

化。

【实施例 3】

基本的镜头数据如以下的表 3 所示。

【表 3】

【0213】

实施例 3

单位:mm

f=7.5

Fno=2.8

$\omega_f=37.7$

$H=5.99$

TTL=9.93

面数据

| 面编号:<br>(物面) | 曲率半径r   | 面间隔d  | 折射率nd  | 阿贝数vd |
|--------------|---------|-------|--------|-------|
| 1*           | 无限远     | 无限远   |        |       |
| 2*           | 4.135   | 0.458 | 1.5438 | 55.57 |
| 3*           | 8.081   | 0.237 |        |       |
| 3 (光面)       | 无限远     | 0.000 |        |       |
| 4*           | 9.482   | 0.504 | 1.5438 | 55.57 |
| 5*           | -22.482 | 0.018 |        |       |
| 6*           | 5.240   | 0.531 | 1.6349 | 23.97 |
| 7*           | 2.805   | 0.385 |        |       |
| 8*           | 13.592  | 0.577 | 1.5438 | 55.57 |
| 9*           | -8.307  | 0.831 |        |       |
| 10*          | -2.499  | 1.525 | 1.5438 | 55.57 |
| 11*          | -2.202  | 0.020 |        |       |
| 12*          | 5.829   | 1.256 | 1.5438 | 55.57 |
| 13*          | 4.886   | 0.853 |        |       |
| 14*          | 42.9885 | 1.003 | 1.6142 | 25.58 |
| 15*          | 6.076   | 0.360 |        |       |
| 16           | 无限远     | 0.210 | 1.5168 | 64.20 |
| 17           | 无限远     | 1.175 |        |       |
| 像面           | 无限远     |       |        |       |

单透镜数据

| 透镜 | 始面 | 焦距     |
|----|----|--------|
| 1  | 1  | 14.94  |
| 2  | 4  | 12.93  |
| 3  | 6  | -10.38 |
| 4  | 8  | 9.33   |
| 5  | 10 | 21.52  |
| 6  | 12 | -71.69 |
| 7  | 14 | -11.64 |

| 透镜        | 合成焦距   |
|-----------|--------|
| 第一透镜-第二透镜 | 7.00   |
| 第四透镜-第五透镜 | 8.16   |
| 第六透镜-第七透镜 | -10.50 |

非球面数据

|     | 第1面        | 第2面        | 第3面        | 第5面        | 第6面        | 第7面        | 第8面        |
|-----|------------|------------|------------|------------|------------|------------|------------|
| k   | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | -2.524E+01 | -6.329E+00 | 0.000E+00  |
| A4  | -4.543E-03 | -5.877E-03 | 3.955E-03  | 3.611E-03  | -6.488E-03 | -2.998E-03 | 1.251E-03  |
| A6  | -8.319E-04 | -1.556E-04 | -7.686E-04 | -2.047E-03 | -9.311E-04 | 3.512E-04  | 9.088E-04  |
| A8  | -2.061E-04 | 0.000E+00  | 0.000E+00  | -1.205E-03 | -1.790E-04 | 1.065E-04  | 0.000E+00  |
| A10 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 3.101E-04  | 1.416E-04  | -6.606E-05 | 0.000E+00  |
| A12 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 2.286E-05  | 0.000E+00  |
| A14 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | -3.032E-06 | 0.000E+00  |
| A16 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  |
|     | 第9面        | 第10面       | 第11面       | 第12面       | 第13面       | 第14面       | 第15面       |
| k   | 0.000E+00  | 0.000E+00  | -9.535E-01 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  |
| A4  | 7.155E-03  | 1.506E-02  | 2.462E-03  | -1.209E-02 | -5.528E-03 | -7.462E-03 | -1.150E-03 |
| A6  | 2.439E-03  | -1.064E-04 | 8.496E-05  | 1.809E-04  | 1.332E-05  | 2.137E-04  | 4.407E-04  |
| A8  | 0.000E+00  | 2.087E-04  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | -6.069E-06 |
| A10 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | -4.396E-07 | 0.000E+00  | -1.892E-07 |
| A12 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 5.041E-09  |
| A14 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 1.423E-10  |
| A16 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | -4.420E-12 |

[0214] 实施例 3 的摄像镜头如表 11 所示, 满足条件式 (1) 至 (8) 的全部。

[0215] 图 16 ~ 18 示出实施例 3 的摄像镜头的被摄体距离为无限远时的像差图, 图 19 ~ 21 是对于实施例 3 的摄像镜头, 表示在使摄像镜头整体伸缩而进行自动对焦时, 被摄体距离为 150mm 时的像差图。如图 16 ~ 18、图 19 ~ 21 所示可知, 各像差被良好地校正。

[0216] 而且, 实现全视角接近  $80^{\circ}$  的广角, 并实现了 F 值为 2.6 而比较明亮的摄像镜头系统。而且, 光学全长 TTL 与最大像高  $ih$  之比 (TTL/ $2ih$ ) 为 0.83, 为 7 片结构且实现小型化。

[0217] **【实施例 4】**

[0218] 基本的镜头数据如以下的表 4 所示。

[0219] **【表 4】**

[0220]

