	0.522	塑膠	1.530	55.8	1.47
9		2.521	ASP	0.400				
10	紅外線濾除	平面		0.175	玻璃	1.517	64.2	-
11	濾光片	平面		0.073				
12	成像面	平面		-				

註：參考波長為 d-line 587.6 nm

表十六				
非球面係數				
表面 #	1	2	4	5
k =	1.7241E+00	-8.9754E+01	-9.0000E+01	-7.5923E-01
A4 =	2.1410E-01	1.4516E+00	1.5168E-01	-5.4982E-01
A6 =	-2.3810E-01	-1.0826E+01	4.8929E+00	2.0791E+00
A8 =	2.3555E+01	1.9495E+02	-3.2116E+01	8.2787E-01
A10 =	-2.5034E+02	-5.1780E+02	-2.6801E+03	-1.4893E+02
A12 =	1.4357E+03	-5.7593E+04	4.6579E+04	1.0534E+03
A14 =	-4.2381E+03	9.2351E+05	-3.3256E+05	-3.0936E+03
A16 =	4.9589E+03	-4.2045E+06	9.0327E+05	3.3098E+03
表面 #	6	7	8	9
k =	-9.9704E-01	-3.7851E+00	-7.3474E-01	-2.0751E+00
A4 =	2.9255E+00	-1.3600E+00	-1.2133E+00	1.8260E+00
A6 =	-2.4852E+00	5.5927E+00	3.0817E+00	-5.9653E+00
A8 =	-5.7718E+01	-1.8755E+01	-1.0034E+01	9.6816E+00
A10 =	6.7135E+02	7.3016E+01	1.9498E+01	-9.2466E+00
A12 =	-3.0733E+03	-1.6937E+02	-2.1549E+01	5.1894E+00
A14 =	6.6780E+03	1.9522E+02	1.2590E+01	-1.5760E+00
A16 =	-5.6393E+03	-8.6932E+01	-3.0510E+00	1.9769E-01

5 第六實施例非球面曲線方程式的表示如同第一實施例的形式。此外，各個關係式的參數係如同第一實施例所闡釋，惟各個關係式的數值係如表十七中所列。

表十七			
第六實施例			
f [mm]	1.27	f2/f3	-0.97
Fno	2.10	f/f4	0.86
HFOV [deg.]	44.4	f/f3	-1.41

V1	55.9	Td [mm]	2.009
CT2/(CT1+CT3+CT4)	0.72	$\Sigma CT/Td$	0.89
(R3+R4)/(R3-R4)	1.03	Td/tan(HFOV) [mm]	2.05
f/ℓ	0.33	FOV [deg.]	88.8

《第七實施例》

本發明第七實施例請參閱第七 A 圖，第一實施例的像差曲線請參閱第七 B 圖。第七實施例的取像裝置包含影像拾取系統透鏡組與一電子感光元件(770)，該影像拾取系統透鏡組主要由四片具屈折力的透鏡構成，由物側至像側依序包含：

一具正屈折力的第一透鏡(710)，其材質為塑膠，其物側面(711)於近光軸處為凸面，其像側面(712)於近光軸處為凹面，且其兩面皆為非球面；

一具正屈折力的第二透鏡(720)，其材質為塑膠，其物側面(721)於近光軸處為凹面，其像側面(722)於近光軸處為凸面，且其兩面皆為非球面；

一具負屈折力的第三透鏡(730)，其材質為塑膠，其物側面(731)於近光軸處為凹面，其像側面(732)於近光軸處為凸面，且其兩面皆為非球面；及

一具正屈折力的第四透鏡(740)，其材質為塑膠，其物側面(741)於近光軸處為凸面，其像側面(742)於近光軸處為凹面，其兩面皆為非球面，且其像側面(742)於離軸處具有至少一凸面；

其中，該影像拾取系統透鏡組另設置有一光圈(700)，置於一被攝物與該第一透鏡(710)間；另包含有一紅外線濾除濾光元件(750)置於該第四透鏡(740)與一成像面(760)間，其材質為玻璃且不影響焦距。

其中，該電子感光元件(770)設置於該成像面(760)上。

第七實施例詳細的光學數據如表十八所示，其非球面數據如表十九所示，其中曲率半徑、厚度及焦距的單位為毫米，HFOV 定義為最大視角的一半。

表十八								
(第七實施例)								
$f = 1.57 \text{ mm}$, $Fno = 2.05$, $HFOV = 48.5 \text{ deg.}$								
表面 #		曲率半徑		厚度	材質	折射率	色散係數	焦距
0	被攝物	平面		無限				
1	光圈	平面		-0.052				
2	第一透鏡	1.142	ASP	0.279	塑膠	1.544	55.9	2.84
3		4.008	ASP	0.159				
4	第二透鏡	-4.075	ASP	0.614	塑膠	1.544	55.9	1.24
5		-0.608	ASP	0.142				
6	第三透鏡	-0.255	ASP	0.230	塑膠	1.634	23.8	-1.37
7		-0.487	ASP	0.030				
8	第四透鏡	0.636	ASP	0.414	塑膠	1.535	55.7	2.35
9		0.998	ASP	0.500				
10	紅外線濾除	平面		0.175	玻璃	1.517	64.2	-
11	濾光片	平面		0.141				
12	成像面	平面						

註：參考波長為 d-line 587.6 nm

表十九				
非球面係數				
表面 #	2	3	4	5
k =	-5.4318E-01	6.9324E+01	6.0179E+01	-4.8138E-01
A4 =	1.1275E-01	-3.4138E-01	-6.6571E-01	-8.5384E-02
A6 =	-1.4350E+00	-2.7321E+00	4.9846E-01	-6.6518E-01
A8 =	6.0529E+00	2.0740E+01	-4.5807E+00	-2.1554E-01
A10 =	4.7148E+01	-7.0776E+01	-1.7027E+02	-7.9977E+00
A12 =	-1.4571E+02	-1.4998E+03	1.2130E+03	2.5638E+01
A14 =	-3.8164E+03	1.2389E+04	-4.4615E+03	-4.3167E+01
A16 =	1.5882E+04	-2.9058E+04	6.2425E+03	7.2938E+01
表面 #	6	7	8	9
k =	-1.1103E+00	-3.0258E+00	-9.3042E-01	-5.1455E+00
A4 =	5.4423E+00	4.5345E-01	-7.7223E-01	7.0200E-01
A6 =	-3.5666E+01	-4.9768E+00	9.4468E-01	-1.5850E+00
A8 =	1.3446E+02	1.9752E+01	-1.3669E+00	1.7028E+00
A10 =	-2.5131E+02	-4.2912E+01	1.1409E+00	-1.1082E+00
A12 =	-7.3665E+01	5.3544E+01	-5.2307E-01	4.3302E-01
A14 =	1.1117E+03	-3.5702E+01	1.2365E-01	-9.2838E-02
A16 =	-1.2600E+03	1.0063E+01	-1.1645E-02	8.3092E-03

第七實施例非球面曲線方程式的表示如同第一實施例的形式。此外，各個關係式的參數係如同第一實施例所闡釋，惟各個關係式的數值係如表二十中所列。

表二十			
第七實施例			
f [mm]	1.57	$f2/f3$	-0.91
Fno	2.05	$ f/f4 $	0.67
HFOV [deg.]	48.5	$f/f3$	-1.15
$V1$	55.9	Td [mm]	1.868
$CT2/(CT1+CT3+CT4)$	0.67	$\Sigma CT/Td$	0.82
$(R3+R4)/(R3-R4)$	1.35	$Td/\tan(HFOV)$ [mm]	1.65
$f/f1$	0.55	FOV [deg.]	97.0

5

《第八實施例》

本發明第八實施例請參閱第八 A 圖，第八實施例的像差曲線請參閱第八 B 圖。第八實施例的取像裝置包含影像拾取系統透鏡組與一電子感光元件(870)，該影像拾取系統透鏡組主要由四片具屈折力的透鏡構成，由物側至像側依序包含：

10

一具正屈折力的第一透鏡(810)，其材質為塑膠，其物側面(811)於近光軸處為凸面，其像側面(812)於近光軸處為凹面，且其兩面皆為非球面；

15

一具正屈折力的第二透鏡(820)，其材質為塑膠，其物側面(821)於近光軸處為凹面，其像側面(822)於近光軸處為凸面，且其兩面皆為非球面；

一具負屈折力的第三透鏡(830)，其材質為塑膠，其物側面(831)於近光軸處為凹面，其像側面(832)於近光軸處為凸面，且其兩面皆為非球面；及

20

一具正屈折力的第四透鏡(840)，其材質為塑膠，其物側面(841)於近光軸處為凸面，其像側面(842)於近光軸處為凹面，其兩面皆為非球面，且其像側面(842)於離軸處具有至少一凸面；

其中，該影像拾取系統透鏡組另設置有一光圈(800)，置於該第一透鏡(810)與該第二透鏡(820)間；另包含有一紅外線濾除濾光元件(850)置於該第四透鏡(840)與一成像面(860)間，其材質為玻璃且不影響焦距。

5 其中，該電子感光元件(870)設置於該成像面(860)上。

第八實施例詳細的光學數據如表二十一所示，其非球面數據如表二十二所示，其中曲率半徑、厚度及焦距的單位為毫米，HFOV 定義為最大視角的一半。

表二十一								
(第八實施例)								
$f = 1.68 \text{ mm}$, $Fno = 2.10$, $HFOV = 46.0 \text{ deg.}$								
表面 #		曲率半徑		厚度	材質	折射率	色散係數	焦距
0	被攝物	平面		無限				
1	第一透鏡	1.787	ASP	0.278	塑膠	1.544	55.9	3.81
2		12.133	ASP	0.022				
3	光圈	平面		0.145				
4	第二透鏡	-3.839	ASP	0.668	塑膠	1.544	55.9	1.38
5		-0.668	ASP	0.194				
6	第三透鏡	-0.273	ASP	0.230	塑膠	1.639	23.5	-1.18
7		-0.569	ASP	0.030				
8	第四透鏡	0.784	ASP	0.496	塑膠	1.530	55.8	1.65
9		5.992	ASP	0.400				
10	紅外線濾除	平面		0.175	玻璃	1.517	64.2	-
11	濾光片	平面		0.472				
12	成像面	平面		-				

註：參考波長為 d-line 587.6 nm

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表二十二				
非球面係數				
表面 #	1	2	4	5
k =	-1.3232E+00	5.3151E+01	5.1693E+01	-5.9308E-01
A4 =	1.6281E-02	-1.2122E-02	-2.5602E-01	-1.1508E-01
A6 =	1.5823E-01	-1.1940E+00	-1.0332E+00	-6.8787E-01
A8 =	5.9941E-01	1.2093E+01	1.0464E+01	-9.7964E-02
A10 =	-1.3812E+01	-2.0003E+01	-1.9940E+02	-6.2734E+00
A12 =	4.5317E+01	-1.4998E+03	1.2130E+03	2.8529E+01

A14 =	-4.4460E+01	1.2389E+04	-4.4615E+03	-4.4589E+01
A16 =	-4.7734E+01	-2.9058E+04	6.2425E+03	2.7908E+01
表面 #	6	7	8	9
k =	-1.0578E+00	-3.0032E+00	-8.6121E-01	5.6610E+00
A4 =	4.0391E+00	9.4553E-02	-6.6716E-01	7.7788E-01
A6 =	-2.6571E+01	-4.4170E+00	1.1395E+00	-1.2944E+00
A8 =	1.2417E+02	1.9085E+01	-1.7698E+00	1.0967E+00
A10 =	-3.9394E+02	-4.1568E+01	1.6239E+00	-5.7605E-01
A12 =	8.2748E+02	5.5376E+01	-8.6944E-01	1.8609E-01
A14 =	-9.7331E+02	-4.1902E+01	2.5418E-01	-3.3617E-02
A16 =	4.7213E+02	1.3653E+01	-3.1838E-02	2.5144E-03

第八實施例非球面曲線方程式的表示如同第一實施例的形式。此外，各個關係式的參數係如同第一實施例所闡釋，惟各個關係式的數值係如表二十三中所列。

表二十三			
第八實施例			
f [mm]	1.68	Ω/Ω_3	-1.17
Fno	2.10	$ D/f_4 $	1.02
HFOV [deg.]	46.0	θ/f_3	-1.42
V1	55.9	Td [mm]	2.063
CT2/(CT1+CT3+CT4)	0.67	$\Sigma CT/Td$	0.81
$(R3+R4)/(R3-R4)$	1.42	Td/tan(HFOV) [mm]	1.99
θ/f_1	0.44	FOV [deg.]	92.0

5

《第九實施例》

本發明第九實施例請參閱第九 A 圖，第九實施例的像差曲線請參閱第九 B 圖。第一實施例的取像裝置包含影像拾取系統透鏡組與一電子感光元件(970)，該影像拾取系統透鏡組主要由四片具屈折力的透鏡構成，由物側至像側依序包含：

10

一具正屈折力的第一透鏡(910)，其材質為塑膠，其物側面(911)於近光軸處為凸面，其像側面(912)於近光軸處為凸面，且其兩面皆為非球面；

一具正屈折力的第二透鏡(920)，其材質為塑膠，其物側面(921)於近光軸處為凸面，其像側面(922)於近光軸處為凸面，且

15

其兩面皆為非球面；

一具負屈折力的第三透鏡(930)，其材質為塑膠，其物側面(931)於近光軸處為凹面，其像側面(932)於近光軸處為凸面，且其兩面皆為非球面；及

5 一具正屈折力的第四透鏡(940)，其材質為塑膠，其物側面(941)於近光軸處為凸面，其像側面(942)於近光軸處為凹面，其兩面皆為非球面，且其像側面(942)於離軸處具有至少一凸面；

其中，該影像拾取系統透鏡組另設置有一光圈(900)，置於該第一透鏡(910)與該第二透鏡(920)間；另包含有一紅外線濾除濾光元件(950)置於該第四透鏡(940)與一成像面(960)間，其材質為玻璃且不影響焦距。

其中，該電子感光元件(970)設置於該成像面(960)上。

第九實施例詳細的光學數據如表二十四所示，其非球面數據如表二十五所示，其中曲率半徑、厚度及焦距的單位為毫米，
15 HFOV 定義為最大視角的一半。

表二十四								
(第九實施例)								
$f = 0.92 \text{ mm}$, $Fno = 2.45$, $HFOV = 43.9 \text{ deg.}$								
表面 #		曲率半徑		厚度	材質	折射率	色散係數	焦距
0	被攝物	平面		無限				
1	第一透鏡	100.000	ASP	0.205	塑膠	1.633	23.4	13.12
2		-9.046	ASP	0.017				
3	光圈	平面		0.024				
4	第二透鏡	1.695	ASP	0.475	塑膠	1.544	55.9	0.54
5		-0.319	ASP	0.100				
6	第三透鏡	-0.148	ASP	0.160	塑膠	1.634	23.8	-0.65
7		-0.329	ASP	0.030				
8	第四透鏡	0.595	ASP	0.239	塑膠	1.530	55.8	1.28
9		4.109	ASP	0.300				
10	紅外線濾除	平面		0.145	玻璃	1.517	64.2	-
11	濾光片	平面		0.151				
12	成像面	平面		-				
註：參考波長為 d-line 587.6 nm								

表二十五				
非球面係數				
表面 #	1	2	4	5
k =	-9.0000E+01	9.0000E+01	3.3243E+01	-6.6437E-01
A4 =	2.5656E-01	2.4894E+00	-1.9077E+00	-1.5093E+00
A6 =	-1.0613E+00	-9.5530E+01	-1.3506E+01	4.3096E+00
A8 =	1.6769E+02	3.0126E+03	1.0928E+01	1.6065E+02
A10 =	-3.7307E+03	-2.3016E+04	-4.4021E+04	-2.9203E+03
A12 =	3.9786E+04	-1.5960E+06	1.2908E+06	2.9181E+04
A14 =	-2.1485E+05	4.6819E+07	-1.6860E+07	-1.5683E+05
A16 =	4.5990E+05	-3.8994E+08	8.3772E+07	3.0696E+05
表面 #	6	7	8	9
k =	-1.0921E+00	-2.4247E+00	-6.0015E-01	3.3921E+01
A4 =	8.8579E+00	-1.7457E+00	-1.8642E+00	3.4965E+00
A6 =	-9.7201E+00	2.7059E+01	4.2816E+00	-1.7965E+01
A8 =	-4.6210E+02	-1.6609E+02	-3.6842E+01	3.3243E+01
A10 =	1.0079E+04	1.0699E+03	9.4802E+01	-3.1178E+01
A12 =	-8.5169E+04	-4.7330E+03	-1.9140E+02	1.8452E+01
A14 =	3.3855E+05	1.0605E+04	3.6755E+02	-3.7397E+01
A16 =	-5.2300E+05	-7.7191E+03	-9.3365E+02	3.7762E+01

第九實施例非球面曲線方程式的表示如同第一實施例的形式。此外，各個關係式的參數係如同第一實施例所闡釋，惟各個關係式的數值係如表二十六中所列。

表二十六			
第九實施例			
f [mm]	0.92	f2/f3	-0.83
Fno	2.45	f/f4	0.72
HFOV [deg.]	43.9	f/f3	-1.42
V1	23.4	Td [mm]	1.250
CT2/(CT1+CT3+CT4)	0.79	ΣCT/Td	0.86
(R3+R4)/(R3-R4)	0.68	Td/tan(HFOV) [mm]	1.30
f/f1	0.07	FOV [deg.]	87.8

《第十實施例》

本發明第十實施例請參閱第十 A 圖，第十實施例的像差曲線請參閱第十 B 圖。第一實施例的取像裝置包含影像拾取系統透鏡

組與一電子感光元件(1070)，該影像拾取系統透鏡組主要由四片具屈折力的透鏡構成，由物側至像側依序包含：

5 一具正屈折力的第一透鏡(1010)，其材質為塑膠，其物側面(1011)於近光軸處為凸面，其像側面(1012)於近光軸處為凹面，且其兩面皆為非球面；

一具正屈折力的第二透鏡(1020)，其材質為塑膠，其物側面(1021)於近光軸處為凹面，其像側面(1022)於近光軸處為凸面，且其兩面皆為非球面；

10 一具負屈折力的第三透鏡(1030)，其材質為塑膠，其物側面(1031)於近光軸處為凹面，其像側面(1032)於近光軸處為凸面，且其兩面皆為非球面；及

一具正屈折力的第四透鏡(1040)，其材質為塑膠，其物側面(1041)於近光軸處為凸面，其像側面(1042)於近光軸處為凹面，其兩面皆為非球面，且其像側面(1042)於離軸處具有至少一凸面；

15 其中，該影像拾取系統透鏡組另設置有一光圈(1000)，置於一被攝物與該第一透鏡(1010)間；另包含有一紅外線濾除濾光元件(1050)置於該第四透鏡(1040)與一成像面(1060)間，其材質為玻璃且不影響焦距。

其中，該電子感光元件(1070)設置於該成像面(1060)上。

20 第十實施例詳細的光學數據如表二十七所示，其非球面數據如表二十八所示，其中曲率半徑、厚度及焦距的單位為毫米，HFOV 定義為最大視角的一半。

表二十七								
(第十實施例)								
$f = 1.80 \text{ mm}$, $F_{no} = 2.12$, $HFOV = 47.2 \text{ deg.}$								
表面 #		曲率半徑		厚度	材質	折射率	色散係數	焦距
0	被攝物	平面		無限				
1	光圈	平面		-0.060				
2	第一透鏡	1.246	ASP	0.289	塑膠	1.544	55.9	2.97
3		5.018	ASP	0.191				

4	第二透鏡	-3.749	ASP	0.593	塑膠	1.544	55.9	1.57
5		-0.733	ASP	0.156				
6	第三透鏡	-0.288	ASP	0.248	塑膠	1.634	23.8	-1.33
7		-0.584	ASP	0.030				
8	第四透鏡	0.704	ASP	0.601	塑膠	1.535	55.7	2.05
9		1.382	ASP	0.500				
10	紅外線濾除	平面		0.210	玻璃	1.517	64.2	-
11	濾光片	平面		0.198				
12	成像面	平面		-				
註：參考波長為 d-line 587.6 nm								
第 9 面有效半徑為 1.676 mm								

表二十八				
非球面係數				
表面 #	2	3	4	5
k =	-5.0585E-01	9.0000E+01	3.6143E+01	-3.9805E-01
A4 =	8.6099E-02	-2.2970E-01	-4.8540E-01	-1.5034E-01
A6 =	-9.1382E-01	-1.8900E+00	2.7508E-01	-5.1276E-01
A8 =	1.9706E+00	1.1233E+01	-2.0152E+00	-1.5742E-01
A10 =	1.9492E+01	-3.0654E+01	-6.3534E+01	-3.0117E+00
A12 =	-3.5519E+01	-4.4967E+02	3.6120E+02	7.3424E+00
A14 =	-8.0910E+02	2.9681E+03	-1.0702E+03	-1.0241E+01
A16 =	2.4600E+03	-5.5960E+03	1.2022E+03	1.7746E+01
表面 #	6	7	8	9
k =	-1.1070E+00	-2.9894E+00	-9.3316E-01	-5.2865E+00
A3 =			-1.4739E-01	5.0831E-01
A4 =	4.3809E+00	4.3352E-01	-3.5412E+00	2.6512E+00
A5 =			2.4672E-02	1.3099E-01
A6 =	-2.6437E+01	-3.7903E+00	1.0303E+01	-3.1255E+01
A7 =			3.7082E-02	2.0652E-01
A8 =	9.1296E+01	1.0965E+01	-3.1616E+01	1.1148E+02
A9 =			-2.2687E-03	-9.0797E-01
A10 =	-1.5853E+02	-1.4675E+01	6.3626E+01	-2.2327E+02
A11 =			-2.3794E-03	3.6058E-01
A12 =	8.3141E+00	7.7310E+00	-7.5604E+01	2.6201E+02
A13 =			8.0966E-03	1.7201E-01
A14 =	3.8963E+02	1.2159E+00	4.7652E+01	-1.7041E+02
A15 =			-5.5857E-02	1.0396E-01
A16 =	-3.9976E+02	-1.8447E+00	-1.2153E+01	4.7523E+01

第十實施例非球面曲線方程式的表示如同第一實施例的形

式。此外，各個關係式的參數係如同第一實施例所闡釋，惟各個關係式的數值係如表二十六中所列。

表二十九			
第十實施例			
f [mm]	1.80	ℓ_2/ℓ_3	-1.18
Fno	2.12	$ \ell/\ell_4 $	0.88
HFOV [deg.]	47.2	ℓ/ℓ_3	-1.35
$V1$	55.9	Td [mm]	2.108
$CT2/(CT1+CT3+CT4)$	0.52	$\Sigma CT/Td$	0.82
$(R3+R4)/(R3-R4)$	1.49	$Td/\tan(HFOV)$ [mm]	1.95
ℓ/ℓ_1	0.61	FOV [deg.]	94.4

表一至表二十九所示為本發明的影像拾取系統透鏡組實施例的不同數值變化表，然本發明各個實施例的數值變化皆屬實驗所得，即使使用不同數值，相同結構的產品仍應屬於本發明的保護範疇，故以上的說明所描述的及圖式僅做為例示性，非用以限制本發明的申請專利範圍。

【符號說明】

光圈 100、200、300、400、500、600、700、800、900、

1000

第一透鏡 110、210、310、410、510、610、710、810、910、

1010

物側面 111、211、311、411、511、611、711、811、911、

1011

像側面 112、212、312、412、512、612、712、812、912、

1012

第二透鏡 120、220、320、420、520、620、720、820、920、

1020

物側面 121、221、321、421、521、621、721、821、921、

	1021		
	像側面	122、222、322、422、522、622、722、822、922、	
	1022		
	第三透鏡	130、230、330、430、530、630、730、830、930、	
5	1030		
	物側面	131、231、331、431、531、631、731、831、931、	
	1031		
	像側面	132、322、332、432、532、632、732、832、932、	
	1032		
10	第四透鏡	140、240、340、440、540、640、740、840、940、	
	1040		
	物側面	141、241、341、441、541、641、741、841、941、	
	1041		
	像側面	142、422、342、442、542、642、742、842、942、	
15	1042		
	紅外線濾除濾光元件	150、250、350、450、550、650、	
		750、850、950、1050	
	成像面	160、260、360、460、560、660、760、860、960、	
	1060		
20	電子感光元件	170、270、370、470、570、670、770、870、	
		970、1070	
	取像裝置	1101	
	智慧型手機	1110	
	平板電腦	1120	
25	可穿戴式設備	1130	

影像拾取系統透鏡組的焦距為 f

第一透鏡的焦距為 f_1



第二透鏡的焦距為 f_2

第三透鏡的焦距為 f_3

第四透鏡的焦距為 f_4

第一透鏡的色散係數為 V_1

5 第一透鏡物側面至第四透鏡像側面於光軸上的距離為 T_d

第一透鏡於光軸上的厚度為 CT_1

第二透鏡於光軸上的厚度為 CT_2

第三透鏡於光軸上的厚度為 CT_3

第四透鏡於光軸上的厚度為 CT_4

10 第一透鏡、第二透鏡、第三透鏡、及第四透鏡於光軸上的厚度的總和為 $\sum CT$

第二透鏡物側面的曲率半徑為 R_3

第二透鏡像側面的曲率半徑為 R_4

影像拾取系統透鏡組的光圈值為 F_{no}

15 影像拾取系統透鏡組的最大視角為 FOV

影像拾取系統透鏡組中最大視角的一半為 $HFOV$

【生物材料寄存】

國內寄存資訊【請依寄存機構、日期、號碼順序註記】

20 無

國外寄存資訊【請依寄存國家、機構、日期、號碼順序註記】

無

申請專利範圍

1. 一種影像拾取系統透鏡組，由物側至像側依序包含：

一具屈折力的第一透鏡；

5 一具正屈折力的第二透鏡，其像側面於近光軸處為凸面；

一具負屈折力的第三透鏡，其物側面於近光軸處為凹面，其像側面於近光軸處為凸面；及

一具屈折力的第四透鏡，其像側面於近光軸處為凹面，其物側面及像側面皆為非球面，且其像側面於離軸處具有至少一凸面；

10 其中，該影像拾取系統透鏡組中具有屈折力的透鏡為四片；

其中，該第一透鏡物側面至該第四透鏡像側面於光軸上的距離為 T_d ，該影像拾取系統透鏡組中最大視角的一半為 $HFOV$ ，該影像拾取系統透鏡組的焦距為 f ，該第四透鏡的焦距為 f_4 ，該第二透鏡的焦距為 f_2 ，該第三透鏡的焦距為 f_3 ，係滿足下列關係式：