## 实施例4

单位:mm

f=7.51

Fno=2.6

 $\omega(\omega)=37.7$ 

H=5.99

TTL=9.51

## 面数据

| 面编号;<br>(物面) | 曲率半径r    | 面间隔d  | 折射率nd  | 阿贝数vd |
|--------------|----------|-------|--------|-------|
| 1*           | 3.872    | 0.468 | 1.5438 | 55.57 |
| 2*           | 7.066    | 0.237 |        |       |
| 3(光阑)        | 无限远      | 0.000 |        |       |
| 4*           | 16.245   | 0.564 | 1.5438 | 55.57 |
| 5*           | -10.566  | 0.027 |        |       |
| 6*           | 3.401    | 0.617 | 1.5349 | 23.97 |
| 7*           | 2.789    | 0.272 |        |       |
| 8*           | 11.800   | 0.629 | 1.5438 | 55.57 |
| 9*           | -7.986   | 0.893 |        |       |
| 10*          | -2.371   | 0.863 | 1.5438 | 55.57 |
| 11*          | -2.046   | 0.020 |        |       |
| 12*          | -100.000 | 1.500 | 1.5438 | 55.57 |
| 13*          | 5.059    | 0.467 |        |       |
| 14*          | 21.2943  | 1.432 | 1.5142 | 29.35 |
| 15*          | 6.59893  | 0.300 |        |       |
| 16           | 无限远      | 0.210 | 1.5158 | 64.30 |
| 17           | 无限远      | 1.079 |        |       |
| 像面           | 无限远      |       |        |       |

## 单透镜数据

| 透镜 | 始面 | 焦距     |
|----|----|--------|
| 1  | 1  | 13.41  |
| 2  | 4  | 11.86  |
| 3  | 6  | -10.00 |
| 4  | 8  | 8.86   |
| 5  | 10 | 14.19  |
| 6  | 12 | -10.52 |
| 7  | 14 | -16.17 |

## 透镜

## 合成焦距

|           |       |
|-----------|-------|
| 第一透镜-第二透镜 | 6.37  |
| 第四透镜-第五透镜 | 6.32  |
| 第六透镜-第七透镜 | -5.95 |

## 非球面数据

|     | 第1面        | 第2面        | 第4面        | 第5面        | 第6面        | 第7面        | 第8面        |
|-----|------------|------------|------------|------------|------------|------------|------------|
| k   | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | -2.781E+01 | -6.245E+00 |
| A4  | -7.243E-03 | -8.036E-03 | 5.777E-03  | 4.089E-03  | -8.671E-03 | -3.634E-03 | 1.804E-03  |
| A6  | -1.196E-03 | 4.251E-04  | -3.233E-04 | -1.618E-03 | -1.175E-03 | 3.845E-04  | 1.788E-03  |
| A8  | -2.487E-04 | 0.000E+00  | 0.000E+00  | -1.412E-03 | -1.205E-04 | 3.638E-04  | 0.000E+00  |
| A10 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 3.585E-04  | 1.833E-04  | -1.302E-04 | 0.000E+00  |
| A12 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 3.800E-05  | 0.000E+00  |
| A14 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | -3.187E-06 | 0.000E+00  |
| A16 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  |
|     | 第9面        | 第10面       | 第11面       | 第12面       | 第13面       | 第14面       | 第15面       |
| k   | 0.000E+00  | 0.000E+00  | 0.000E+00  | -8.519E-01 | 0.000E+00  | 0.000E+00  | 0.000E+00  |
| A4  | 3.027E-03  | 1.397E-02  | -1.659E-03 | -2.042E-02 | -1.047E-02 | -4.930E-03 | -1.021E-02 |
| A6  | 3.358E-03  | 6.744E-04  | 3.809E-05  | 9.089E-05  | 4.618E-05  | -5.761E-05 | 4.330E-04  |
| A8  | 0.000E+00  | 2.283E-04  | 0.000E+00  | 0.000E+00  | 1.030E-05  | 0.000E+00  | -6.934E-06 |
| A10 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | -8.458E-07 | 0.000E+00  | -4.368E-07 |
| A12 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 1.414E-08  |
| A14 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 2.235E-10  |
| A16 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | -9.606E-12 |

[0221] 实施例4的摄像镜头如表11所示,满足条件式(1)至(8)的全部。

[0222] 图23~25示出实施例4的摄像镜头的被摄体距离为无限远时的像差图,图26~28是对于实施例4的摄像镜头,表示在使摄像镜头整体伸缩而进行自动对焦时,被摄体距离为150mm时的像差图。如图23~25、图26~28所示可知,各像差被良好地校正。

[0223] 而且,实现全视角接近80°的广角,并实现了F值为2.6而比较明亮的摄像镜头

系统。而且,光学全长 TTL 与最大像高  $1h$  之比 (TTL/ $21h$ ) 为 0.79,为 7 片结构且实现小型化。

[0224] 【实施例 5】

[0225] 基本的镜头数据如以下的表 5 所示。

[0226] 【表 5】

[0227]

实施例 5

单位:mm

$f_w=7.468$

$Fno=2.6$

$\omega(\circ)=33.2$

$Bf=3.39$

$TTL=9.60$

面数据

| 面编号<br>(物面) | 曲率半径 $r$ | 面间隔 $d$ | 折射率 $N_d$ | 阿贝数 $\nu_d$ |
|-------------|----------|---------|-----------|-------------|
| 1*          | 无限远      | 无限远     |           |             |
| 2*          | 4.438    | 0.583   | 1.5438    | 55.57       |
| 3*          | -81.371  | 0.078   |           |             |
| 3 (光阑)      | 无限远      | 0.181   |           |             |
| 4*          | -6.429   | 0.471   | 1.5438    | 55.57       |
| 5*          | -6.404   | 0.018   |           |             |
| 6*          | 4.954    | 0.457   | 1.6340    | 23.97       |
| 7*          | 2.639    | 0.326   |           |             |
| 8*          | 7.850    | 0.808   | 1.5438    | 55.57       |
| 9*          | -13.100  | 1.013   |           |             |
| 10*         | -2.514   | 1.231   | 1.5438    | 55.57       |
| 11*         | -2.409   | 0.018   |           |             |
| 12*         | 6.622    | 1.401   | 1.5438    | 55.57       |
| 13*         | 4.469    | 0.988   |           |             |
| 14*         | -18.3113 | 1.067   | 1.5438    | 55.57       |
| 15*         | 9.054    | 0.300   |           |             |
| 16          | 无限远      | 0.210   | 1.5168    | 84.20       |
| 17          | 无限远      | 0.722   |           |             |
| 像面          | 无限远      |         |           |             |

单透镜数据

| 透镜 | 始面 | 焦距     |
|----|----|--------|
| 1  | 1  | 7.76   |
| 2  | 4  | 45.29  |
| 3  | 6  | -9.63  |
| 4  | 8  | 9.13   |
| 5  | 10 | 20.92  |
| 6  | 12 | -32.79 |
| 7  | 14 | -10.39 |

透镜

| 第一透镜-第二透镜 | 合成焦距  |
|-----------|-------|
| 第四透镜-第五透镜 | 6.85  |
| 第六透镜-第七透镜 | 7.61  |
|           | -8.42 |

非球面系数

|     | 第1面        | 第2面        | 第4面        | 第5面        | 第6面        | 第7面        | 第8面        |
|-----|------------|------------|------------|------------|------------|------------|------------|
| k   | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | -3.107E+01 | -6.796E+00 | 0.000E+00  |
| A4  | -5.673E-03 | -6.387E-03 | 7.637E-03  | 1.841E-03  | -8.302E-03 | -1.430E-03 | -0.968E-04 |
| A6  | -1.785E-03 | 6.113E-04  | -1.213E-03 | -1.413E-03 | -2.961E-04 | 1.611E-03  | 1.488E-03  |
| A8  | -1.141E-04 | 0.000E+00  | 0.000E+00  | -1.353E-03 | 2.601E-04  | 6.243E-03  | 0.000E+00  |
| A10 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 3.647E-04  | 1.128E-04  | -9.977E-05 | 0.000E+00  |
| A12 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 4.021E-05  | 0.000E+00  |
| A14 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | -3.481E-06 | 0.000E+00  |
| A16 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  |
|     | 第9面        | 第10面       | 第11面       | 第12面       | 第13面       | 第14面       | 第15面       |
| k   | 0.000E+00  | 0.000E+00  | -9.697E-01 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  |
| A4  | 4.100E-03  | 1.785E-02  | -4.443E-04 | -1.662E-02 | -1.310E-02 | -5.710E-03 | -9.278E-02 |
| A6  | 1.709E-03  | -7.718E-04 | 2.441E-04  | 4.757E-04  | 3.605E-04  | 1.947E-04  | 3.010E-04  |
| A8  | 0.000E+00  | 5.114E-05  | -1.432E-04 | -7.566E-05 | -1.398E-05 | 0.000E+00  | -3.688E-06 |
| A10 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | -8.723E-09 | 0.000E+00  | -7.926E-08 |
| A12 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 4.322E-08  |
| A14 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 4.944E-11  |
| A16 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | -3.757E-12 |

[0228] 实施例 5 的摄像镜头如表 11 所示, 满足条件式 (1) 至 (8) 的全部。

[0229] 图 30 ~ 32 示出实施例 5 的摄像镜头的被摄体距离为无限远时的像差图, 图 33 ~ 35 是对于实施例 5 的摄像镜头, 表示在使摄像镜头整体伸缩而进行自动对焦时, 被摄体距离为 150mm 时的像差图。如图 30 ~ 32、图 33 ~ 35 所示可知, 各像差被良好地校正。

[0230] 而且, 实现全视角接近  $80^\circ$  的广角, 并实现了 F 值为 2.6 而比较明亮的摄像镜头系统。而且, 光学全长 TTL 与最大像高  $ih$  之比 (TTL/ $2ih$ ) 为 0.80, 为 7 片结构且实现小型化。