15 $0.5 \text{ mm} < T_d < 3.2 \text{ mm}$ ；

$1.0 \text{ mm} < T_d / \tan(HFOV) < 3.75 \text{ mm}$ ；

$|f / f_4| < 1.20$ ；及

$f_2 / f_3 < -0.65$ 。

20 2. 如申請專利範圍第 1 項所述的影像拾取系統透鏡組，其中該第四透鏡的物側面於近光軸處為凸面。

3. 如申請專利範圍第 2 項所述的影像拾取系統透鏡組，其中該影像拾取系統透鏡組的焦距為 f ，該第一透鏡的焦距為 f_1 ，係滿足下列關係式：

$-0.25 < f / f_1 < 0.75$ 。

25 4. 如申請專利範圍第 2 項所述的影像拾取系統透鏡組，其中該第一透鏡物側面至該第四透鏡像側面於光軸上的距離為 T_d ，係滿足下列關係式：

$0.8 \text{ mm} < T_d < 2.5 \text{ mm}$ 。

5. 如申請專利範圍第 2 項所述的影像拾取系統透鏡組，其中該影像拾取系統透鏡組的光圈值為 Fno ，係滿足下列關係式：

$$1.4 < Fno \leq 2.25。$$

6. 如申請專利範圍第 2 項所述的影像拾取系統透鏡組，該第二透鏡物側面的曲率半徑為 $R3$ ，該第二透鏡像側面的曲率半徑為 $R4$ ，係滿足下列關係式：

$$0.5 < (R3+R4) / (R3-R4) < 2.5。$$

7. 如申請專利範圍第 2 項所述的影像拾取系統透鏡組，其中該影像拾取系統透鏡組的焦距為 f ，係滿足下列關係式：

$$0.5 \text{ mm} < f < 2.0 \text{ mm}。$$

8. 如申請專利範圍第 1 項所述的影像拾取系統透鏡組，其中該第一透鏡物側面於近光軸處為凸面。

9. 如申請專利範圍第 8 項所述的影像拾取系統透鏡組，其中該第一透鏡物側面至該第四透鏡像側面於光軸上的距離為 Td ，該影像拾取系統透鏡組中最大視角的一半為 $HFOV$ ，係滿足下列關係式：

$$1.2 \text{ mm} < Td / \tan(HFOV) < 2.75 \text{ mm}。$$

10. 如申請專利範圍第 8 項所述的影像拾取系統透鏡組，其中該第一透鏡、該第二透鏡、該第三透鏡、及該第四透鏡於光軸上之厚度的總合為 $\sum CT$ ，該第一透鏡物側面至該第四透鏡像側面於光軸上的距離為 Td ，係滿足下列關係式：

$$0.80 < \sum CT / Td < 0.95。$$

11. 如申請專利範圍第 8 項所述的影像拾取系統透鏡組，其中該第一透鏡的色散係數為 $V1$ ，係滿足下列關係式：

$$45 < V1。$$

12. 如申請專利範圍第 8 項所述的影像拾取系統透鏡組，其中該第二透鏡於光軸上的厚度為 $CT2$ ，該第一透鏡於光軸上的厚度為 $CT1$ ，該第三透鏡於光軸上的厚度為 $CT3$ ，該第四透鏡於光軸上

的厚度為 CT4，係滿足下列關係式：

$$0.65 < CT2 / (CT1+CT3+CT4) < 2.0。$$

13.一種取像裝置，包含如申請專利範圍第 1 項所述的影像拾取系統透鏡組及一電子感光元件。

5 14.一種可攜裝置，包含如申請專利範圍第 13 項所述的取像裝置。

15.一種影像拾取系統透鏡組，由物側至像側依序包含：

一具屈折力的第一透鏡；

一具正屈折力的第二透鏡，其像側面於近光軸處為凸面；

一具負屈折力的第三透鏡，其物側面於近光軸處為凹面，其

10 像側面於近光軸處為凸面；及

一具屈折力的第四透鏡，其像側面於近光軸處為凹面，其物側面及像側面皆為非球面，且其像側面於離軸處具有至少一凸面；

其中，該影像拾取系統透鏡組中具有屈折力的透鏡為四片；

其中，該第一透鏡物側面至該第四透鏡像側面於光軸上的距離
15 為 Td，該影像拾取系統透鏡組中最大視角的一半為 HFOV，該影像拾取系統透鏡組的焦距為 f，該第四透鏡的焦距為 f4，該第三透鏡的焦距為 f3，係滿足下列關係式：

$$0.5 \text{ mm} < Td < 3.2 \text{ mm}；$$

$$1.0 \text{ mm} < Td / \tan(HFOV) < 3.75 \text{ mm}；$$

20 $|f / f4| < 1.20$ ；及

$$-2.0 < f / f3 < -0.95。$$

16.如申請專利範圍第 15 項所述的影像拾取系統透鏡組，其中該第一透鏡的色散係數為 V1，係滿足下列關係式：

$$45 < V1。$$

25 17.如申請專利範圍第 15 項所述的影像拾取系統透鏡組，其中該影像拾取系統透鏡組的焦距為 f，該第一透鏡的焦距為 f1，係滿足下列關係式：

$$-0.25 < f / f1 < 0.75。$$

18.如申請專利範圍第 15 項所述的影像拾取系統透鏡組，其中該影像拾取系統透鏡組的最大視角為 FOV，係滿足下列關係式：

$$80 \text{ 度} < \text{FOV} < 110 \text{ 度}。$$

19.如申請專利範圍第 15 項所述的影像拾取系統透鏡組，其中該第一透鏡物側面至該第四透鏡像側面於光軸上的距離為 Td，係滿足下列關係式：

$$0.8 \text{ mm} < \text{Td} < 2.5 \text{ mm}。$$

20.如申請專利範圍第 15 項所述的影像拾取系統透鏡組，其中該第二透鏡的焦距為 f2，該第三透鏡的焦距為 f3，係滿足下列關係式：

$$f2 / f3 < -0.75。$$

21.一種影像拾取系統透鏡組，由物側至像側依序包含：

一具屈折力的第一透鏡；

一具正屈折力的第二透鏡，其像側面於近光軸處為凸面；

一具負屈折力的第三透鏡，其物側面於近光軸處為凹面，其像側面於近光軸處為凸面；及

一具屈折力的第四透鏡，其像側面於近光軸處為凹面，其物側面及像側面皆為非球面，且其像側面於離軸處具有至少一凸面；

其中，該影像拾取系統透鏡組中具有屈折力的透鏡為四片；

其中，該第一透鏡物側面至該第四透鏡像側面於光軸上的距離為 Td，該影像拾取系統透鏡組中最大視角的一半為 HFOV，該影像拾取系統透鏡組的焦距為 f，該第四透鏡的焦距為 f4，該影像拾取系統透鏡組的光圈值為 Fno，係滿足下列關係式：

$$0.5 \text{ mm} < \text{Td} < 3.2 \text{ mm}；$$

$$1.0 \text{ mm} < \text{Td} / \tan(\text{HFOV}) < 3.75 \text{ mm}；$$

$$|f / f4| < 1.20；及$$

$$1.40 < \text{Fno} \leq 2.25。$$

22.如申請專利範圍第 21 項所述的影像拾取系統透鏡組，其中該第

二透鏡的焦距為 f_2 ，該第三透鏡的焦距為 f_3 ，係滿足下列關係式：

$$f_2 / f_3 < -0.65。$$

- 23.如申請專利範圍第 21 項所述的影像拾取系統透鏡組，其中該第一透鏡的色散係數為 V_1 ，係滿足下列關係式：

$$45 < V_1。$$

- 24.如申請專利範圍第 21 項所述的影像拾取系統透鏡組，其中該第一透鏡具正屈折力，該影像拾取系統透鏡組的焦距為 f ，該第一透鏡的焦距為 f_1 ，係滿足下列關係式：

$$0.25 < f / f_1 < 0.75。$$

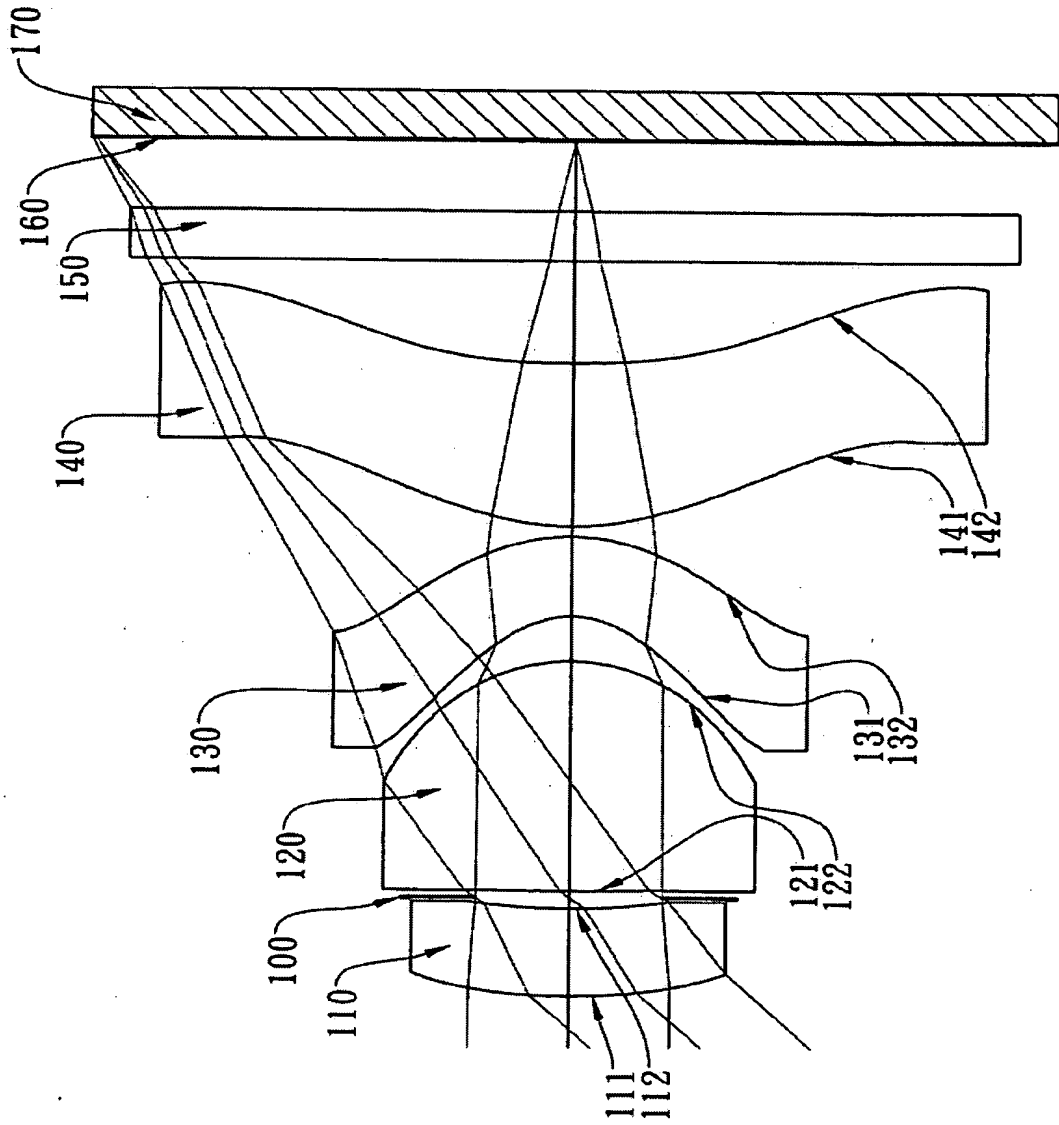
- 25.如申請專利範圍第 21 項所述的影像拾取系統透鏡組，其中該影像拾取系統透鏡組的最大視角為 FOV ，係滿足下列關係式：

$$80 \text{ 度} < FOV < 110 \text{ 度}。$$

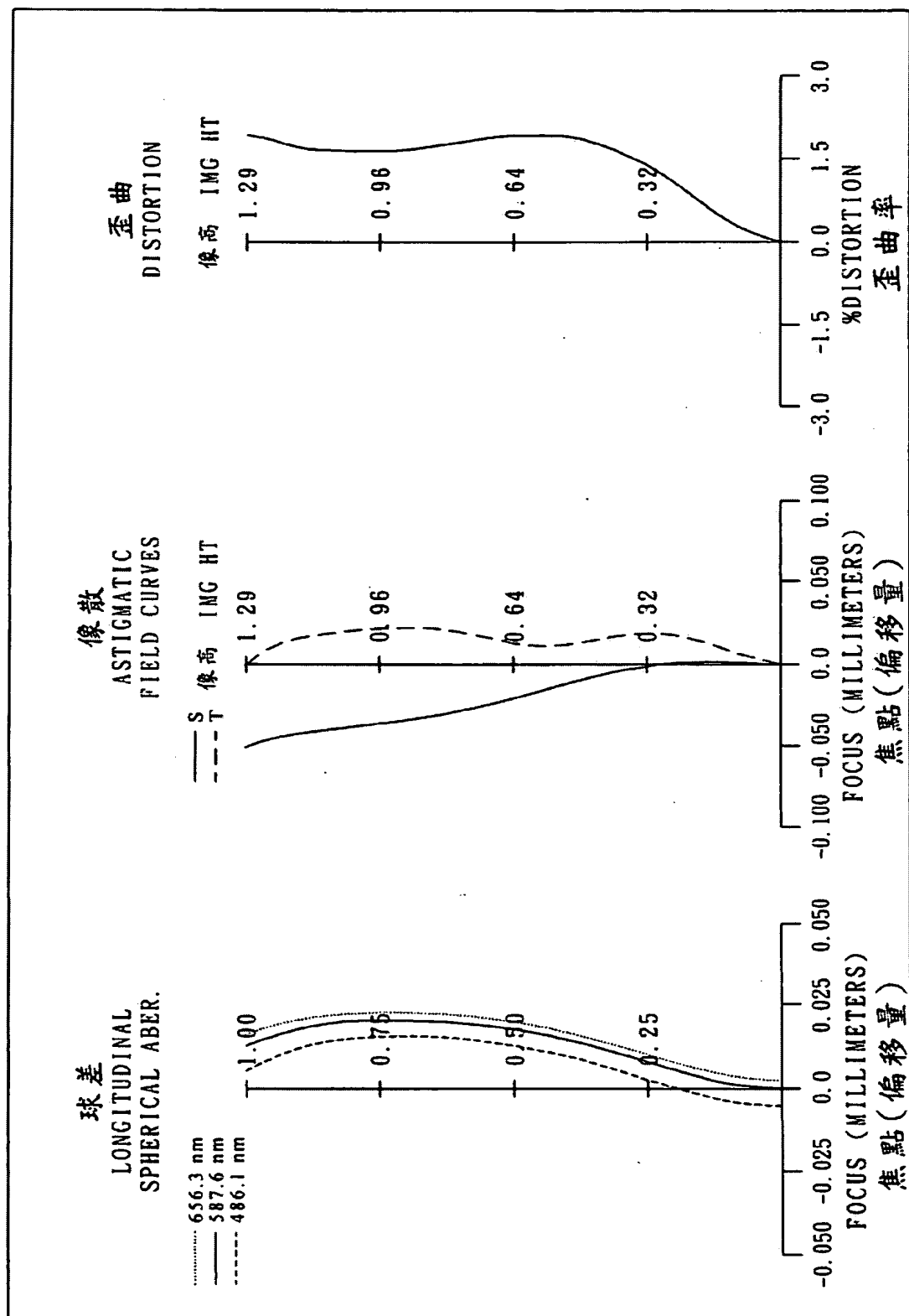
- 26.如申請專利範圍第 21 項所述的影像拾取系統透鏡組，其中該第二透鏡於光軸上的厚度為 CT_2 ，該第一透鏡於光軸上的厚度為 CT_1 ，該第三透鏡於光軸上的厚度為 CT_3 ，該第四透鏡於光軸上的厚度為 CT_4 ，係滿足下列關係式：