[0231] **【实施例 6】**

[0232] 基本的镜头数据如以下的表 6 所示。

[0233] **【表 6】**

[0234]

## 实施例6

单位:mm

f=7.47

Fno=2.4

 $\omega^\circ=38.3$ 

H=5.89

TTL=9.61

## 面数据

| 面序号i  | 曲率半径 $r_i$ | 面间隔 $d_i$ | 折射率 $n_d$ | 阿贝数 $v_d$ |
|-------|------------|-----------|-----------|-----------|
| (物面)  | 无限远        | 无限远       |           |           |
| 1*    | 4.228      | 0.485     | 1.5438    | 55.57     |
| 2*    | 21.299     | 0.185     |           |           |
| 3(光阑) | 无限远        | 0.071     |           |           |
| 4*    | -17.571    | 0.527     | 1.5438    | 55.57     |
| 5*    | -6.743     | 0.018     |           |           |
| 6*    | 4.767      | 0.453     | 1.6349    | 23.97     |
| 7*    | 2.643      | 0.312     |           |           |
| 8*    | 9.287      | 0.552     | 1.5438    | 55.57     |
| 9*    | -11.433    | 1.010     |           |           |
| 10*   | -2.932     | 1.363     | 1.5438    | 55.57     |
| 11*   | -2.306     | 0.020     |           |           |
| 12*   | 6.453      | 1.590     | 1.5438    | 55.57     |
| 13*   | 4.512      | 1.210     |           |           |
| 14*   | -6.0891    | 0.774     | 1.6142    | 25.58     |
| 15*   | -93        | 0.350     |           |           |
| 16    | 无限远        | 0.210     | 1.5168    | 64.26     |
| 17    | 无限远        | 0.684     |           |           |
| 像面    | 无限远        |           |           |           |

## 单透镜数据

| 透镜 | 始面 | 焦距     |
|----|----|--------|
| 1  | 1  | 9.61   |
| 2  | 4  | 19.79  |
| 3  | 6  | -10.18 |
| 4  | 8  | 9.52   |
| 5  | 10 | 19.32  |
| 6  | 12 | -37.92 |
| 7  | 14 | -10.63 |

| 透镜        | 合成焦距  |
|-----------|-------|
| 第一透镜-第二透镜 | 6.74  |
| 第四透镜-第五透镜 | 7.82  |
| 第六透镜-第七透镜 | -8.64 |

## 非球面数据

|     | 第9面        | 第9面        | 第4面        | 第5面        | 第6面        | 第7面        | 第8面        |
|-----|------------|------------|------------|------------|------------|------------|------------|
| k   | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | -2.970E+01 | -7.426E+00 | 0.000E+00  |
| A4  | -7.587E-03 | -8.307E-03 | 9.881E-03  | -5.442E-03 | -1.009E-02 | -4.272E-03 | -1.835E-03 |
| A6  | -2.348E-03 | 1.507E-03  | 1.348E-03  | -1.394E-03 | -3.883E-04 | 1.278E-03  | 1.102E-03  |
| A8  | -1.446E-04 | 0.000E+00  | 0.000E+00  | -1.481E-03 | -1.770E-03 | 2.871E-04  | 0.000E+00  |
| A10 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 3.652E-04  | 1.087E-04  | -1.215E-04 | 0.000E+00  |
| A12 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 2.915E-05  | 0.000E+00  |
| A14 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | -7.263E-07 | 0.000E+00  |
| A16 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  |
|     | 第9面        | 第10面       | 第11面       | 第12面       | 第13面       | 第14面       | 第15面       |
| k   | 0.000E+00  | 0.000E+00  | -8.168E-01 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  |
| A4  | -4.557E-03 | 1.858E-03  | -2.357E-03 | -1.879E-02 | -1.394E-02 | -4.410E-05 | -5.882E-03 |
| A6  | 1.315E-03  | -1.713E-03 | 5.729E-04  | 8.913E-04  | 3.864E-04  | 4.363E-05  | 2.120E-04  |
| A8  | 0.000E+00  | 3.873E-04  | -1.254E-04 | -8.037E-03 | -2.756E-03 | 0.000E+00  | -1.138E-06 |
| A10 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 2.817E-07  | 0.000E+00  | -2.542E-08 |
| A12 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | -5.281E-10 |
| A14 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 2.365E-11  |
| A16 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | -1.851E-12 |

[0235] 实施例6的摄像镜头如表11所示,满足条件式(1)至(8)的全部。

[0236] 图37~39示出实施例6的摄像镜头的被摄体距离为无限远时的像差图,图40~42是对于实施例6的摄像镜头,表示在使摄像镜头整体伸缩而进行自动对焦时,被摄体距离为150mm时的像差图。如图37~39、图40~42所示可知,各像差被良好地校正。

[0237] 而且,实现全视角接近80°的广角,并实现了F值为2.4而明亮的摄像镜头系统。

而且,光学全长 TTL 与最大像高  $ih$  之比 (TTL/21b) 为 0.80,为 7 片结构且实现小型化。

[0238] 【实施例 7】

[0239] 基本的镜头数据如以下的表 7 所示。

[0240] 【表 7】

[0241]

实施例7

单位:mm

$f_w=7.52$

$Fno=2.5$

$\omega(^{\circ})=38.1$

$ih=5.99$

TTL=9.76

面数据

面编号i

曲率半径r

面间隔d

折射率Nd

阿贝数vd

(物面)

无限远

无限远

1\*

5.903

0.526

1.5438

55.57

2\*

-15.781

0.021

3(光阑)

无限远

0.209

4\*

-6.865

0.527

1.5438

55.57

5\*

-4.673

0.018

6\*

3.866

0.409

1.6349

23.97

7\*

3.428

0.378

8\*

22.701

0.675

1.6142

25.58

9\*

20.000

1.004

10\*

-2.416

0.973

1.5438

55.57

11\*

-2.536

0.020

12\*

5.741

1.503

1.5438

55.57

13\*

4.538

1.124

14\*

-45.2955

1.118

1.6142

25.58

15\*

7.7347

0.900

1.5168

54.20

16

无限远

0.210

17

无限远

0.820

像面

无限远

单透镜数据

透镜

始面

焦距

1

1

7.48

2

4

24.72

3

6

-14.00

4

8

-302.47

5

10

15.02

6

12

-71.13

7

14

-10.67

透镜

合成焦距

第一透镜-第二透镜

6.01

第四透镜-第五透镜

13.64

第六透镜-第七透镜

-9.86

非球面数据

第1面

第2面

第4面

第5面

第6面

第7面

第8面

k

0.000E+00

0.000E+00

0.000E+00

0.000E+00

-3.056E+01

-7.657E+00

0.000E+00

A4

-9.203E-03

-6.526E-03

9.043E-03

9.874E-05

-8.557E-03

-3.065E-03

-1.207E-03

A6

-2.698E-03

1.268E-04

-1.742E-04

-1.023E-05

-1.214E-03

1.216E-03

2.024E-03

A8

-2.373E-04

0.000E+00

0.000E+00

-1.017E-03

-2.494E-05

1.572E-05

0.000E+00

A10

0.000E+00

0.000E+00

0.000E+00

2.804E-04

1.064E-04

-1.073E-04

0.000E+00

A12

0.000E+00

0.000E+00

0.000E+00

0.000E+00

0.000E+00

5.115E-05

0.000E+00

A14

0.000E+00

0.000E+00

0.000E+00

0.000E+00

0.000E+00

-3.527E-05

0.000E+00

A16

0.000E+00

0.000E+00

0.000E+00

0.000E+00

0.000E+00

0.000E+00

0.000E+00

第9面

第10面

第11面

第12面

第13面

第14面

第15面

k

0.000E+00

0.000E+00

-1.075E+00

0.000E+00

0.000E+00

0.000E+00

0.000E+00

A4

3.404E-03

1.713E-02

4.304E-04

-1.416E-02

-1.210E-02

-6.414E-03

-8.982E-03

A6

8.983E-04

-8.771E-04

4.437E-04

5.551E-04

3.585E-04

1.754E-04

2.930E-04

A8

0.000E+00

6.933E-06

-7.997E-05

-3.859E-05

-1.313E-05

0.000E+00

-3.263E-06

A10

0.000E+00

0.000E+00

0.000E+00

0.000E+00

-8.078E-08

0.000E+00

-1.744E-07

A12

0.000E+00

0.000E+00

0.000E+00

0.000E+00

0.000E+00

0.000E+00

5.456E-09

A14

0.000E+00

0.000E+00

0.000E+00

0.000E+00

0.000E+00

0.000E+00

1.177E-10

A16

0.000E+00

0.000E+00

0.000E+00

0.000E+00

0.000E+00

0.000E+00

-4

[0242] 实施例 7 的摄像镜头如表 11 所示, 满足条件式 (1) 至 (8) 的全部。

[0243] 图 44 ~ 46 示出实施例 7 的摄像镜头的被摄体距离为无限远时的像差图, 图 47 ~ 49 是对于实施例 7 的摄像镜头, 表示在使摄像镜头整体伸缩而进行自动对焦时, 被摄体距离为 150mm 时的像差图。如图 44 ~ 46、图 47 ~ 49 所示可知, 各像差被良好地校正。

[0244] 而且, 实现全视角接近  $80^{\circ}$  的广角, 并实现了 F 值为 2.6 而比较明亮的摄像镜头系统。而且, 光学全长 TTL 与最大像高  $ih$  之比 (TTL/ $2ih$ ) 为 0.81, 为 7 片结构且实现小型化。

[0245] **【实施例 8】**

[0246] 基本的镜头数据如以下的表 8 所示。

[0247] **【表 8】**

[0248]