$$0.65 < CT_2 / (CT_1 + CT_3 + CT_4) < 2.0。$$

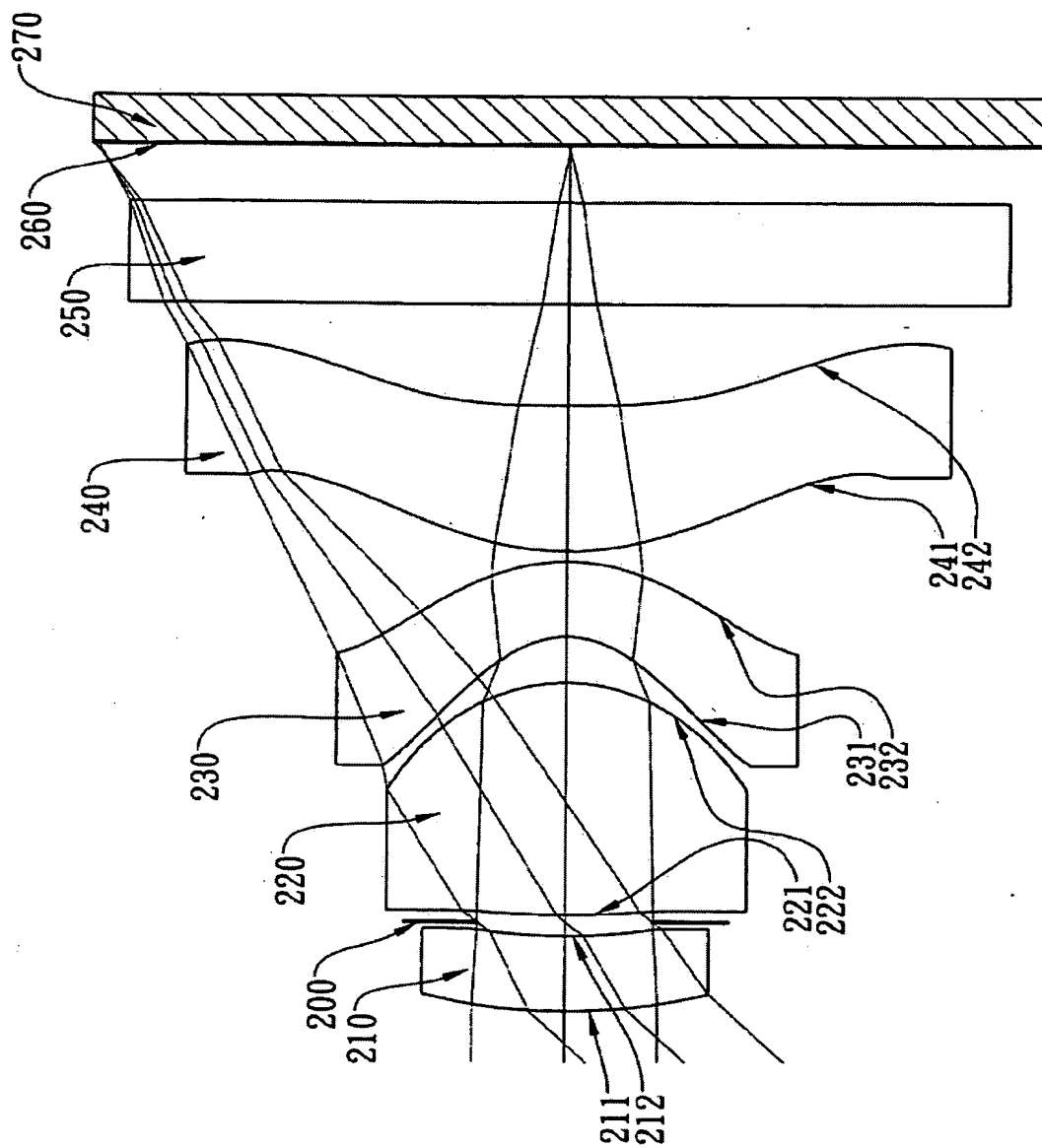
圖式



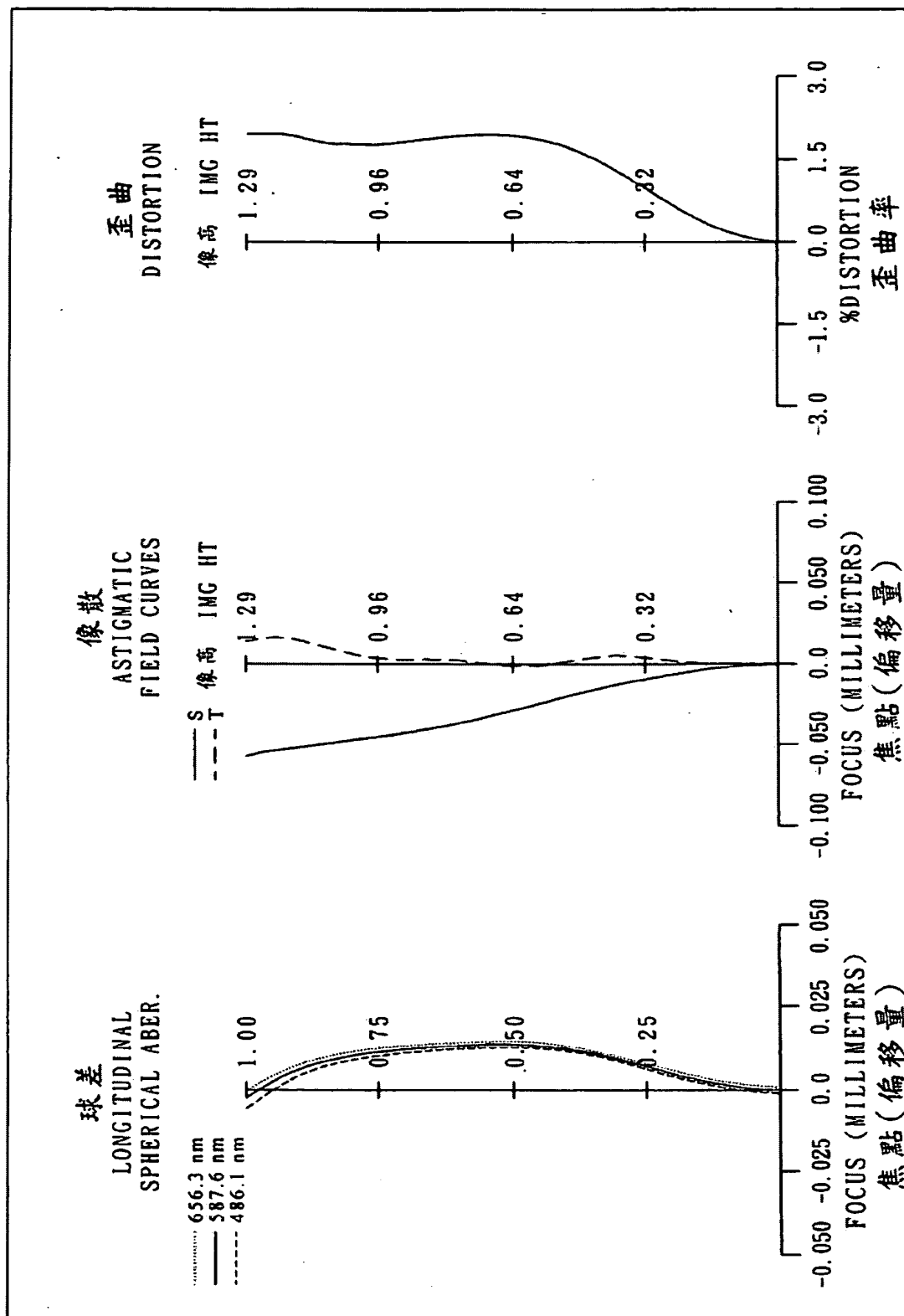
第一A圖



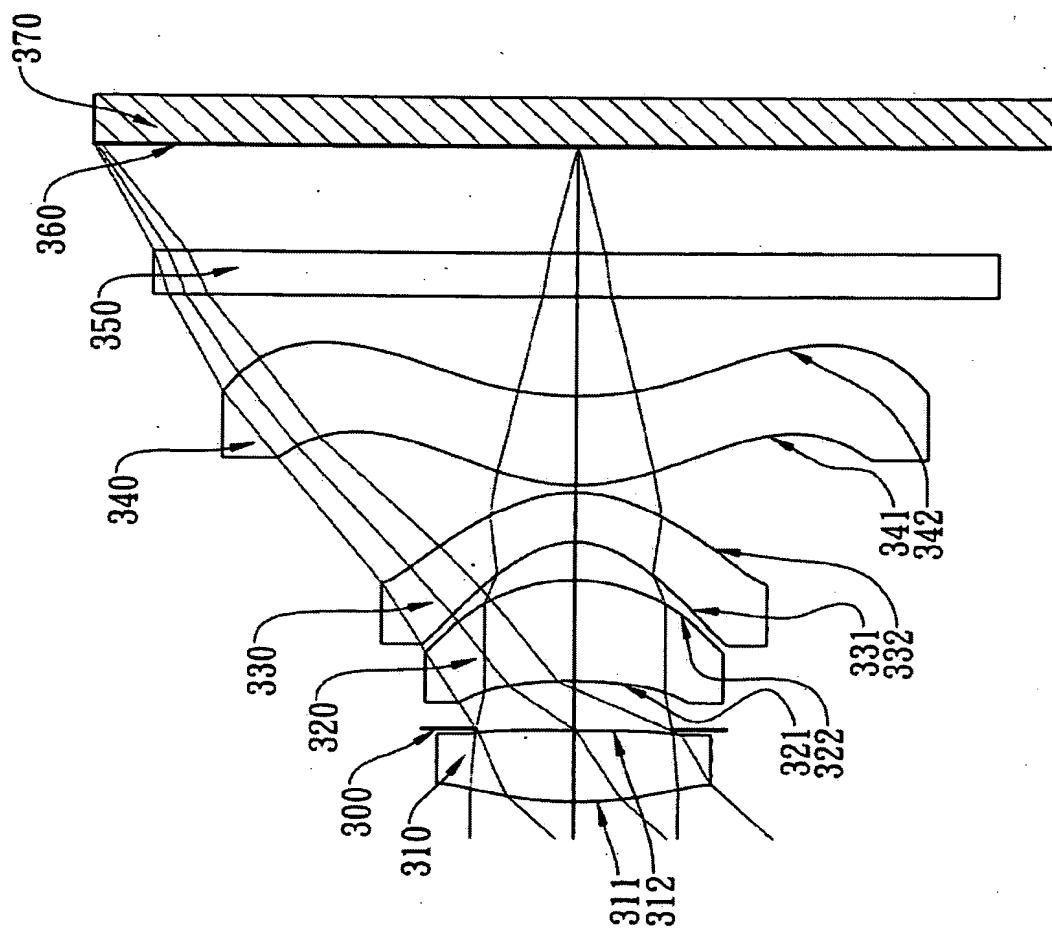
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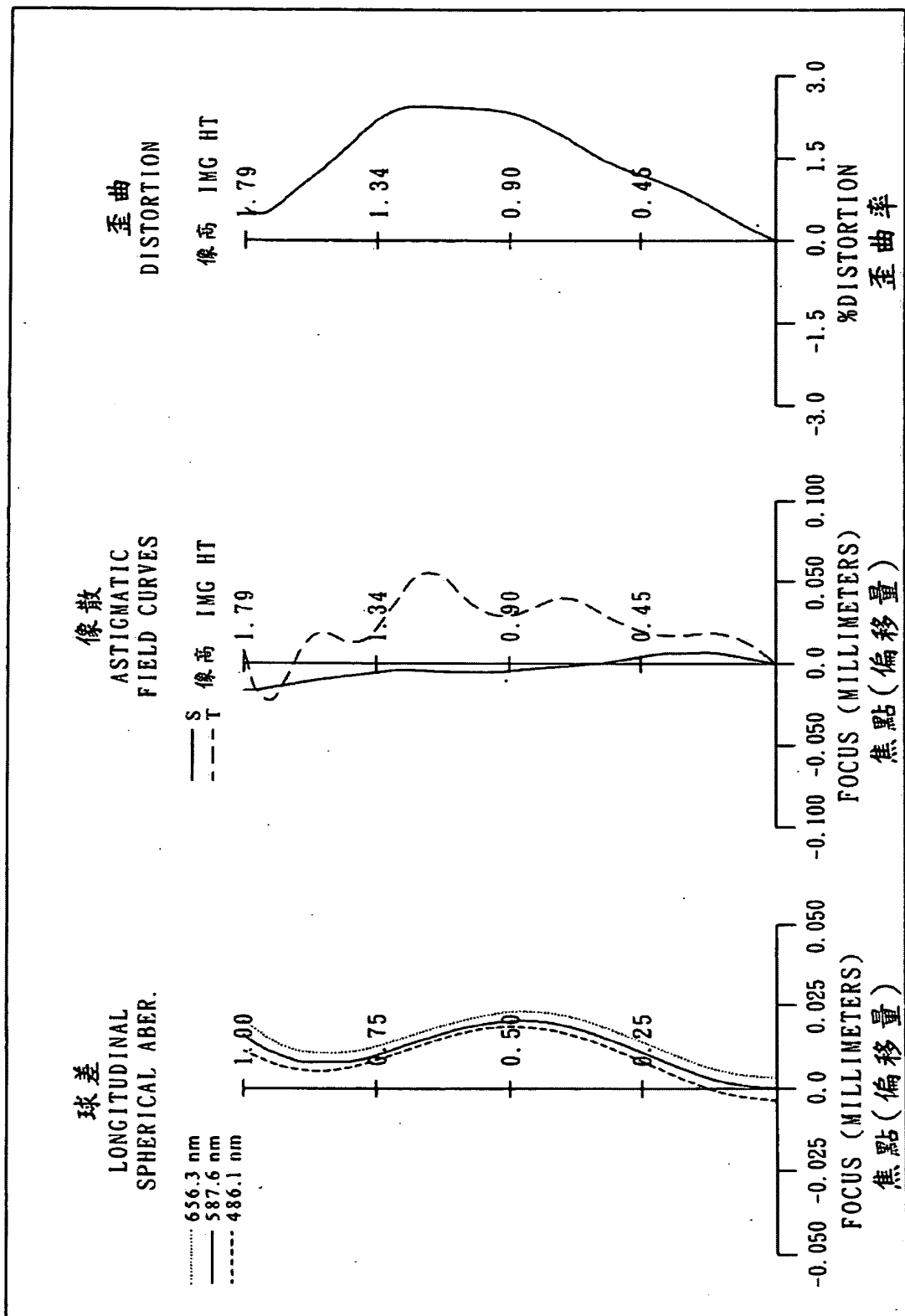
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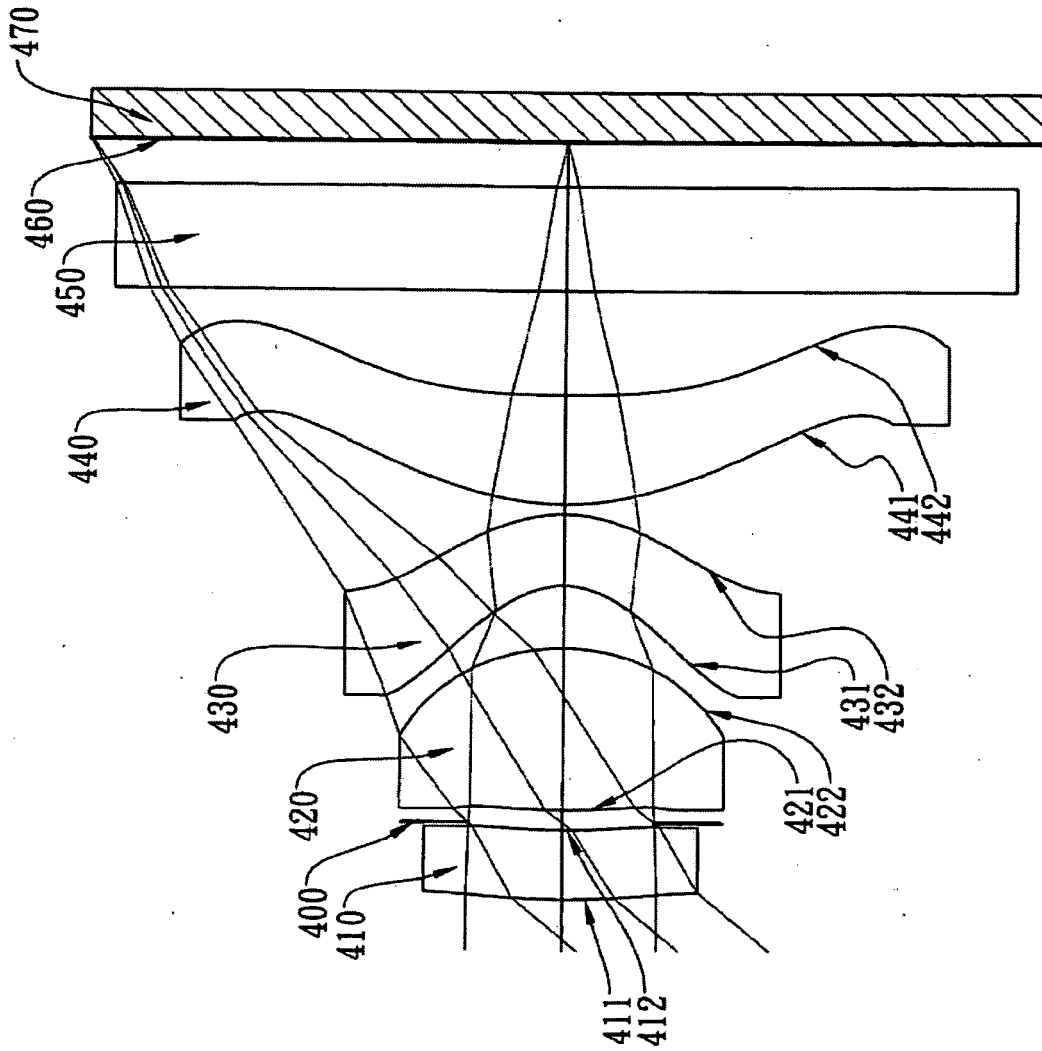
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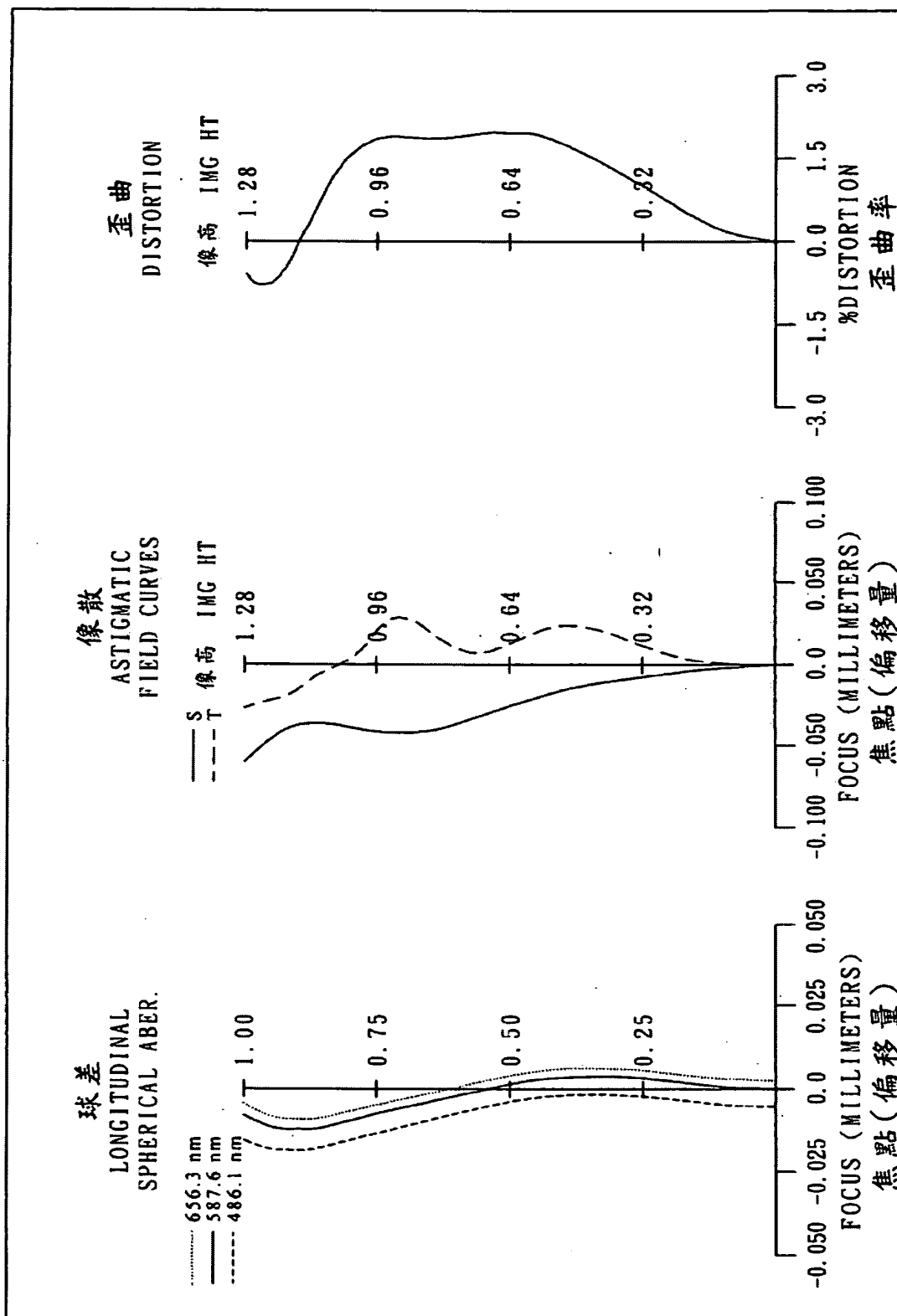
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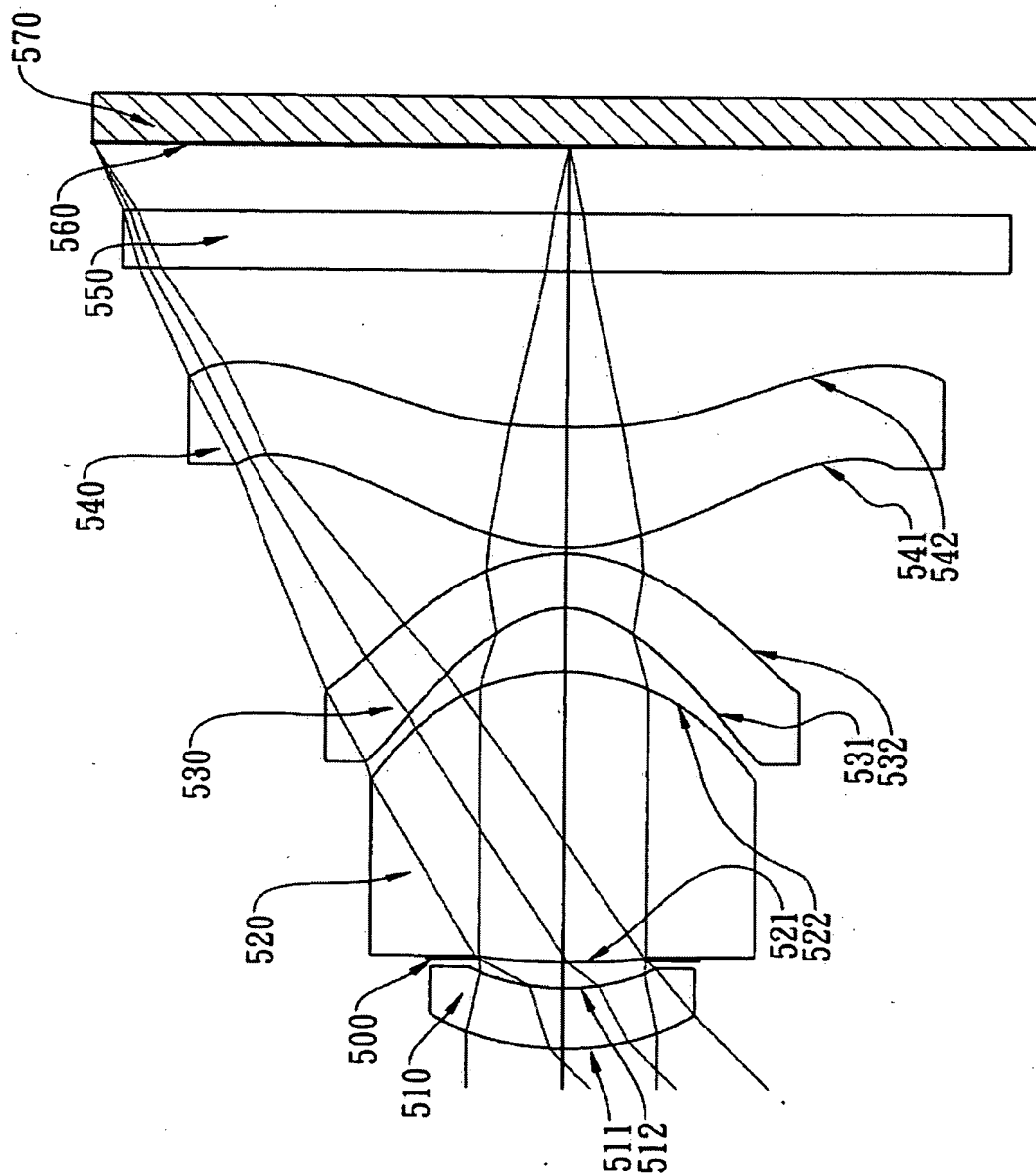
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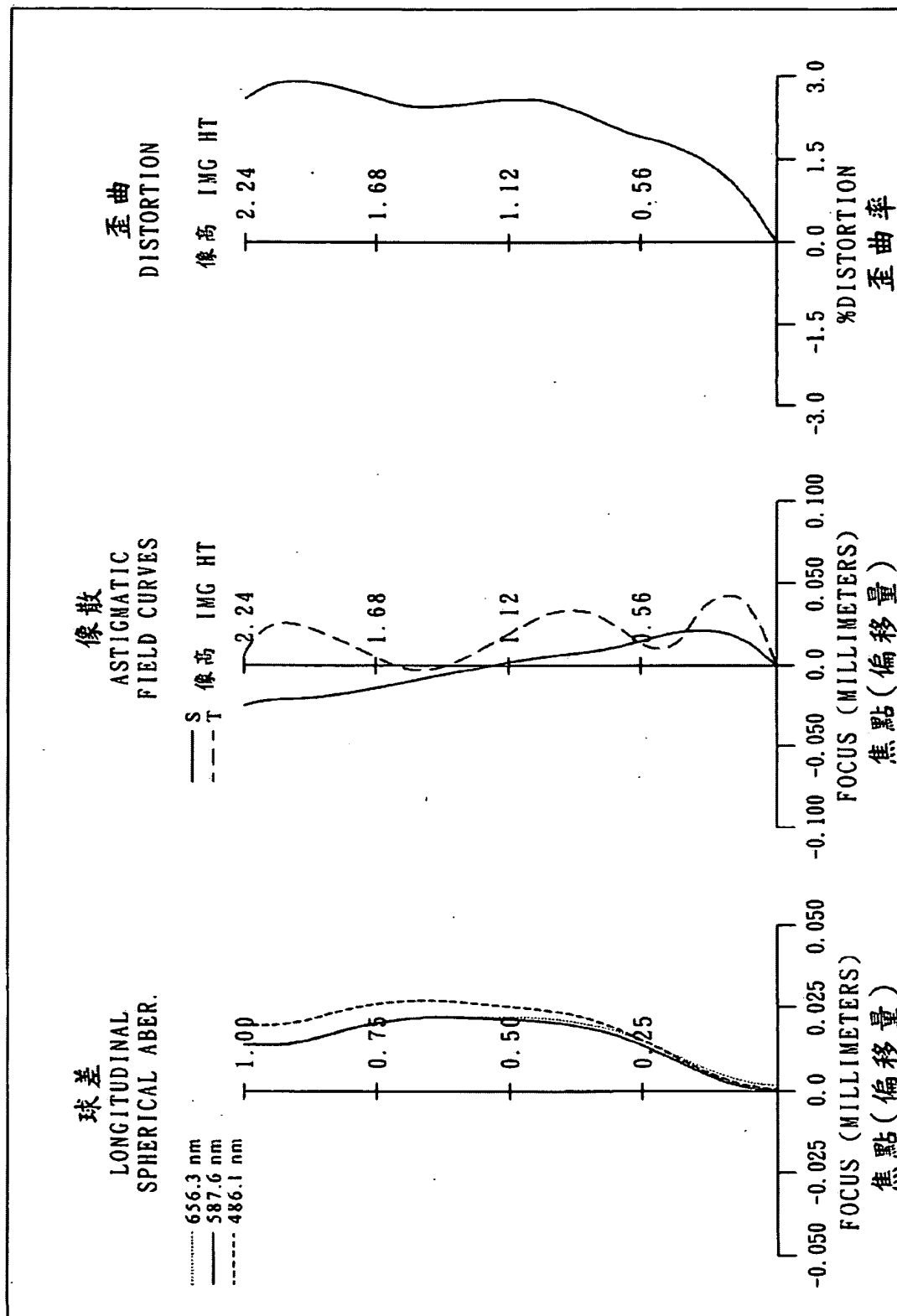
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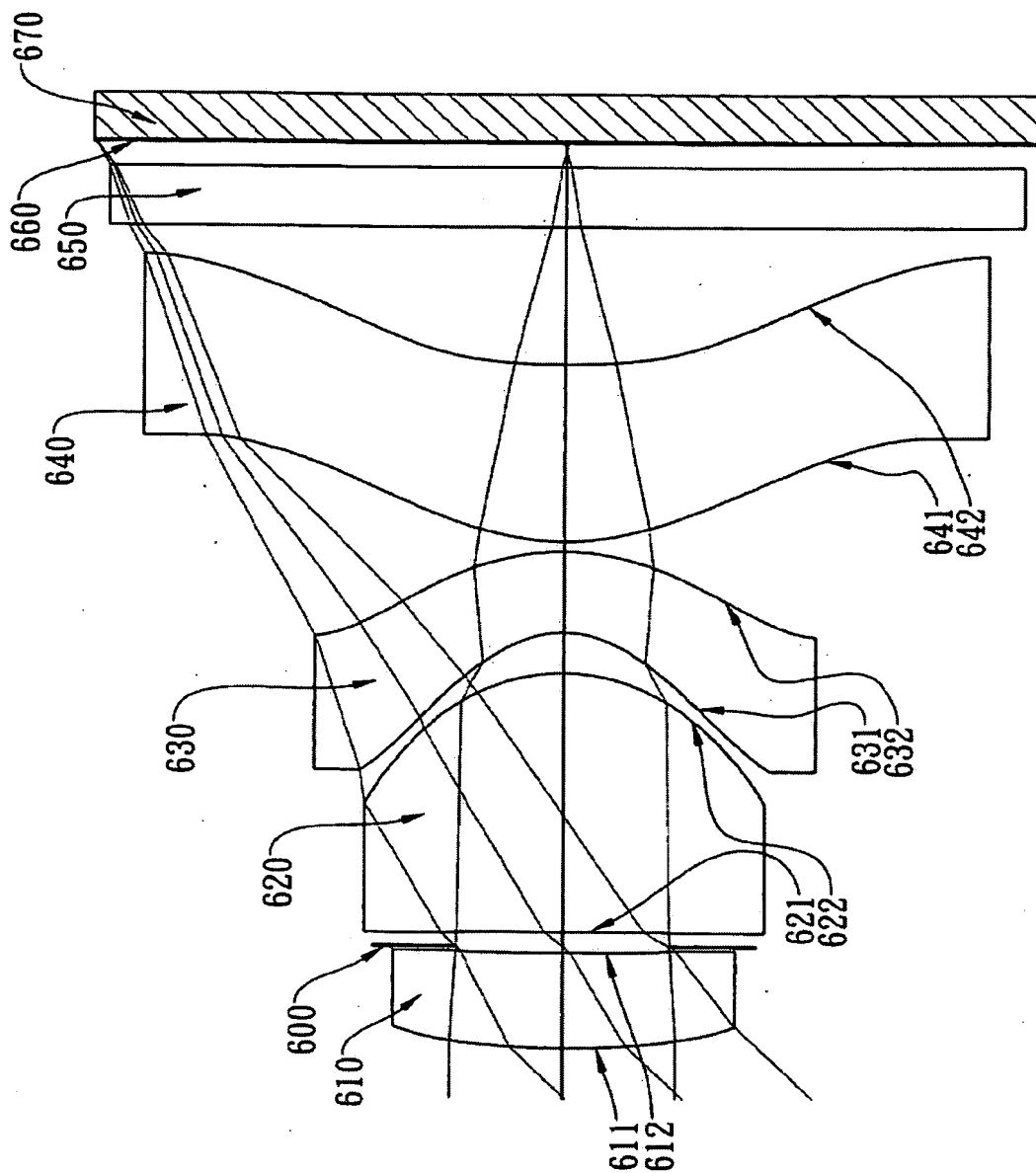
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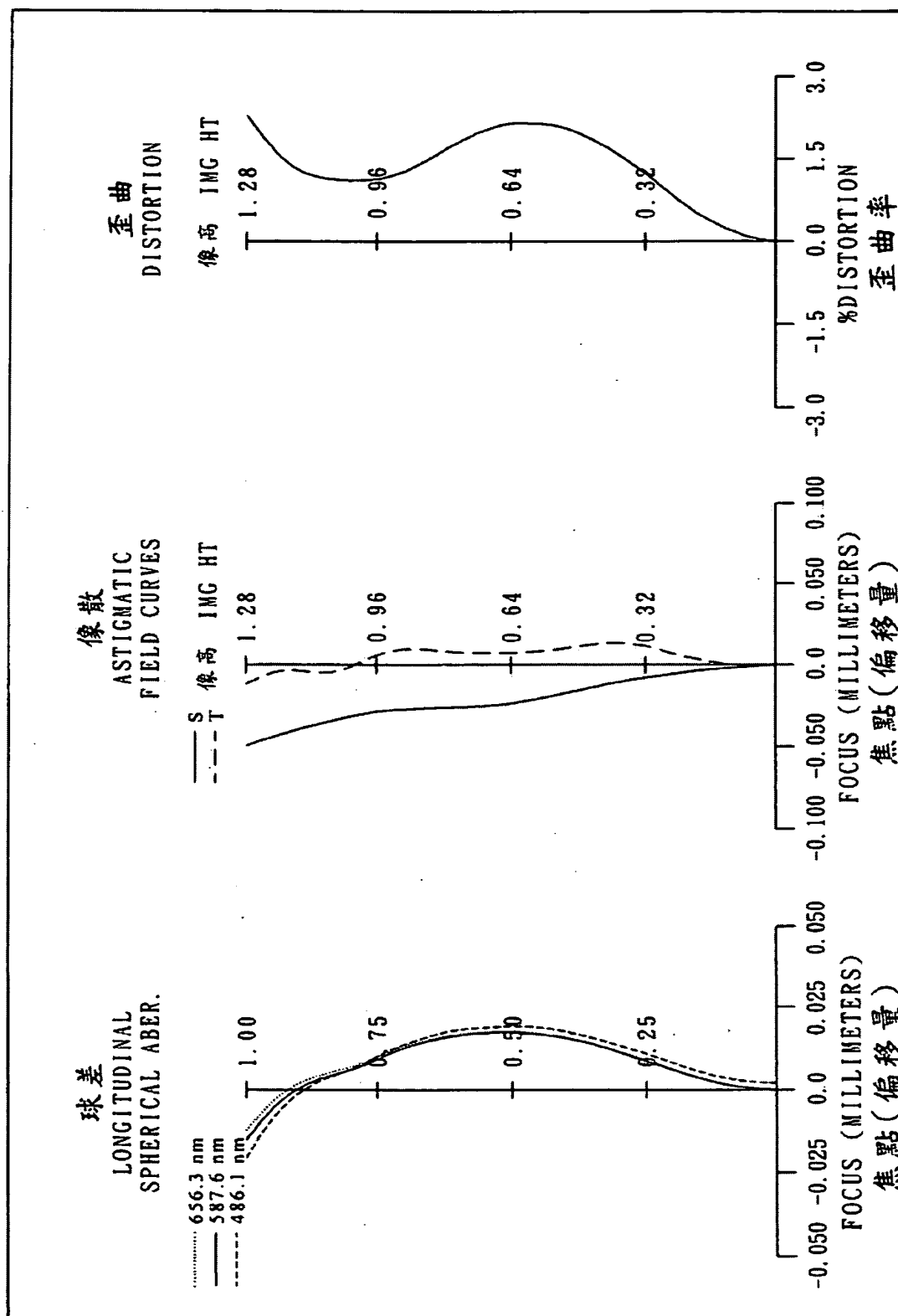
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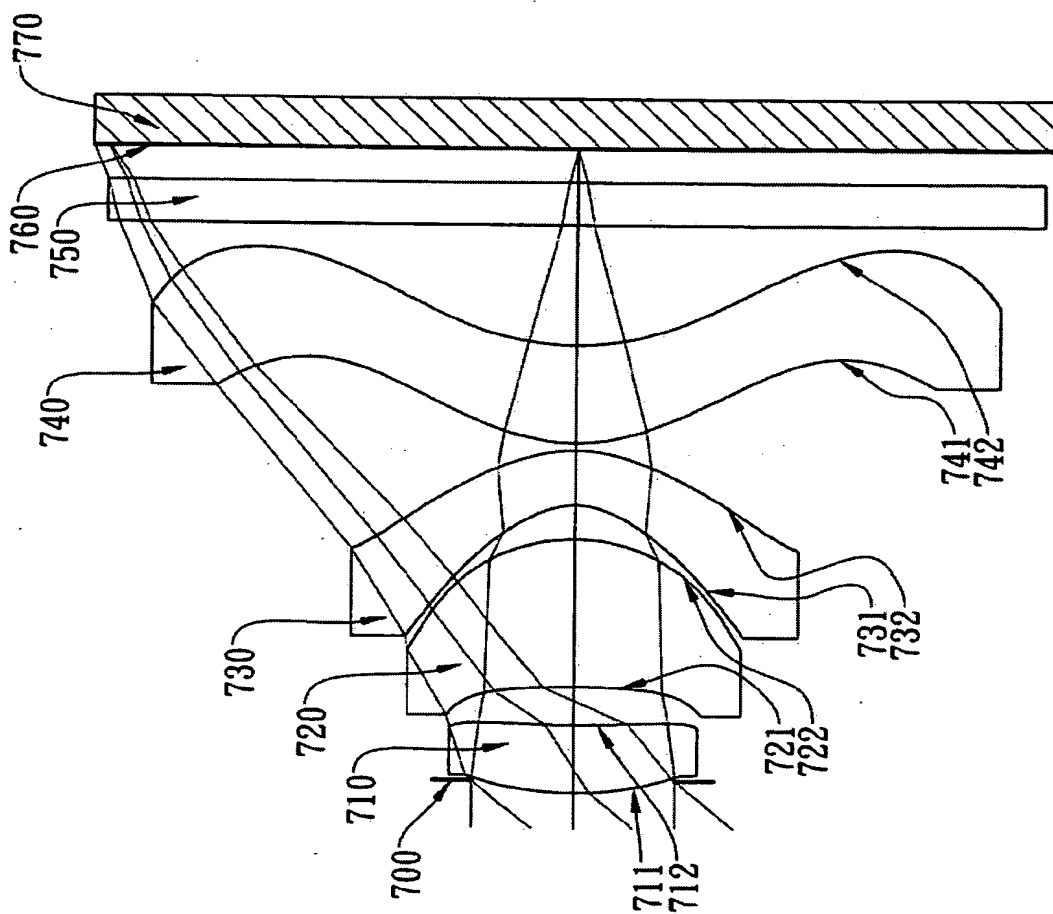
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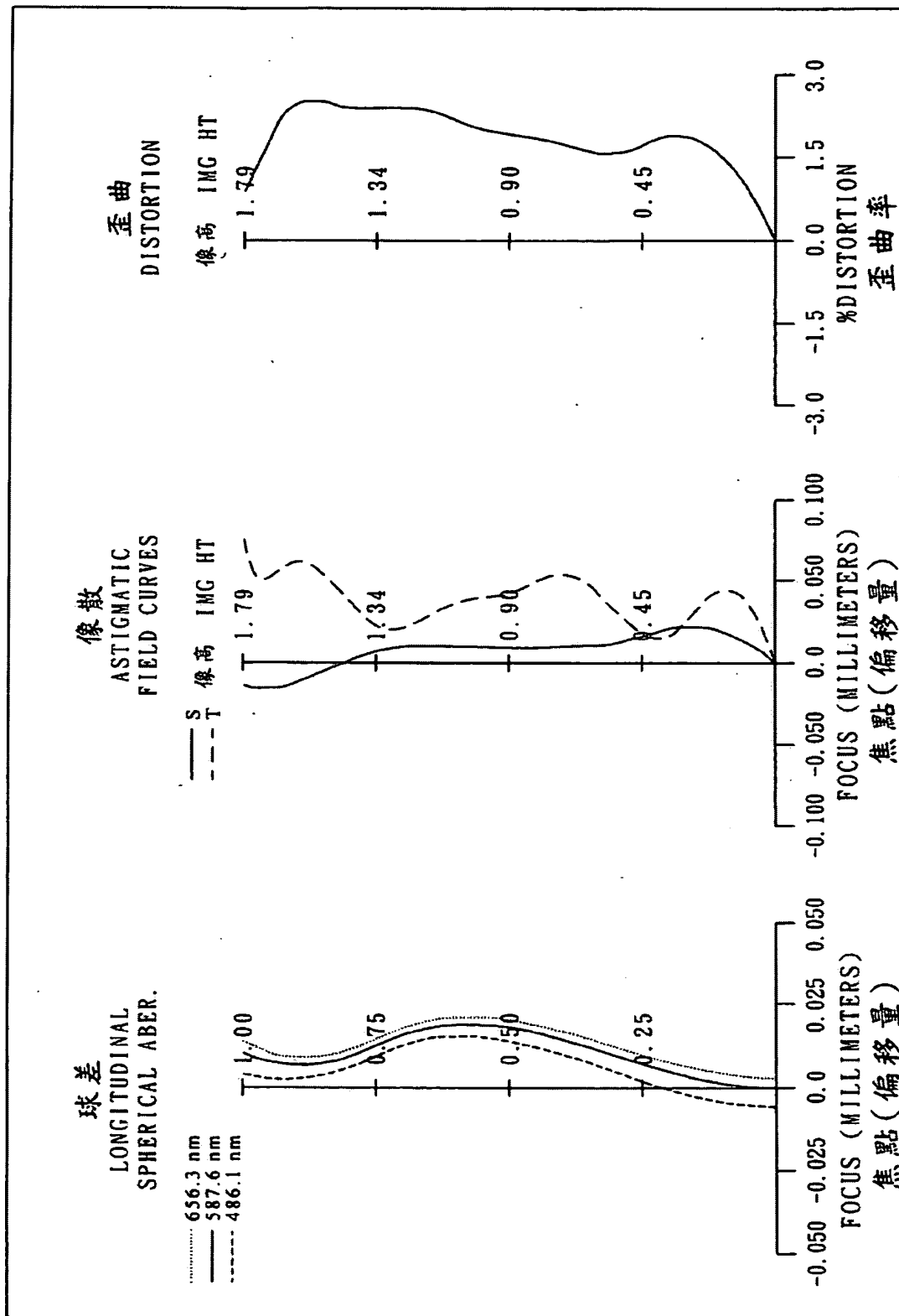
第六A圖