## 实施例8

单位:mm

f=7.35

Fno=2.5

 $\omega\omega=38.1$ 

H=5.99

TTL=9.45

## 面数据

| 面编号   | 曲率半径r   | 面间隔d  | 折射率Nd  | 阿贝数vd |
|-------|---------|-------|--------|-------|
| (物面)  | 无限远     | 无限远   |        |       |
| 1*    | 4.129   | 0.488 | 1.5438 | 55.57 |
| 2*    | 27.823  | 0.176 |        |       |
| 3(光阑) | 无限远     | 0.128 |        |       |
| 4*    | -5.197  | 0.504 | 1.5438 | 55.57 |
| 5*    | -5.481  | 0.018 |        |       |
| 6*    | 4.477   | 0.577 | 1.5349 | 23.97 |
| 7*    | 2.598   | 0.255 |        |       |
| 8*    | 5.706   | 0.494 | 1.5438 | 55.57 |
| 9*    | 93.060  | 1.192 |        |       |
| 10*   | -2.340  | 1.178 | 1.5438 | 55.57 |
| 11*   | -2.194  | 0.018 |        |       |
| 12*   | 6.759   | 1.600 | 1.5438 | 55.57 |
| 13*   | 4.7259  | 1.036 |        |       |
| 14*   | -7.3276 | 0.526 | 1.5142 | 25.58 |
| 15*   | 99.3393 | 0.300 |        |       |
| 16    | 无限远     | 0.210 | 1.5168 | 64.20 |
| 17    | 无限远     | 0.639 |        |       |
| 像面    | 无限远     |       |        |       |

## 单透镜数据

| 透镜 | 始面 | 终面     |
|----|----|--------|
| 1  | 1  | 3.84   |
| 2  | 4  | 24.13  |
| 3  | 6  | -10.55 |
| 4  | 8  | 11.14  |
| 5  | 10 | 16.87  |
| 6  | 12 | -39.80 |
| 7  | 14 | -10.74 |

## 透镜

| 第一透镜-第二透镜 | 合成焦距  |
|-----------|-------|
| 第一透镜-第二透镜 | 6.77  |
| 第四透镜-第五透镜 | 8.07  |
| 第六透镜-第七透镜 | -8.85 |

## 非球面数据

|     | 第1面        | 第2面        | 第4面        | 第5面        | 第6面        | 第7面        | 第8面        |
|-----|------------|------------|------------|------------|------------|------------|------------|
| K   | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | -2.602E+01 | -2.472E+09 | 0.000E+00  |
| A4  | -8.517E-03 | -9.012E-03 | 1.127E-02  | 4.298E-03  | -1.117E-02 | -3.998E-03 | -3.280E-03 |
| A6  | -2.536E-03 | 1.390E-03  | 1.686E-03  | -1.531E-03 | -6.814E-04 | 1.248E-03  | 7.717E-04  |
| A8  | -3.871E-04 | 0.000E+00  | 0.000E+00  | -1.432E-03 | -3.742E-05 | 3.045E-04  | 0.000E+00  |
| A10 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 3.826E-04  | 1.584E-04  | -1.142E-04 | 0.000E+00  |
| A12 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 2.381E-05  | 0.000E+00  |
| A14 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | -7.263E-07 | 0.000E+00  |
| A16 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  |
|     | 第9面        | 第10面       | 第11面       | 第12面       | 第13面       | 第14面       | 第15面       |
| K   | 0.000E+00  | 0.000E+00  | -7.895E-01 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  |
| A4  | 5.830E-03  | 1.845E-02  | -2.760E-03 | -1.839E-02 | -1.264E-02 | -4.883E-04 | -3.386E-03 |
| A6  | 5.377E-04  | -2.092E-03 | 4.905E-04  | 9.492E-04  | 5.286E-04  | -1.829E-06 | 1.687E-04  |
| A8  | 0.000E+00  | 4.884E-04  | -1.012E-04 | -8.811E-05 | -2.519E-05 | 0.000E+00  | -2.936E-07 |
| A10 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 2.486E-07  | 0.000E+00  | -9.285E-09 |
| A12 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | -1.847E-09 |
| A14 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 1.250E-12  |
| A16 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 2.940E-13  |

[0249] 实施例8的摄像镜头如表11所示,满足条件式(1)至(8)的全部。

[0250] 图51~53示出实施例8的摄像镜头的被摄体距离为无限远时的像差图,图54~56是对于实施例8的摄像镜头,表示在使摄像镜头整体伸缩而进行自动对焦时,被摄体距离为150mm时的像差图。如图51~53、图54~56所示可知,各像差被良好地校正。

[0251] 而且,实现全视角接近80°的广角,并实现了F值为2.5而明亮的摄像镜头系统。

而且,光学全长 TTL 与最大像高  $ih$  之比 (TTL/21b) 为 0.79,为 7 片结构且实现小型化。

# [0252] 【实施例 9】

[0253] 基本的镜头数据如以下的表 9 所示。

# [0254] 【表 9】

[0255]