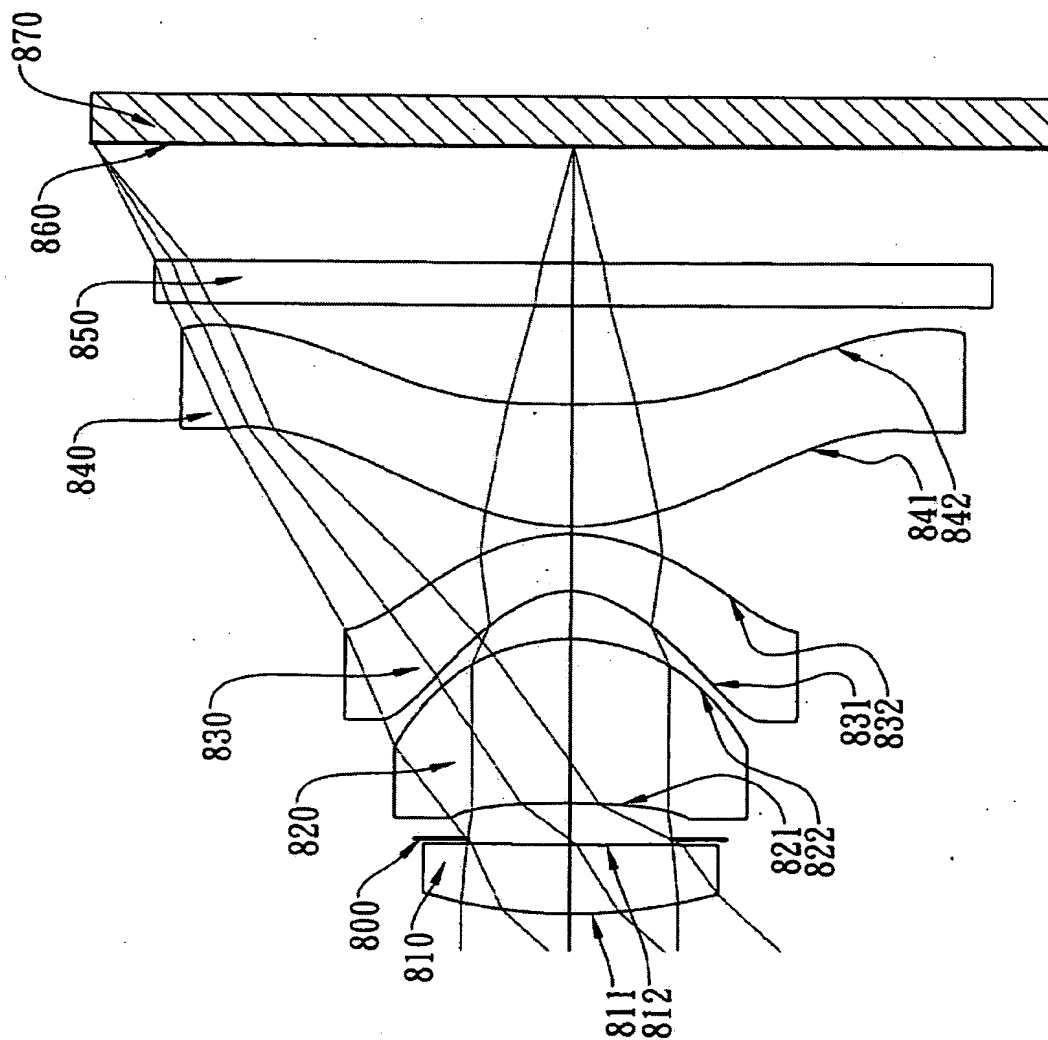
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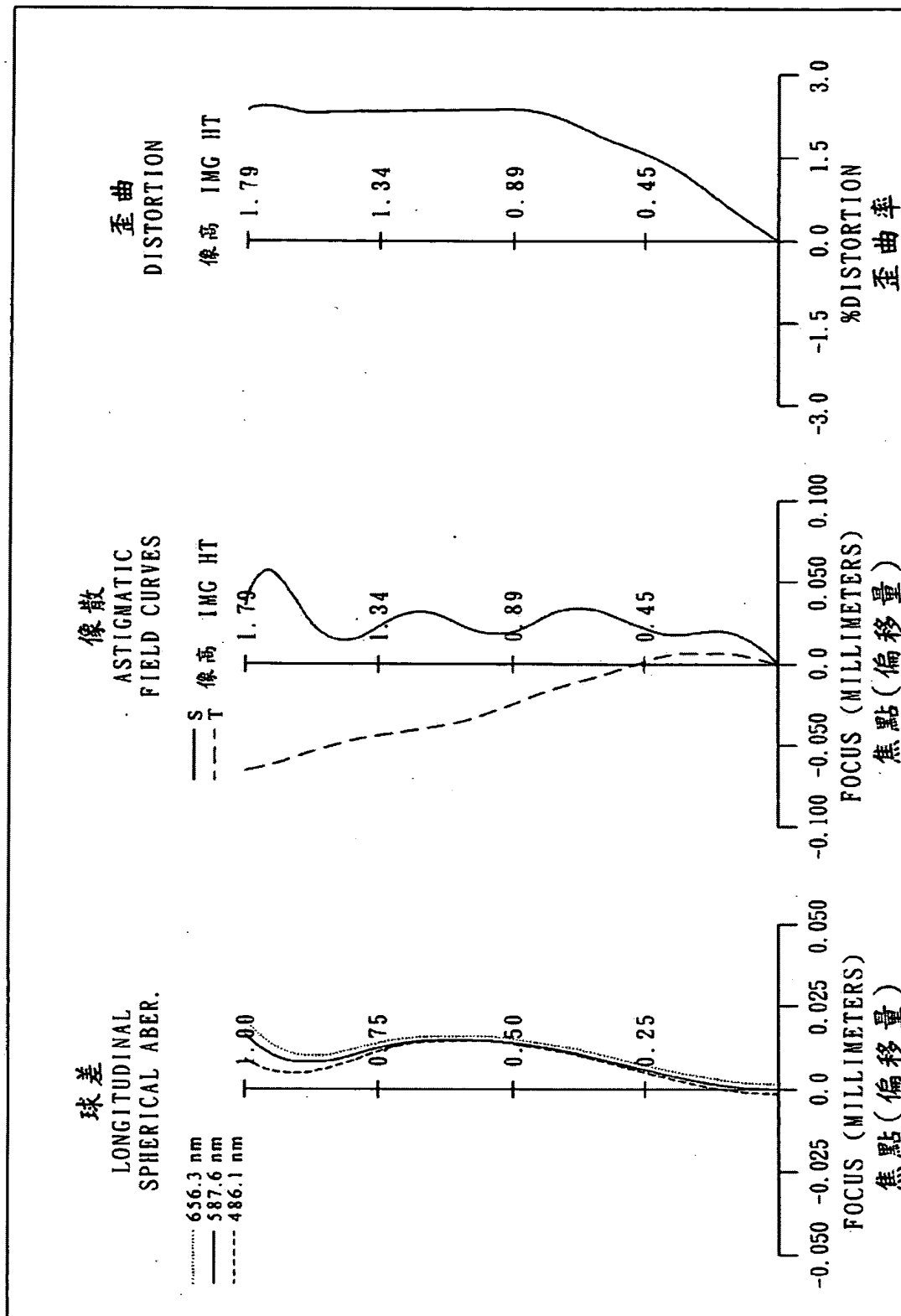
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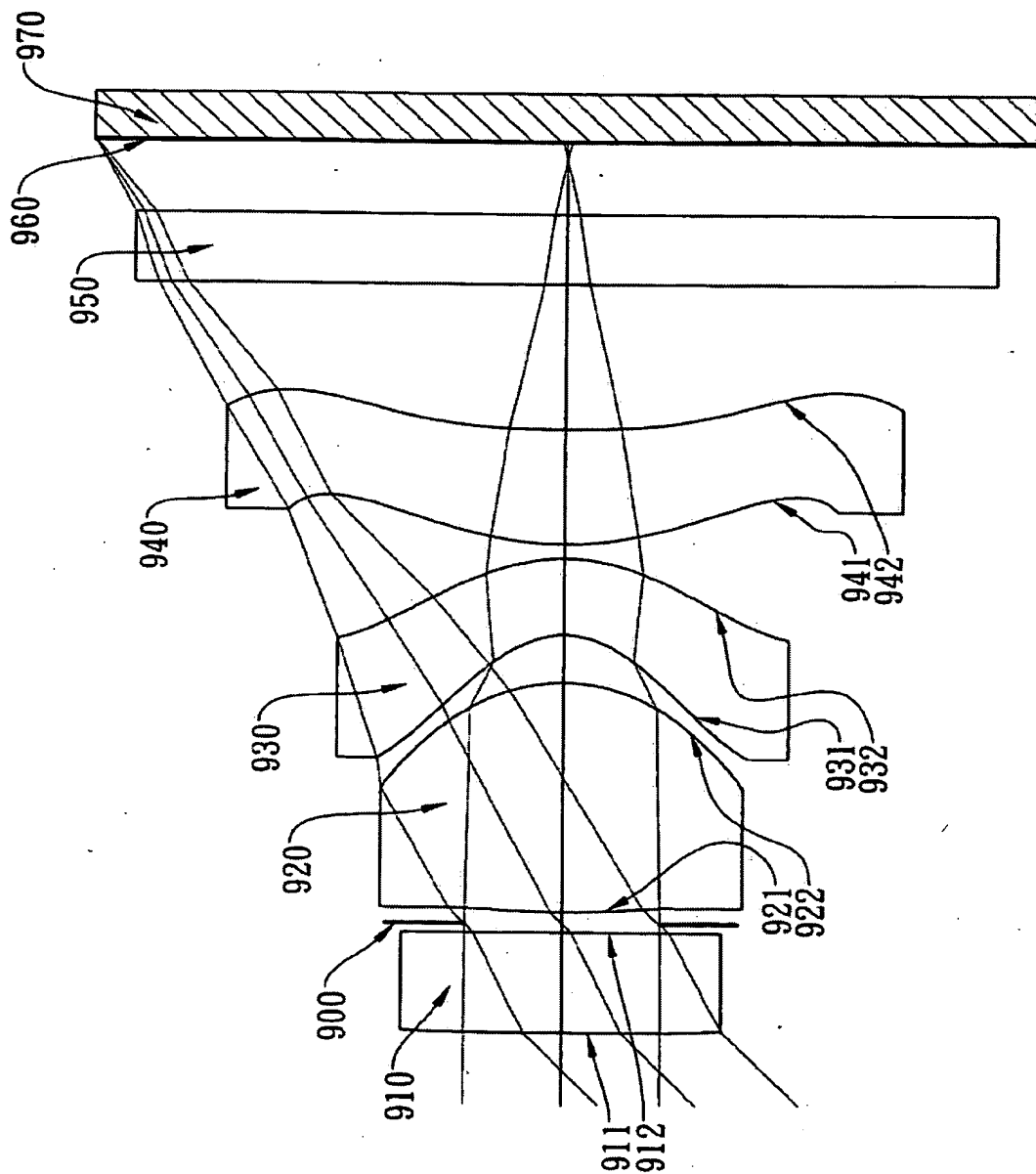
第七B圖



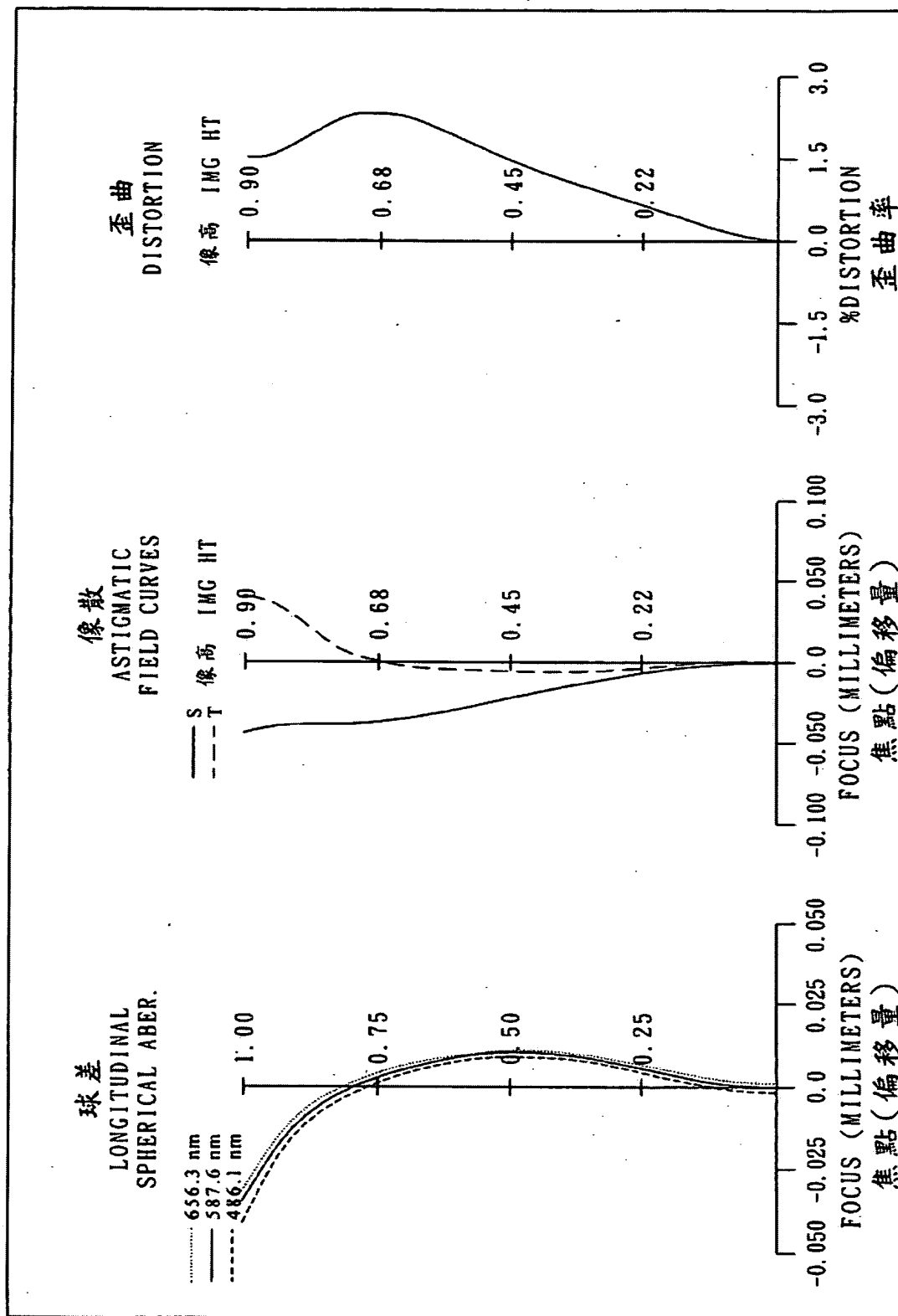
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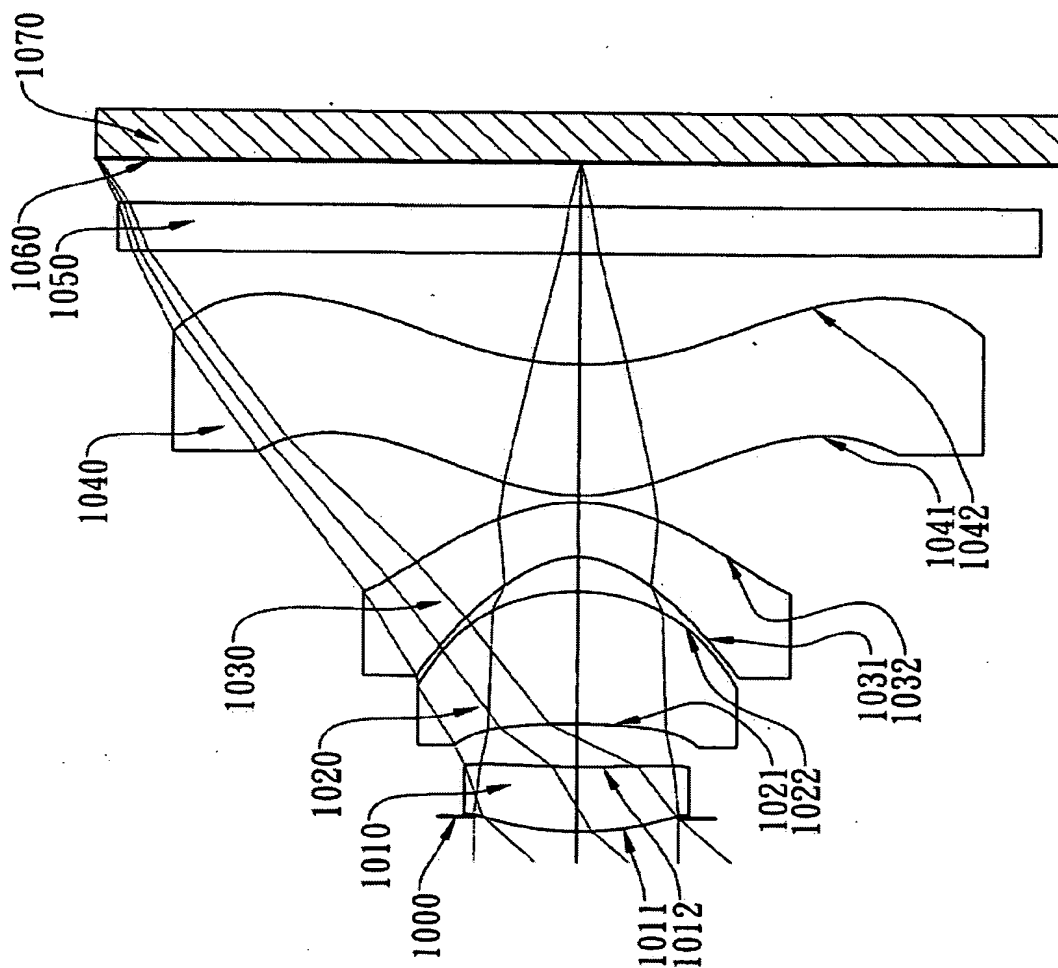
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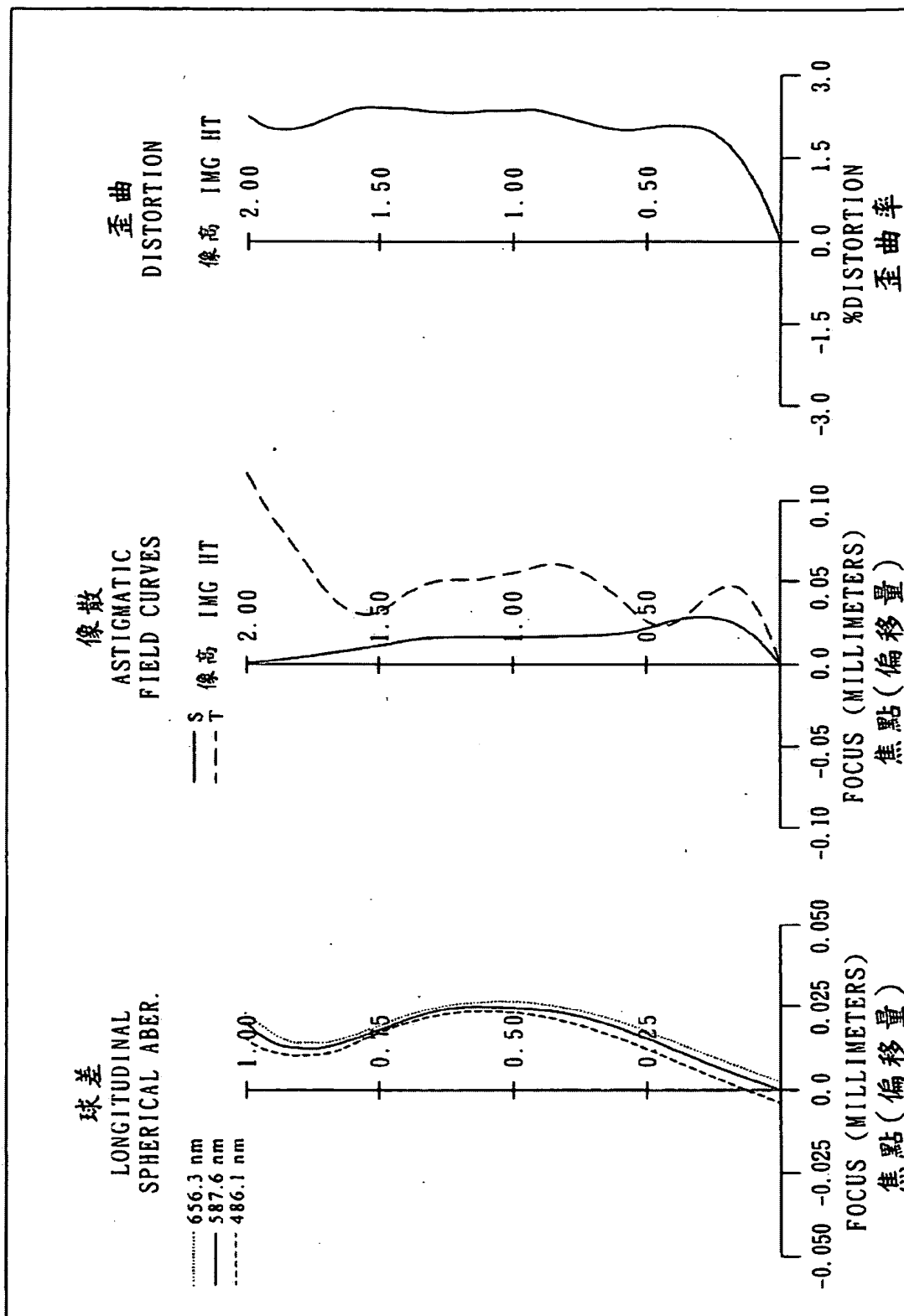
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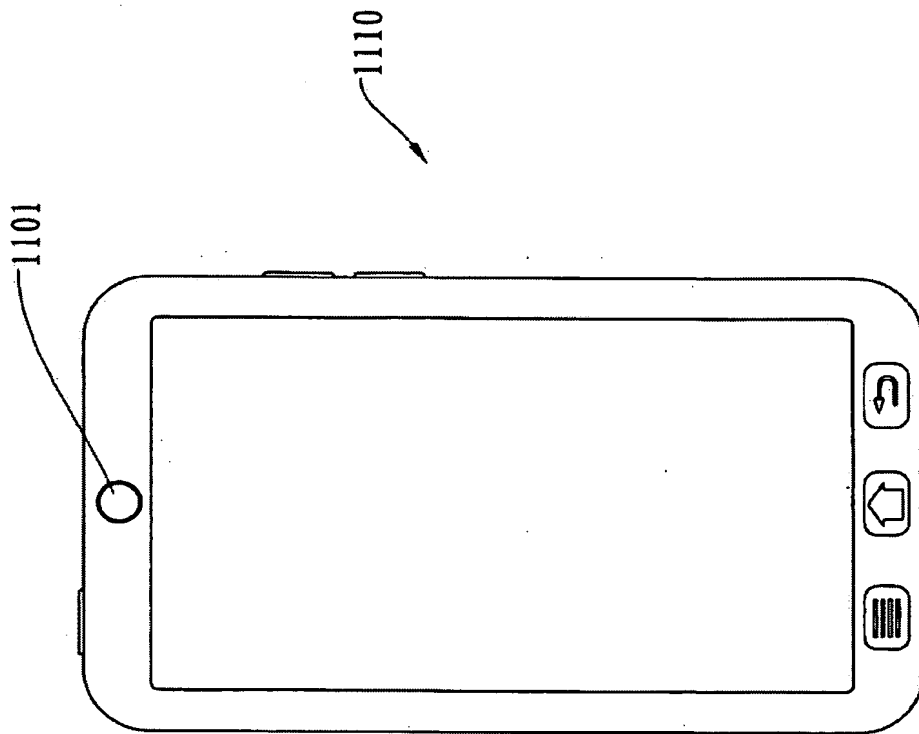
第九B圖