|          |          |       |        |        |
|----------|----------|-------|--------|--------|
| 实施例9     |          |       |        |        |
| 单位:mm    |          |       |        |        |
| f=7.47   |          |       |        |        |
| Fno=2.5  |          |       |        |        |
| ω=98.1   |          |       |        |        |
| B=5.99   |          |       |        |        |
| TTL=8.45 |          |       |        |        |
| 面数据      |          |       |        |        |
| 面编号      | 曲率半径 r   | 面间隔 d | 折射率 Nd | 阿贝数 vd |
| (物面)     | 无限远      | 无限远   |        |        |
| 1*       | 4.789    | 0.460 | 1.5438 | 55.57  |
| 2*       | 16.752   | 0.160 |        |        |
| 3(光阑)    | 无限远      | 0.110 |        |        |
| 4*       | 95.000   | 0.320 | 1.5438 | 55.57  |
| 5*       | -7.479   | 0.018 |        |        |
| 6*       | 3.133    | 0.500 | 1.6349 | 23.97  |
| 7*       | 2.770    | 0.431 |        |        |
| 8*       | 26.838   | 0.725 | 1.5438 | 55.57  |
| 9*       | -3.144   | 0.783 |        |        |
| 10*      | -2.200   | 1.444 | 1.5438 | 55.57  |
| 11*      | -2.832   | 0.020 |        |        |
| 12*      | 4.504    | 1.293 | 1.5438 | 55.57  |
| 13*      | 4.2233   | 1.299 |        |        |
| 14*      | -11.9793 | 0.827 | 1.6142 | 25.58  |
| 15*      | 13.4343  | 0.259 |        |        |
| 16       | 无限远      | 0.210 | 1.5168 | 64.20  |
| 17       | 无限远      | 0.687 |        |        |
| 像面       | 无限远      |       |        |        |

## 单透镜数据

| 透镜 | 始面 | 终面     |
|----|----|--------|
| 1  | 1  | 12.17  |
| 2  | 4  | 12.77  |
| 3  | 6  | -19.33 |
| 4  | 8  | 8.00   |
| 5  | 10 | -92.74 |
| 6  | 12 | 199.91 |
| 7  | 14 | -15.18 |

## 透镜

|      |      |        |
|------|------|--------|
| 第一透镜 | 第二透镜 | 8.49   |
| 第四透镜 | 第五透镜 | 10.77  |
| 第六透镜 | 第七透镜 | -12.11 |

## 非球面数据

|     | 第1面        | 第2面        | 第4面        | 第5面        | 第6面        | 第7面        | 第8面        |
|-----|------------|------------|------------|------------|------------|------------|------------|
| k   | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | -2.783E+01 | -7.236E+00 | 0.000E+00  |
| A4  | -8.273E-03 | -3.963E-03 | 1.816E-03  | 3.443E-09  | -1.061E-02 | -3.471E-03 | -5.906E-03 |
| A6  | -2.505E-03 | -2.187E-04 | -8.235E-04 | -2.066E-03 | -2.861E-04 | 8.096E-04  | 1.742E-03  |
| A8  | 0.000E+00  | 0.000E+00  | 0.000E+00  | -1.004E-09 | -8.302E-05 | 2.716E-04  | 0.000E+00  |
| A10 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 3.321E-04  | 1.942E-04  | -1.350E-04 | 0.000E+00  |
| A12 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 2.580E-05  | 0.000E+00  |
| A14 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  |
| A16 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  |
|     | 第9面        | 第10面       | 第11面       | 第12面       | 第13面       | 第14面       | 第15面       |
| k   | 0.000E+00  | 0.000E+00  | -9.979E-01 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  |
| A4  | -9.927E-04 | 3.847E-02  | -1.491E-03 | -2.009E-02 | -1.310E-02 | -8.896E-03 | -9.550E-03 |
| A6  | 1.172E-03  | -1.587E-03 | 3.939E-04  | 8.868E-04  | 2.096E-04  | 3.251E-04  | 2.311E-04  |
| A8  | 0.000E+00  | 0.000E+00  | -2.078E-04 | -1.527E-04 | -1.462E-05 | 0.000E+00  | 4.801E-06  |
| A10 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | -1.374E-07 |
| A12 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | -2.691E-09 |
| A14 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 9.923E-11  |
| A16 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | -1.248E-12 |

[0256] 实施例 9 的摄像镜头如表 11 所示,满足条件式 (1) 至 (8) 的全部。

[0257] 图 58 ~ 60 示出实施例 9 的摄像镜头的被摄体距离为无限远时的像差图, 图 61 ~ 63 是对于实施例 9 的摄像镜头, 表示在使摄像镜头整体伸缩而进行自动对焦时, 被摄体距离为 150mm 时的像差图。如图 58 ~ 60、图 61 ~ 63 所示可知, 各像差被良好地校正。

[0258] 而且, 实现全视角接近  $80^{\circ}$  的广角, 并实现了 F 值为 2.6 而比较明亮的摄像镜头系统。而且, 光学全长 TTL 与最大像高  $1h$  之比 (TTL/ $21h$ ) 为 0.82, 为 7 片结构且实现小型化。

[0259] 【实施例 10】

[0260] 基本的镜头数据如以下的表 10 所示。

[0261] 【表 10】

[0262]