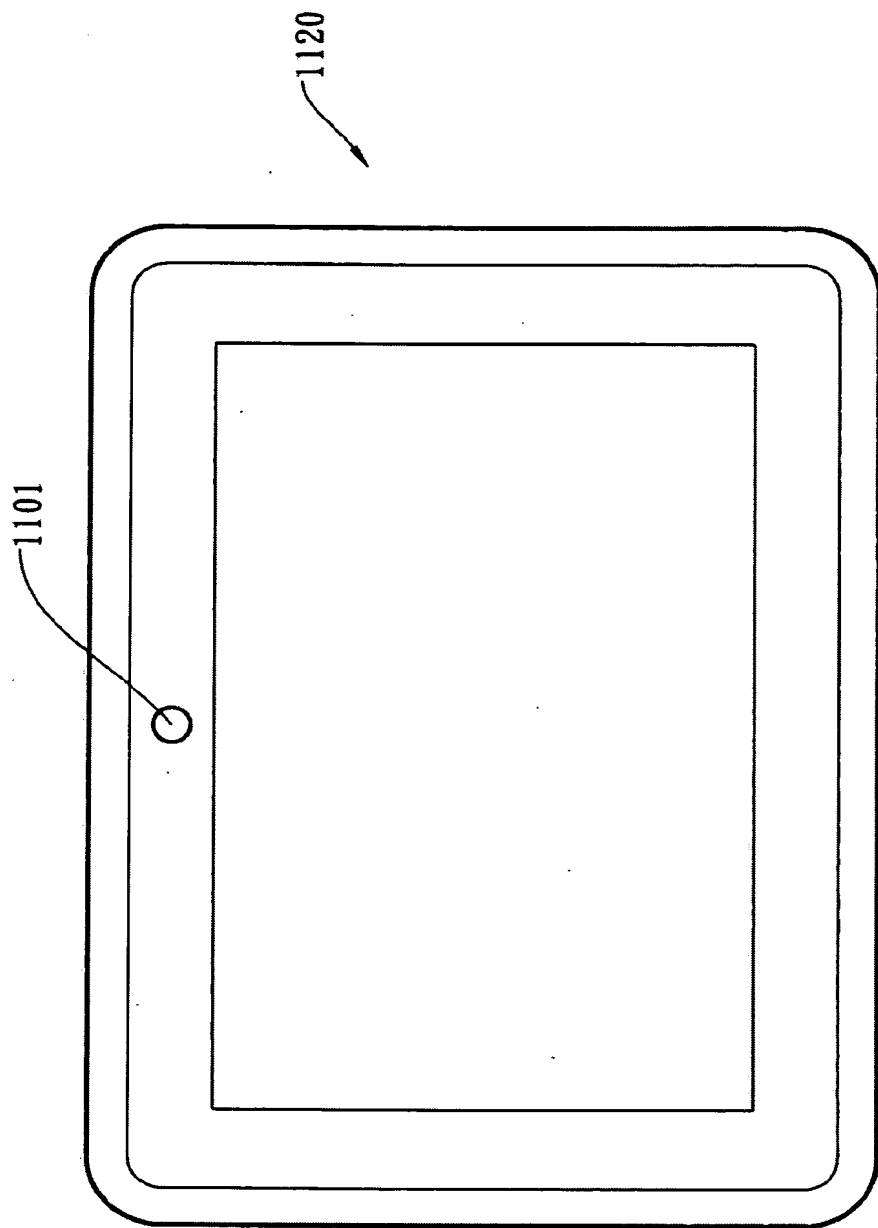
第十A圖



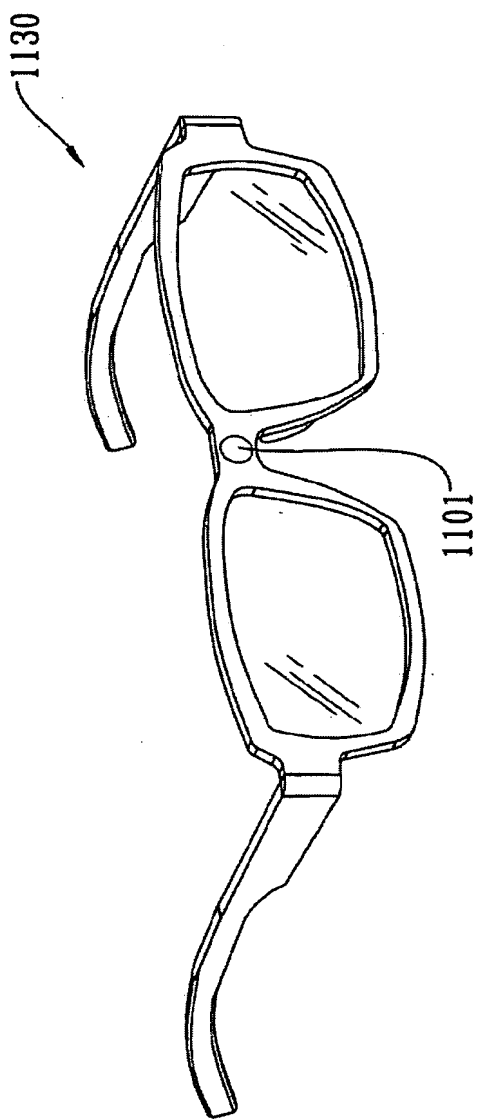
第十B圖



第十一A圖



第十一B圖



第十一C圖

S/N: 14/105,811

PATENT
Confirmation No. 5836



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Wei-Yu Chen Examiner: Unassigned
Serial No.: 14/105,811 Group Art Unit: Unassigned
Filed: December 13, 2013 Docket No.: 14970-94702
Title: IMAGE CAPTURING LENS SYSTEM, IMAGING DEVICE AND MOBILE
 TERMINAL

CERTIFICATE UNDER 37 CFR 1.8:

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By: 

Name: Tim Tingkang Xia

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P.O. Box 1450
Alexandria, VA 22313-1450

January 6, 2014

Customer No. 24728

Sir:

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- ☒ Transmittal Sheet containing Certificate of Mailing (1 page)
- ☒ Submission of Priority Document (1 page)
- ☒ Certified Copy of Priority Document Taiwan Patent Application 102139029,
filed October 29, 2013 (66 pages)
- ☒ Return Postcard

MORRIS, MANNING & MARTIN, LLP
1600 Atlanta Financial Center
3343 Peachtree Road NE
Atlanta, Georgia 30326
404.495.3678
Customer No. 24728

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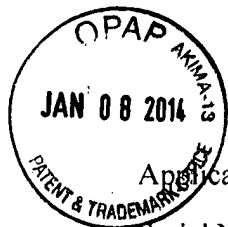
Name: Tim Tingkang Xia
Reg. No.: 45,242
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HP, Ex. 1002
Page 167

S/N: 14/105,811

PATENT
Confirmation No. 5836



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Wei-Yu Chen Examiner: Unassigned
Serial No.: 14/105,811 Group Art Unit: Unassigned
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Commissioner for Patents
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Alexandria, VA 22313-1450

January 6, 2014

CUSTOMER NO. 24728

Dear Sir:


The certified copy of Taiwan Patent Application No. 102139029, from which this application claims priority is hereby submitted as the priority document.

If there are any questions regarding this matter, please call the undersigned at 404-495-3678.

Respectfully submitted,

MORRIS, MANNING & MARTIN, LLP

January 6, 2014


Tim Tingkang Xia
Reg. No. 45,242
Attorney for the Assignee and Applicants on Record

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APPLICATION NUMBER	PATENT NUMBER	GROUP ART UNIT	FILE WRAPPER LOCATION
14/105,811		2872	



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24728
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3343 PEACHTREE ROAD, NE
1600 ATLANTA FINANCIAL CENTER
ATLANTA, GA 30326

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		14105811	
	Filing Date		2013-12-13	
	First Named Inventor	WEI-YU CHEN		
	Art Unit	2872		
	Examiner Name			
	Attorney Docket Number	14970-94702		

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	Filing Date		2013-12-13
	First Named Inventor	WEI-YU CHEN	
	Art Unit	2872	
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	Attorney Docket Number	14970-94702	

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STATEMENT BY APPLICANT**
(Not for submission under 37 CFR 1.99)

Application Number	14105811
Filing Date	2013-12-13
First Named Inventor	WEI-YU CHEN
Art Unit	2872
Examiner Name	
Attorney Docket Number	14970-94702

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☒ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Tim Tingkang Xia/	Date (YYYY-MM-DD)	2014-12-01
Name/Print	Tim Tingkang Xia	Registration Number	45242

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

English Translation of Abstract of JP2014-178623

This invention provides a wide-angle lens system 10 from an object-side to an image-side in order including a first lens element 11 with negative refractive power, a second lens element 12 with positive refractive power, a third lens element 13 with negative refractive power and a fourth lens element 14 with positive refractive power. The first lens element 11 has negative refractive power and a concave surface and the second lens element 12 has positive refractive power and convex surfaces such that a total track length of the lens system with more than 65-degree view of angle is controlled within about 5mm. An image surface 14b of the fourth lens element 14 is provided with inflection points so as to control a direction of the light coming from the wide-angle lens system 10.

(19) 日本国特許庁(JP)

(12) 公開特許公報(A)

(11) 特許出願公開番号

特開2014-178623

(P2014-178623A)

(43) 公開日 平成26年9月25日(2014.9.25)

(51) Int. Cl.	F 1	テーマコード (参考)
G02B 13/00 (2006.01)	G02B 13/00	2H087
G02B 13/18 (2006.01)	G02B 13/18	

審査請求 未請求 請求項の数 7 O L (全 31 頁)

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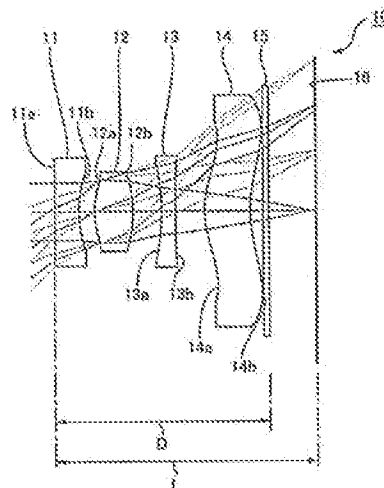
(54) 【発明の名称】 広角レンズおよび撮像装置

(57) 【要約】

【課題】 レンズ系の全長を短く抑え、結像面に対する主光線入射角度を小さく抑制できる広角レンズを提供すること。

【解決手段】 広角レンズ10は、物体側から像側に向かって順に配置された、負のパワーを有する第1レンズ11、正のパワーを有する第2レンズ12、負のパワーを有する第3レンズ13、および正のパワーを有する第4レンズ14からなる。第1レンズ11に凹形状を備える負のパワーのレンズを配置し、第2レンズ12に凸形状を備える正のパワーを有するレンズを配置したので、6.5°以上の面角を備えるレンズ系の全長を5mm程度に抑えることができる。第4レンズ14の像側レンズ面14bは、変曲点を有しているので、広角レンズ10からの射出光線の方向を制御できる。

【選択図】 図1



【特許請求の範囲】

【請求項1】

物体側から像側に向かって順に配置された、負のパワーを有する第1レンズ、正のパワーを有する第2レンズ、負のパワーを有する第3レンズおよび正のパワーを有する第4レンズからなり、

前記第1レンズの像側レンズ面は、凹形状を備え、

前記第2レンズの物体側レンズ面は、凸形状を備え、

前記第4レンズの像側レンズ面は、変曲点を備える非球面であり、光軸を含む中央部分が凹形状をしており、

前記第4レンズの像側レンズ面を含む少なくとも2つのレンズ面が非球面とされていることを特徴とする広角レンズ。 10

【請求項2】

請求項1において、

レンズ系全体の焦点距離を f 、前記第2レンズの焦点距離を f_2 としたときに、以下の条件式(1)を満たすことを特徴とする広角レンズ。

$$0.4 \leq f_2/f \leq 0.7 \quad \cdots (1)$$

【請求項3】

請求項1または2において、

前記第3レンズの焦点距離を f_3 としたときに、以下の条件式(2)を満たすことを特徴とする広角レンズ。 20

$$-1 \leq f_2/f_3 \leq -0.25 \quad \cdots (2)$$

【請求項4】

請求項1ないし3のうちのいずれかの項において、

前記第1レンズの物体側レンズ面の物体側の端から第4レンズの像側レンズ面の像側の端までの距離を D としたときに、以下の条件式(3)を満たすことを特徴とする広角レンズ。

$$1.0 \leq D/f \leq 2.0 \quad \cdots (3)$$

【請求項5】

請求項1ないし4のうちのいずれかの項において、

前記第1レンズの焦点距離を f_1 としたときに、以下の条件式(4)を満たすことを特徴とする広角レンズ。 30

$$-3.0 \leq f_1/f \leq -0.5 \quad \cdots (4)$$

【請求項6】

請求項1ないし5のうちのいずれかの項において、

画角が 65° 以上であることを特徴とする広角レンズ。

【請求項7】

請求項1ないし6のうちのいずれかの項に記載の広角レンズと、

前記広角レンズの焦点位置に配置された撮像素子と、を有することを特徴とする撮像装置。 40

【発明の詳細な説明】

【技術分野】

【0001】

本発明は、4枚のレンズからなる小型の広角レンズおよび当該広角レンズを搭載する撮像装置に関する。

【背景技術】

【0002】

携帯電話などの情報端末や小型のデジタルカメラに搭載される撮像レンズは特許文献1に記載されている。同文献の撮像レンズは物体側から像側に向かって順に配置された、正のパワーを備える第1レンズ、負のパワーを備える第2レンズ、正のパワーを備える第3レンズ、像側が凸のメニスカス形状の第4レンズ、および、像側レンズ面が変曲点を備え 50

る非球面形状とされた第5レンズを備えている。同文献の撮像レンズの最大画角は 60° である。

【先行技術文献】

【特許文献】

【0003】

【特許文献1】特開2009-14947号公報

【発明の概要】

【発明が解決しようとする課題】

【0004】

情報端末や小型のデジタルカメラなどの機器に搭載される撮像レンズにおいては、使い勝手を考慮して画角を広くする場合がある。すなわち、これらの小型の機器においては、標準画角の撮像レンズを、 60° 以上の画角の広角レンズに置き換えることが要求される場合がある。

【0005】

ここで、標準レンズを広角レンズに置き換えるためには、広角レンズのレンズ系の全長（第1レンズの物体側レンズ面の物体側の端から結像面までの距離）を短く抑え、広角レンズを標準レンズの配置スペースに設置可能としなければならない。また、これらの機器において、撮像レンズの焦点位置に配置される撮像素子には、そのセンサ面に斜めから入射する光に対して感度が低下する特性を有するものがあるので、センサ面（撮像レンズの結像面）に対する主光線入射角度を小さく抑制して、画質の劣化を抑制しなければならない。

【0006】

さらに、情報端末や小型のデジタルカメラなどの機器に搭載される撮像レンズには、軽量化や製造コストの抑制が求められている。かかる要求に対応するためには、撮像レンズを構成しているレンズの枚数を減少させることが望ましい。

【0007】

このような点に鑑みて、本発明の課題は、レンズ系の全長を短く抑え、結像面に対する主光線入射角度を小さく抑制できる4枚のレンズから構成された広角レンズを提供することにある。また、このような広角レンズを搭載する撮像装置を提供することにある。

【課題を解決するための手段】

【0008】

上記課題を解決するために、本発明の広角レンズは、

物体側から像側に向かって順に配置された、負のパワーを有する第1レンズ、正のパワーを有する第2レンズ、負のパワーを有する第3レンズおよび正のパワーを有する第4レンズからなり、

前記第1レンズの像側レンズ面は、凹形状を備え、

前記第2レンズの物体側レンズ面は、凸形状を備え、

前記第4レンズの像側レンズ面は、変曲点を備える非球面であり、光軸を含む中央部分が凹形状をしており、

前記第4レンズの像側レンズ面を含む少なくとも2つのレンズ面が非球面とされていることを特徴とする。

【0009】

本発明によれば、第1レンズに凹形状を備える負のパワーのレンズを配置し、第2レンズに凸形状を備える正のパワーを有するレンズを配置したので、レンズ系の全長を抑えた広角レンズを構成できる。また、第4レンズの像側レンズ面を、変曲点を備える非球面としたので、広角レンズからの射出光線方向を制御することが容易となり、結像面に入射する主光線入射角度を小さく抑制することができる。さらに、第4レンズの像側レンズ面を含む少なくとも2つのレンズ面が非球面とされているので、広角レンズを明るく構成することが容易である。これに加えて、4枚のレンズから広角レンズを構成したので、5枚以上のレンズを備える撮像レンズと比較して、軽量化や製造コストの抑制を図ることが容

易である。なお、広角レンズとは、一般的に、画角が 60° 以上の撮像レンズをいう。主光線入射角度とは、結像面へ入射する光線と光軸が交差する角度である。

【0010】

本発明において、レンズ系全体の焦点距離を f 、前記第2レンズの焦点距離を f_2 としたときに、以下の条件式(1)を満たすことが望ましい。

$$0.4 \leq f_2/f \leq 0.7 \quad \cdots (1)$$

【0011】

条件式(1)はレンズ系の全長の抑制を容易にするものであり、条件式(1)の上限値を上回ると、レンズ系の全長の増大を招く。条件式(1)の下限値を下回ると、バックフォーカスを確保することが困難となる。

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【0012】

本発明において、前記第3レンズの焦点距離を f_3 としたときに、以下の条件式(2)を満たすことが望ましい。

$$-1 \leq f_2/f_3 \leq -0.25 \quad \cdots (2)$$

【0013】

条件式(2)は軸上の色収差を抑制するものである。すなわち、軸上の色収差は隣接配置した正のパワーを有する第2レンズ12、負のパワーを有する第3レンズ13によって抑制することが可能であるが、第2レンズのパワーと第3レンズのパワーのバランスによって、条件式(2)の上限値を上回ると色収差の補正が不足となり、条件式(2)の下限値を下回ると色収差に過剰補正が生じる。

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【0014】

本発明において、前記第1レンズの物体側レンズ面の物体側の端から第4レンズの像側レンズ面の像側の端までの距離(レンズ系のレンズ厚)を D としたときに、以下の条件式(3)を満たすことが望ましい。

$$1.0 \leq D/f \leq 2.0 \quad \cdots (3)$$

【0015】

条件式(3)はバックフォーカスを確保しながらレンズ系の全長の抑制することを容易にするものである。条件式(3)の上限値を上回るとバックフォーカスを確保することが困難となる。条件式(3)の下限値を下回ると、各レンズの間の距離が短くなり、各レンズの配置に無理が生じやすい。すなわち、各レンズの中心厚やコバ厚によって、各レンズの配置が困難となる場合が発生する。

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【0016】

本発明において、前記第1レンズの焦点距離を f_1 としたときに、以下の条件式(4)を満たすことが望ましい。

$$-3.0 \leq f_1/f \leq -0.5 \quad \cdots (4)$$

【0017】

条件式(4)は画角の確保を容易にするものである。条件式(4)の上限値を上回ると第1レンズのパワーがレンズ系の中で大きくなりすぎて、全長の増大を招く。また、第1レンズのパワーがレンズ系の中で大きくなりすぎて、像面湾曲の補正が困難となる。条件式(4)の下限値を下回ると、第1レンズのパワーの低下により画角の確保が難しくなる。

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【0018】

本発明において、画角は 65° 以上とすることができる。すなわち、標準レンズよりも広い画角を備えるものとすることができる。

【0019】

次に、本発明の撮像装置は、上記の広角レンズと、前記広角レンズの焦点位置に配置された撮像素子とを有することを特徴とする。

【0020】

本発明によれば、広角レンズのレンズ系の全長が短く抑えられている。従って、撮像装置を小さく構成できる。また、広角レンズが明るく、結像面に対する主光線入射角度が小

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さく抑制されている。従って、撮像レンズの焦点位置に配置される撮像素子がそのセンサ面に斜めから入射する光に対して感度が低下する特性を有するものであっても、画質の劣化を抑制することができる。さらに、4枚のレンズから広角レンズを構成したので、5枚以上のレンズを備える撮像レンズを搭載する場合と比較して、撮像装置の軽量化や製造コストの抑制を図ることが容易である。

【発明の効果】

【0021】

本発明によれば、レンズ系の全長を短く抑え、結像面に対する主光線入射角度を小さく抑制した明るい広角レンズを4枚のレンズから構成できる。

【図面の簡単な説明】

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【0022】

【図1】本発明を適用した実施例1の広角レンズの構成図である。

【図2】図1の広角レンズの縦収差図、横収差図、像面湾曲図、歪曲収差図である。

【図3】本発明を適用した実施例2の広角レンズの構成図である。

【図4】図3の広角レンズの縦収差図、横収差図、像面湾曲図、歪曲収差図である。

【図5】本発明を適用した実施例3の広角レンズの構成図である。

【図6】図5の広角レンズの縦収差図、横収差図、像面湾曲図、歪曲収差図である。

【図7】本発明を適用した実施例4の広角レンズの構成図である。

【図8】図7の広角レンズの縦収差図、横収差図、像面湾曲図、歪曲収差図である。

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【図9】本発明を適用した実施例5の広角レンズの構成図である。

【図10】図9の広角レンズの縦収差図、横収差図、像面湾曲図、歪曲収差図である。

【図11】広角レンズを搭載する撮像装置の説明図である。

【発明を実施するための形態】

【0023】

以下に図面を参照して、本発明を適用した広角レンズを説明する。

【0024】

(実施例1)

図1は実施例1の広角レンズの光線図である。図1に示すように、広角レンズ10は、物体側から像側に向かって順に配置された、負のパワーを有する第1レンズ11、正のパワーを有する第2レンズ12、負のパワーを有する第3レンズ13、および正のパワーを有する第4レンズ14からなる。第1レンズ11と第2レンズ12の間には絞り（不図示）が配置されている。第4レンズ14の像側にはカバーガラス15が配置されている。結像面16はカバーガラス15と間隔を開けた位置にある。

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【0025】

第1レンズ11は、物体側レンズ面11aおよび像側レンズ面11bのそれぞれが非球面とされている。物体側レンズ面11aは凸形状を備えており、像側レンズ面11bは凹形状を備えている。物体側レンズ面11aは、凸形状をしているレンズ面部分の曲率半径が大きく、平面形状に近い。

【0026】

第2レンズ12は、物体側レンズ面12aおよび像側レンズ面12bのそれぞれが非球面とされている。物体側レンズ面12aおよび像側レンズ面12bは、それぞれ凸形状を備えている。

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【0027】

第3レンズ13は、物体側レンズ面13aおよび像側レンズ面13bのそれぞれが非球面とされている。物体側レンズ面13aおよび像側レンズ面13bは、それぞれ凹形状を備えている。

【0028】

第4レンズ14は、物体側レンズ面14aおよび像側レンズ面14bのそれぞれが非球面とされている。物体側レンズ面14aは光軸を含む中央部分に凸形状を備えている。像側レンズ面14bは、変曲点を有しており、光軸を含む中央部分に凹形状を備えている。

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従って、像側レンズ面14bは変曲点から内周側に向かって物体側に湾曲しており、変曲点から外周側に向かって物体側に湾曲している。

【0029】

広角レンズ10の開口数をFno.、半画角を m 、および、レンズ系の全長（第1レンズ11の物体側レンズ面11aの物体側の端から結像面16までの距離）をL、レンズ系のレンズ厚（第1レンズ11の物体側レンズ面11aの物体側の端から第4レンズ14の像側レンズ面14bの像側の端までの距離）をDとすると、これらの値は以下のとおりである。

$$Fno. = 2.8$$

$$m = 85.8^\circ$$

$$L = 4.281\text{ mm}$$

$$D = 3.212\text{ mm}$$

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【0030】

また、全レンズ系の焦点距離を f 、第1レンズ11の焦点距離を f_1 、第2レンズ12の焦点距離を f_2 、第3レンズ13の焦点距離を f_3 、第4レンズ14の焦点距離を f_4 とすると、これらの値は以下のとおりである。

$$f = 2.564$$

$$f_1 = -3.390$$

$$f_2 = 1.490$$

$$f_3 = -3.241$$

$$f_4 = 4.561$$

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【0031】

ここで、本例の広角レンズ10は、以下の条件式(1)～(4)を満たす。

$$0.4 \leq f_2/f \leq 0.7 \quad \cdots (1)$$

$$-1 \leq f_2/f_3 \leq -0.25 \quad \cdots (2)$$

$$1.0 \leq D/f \leq 2.0 \quad \cdots (3)$$

$$-3.0 \leq f_1/f \leq -0.5 \quad \cdots (4)$$

【0032】

すなわち、 $f_2/f = 0.581$ であり、 $f_2/f_3 = -0.460$ であり、 $D/f = 1.253$ であり、 $f_1/f = -1.322$ である。

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【0033】

広角レンズ10は条件式(1)を満たすので、レンズ系の全長を抑制し、バックフォーカスを確保することが容易である。すなわち、条件式(1)の上限値を上回ると、全長の増大を招く。条件式(1)の下限値を下回ると、バックフォーカスを確保することが困難となる。

【0034】

広角レンズ10は条件式(2)を満たすので、軸上の色収差が抑制される。すなわち、軸上の色収差は隣接配置した正のパワーを有する第2レンズ12、負のパワーを有する第3レンズ13によって抑制することが可能となっているが、第2レンズ12のパワーと第3レンズ13のパワーのバランスによって、条件式(2)の上限値を上回ると色収差の補正が不足となり、条件式(2)の下限値を下回ると色収差に過剰補正が生じる。

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【0035】

広角レンズ10は条件式(3)を満たすので、バックフォーカスを確保しながらレンズ系の全長を抑制することが容易である。すなわち、条件式(3)の上限値を上回るとバックフォーカスを確保することが困難となる。条件式(3)の下限値を下回ると、各レンズの間の距離が短くなるので、各レンズの中心厚やコバ厚によって、各レンズの配置が困難となる場合が発生する。

【0036】

広角レンズ10は条件式(4)を満たすので、画角の確保が容易である。すなわち、条件式(4)の上限値を上回ると第1レンズ11のパワーがレンズ系の中で大きくなりすぎ

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て、レンズ系の全長の増大を招く。また、条件式(4)の上限値を上回ると第1レンズ11のパワーがレンズ系の中で大きくなりすぎて、像面湾曲の補正が困難となる。一方、条件式(2)の下限値を下回ると、第1レンズ11のパワーの低下により画角の確保が難しくなる。

【0037】

また、広角レンズ10は、以下の条件式(5)、(6)を満たす。

$$-1.4 \leq f_3/f \leq -0.6 \quad \cdots (5)$$

$$1.3 \leq L/f \leq 2.5 \quad \cdots (6)$$

【0038】

すなわち、 $f_3/f = -1.264$ であり、 $L/f = 1.670$ である。

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【0039】

広角レンズ10は条件式(5)を満たすので、色収差を良好に補正できる。すなわち、条件式(5)の上限値を上回ると色収差の補正が過剰となり、下限値を下回ると色収差の補正に不足が生じる。

【0040】

さらに、広角レンズ10は条件式(6)を満たすので、バックフォーカスを確保しながらレンズ系の全長を抑制することがより容易となる。すなわち、条件式(6)の上限値を上回るとバックフォーカスを確保することが困難となる。条件式(6)の下限値を下回ると、各レンズの間の距離が短くなるので、各レンズの中心厚やコバ厚によって、各レンズの配向が困難となる場合が発生する。

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【0041】

以下の表1Aは広角レンズ10の各レンズ面のレンズデータを示す。表1Aでは物体側から数えた順番で各レンズ面を特定している。本例では、各レンズの全てのレンズ面が非球面である。なお、9面および10面はカバーガラス15のガラス面であり、11面は結像面16である。曲率半径および間隔の単位はミリメートルである。

【0042】

【表1A】

面番	曲率半径	間隔	Nd(屈折率)	Vd(アッベ数)	材料
1	19.988	0.400	1.53116	56.0	樹脂
2	1.639	0.259			
3	1.306	0.627	1.53116	56.0	樹脂
4	-1.693	0.477			
5	-2.153	0.226	1.63494	24.0	樹脂
6	61.884	0.479			
7	1.220	0.744	1.53116	56.0	樹脂
8	1.929	0.210			
9	infinity	0.100	1.51880	64.2	光学ガラス
10	infinity	0.781			
11	infinity	-0.022			

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【0043】

次に、表1B、表1Cは非球面とされたレンズ面の非球面形状を規定するための非球面係数を示す。表1B、表1Cにおいても物体側から数えた順番で各レンズ面を特定している。

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【表 1 B】

	第1面	第2面	第3面	第4面	第5面	第6面
K	0.00000E+00	1.96845E+00	-3.24241E+00	0.00000E+00	-4.91958E+01	3.84487E+03
A4	-6.70903E-02	-1.23090E-01	1.05137E-01	2.08286E-01	-4.45527E-02	2.10240E-02
A6	1.43040E-02	1.93268E-01	2.60961E-01	-7.07806E-01	0.00000E+00	0.00000E+00
A8	0.00000E+00	0.00000E+00	-5.44854E-01	1.00543E+00	-1.05324E-01	5.55869E-02
A10	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
A12	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
A14	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
A16	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00

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【表 1 C】

	第7面	第8面
K	-5.25406E+00	0.00000E+00
A4	-6.29015E-02	-1.28252E-01
A6	-2.28756E-03	3.60116E-02
A8	-0.15992E-03	-3.97193E-02
A10	3.30573E-04	3.02394E-02
A12	7.78451E-03	-1.38145E-02
A14	-4.09359E-03	3.33327E-03
A16	4.32061E-04	-3.35E-04

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【0044】

なお、レンズ面に採用する非球面形状は、Yをサグ量、cを曲率半径の逆数、Kを円錐係数、hを光線高さ、4次、6次、8次、10次、12次、14次、16次の非球面係数をそれぞれA4、A6、A8、A10、A12、A14、A16とすると、次式により表わされる。

【0045】

【数1】

$$Y(h) = \frac{ch^2}{1 + \sqrt{1 - (K+1)c^2h^2}} + A_4h^4 + A_6h^6 + A_8h^8 + A_{10}h^{10} + A_{12}h^{12} + A_{14}h^{14} + A_{16}h^{16}$$

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【0046】

(作用効果)

図2(a)～(d)は広角レンズ10の縦収差図、横収差図、像面湾曲図、歪曲収差図である。図2(a)の縦収差図では、横軸は光線が光軸Lと交わる位置を示し、縦軸は光線がレンズ系に入射する高さを示している。図2(b)の横収差図では横軸は入射位置を示し、縦軸は収差量を示す。図2(a)、(b)では、波長の異なる複数の可視光線についてのシミュレーション結果を示してある。図2(c)の像面湾曲図では横軸は光軸方向の距離を示し、縦軸は像の高さを示す。図2(c)において、Sはサジタル面における像面湾曲収差を示し、Tはタンジェンシャル面における像面湾曲収差を示す。図2(d)の歪曲収差図では横軸は像の歪み量を示し、縦軸は像の高さを示す。

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【0047】

図2(a)に示すように、広角レンズ10によれば、軸上の色収差が良好に補正されている。また、図2(b)に示すように、色の滲みが抑制される。さらに、図2(c)、(d)に示すように、像面湾曲が良好に補正されている。従って、広角レンズ10が高解像度となる。

【0048】

また、広角レンズ10では、第1レンズ11に凹形状を備える負のパワーのレンズを配置し、第2レンズ12に凸形状を備える正のパワーを有するレンズを配置したので、65°以上の画角を備えるレンズ系の全長を4.3mm以下に抑えることができる。さらに、第4レンズ14の像側レンズ面14bを、変曲点を備える非球面としたので、広角レンズ

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10からの射出光線方向を制御することが容易となり、結像面16に入射する主光線入射角度を小さく抑制することができる。また、本例では、各レンズのレンズ面を非球面としたので、広角レンズ10が明るく構成される。さらに、4枚のレンズから広角レンズ10を構成したので、5枚以上のレンズを備える撮像レンズと比較して、軽量化や製造コストの抑制を図ることが容易である。

【0049】

(実施例2)

図3は実施例2の広角レンズの光線図である。図3に示すように、広角レンズ20は、物体側から像側に向かって順に配置された、負のパワーを有する第1レンズ21、正のパワーを有する第2レンズ22、負のパワーを有する第3レンズ23、および正のパワーを有する第4レンズ24からなる。第1レンズ21と第2レンズ22の間には絞り（不図示）が配置されている。第4レンズ24の像側にはカバーガラス25が配置されている。結像面26はカバーガラス25と間隔を開けた位置にある。

【0050】

第1レンズ21は、物体側レンズ面21aおよび像側レンズ面21bのそれぞれが非球面とされている。物体側レンズ面21aは凸形状を備えており、像側レンズ面21bは凹形状を備えている。物体側レンズ面21aは、凸形状をしているレンズ面部分の曲率半径が大きく、平面形状に近い。

【0051】

第2レンズ22は、物体側レンズ面22aおよび像側レンズ面22bのそれぞれが非球面とされている。物体側レンズ面22aおよび像側レンズ面22bは、それぞれ凸形状を備えている。

【0052】

第3レンズ23は、物体側レンズ面23aおよび像側レンズ面23bのそれぞれが非球面とされている。物体側レンズ面23aおよび像側レンズ面23bは、それぞれ凹形状を備えている。

【0053】

第4レンズ24は、物体側レンズ面24aおよび像側レンズ面24bのそれぞれが非球面とされている。物体側レンズ面24aは光軸を含む中央部分に凸形状を備えている。像側レンズ面24bは、変曲点を有しており、光軸を含む中央部分に凹形状を備えている。従って、像側レンズ面24bは変曲点から内周側に向かって物体側に湾曲しており、変曲点から外周側に向かって物体側に湾曲している。

【0054】

広角レンズ20の開口数をFno.、半面角を ω 、および、レンズ系の全長（第1レンズ21の物体側レンズ面21aの物体側の端から結像面26までの距離）をL、レンズ系のレンズ厚（第1レンズ21の物体側レンズ面21aの物体側の端から第4レンズ24の像側レンズ面24bの像側の端までの距離）をDとすると、これらの値は以下のとおりである。

$$Fno. = 2.8$$

$$\omega = 85.8^\circ$$

$$L = 4.983 \text{ mm}$$

$$D = 3.935 \text{ mm}$$

【0055】

また、全レンズ系の焦点距離をf、第1レンズ21の焦点距離をf1、第2レンズ22の焦点距離をf2、第3レンズ23の焦点距離をf3、第4レンズ24の焦点距離をf4とすると、これらの値は以下のとおりである。

$$f = 2.563$$

$$f1 = -6.972$$

$$f2 = 1.529$$

$$f3 = -2.479$$

$$f_4 = 7.890$$

【0056】

ここで、本例の広角レンズ20は、以下の条件式(1)～(4)を満たす。

$$0.4 \leq f_2/f = 0.596 \leq 0.7 \quad \cdots (1)$$

$$-1 \leq f_2/f_3 = -0.617 \leq -0.25 \quad \cdots (2)$$

$$1.0 \leq D/f = 1.535 \leq 2.0 \quad \cdots (3)$$

$$-3.0 \leq f_1/f = -2.720 \leq -0.5 \quad \cdots (4)$$

【0057】

広角レンズ20は、条件式(1)～(4)を満たすので、65°以上の画角を確保しながら、レンズ系の全長を抑制し、バックフォーカスを確保することが容易である。また、軸上の色収差を抑制することができる。

【0058】

また、広角レンズ20は、以下の条件式(5)、(6)を満たす。

$$-1.4 \leq f_3/f = -0.967 \leq -0.6 \quad \cdots (5)$$

$$1.3 \leq L/f = 1.944 \leq 2.5 \quad \cdots (6)$$

【0059】

広角レンズ20は条件式(5)、(6)を満たすので、色収差を良好に補正できる。また、結像面26に入射する主光線入射角度を小さくできる。さらに、バックフォーカスを確保しながらレンズ系の全長を抑制することが容易である。

【0060】

以下の表2Aは広角レンズ20の各レンズ面のレンズデータを示す。表2Aでは物体側から数えた順番で各レンズ面を特定している。本例では、各レンズの全てのレンズ面が非球面である。なお、9面および10面はカバーガラス25のガラス面であり、11面は結像面26である。曲率半径および間隔の単位はミリメートルである。

【0061】

【表2A】

面番	曲率半径	間隔	Nd(屈折率)	Vd(アッベ数)	材料
1	18.988	0.400	1.53116	56.0	樹脂
2	3.067	1.067			
3	1.218	0.529	1.53116	56.0	樹脂
4	-2.093	0.215			
5	-2.030	0.383	1.63494	24.0	樹脂
6	7.868	0.601			
7	1.498	0.739	1.53116	56.0	樹脂
8	1.928	0.210			
9	infinity	0.100	1.51680	64.2	光学ガラス
10	infinity	0.762			
11	infinity	-0.024			

【0062】

次に、表2B、表2Cは非球面とされたレンズ面の非球面形状を規定するための非球面係数を示す。表2B、表2Cにおいても物体側から数えた順番で各レンズ面を特定している。

【表 2 B】

	第1面	第2面	第3面	第4面	第5面	第6面
K	0.00000E+00	3.85318E+00	-2.99208E+00	2.54698E+00	-4.46502E+01	0.00000E+00
A4	5.78055E-03	5.21124E-03	7.81867E-02	1.02266E-01	-7.96020E-02	2.08047E-01
A6	-1.09778E-02	-4.44309E-02	3.32598E-02	-5.30863E-01	0.00000E+00	0.00000E+00
A8	0.00000E+00	0.00000E+00	-7.00411E-01	6.21259E-01	-2.22084E-01	8.71856E-02
A10	0.00000E+00	0.00000E+00	-3.91407E-01	-1.97758E+00	-3.06686E-01	-8.16509E-02
A12	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
A14	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
A16	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00

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【表 2 C】

	第7面	第8面
K	-5.38920E+00	0.00000E+00
A4	-1.11271E-01	-1.63845E-01
A6	3.08045E-02	4.93248E-02
A8	-3.76929E-03	-3.99351E-02
A10	-3.21886E-03	3.00214E-02
A12	5.97323E-03	-1.39517E-02
A14	-4.16558E-03	3.30562E-03
A16	9.01603E-04	-3.20E-04

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【0063】

(作用効果)

図4(a)～(d)は広角レンズ20の縦収差図、横収差図、像面湾曲図、歪曲収差図である。図4(a)に示すように、広角レンズ20によれば、軸上の色収差が良好に補正されている。また、図4(b)に示すように、色の滲みが抑制される。さらに、図4(c)、(d)に示すように、像面湾曲が良好に補正されている。従って、広角レンズ20が高解像度となる。

【0064】

また、広角レンズ20では、第1レンズ21に凹形状を備える負のパワーのレンズを配置し、第2レンズ22に凸形状を備える正のパワーを有するレンズを配置したので、65°以上の画角を備えるレンズ系の全長を5mm以下に抑えることができる。さらに、第4レンズ24の像側レンズ面24bを、変曲点を備える非球面としたので、広角レンズ20からの射出光線の方向を制御することが容易となり、結像面26に入射する主光線入射角度を小さく抑制することができる。また、本例では、各レンズのレンズ面を非球面としたので、広角レンズ20が明るく構成される。さらに、4枚のレンズから広角レンズを構成したので、5枚以上のレンズを備える撮像レンズと比較して、軽量化や製造コストの抑制を図ることが容易である。

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【0065】

(実施例3)

図5は実施例3の広角レンズの光線図である。図5に示すように、広角レンズ30は、物体側から像側に向かって順に配置された、負のパワーを有する第1レンズ31、正のパワーを有する第2レンズ32、負のパワーを有する第3レンズ33、および正のパワーを有する第4レンズ34からなる。第1レンズ31と第2レンズ32の間には絞り(不図示)が配置されている。第4レンズ34の像側にはカバーガラス35が配置されている。結像面36はカバーガラス35と間隔を開けた位置にある。

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【0066】

第1レンズ31は、物体側レンズ面31aおよび像側レンズ面31bのそれぞれが非球面とされている。物体側レンズ面31aは凸形状を備えており、像側レンズ面31bは凹形状を備えている。物体側レンズ面31aは、凸形状をしているレンズ面部分の曲率半径が大きく、平面形状に近い。

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【0067】

第2レンズ32は、物体側レンズ面32aおよび像側レンズ面32bのそれぞれが非球面とされている。物体側レンズ面32aおよび像側レンズ面32bは、それぞれ凸形状を備えている。

【0068】

第3レンズ33は、物体側レンズ面33aおよび像側レンズ面33bのそれぞれが非球面とされている。物体側レンズ面33aは凹形状を備えており、像側レンズ面33bは凸形状を備えている。

【0069】

第4レンズ34は、物体側レンズ面34aおよび像側レンズ面34bのそれぞれが非球面とされている。物体側レンズ面34aは光軸を含む中央部分に凸形状を備えている。像側レンズ面34bは、変曲点を有しており、光軸を含む中央部分に凹形状を備えている。従って、像側レンズ面34bは変曲点から内周側に向かって物体側に湾曲しており、変曲点から外周側に向かって物体側に湾曲している。

【0070】

広角レンズ30の開口数をFno.、半画角を ω 、および、レンズ系の全長（第1レンズ31の物体側レンズ面31aの物体側の端から結像面36までの距離）をL、レンズ系のレンズ厚（第1レンズ31の物体側レンズ面31aの物体側の端から第4レンズ34の像側レンズ面34bの像側の端までの距離）をDとすると、これらの値は以下のとおりである。

$$\begin{aligned} \text{Fno.} &= 2.8 \\ \omega &= 85.8^\circ \\ L &= 3.838 \text{ mm} \\ D &= 2.783 \text{ mm} \end{aligned}$$

【0071】

また、全レンズ系の焦点距離をf、第1レンズ31の焦点距離をf1、第2レンズ32の焦点距離をf2、第3レンズ33の焦点距離をf3、第4レンズ34の焦点距離をf4とすると、これらの値は以下のとおりである。

$$\begin{aligned} f &= 2.563 \\ f1 &= -4.824 \\ f2 &= 1.340 \\ f3 &= -2.259 \\ f4 &= 4.190 \end{aligned}$$

【0072】

ここで、本例の広角レンズ30は、以下の条件式(1)～(4)を満たす。

$$\begin{aligned} 0.4 &\leq f2/f = 0.523 \leq 0.7 \quad \cdots (1) \\ -1 &\leq f2/f3 = -0.593 \leq -0.25 \quad \cdots (2) \\ 1.0 &\leq D/f = 1.086 \leq 2.0 \quad \cdots (3) \\ -30 &\leq f1/f = -1.882 \leq -0.5 \quad \cdots (4) \end{aligned}$$

【0073】

広角レンズ30は、条件式(1)～(4)を満たすので、65°以上の画角を確保しながら、レンズ系の全長を抑制し、バックフォーカスを確保することが容易である。また、軸上の色収差を抑制することができる。

【0074】

また、広角レンズ30は、以下の条件式(5)、(6)を満たす。

$$\begin{aligned} -1.4 &\leq f3/f = -0.881 \leq -0.6 \quad \cdots (5) \\ 1.3 &\leq L/f = 1.498 \leq 2.5 \quad \cdots (6) \end{aligned}$$

【0075】

広角レンズ30は条件式(5)、(6)を満たすので、色収差を良好に補正できる。また、結像面36に入射する主光線入射角度を小さくできる。さらに、バックフォーカスを

確保しながらレンズ系の全長を抑制することが容易である。

【0076】

以下の表3Aは広角レンズ30の各レンズ面のレンズデータを示す。表3Aでは物体側から数えた順番で各レンズ面を特定している。本例では、各レンズの全てのレンズ面が非球面である。なお、9面および10面はカバーガラス35のガラス面であり、11面は結像面36である。曲率半径および間隔の単位はミリメートルである。

【0077】

【表3A】

面番	曲率半径	間隔	Nd(屈折率)	Vd(アッベ数)	材料
1	150.000	0.400	1.53116	56.0	樹脂
2	2.527	0.068			
3	0.974	0.479	1.53116	56.0	樹脂
4	-2.225	0.289			
5	-0.678	0.322	1.53494	24.0	樹脂
6	-1.512	0.301			
7	1.218	0.923	1.53116	56.0	樹脂
8	1.971	0.210			
9	infinity	0.100	1.51680	64.2	光学ガラス
10	infinity	0.773			
11	infinity	-0.028			

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【0078】

次に、表3B、表3Cは非球面とされたレンズ面の非球面形状を規定するための非球面係数を示す。表3B、表3Cにおいても物体側から数えた順番で各レンズ面を特定している。

【表3B】

	第1面	第2面	第3面	第4面	第5面	第6面
K	0.00000E+00	3.50577E+00	-3.83881E+00	5.33536E+00	-4.54098E+00	0.00000E+00
A4	-1.74521E-02	-3.32642E-01	5.90588E-02	8.27775E-02	-4.37925E-01	1.43565E-01
A6	-1.70578E-01	-1.70011E-01	8.54668E-02	-2.36439E-01	0.00000E+00	0.00000E+00
A8	0.00000E+00	0.00000E+00	-5.37071E-01	-1.38358E+00	1.01643E+00	6.87456E-01
A10	0.00000E+00	0.00000E+00	-3.10124E+00	9.66727E-01	1.18549E+00	-1.55451E-01
A12	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
A14	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
A16	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00

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【表3C】

	第7面	第8面
K	-7.24393E+00	0.00000E+00
A4	-1.40591E-01	-1.60857E-01
A6	4.71327E-02	6.52796E-02
A8	-5.32562E-03	-4.48510E-02
A10	-5.36876E-03	2.97256E-02
A12	5.96681E-03	-1.34959E-02
A14	-4.45794E-03	3.25636E-03
A16	1.08898E-03	-3.23E-04

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【0079】

(作用効果)

図6(a)～(d)は広角レンズ30の縦収差図、横収差図、像面湾曲図、歪曲収差図である。図6(a)に示すように、広角レンズ30によれば、軸上の色収差が良好に補正されている。また、図6(b)に示すように、色の滲みが抑制される。さらに、図6(c)、(d)に示すように、像面湾曲が良好に補正されている。従って、広角レンズ30が

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高解像度となる。

【0080】

また、広角レンズ30では、第1レンズ31に凹形状を備える負のパワーのレンズを配置し、第2レンズ32に凸形状を備える正のパワーを有するレンズを配置したので、65°以上の画角を備えるレンズ系の全長を4mm以下に抑えることができる。さらに、第4レンズ34の像側レンズ面34bを、変曲点を備える非球面としたので、広角レンズ30からの射出光線方向を制御することが容易となり、結像面36に入射する主光線入射角度を小さく抑制することができる。また、本例では、各レンズのレンズ面を非球面としたので、広角レンズ30が明るく構成される。さらに、4枚のレンズから広角レンズ10を構成したので、5枚以上のレンズを備える撮像レンズと比較して、軽量化や製造コストの抑制を図ることが容易である。

【0081】

(実施例4)

図7は実施例4の広角レンズの光線図である。図7に示すように、広角レンズ40は、物体側から像側に向かって順に配置された、負のパワーを有する第1レンズ41、正のパワーを有する第2レンズ42、負のパワーを有する第3レンズ43、および正のパワーを有する第4レンズ44からなる。第1レンズ41と第2レンズ42の間には絞り（不図示）が配置されている。第4レンズ44の像側にはカバーガラス45が配置されている。結像面46はカバーガラス45と間隔を開けた位置にある。

【0082】

第1レンズ41は、物体側レンズ面41aおよび像側レンズ面41bのそれぞれが非球面とされている。物体側レンズ面41aは凸形状を備えており、像側レンズ面41bは凹形状を備えている。物体側レンズ面41aは、凸形状をしているレンズ面部分の曲率半径が大きく、平面形状に近い。

【0083】

第2レンズ42は、物体側レンズ面42aおよび像側レンズ面42bのそれぞれが非球面とされている。物体側レンズ面42aおよび像側レンズ面42bは、それぞれ凸形状を備えている。

【0084】

第3レンズ43は、物体側レンズ面43aおよび像側レンズ面43bのそれぞれが非球面とされている。物体側レンズ面43aは凹形状を備えており、像側レンズ面43bは凸形状を備えている。

【0085】

第4レンズ44は、物体側レンズ面44aおよび像側レンズ面44bのそれぞれが非球面とされている。物体側レンズ面44aは光軸を含む中央部分に凸形状を備えている。像側レンズ面44bは、変曲点を有しており、光軸を含む中央部分に凹形状を備えている。従って、像側レンズ面44bは変曲点から内周側に向かって物体側に湾曲しており、変曲点から外周側に向かって物体側に湾曲している。

【0086】

広角レンズ40の開口数をFno.、半画角を ω 、および、レンズ系の全長（第1レンズ41の物体側レンズ面41aの物体側の端から結像面46までの距離）をL、レンズ系のレンズ厚（第1レンズ41の物体側レンズ面41aの物体側の端から第4レンズ44の像側レンズ面44bの像側の端までの距離）をDとすると、これらの値は以下のとおりである。

$$Fno. = 2.8$$

$$\omega = 85.8^\circ$$

$$L = 3.932 \text{ mm}$$

$$D = 2.895 \text{ mm}$$

【0087】

また、全レンズ系の焦点距離をf、第1レンズ41の焦点距離をf1、第2レンズ42

の焦点距離を f_2 、第3レンズ43の焦点距離を f_3 、第4レンズ44の焦点距離を f_4 とすると、これらの値は以下のとおりである。

$$f = 2.563$$

$$f_1 = -14.456$$

$$f_2 = 1.595$$

$$f_3 = -2.032$$

$$f_4 = 3.607$$

【0088】

ここで、本例の広角レンズ40は、以下の条件式(1)～(4)を満たす。

$$0.4 \leq f_2/f = 0.622 \leq 0.7 \quad \cdots (1)$$

$$-1 \leq f_2/f_3 = -0.785 \leq -0.25 \quad \cdots (2)$$

$$1.0 \leq D/f = 1.129 \leq 2.0 \quad \cdots (3)$$

$$-3.0 \leq f_1/f = -5.640 \leq -0.5 \quad \cdots (4)$$

【0089】

広角レンズ40は、条件式(1)～(4)を満たすので、 65° 以上の画角を確保しながら、レンズ系の全長を抑制し、バックフォーカスを確保することが容易である。また、軸上の色収差を抑制することができる。

【0090】

また、広角レンズ40は、以下の条件式(5)、(6)を満たす。

$$-1.4 \leq f_3/f = -0.793 \leq -0.6 \quad \cdots (5)$$

$$1.3 \leq L/f = 1.534 \leq 2.5 \quad \cdots (6)$$

【0091】

広角レンズ40は条件式(5)、(6)を満たすので、色収差を良好に補正できる。また、結像面46に入射する主光線入射角度を小さくできる。さらに、バックフォーカスを確保しながらレンズ系の全長を抑制することが容易である。

【0092】

以下の表4Aは広角レンズ40の各レンズ面のレンズデータを示す。表4Aでは物体側から数えた順番で各レンズ面を特定している。本例では、各レンズの全てのレンズ面が非球面である。なお、9面および10面はカバーガラス45のガラス面であり、11面は結像面46である。曲率半径および間隔の単位はミリメートルである。

【0093】

【表4A】

面番	曲率半径	間隔	Nd(屈折率)	Vd(アッベ数)	材料
1	150.000	0.400	1.53116	56.0	樹脂
2	7.327	0.099			
3	1.413	0.556	1.53116	56.0	樹脂
4	-1.846	0.338			
5	-0.576	0.361	1.63494	24.0	樹脂
6	-1.285	0.146			
7	1.147	0.995	1.53116	56.0	樹脂
8	1.985	0.210			
9	infinity	0.100	1.51680	64.2	光学ガラス
10	infinity	0.753			
11	infinity	-0.026			

【0094】

次に、表4B、表4Cは非球面とされたレンズ面の非球面形状を規定するための非球面係数を示す。表4B、表4Cにおいても物体側から数えた順番で各レンズ面を特定している。

【表 4 B】

	第1面	第2面	第3面	第4面	第5面	第6面
K	0.00000E+00	9.96692E+01	-4.55267E+00	5.20287E+00	-3.51020E+00	0.00000E+00
A4	-2.50823E-03	-3.83857E-02	3.83770E-02	-1.33640E-01	-5.16180E-01	1.22505E-01
A6	-8.07761E-02	-6.22535E-02	-1.17843E-01	7.52591E-02	0.00000E+00	0.00000E+00
A8	0.00000E+00	-3.63324E-01	-7.96090E-01	-1.60860E+00	8.70251E-01	6.90508E-01
A10	0.00000E+00	0.00000E+00	-4.16550E+00	5.85779E-01	8.59358E-01	-3.11595E-01
A12	0.00000E+00	0.00000E+00	8.20707E+00	1.85436E+00	-3.35126E-01	-4.39279E-02
A14	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
A16	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00

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【表 4 C】

	第7面	第8面
K	-8.11925E+00	0.00000E+00
A4	-1.95885E-01	-1.93101E-01
A6	1.03146E-01	7.12000E-02
A8	-3.61144E-02	-4.41820E-02
A10	2.64718E-03	2.85423E-02
A12	6.32241E-03	-1.35319E-02
A14	-6.95948E-03	3.43603E-03
A16	1.89193E-03	-3.56E-04

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【0095】

(作用効果)

図8(a)～(d)は広角レンズ40の縦収差図、横収差図、像面湾曲図、歪曲収差図である。図8(a)に示すように、広角レンズ40によれば、軸上の色収差が良好に補正されている。また、図8(b)に示すように、色のゆみが抑制される。さらに、図8(c)、(d)に示すように、像面湾曲が良好に補正されている。従って、広角レンズ40が高解像度となる。

【0096】

また、広角レンズ40では、第1レンズ41に凹形状を備える負のパワーのレンズを配置し、第2レンズ42に凸形状を備える正のパワーを有するレンズを配置したので、65°以上の画角を備えるレンズ系の全長を4.0mm以下に抑えることができる。さらに、第4レンズ44の像側レンズ面44bを、変曲点を備える非球面としたので、広角レンズ40からの射出光線の方法を制御することが容易となり、結像面46に入射する主光線入射角度を小さく抑制することができる。また、本例では、各レンズのレンズ面を非球面としたので、広角レンズ40が明るく構成される。さらに、4枚のレンズから広角レンズを構成したので、5枚以上のレンズを備える撮像レンズと比較して、軽量化や製造コストの抑制を図ることが容易である。

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【0097】

(実施例5)

図9は実施例5の広角レンズの光線図である。図9に示すように、広角レンズ50は、物体側から像側に向かって順に配置された、負のパワーを有する第1レンズ51、正のパワーを有する第2レンズ52、負のパワーを有する第3レンズ53、および正のパワーを有する第4レンズ54からなる。第1レンズ51と第2レンズ52の間には絞り(不図示)が配置されている。第4レンズ54の像側にはカバーガラス55が配置されている。結像面56はカバーガラス55と間隔を開けた位置にある。

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【0098】

第1レンズ51は、物体側レンズ面51aおよび像側レンズ面51bのそれぞれが非球面とされている。物体側レンズ面51aは凸形状を備えており、像側レンズ面51bは凹形状を備えている。物体側レンズ面51aは、凸形状をしているレンズ面部分の曲率半径が大きく、平面形状に近い。

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【0099】

第2レンズ52は、物体側レンズ面52aおよび像側レンズ面52bのそれぞれが非球面とされている。物体側レンズ面52aおよび像側レンズ面52bは、それぞれ凸形状を備えている。

【0100】

第3レンズ53は、物体側レンズ面53aおよび像側レンズ面53bのそれぞれが非球面とされている。物体側レンズ面53aは凹形状を備えており、像側レンズ面53bは凸形状を備えている。

【0101】

第4レンズ54は、物体側レンズ面54aおよび像側レンズ面54bのそれぞれが非球面とされている。物体側レンズ面54aは光軸を含む中央部分に凸形状を備えている。像側レンズ面54bは、変曲点を有しており、光軸を含む中央部分に凹形状を備えている。従って、像側レンズ面54bは変曲点から内周側に向かって物体側に湾曲しており、変曲点から外周側に向かって物体側に湾曲している。

【0102】

広角レンズ50の開口数を $Fno.$ 、半面角を ω 、および、レンズ系の全長（第1レンズ51の物体側レンズ面51aの物体側の端から結像面56までの距離）を L 、レンズ系のレンズ厚（第1レンズ51の物体側レンズ面51aの物体側の端から第4レンズ54の像側レンズ面54bの像側の端までの距離）を D とすると、これらの値は以下のとおりである。

$$Fno. = 2.8$$

$$\omega = 85.7^\circ$$

$$L = 4.107 \text{ mm}$$

$$D = 3.031 \text{ mm}$$

【0103】

また、全レンズ系の焦点距離を f 、第1レンズ51の焦点距離を f_1 、第2レンズ52の焦点距離を f_2 、第3レンズ53の焦点距離を f_3 、第4レンズ54の焦点距離を f_4 とすると、これらの値は以下のとおりである。

$$f = 2.563$$

$$f_1 = -62.580$$

$$f_2 = 1.715$$

$$f_3 = -1.832$$

$$f_4 = 3.091$$

【0104】

ここで、本例の広角レンズ50は、以下の条件式(1)～(4)を満たす。

$$0.4 \leq f_2/f = 0.669 \leq 0.7 \quad \cdots (1)$$

$$-1 \leq f_2/f_3 = -0.936 \leq -0.25 \quad \cdots (2)$$

$$1.0 \leq D/f = 1.182 \leq 2.0 \quad \cdots (3)$$

$$-30 \leq f_1/f = -24.417 \leq -0.5 \quad \cdots (4)$$

【0105】

広角レンズ50は、条件式(1)～(4)を満たすので、 65° 以上の画角を確保しながら、レンズ系の全長を抑制し、バックフォーカスを確保することが容易である。また、軸上の色収差を抑制することができる。

【0106】

また、広角レンズ50は、以下の条件式(5)、(6)を満たす。

$$-1.4 \leq f_3/f = -0.715 \leq -0.6 \quad \cdots (5)$$

$$1.3 \leq L/f = 1.602 \leq 2.5 \quad \cdots (6)$$

【0107】

広角レンズ50は条件式(5)、(6)を満たすので、色収差を良好に補正できる。また、結像面56に入射する主光線入射角度を小さくできる。さらに、バックフォーカスを

確保しながらレンズ系の全長を抑制することが容易である。

【0108】

以下の表5Aは広角レンズ50の各レンズ面のレンズデータを示す。表5Aでは物体側から数えた順番で各レンズ面を特定している。本例では、各レンズの全てのレンズ面が非球面である。なお、9面および10面はカバーガラス55のガラス面であり、11面は結像面56である。曲率半径および間隔の単位はミリメートルである。

【0109】

【表5A】

面番	曲率半径	間隔	Nd(屈折率)	Vd(アッベ数)	材料
1	150.000	0.400	1.53116	56.0	樹脂
2	27.279	0.298			
3	1.796	0.549	1.53116	56.0	樹脂
4	-1.667	0.352			
5	-0.536	0.331	1.83494	24.0	樹脂
6	-1.225	0.109			
7	1.053	0.992	1.53116	56.0	樹脂
8	1.960	0.210			
9	infinity	0.100	1.51680	64.2	光学ガラス
10	infinity	0.791			
11	infinity	-0.025			

【0110】

次に、表5B、表5Cは非球面とされたレンズ面の非球面形状を規定するための非球面係数を示す。表5B、表5Cにおいても物体側から数えた順番で各レンズ面を特定している。

【表5B】

	第1面	第2面	第3面	第4面	第5面	第6面
K	0.00000E+00	1.68169E+03	-7.82206E-01	4.95063E+00	-3.52793E+00	0.00000E+00
A4	1.35856E-01	4.80109E-01	1.56539E-01	-1.62437E-01	-7.43230E-01	1.06681E-01
A6	-2.24346E-02	-6.34423E-01	-2.72463E-02	4.51584E-01	0.00000E+00	0.00000E+00
A8	0.00000E+00	1.41506E+00	-7.42170E-01	-1.63061E+00	9.47084E-01	7.11233E-01
A10	0.00000E+00	0.00000E+00	-3.96390E+00	-7.77874E-02	7.17913E-01	-3.14780E-01
A12	0.00000E+00	0.00000E+00	7.84072E+00	2.79289E+00	-3.48348E+00	-6.16063E-02
A14	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
A16	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00

【表5C】

	第7面	第8面
K	-8.73455E+00	0.00000E+00
A4	-1.65191E-01	-1.98948E-01
A6	9.59854E-02	7.50201E-02
A8	-3.21706E-02	-4.53006E-02
A10	2.48962E-03	2.62001E-02
A12	6.31466E-03	-1.34263E-02
A14	-7.56292E-03	3.48357E-03
A16	2.27749E-03	-3.70E-04

【0111】

(作用効果)

図10(a)～(d)は広角レンズ50の縦収差図、横収差図、像面湾曲図、歪曲収差図である。図10(a)に示すように、広角レンズ50によれば、軸上の色収差が良好に補正されている。また、図10(b)に示すように、色の滲みが抑制される。さらに、図10(c)、(d)に示すように、像面湾曲が良好に補正されている。従って、広角レン

ズ50が高解像度となる。

【0112】

また、広角レンズ50では、第1レンズ51に凹形状を備える負のパワーのレンズを配置し、第2レンズ52に凸形状を備える正のパワーを有するレンズを配置したので、65°以上の画角を備えるレンズ系の全長を4.1mm程度に抑えることができる。さらに、第4レンズ54の像側レンズ面54bを、変曲点を備える非球面としたので、広角レンズ50からの射出光線方向を制御することが容易となり、結像面56に入射する主光線入射角度を小さく抑制することができる。また、本例では、各レンズのレンズ面を非球面としたので、広角レンズ50が明るく構成される。さらに、4枚のレンズから広角レンズを構成したので、5枚以上のレンズを備える撮像レンズと比較して、軽量化や製造コストの抑制を図ることが容易である。

【0113】

(撮像装置)

図11は本発明の広角レンズ10を搭載する撮像装置100の説明図である。図11に示すように、撮像装置100は広角レンズ10の結像面16(焦点位置)にセンサ面101aを配置した撮像素子101を備えるものである。撮像素子101は、CCDセンサ或いはCMOSセンサである。

【0114】

本例によれば、広角レンズ10のレンズ系の全長Lが短いので、撮像装置100を小型化することができる。さらに、広角レンズ10から撮像素子101に入射する主光線入射角度が小さく抑えられるので、撮像装置100における画質の劣化を抑制できる。すなわち、これらの撮像素子101ではセンサ面101aに斜めから入射する光に対して感度が低下する特性を有するので、主光線入射角度が大きくなると画質の劣化を招いてしまうが、本例の広角レンズ10によれば結像面に対する主光線入射角度を小さくすることができるので、センサ面への光線の入射角度に起因する画質の劣化を抑制できる。また、広角レンズ10の解像度が高いので、撮像素子101として画素数の多い撮像素子101を採用することにより、撮像装置100を高解像度のものとすることができる。なお、撮像装置100には、広角レンズ20～50を広角レンズ10と同様に搭載することができ、この場合にも同様の効果を得ることができる。

【0115】

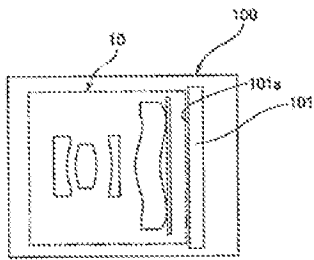
なお、上記の例では、全てのレンズ面が非球面とされているが、第4レンズの像側レンズ面を含む少なくとも2つのレンズ面を非球面とすれば、広角レンズを明るく構成することが容易となる。

【符号の説明】

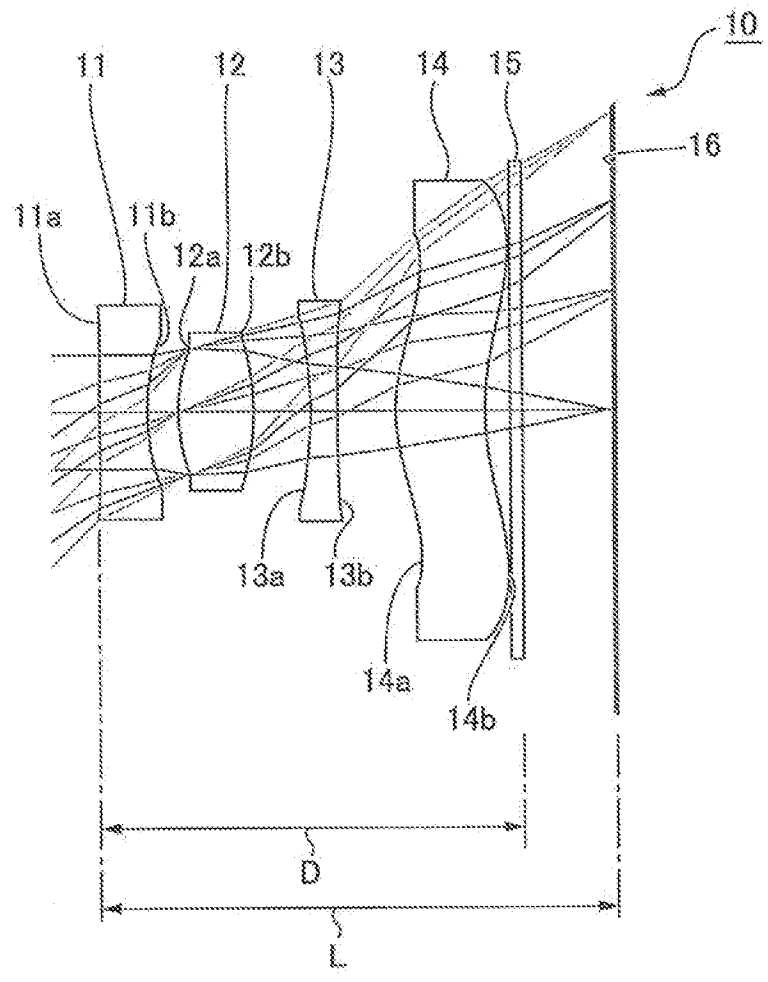
【0116】

10・20・30・40・50・・・広角レンズ
 11・21・31・41・51・・・第1レンズ
 12・22・32・42・52・・・第2レンズ
 13・23・33・43・53・・・第3レンズ
 14・24・34・44・54・・・第4レンズ
 14b・24b・34b・44b・54b・・・第4レンズの物体側レンズ面
 15・25・35・45・55・・・カバーガラス
 16・26・36・46・56・・・結像面
 100・・・撮像装置
 101・・・撮像素子
 101a・・・撮像素子のセンサ面
 D・・・レンズ系のレンズ厚
 L・・・レンズ系の全長

【図 11】

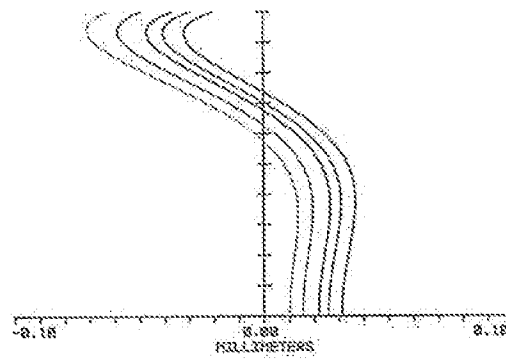


【図 1】

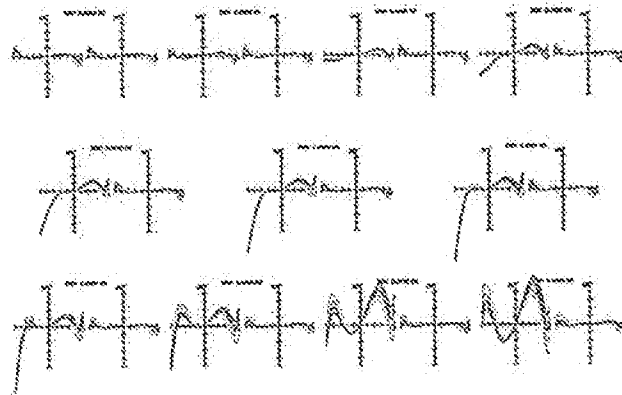


【図 2】

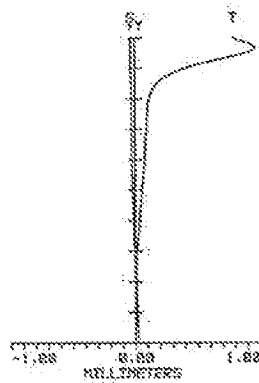
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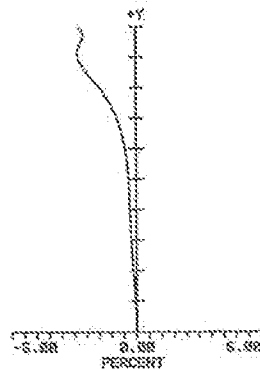
(b)



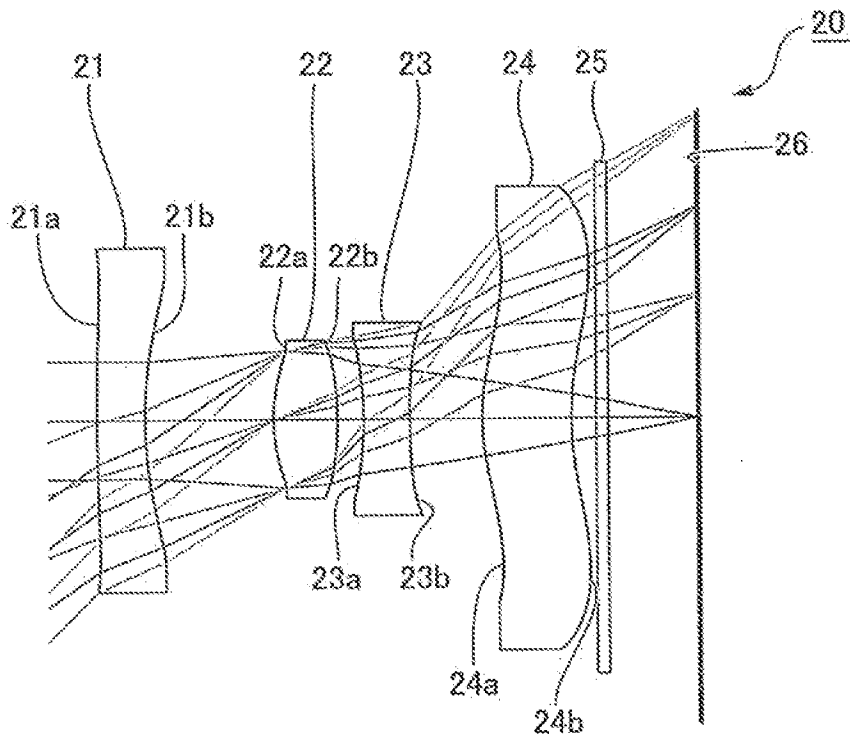
(c)



(d)

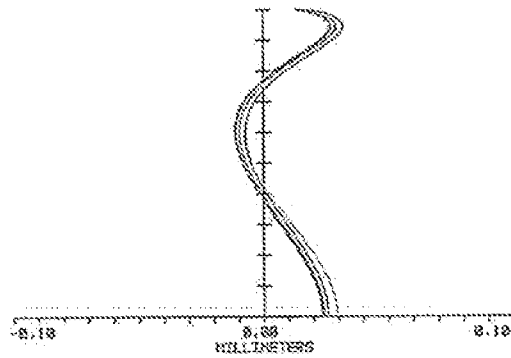


【図3】

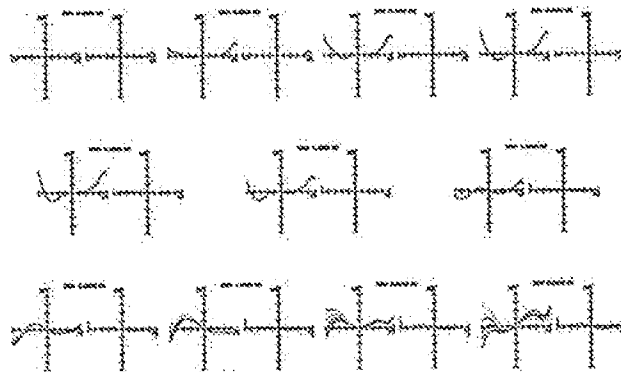


【図 4】

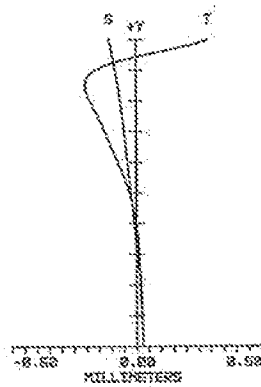
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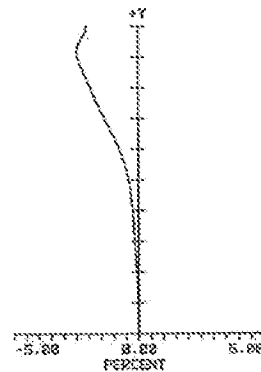
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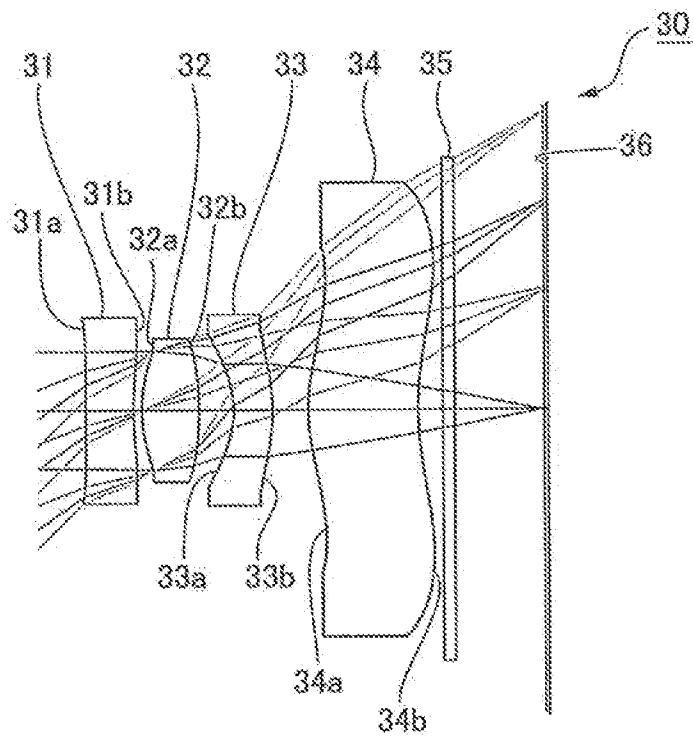
(c)



(d)

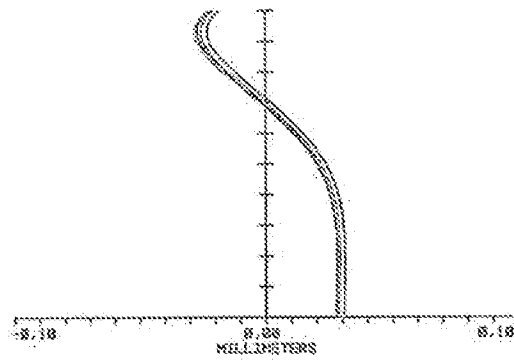


【図 5】

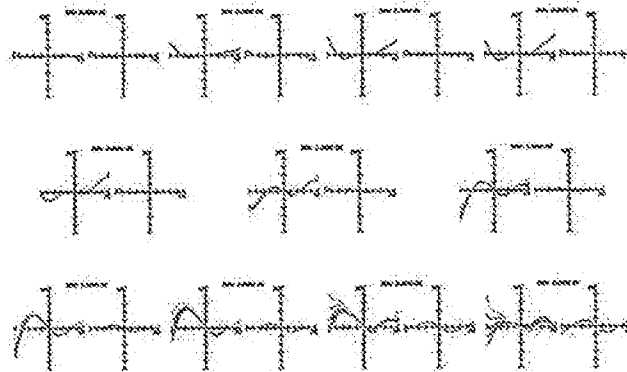


【図6】

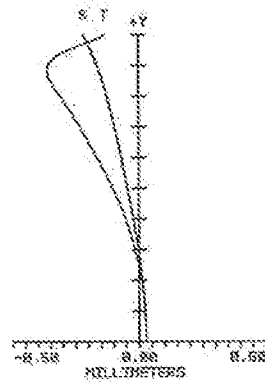
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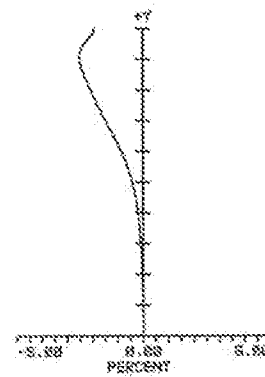
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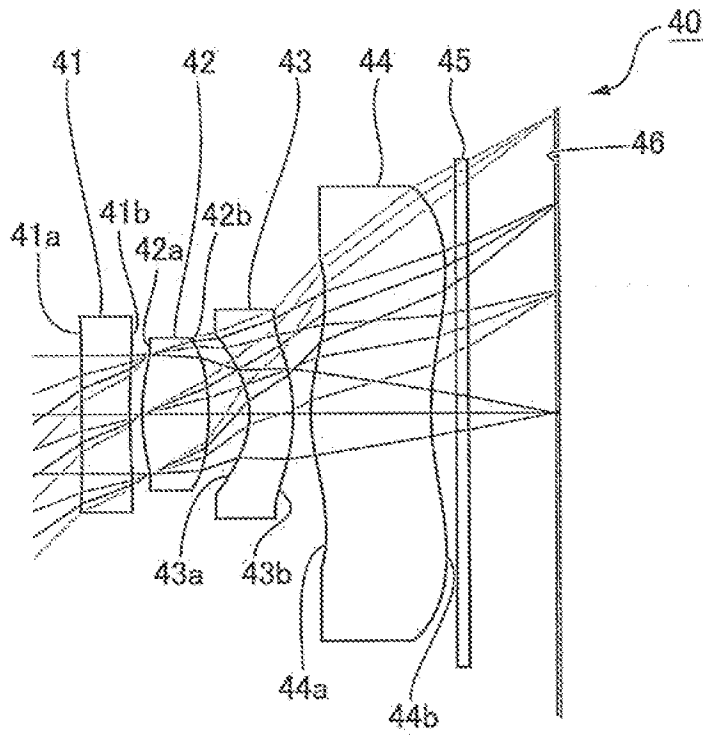
(c)



(d)

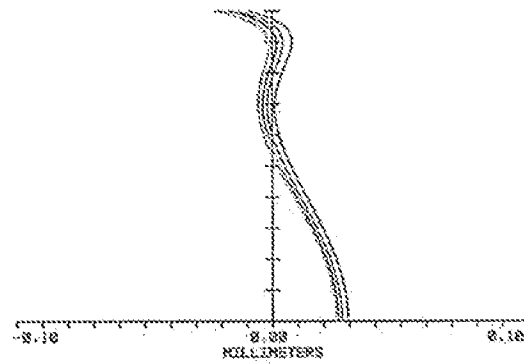


【図 7】

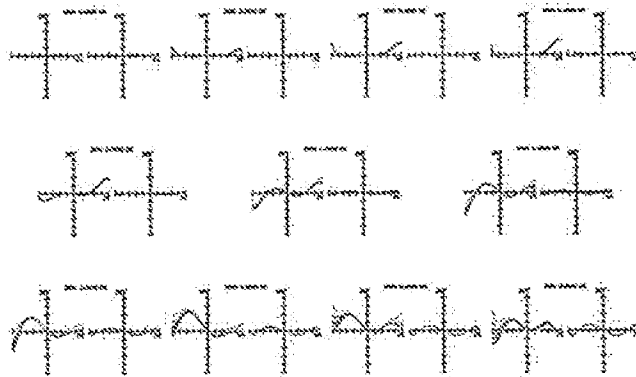


【図 8】

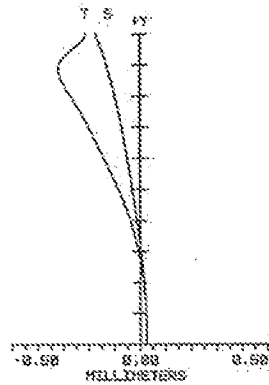
(a)



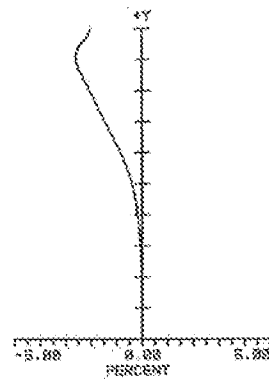
(b)



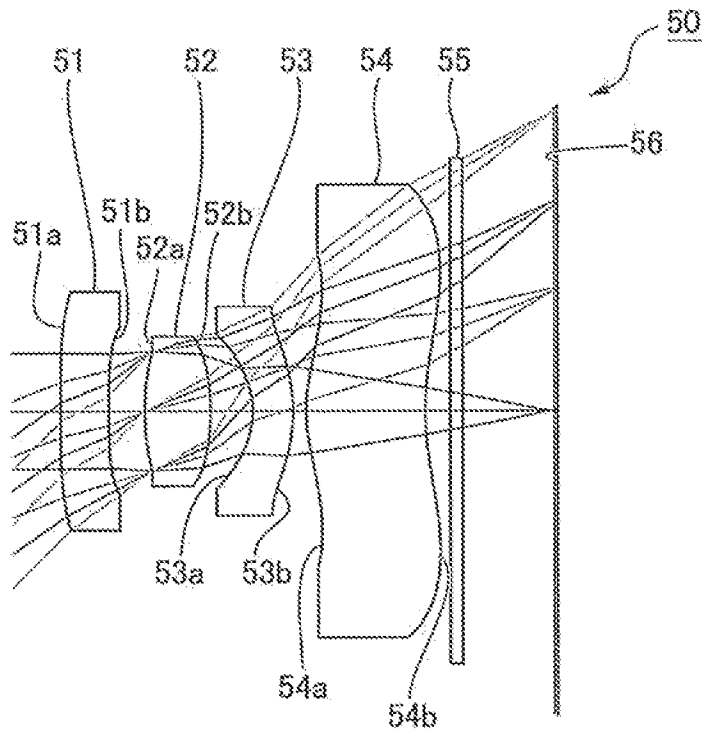
(c)



(d)

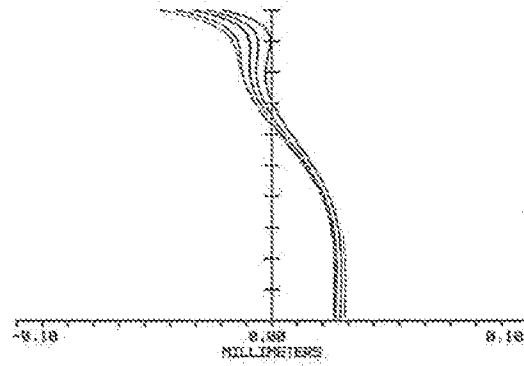


【図9】

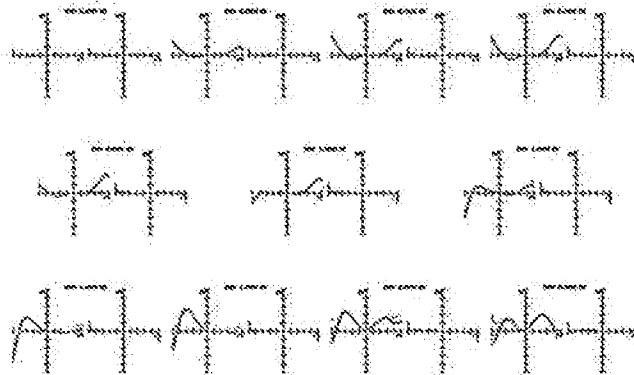


【図 10】

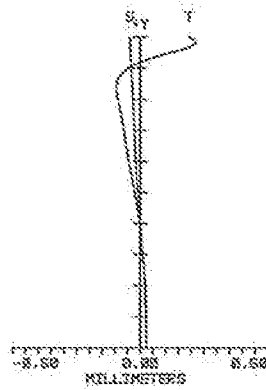
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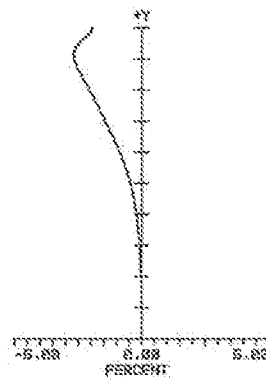
(b)



(c)



(d)



フロントページの続き

Fターム(参考) 2H087 KA01 LA01 PA04 PA17 PH04 QA02 QA06 QA17 QA21 QA26
QA32 QA42 QA45 RA04 RA05 RA12 RA13 RA32 RA42 RA44
UA01

Electronic Acknowledgement Receipt

EFS ID:	20824379
Application Number:	14105811
International Application Number:	
Confirmation Number:	5836
Title of Invention:	IMAGE CAPTURING LENS SYSTEM, IMAGING DEVICE AND MOBILE TERMINAL
First Named Inventor/Applicant Name:	WEI-YU CHEN
Customer Number:	24728
Filer:	Tim Tingkang Xia/Chenae Byrd
Filer Authorized By:	Tim Tingkang Xia
Attorney Docket Number:	14970-94702
Receipt Date:	01-DEC-2014
Filing Date:	13-DEC-2013
Time Stamp:	12:35:20
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	1497094702IDS.pdf	612323 63520b4aa164287e65ef6d12ce3a54d601d d4935	no	4

Warnings:

Information:

HP, Ex. 1002

Page 206

2	Foreign Reference	1497094702JP2014178623.pdf	4629754 f79807dce62880f452d54d28487a8dcd42f43ea4	no	32
Warnings:					
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Total Files Size (in bytes):				5242077	
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NOTICE OF ALLOWANCE AND FEE(S) DUE

24728 7590 01/27/2015
MORRIS MANNING MARTIN LLP
IP Department
3343 PEACHTREE ROAD, NE
1600 ATLANTA FINANCIAL CENTER
ATLANTA, GA 30326

EXAMINER

DINH, JACK

ART UNIT

PAPER NUMBER

2872

DATE MAILED: 01/27/2015

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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14/105,811

12/13/2013

WEI-YU CHEN

14970-94702

5836

TITLE OF INVENTION: IMAGE CAPTURING LENS SYSTEM, IMAGING DEVICE AND MOBILE TERMINAL

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	\$960	\$0	\$0	\$960	04/27/2015

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: **Mail** **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax **(571)-273-2885**

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

24728 7590 01/27/2015
MORRIS MANNING MARTIN LLP
IP Department
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1600 ATLANTA FINANCIAL CENTER
ATLANTA, GA 30326

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/105,811	12/13/2013	WEI-YU CHEN	14970-94702	5836

TITLE OF INVENTION: IMAGE CAPTURING LENS SYSTEM, IMAGING DEVICE AND MOBILE TERMINAL

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	\$960	\$0	\$0	\$960	04/27/2015

EXAMINER	ART UNIT	CLASS-SUBCLASS
DINH, JACK	2872	359-779000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363). <input type="checkbox"/> Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached. <input type="checkbox"/> "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. Use of a Customer Number is required.	2. For printing on the patent front page, list (1) The names of up to 3 registered patent attorneys or agents OR, alternatively, 1 _____ (2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed. 2 _____ 3 _____
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3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☐ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:

- ☐ Issue Fee
☐ Publication Fee (No small entity discount permitted)
☐ Advance Order - # of Copies _____

4b. Payment of Fee(s): (Please first reapply any previously paid issue fee shown above)

- ☐ A check is enclosed.
☐ Payment by credit card. Form PTO-2038 is attached.
☐ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. Change in Entity Status (from status indicated above)

- ☐ Applicant certifying micro entity status. See 37 CFR 1.29
☐ Applicant asserting small entity status. See 37 CFR 1.27
☐ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____
Typed or printed name _____ Registration No. _____



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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/105,811	12/13/2013	WEI-YU CHEN	14970-94702	5836

24728 7590 01/27/2015
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1600 ATLANTA FINANCIAL CENTER
ATLANTA, GA 30326

EXAMINER

DINH, JACK

ART UNIT PAPER NUMBER

2872

DATE MAILED: 01/27/2015

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b) (Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of regulation.

Notice of Allowability	Application No. 14/105,811	Applicant(s) CHEN, WEI-YU	
	Examiner JACK DINH	Art Unit 2872	AIA (First Inventor to File) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to the communication filed on 12/01/14.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on ____.
2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on ____; the restriction requirement and election have been incorporated into this action.
3. ☒ The allowed claim(s) is/are 1-26. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.
4. ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

- a) ☒ All b) ☐ Some *c) ☐ None of the:
1. ☒ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. ____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

* Certified copies not received: ____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.

THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date ____.
- Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).**
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

- | | |
|--|--|
| 1. <input type="checkbox"/> Notice of References Cited (PTO-892) | 5. <input type="checkbox"/> Examiner's Amendment/Comment |
| 2. <input checked="" type="checkbox"/> Information Disclosure Statements (PTO/SB/08),
Paper No./Mail Date <u>20141201</u> | 6. <input checked="" type="checkbox"/> Examiner's Statement of Reasons for Allowance |
| 3. <input type="checkbox"/> Examiner's Comment Regarding Requirement for Deposit
of Biological Material | 7. <input type="checkbox"/> Other ____. |
| 4. <input type="checkbox"/> Interview Summary (PTO-413),
Paper No./Mail Date ____. | |

/JACK DINH/
Primary Examiner, Art Unit 2872

Art Unit: 2872

REASONS FOR ALLOWANCE

1. Claims 1-26 are allowed. The following is an examiner's statement of reasons for allowance. Regarding claims 1, 15 and 21, the prior art fails to satisfy the conditions as claimed.
2. The prior art taken either singly or in combination fails to anticipate or fairly suggest the limitations of the independent claims, in such a manner that a rejection under 35 USC 102 or 103 would be improper. Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Other Information/Remarks


3. Any inquiry concerning this communication or earlier communications from the examiner should be directed to JACK DINH whose telephone number is (571)272-2327. The examiner can normally be reached on M-F (7:30 AM - 4:00 PM).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Thomas K. Pham can be reached on 571-272-3689. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Art Unit: 2872

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Jack Dinh/
Primary Examiner, Art Unit 2872
01/12/15

<i>Index of Claims</i> 	Application/Control No. 14105811	Applicant(s)/Patent Under Reexamination CHEN, WEI-YU
	Examiner JACK DINH	Art Unit 2872

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

<input checked="" type="checkbox"/> Claims renumbered in the same order as presented by applicant <input type="checkbox"/> CPA <input type="checkbox"/> T.D. <input type="checkbox"/> R.1.47										
CLAIM		DATE								
Final	Original	01/12/2015								
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2	2	=								
3	3	=								
4	4	=								
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24	24	=								
25	25	=								
26	26	=								

EAST Search History

EAST Search History (Prior Art)


Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	0	"14105811"	US-PGPUB; USPAT	OR	OFF	2015/01/12 06:50
L2	1	("8842379").PN.	USPAT; USOCR	OR	OFF	2015/01/12 07:09
L3	2	"20100165485"	US-PGPUB; USPAT	OR	OFF	2015/01/12 07:12
L4	10323	lens\$2 same (first) same (second near6 positive) same (third near6 negative) same (fourth)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/12 07:15
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L6	308	(359/772).OCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/12 07:15
L7	186	(359/779).OCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/12 07:15
L8	284	(359/781).OCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/12 07:15
L9	1059	(359/771,772,779,781).OCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/12 07:16
L10	265	L9 and L4	US-PGPUB; USPAT;	OR	OFF	2015/01/12 07:16

			USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
L11	636	lens\$2 same (first) same ((second near6 positive) with convex with image) same ((third near6 negative) with concave with object with convex with image) same (fourth with concave with image)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/12 07:18
L12	889	(359/715).OCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/12 07:18
L13	1714	(359/715,771,772,779,781).OCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/12 07:18
L14	86	L11 and L13	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/12 07:18

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
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L16	0	(lens\$2 and (first) and ((second near6 positive) with convex with image) and ((third near6 negative) with concave with object with convex with image) and (fourth with concave with image) and Td and HFOV).clm.	US-PGPUB; USPAT; UPAD	OR	OFF	2015/01/12 07:30

1/ 12/ 2015 7:31:07 AM
C:\Users\jldinh\Documents\EAST\Workspaces\Case 14105811.wsp

Search Notes 	Application/Control No. 14105811	Applicant(s)/Patent Under Reexamination CHEN, WEI-YU
	Examiner JACK DINH	Art Unit 2872

CPC- SEARCHED		
Symbol	Date	Examiner

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
359	771,772,779,781,715	01/12/15	JD

SEARCH NOTES		
Search Notes	Date	Examiner
Search EAST and NPL.	01/12/15	JD

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner
See search history.		01/12/15	JD

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BIB DATA SHEET

CONFIRMATION NO. 5836


SERIAL NUMBER 14/105,811	FILING or 371(c) DATE 12/13/2013 RULE	CLASS 359	GROUP ART UNIT 2872	ATTORNEY DOCKET NO. 14970-94702		
APPLICANTS LARGAN PRECISION CO., LTD., Taichung, TAIWAN, Assignee (with 37 CFR 1.172 Interest); INVENTORS WEI-YU CHEN, Taichung, TAIWAN; ** CONTINUING DATA ***** ** FOREIGN APPLICATIONS ***** TAIWAN 102139029 10/29/2013 ** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ** 01/02/2014						
Foreign Priority claimed <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No 35 USC 119(a-d) conditions met <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Verified and Acknowledged <u>/JACK DINH/</u> Examiner's Signature		<input type="checkbox"/> Met after Allowance Initials	STATE OR COUNTRY TAIWAN	SHEETS DRAWINGS 23	TOTAL CLAIMS 26	INDEPENDENT CLAIMS 3
ADDRESS MORRIS MANNING MARTIN LLP IP Department 3343 PEACHTREE ROAD, NE 1600 ATLANTA FINANCIAL CENTER ATLANTA, GA 30326 UNITED STATES						
TITLE IMAGE CAPTURING LENS SYSTEM, IMAGING DEVICE AND MOBILE TERMINAL						
FILING FEE RECEIVED 2080	FEES: Authority has been given in Paper No. _____ to charge/credit DEPOSIT ACCOUNT No. _____ for following:			<input type="checkbox"/> All Fees		
				<input type="checkbox"/> 1.16 Fees (Filing)		
				<input type="checkbox"/> 1.17 Fees (Processing Ext. of time)		
				<input type="checkbox"/> 1.18 Fees (Issue)		
				<input type="checkbox"/> Other _____		
			<input type="checkbox"/> Credit			

Issue Classification 	Application/Control No. 14105811	Applicant(s)/Patent Under Reexamination CHEN, WEI-YU	
	Examiner JACK DINH	Art Unit 2872	

CPC					
Symbol				Type	Version
G02B	13	004		F	2013-01-01
G02B	9	34		I	2013-01-01

CPC Combination Sets				
Symbol	Type	Set	Ranking	Version

NONE (Assistant Examiner) _____ (Date) _____		Total Claims Allowed: 26	
/JACK DINH/ Primary Examiner.Art Unit 2872 (Primary Examiner) _____ (Date) _____		01/12/2015 O.G. Print Claim(s) 1	O.G. Print Figure 1A

Issue Classification 	Application/Control No. 14105811	Applicant(s)/Patent Under Reexamination CHEN, WEI-YU
	Examiner JACK DINH	Art Unit 2872

<input checked="" type="checkbox"/> Claims renumbered in the same order as presented by applicant <input type="checkbox"/> CPA <input type="checkbox"/> T.D. <input type="checkbox"/> R.1.47															
Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
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13	13														
14	14														
15	15														
16	16														

NONE	Total Claims Allowed: 26	
(Assistant Examiner)	(Date)	
/JACK DINH/ Primary Examiner.Art Unit 2872	01/12/2015	O.G. Print Claim(s) 1
(Primary Examiner)	(Date)	O.G. Print Figure 1A

Receipt date: 12/01/2014

Doc code: IDS

Doc description: Information Disclosure Statement (IDS) Filed

14105811 - GAI: 2872

Approved for use through 07/31/2012. OMB 0651-0031

U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		14105811	
	Filing Date		2013-12-13	
	First Named Inventor	WEI-YU CHEN		
	Art Unit	2872		
	Examiner Name			
	Attorney Docket Number	14970-94702		

U.S. PATENTS						Remove
Examiner Initial*	Cite No	Patent Number	Kind Code ¹	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear
	1	8842379	B2	2014-09-23	Largan Precision Co., Ltd.	

If you wish to add additional U.S. Patent citation information please click the Add button.

Add

U.S. PATENT APPLICATION PUBLICATIONS						Remove
Examiner Initial*	Cite No	Publication Number	Kind Code ¹	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear
	1	20100165485	A1	2010-07-01	Milestone Co., Ltd.	

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Examiner Initial*	Cite No	Foreign Document Number ³	Country Code ²	Kind Code ⁴	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T ⁵
	1	2014-178623	JP		2014-09-25	Hitachi Maxell, Ltd.		<input checked="" type="checkbox"/>

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NON-PATENT LITERATURE DOCUMENTS		Remove	
Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T ⁵

Receipt date: 12/01/2014 INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		14105811	14105811 - GAU: 2872
	Filing Date		2013-12-13	
	First Named Inventor	WEI-YU CHEN		
	Art Unit	2872		
	Examiner Name			
	Attorney Docket Number	14970-94702		

	1		<input type="checkbox"/>
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EXAMINER SIGNATURE

Examiner Signature	/Jack Dinh/	Date Considered	01/12/2015
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*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

¹ See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. ² Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). ³ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁴ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁵ Applicant is to place a check mark here if English language translation is attached.

Receipt date: 12/01/2014 INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		14105811	14105811 - GAU: 2872
	Filing Date		2013-12-13	
	First Named Inventor	WEI-YU CHEN		
	Art Unit	2872		
	Examiner Name			
	Attorney Docket Number	14970-94702		

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☒ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Tim Tingkang Xia/	Date (YYYY-MM-DD)	2014-12-01
Name/Print	Tim Tingkang Xia	Registration Number	45242

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. **DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Ex. 1002

Page 225

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

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6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Ex. 1002

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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /J.D./

PART B - FEE(S) TRANSMITTAL

**Complete and send this form, together with applicable fee(s), to: Mail Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885**

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

24728 7590 01/27/2015
MORRIS MANNING MARTIN LLP
IP Department
3343 PEACHTREE ROAD, NE
1600 ATLANTA FINANCIAL CENTER
ATLANTA, GA 30326

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/105,811	12/13/2013	WEI-YU CHEN	14970-94702	5836

TITLE OF INVENTION: IMAGE CAPTURING LENS SYSTEM, IMAGING DEVICE AND MOBILE TERMINAL

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	\$960	\$0	\$0	\$960	04/27/2015

EXAMINER	ART UNIT	CLASS-SUBCLASS
DINH, JACK	2872	359-779000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363). <input type="checkbox"/> Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached. <input type="checkbox"/> "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. Use of a Customer Number is required.	2. For printing on the patent front page, list (1) The names of up to 3 registered patent attorneys or agents OR, alternatively, (2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.	1 <u>MORRIS MANNING & MARTIN LLP</u> 2 <u>TIM TINGKANG XIA, ESQ.</u> 3 _____
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3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE LARGAN PRECISION CO., LTD.
(B) RESIDENCE: (CITY and STATE OR COUNTRY) TAICHUNG, TW

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:

- ☒ Issue Fee
☐ Publication Fee (No small entity discount permitted)
☐ Advance Order - # of Copies _____

4b. Payment of Fee(s): (Please first reapply any previously paid issue fee shown above)

- ☐ A check is enclosed.
☐ Payment by credit card. Form PTO-2038 is attached.
☒ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number 503537 (enclose an extra copy of this form).

5. Change in Entity Status (from status indicated above)

- ☐ Applicant certifying micro entity status. See 37 CFR 1.29
☐ Applicant asserting small entity status. See 37 CFR 1.27
☐ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature /Tim Tingkan Xia/

Date FEBRUARY 5, 2015

Typed or printed name TIM TINGKANG XIA

Registration No. 45242

Electronic Patent Application Fee Transmittal

Application Number:	14105811			
Filing Date:	13-Dec-2013			
Title of Invention:	IMAGE CAPTURING LENS SYSTEM, IMAGING DEVICE AND MOBILE TERMINAL			
First Named Inventor/Applicant Name:	WEI-YU CHEN			
Filer:	Tim Tingkang Xia/Michelle Ellis			
Attorney Docket Number:	14970-94702			
Filed as Large Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Utility Appl Issue Fee	1501	1	960	960

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				960

Electronic Acknowledgement Receipt

EFS ID:	21413714
Application Number:	14105811
International Application Number:	
Confirmation Number:	5836
Title of Invention:	IMAGE CAPTURING LENS SYSTEM, IMAGING DEVICE AND MOBILE TERMINAL
First Named Inventor/Applicant Name:	WEI-YU CHEN
Customer Number:	24728
Filer:	Tim Tingkang Xia/Michelle Ellis
Filer Authorized By:	Tim Tingkang Xia
Attorney Docket Number:	14970-94702
Receipt Date:	05-FEB-2015
Filing Date:	13-DEC-2013
Time Stamp:	16:13:28
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	\$960
RAM confirmation Number	2937
Deposit Account	503537
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. Section 1.16 (National application filing, search, and examination fees)

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Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.20 (Post Issuance fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	1497094702IFTrans.pdf	1099156	no	1
			e9bd3b49fe968014aae0f6c3ba7a6e23a5b10b97		

Warnings:

Information:

2	Fee Worksheet (SB06)	fee-info.pdf	30962	no	2
			a3a145258b1acedbb216b5689e7580bb1e1c8a5b		

Warnings:

Information:

Total Files Size (in bytes):			1130118
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This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Receipt date: 12/01/2014

Doc code: IDS

Doc description: Information Disclosure Statement (IDS) Filed

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

14105811 - GAI: 2872

Approved for use through 07/31/2012. OMB 0651-0031

U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		14105811	
	Filing Date		2013-12-13	
	First Named Inventor	WEI-YU CHEN		
	Art Unit	2872		
	Examiner Name			
	Attorney Docket Number	14970-94702		

Change(s) applied

to document,

/M.I.G./

2/10/2015

U.S. PATENTS

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Examiner Initial*	Cite No	Patent Number	Kind Code ¹	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear
	1	8842379	B2	2014-09-23	Largan Precision Co., Ltd.	Hsu, et al.

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	1	20100165485	A1	2010-07-01	Milestone Co., Ltd.	Do; Satoshi

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	1	2014-178623	JP		2014-09-25	Hitachi Maxell, Ltd.		<input checked="" type="checkbox"/>

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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/105,811	03/24/2015	8988796	14970-94702	5836

24728 7590 03/04/2015
MORRIS MANNING MARTIN LLP
IP Department
3343 PEACHTREE ROAD, NE
1600 ATLANTA FINANCIAL CENTER
ATLANTA, GA 30326

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b) (application filed on or after May 29, 2000)

The Patent Term Adjustment is 0 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (<http://pair.uspto.gov>).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site <http://pair.uspto.gov> for additional applicants):

LARGAN PRECISION CO., LTD., Taichung, TAIWAN, Assignee (with 37 CFR 1.172 Interest);
WEI-YU CHEN, Taichung, TAIWAN;

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The USA offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to encourage and facilitate business investment. To learn more about why the USA is the best country in the world to develop technology, manufacture products, and grow your business, visit SelectUSA.gov.