## 实施例10

单位:mm

f= 7.36

Fno= 2.5

 $\omega(^{\circ})= 35.7$ 

lh= 5.99

YFL= 0.50

面数据

| 面编号:  | 曲率半径 $r$ | 面间隔 $d$ | 折射率 $N_d$ | 阿贝数 $\nu_d$ |
|-------|----------|---------|-----------|-------------|
| (物面)  | 无限远      | 无限远     |           |             |
| 1*    | 4.082    | 0.548   | 1.5438    | 55.57       |
| 2*    | -40.974  | 0.073   |           |             |
| 3(光阑) | 无限远      | 0.160   |           |             |
| 4*    | -6.245   | 0.441   | 1.5438    | 55.57       |
| 5*    | -6.857   | 0.018   |           |             |
| 6*    | 4.596    | 0.348   | 1.5349    | 23.97       |
| 7*    | 2.541    | 0.237   |           |             |
| 8*    | 5.491    | 0.548   | 1.5438    | 55.57       |
| 9*    | -39.207  | 1.047   |           |             |
| 10*   | -2.413   | 1.469   | 1.5438    | 55.57       |
| 11*   | -2.404   | 0.020   |           |             |
| 12*   | 6.345    | 1.588   | 1.5438    | 55.57       |
| 13*   | 4.741    | 1.186   |           |             |
| 14*   | -5.6141  | 0.794   | 1.6142    | 25.39       |
| 15*   | -65.3607 | 0.250   |           |             |
| 16    | 无限远      | 0.210   | 1.5168    | 64.20       |
| 17    | 无限远      | 0.638   |           |             |
| 像面    | 无限远      |         |           |             |

## 单透镜数据

| 透镜 | 始面 | 焦距      |
|----|----|---------|
| 1  | 1  | 5.86    |
| 2  | 4  | -302.62 |
| 3  | 6  | -10.49  |
| 4  | 8  | 8.90    |
| 5  | 10 | 20.28   |
| 6  | 12 | -52.62  |
| 7  | 14 | -10.05  |

| 透镜        | 合成焦距  |
|-----------|-------|
| 第一透镜-第二透镜 | 7.17  |
| 第四透镜-第五透镜 | 7.69  |
| 第六透镜-第七透镜 | -8.99 |

## 非球面数据

|     | 第1面        | 第2面        | 第4面        | 第5面        | 第6面        | 第7面        | 第8面        |
|-----|------------|------------|------------|------------|------------|------------|------------|
| k   | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | -2.719E+01 | -7.225E+00 | 0.000E+00  |
| A4  | -7.900E-03 | -7.942E-03 | 1.650E-02  | 2.399E-03  | -1.253E-02 | -4.166E-03 | -5.588E-03 |
| A6  | -3.036E-03 | 2.148E-03  | 1.728E-03  | -1.640E-03 | -2.847E-04 | 1.597E-03  | 9.647E-04  |
| A8  | -3.141E-04 | 0.000E+00  | 0.000E+00  | -1.365E-03 | 3.480E-04  | 4.406E-04  | 0.000E+00  |
| A10 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 4.319E-04  | 8.883E-03  | -1.358E-04 | 0.000E+00  |
| A12 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 2.231E-03  | 0.000E+00  |
| A14 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | -7.263E-07 | 0.000E+00  |
| A16 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  |
|     | 第9面        | 第10面       | 第11面       | 第12面       | 第13面       | 第14面       | 第15面       |
| k   | 0.000E+00  | 0.000E+00  | -7.921E-01 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  |
| A4  | 7.101E-03  | 1.848E-03  | -2.632E-03 | -1.829E-02 | -1.209E-02 | 1.274E-03  | -4.969E-03 |
| A6  | 8.746E-04  | -1.959E-03 | 5.219E-04  | 6.593E-04  | 4.187E-04  | 9.132E-06  | 1.689E-04  |
| A8  | 0.000E+00  | 3.803E-04  | -1.145E-04 | -7.584E-05 | -1.731E-03 | 0.000E+00  | -4.212E-07 |
| A10 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 8.632E-08  | 0.000E+00  | -1.586E-08 |
| A12 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | -1.086E-09 |
| A14 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | -1.717E-11 |
| A16 | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 0.000E+00  | 2.057E-13  |

[0263] 实施例10的摄像镜头如表11所示,满足条件式(1)至(8)的全部。

[0264] 图65~67示出实施例10的摄像镜头的被摄体距离为无限远时的像差图,图68~70是对于实施例10的摄像镜头,表示在使摄像镜头整体伸缩而进行自动对焦时,被摄体距离为150mm时的像差图。如图65~67、图68~70所示可知,各像差被良好地校正。

[0265] 而且,实现全视角接近 $80^{\circ}$ 的广角,并实现了F值为2.5而明亮的摄像镜头系统。

而且,光学全长 TTL 与最大像高  $ih$  之比 (TTL/2ih) 为 0.79,为 7 片结构且实现小型化。

[0266] 如以上说明那样,本实用新型的实施方式的摄像镜头,其拍摄视角实现全视角接近  $80^\circ$  的广角,并且在使摄像镜头整体伸缩而进行自动对焦时,在无限远距离和极近距离这双方的摄像中像差都被良好地校正,能够实现 F 值为 2.4 至 2.6 的比较明亮的摄像镜头系统。而且,能够实现光学全长 TTL 与最大像高  $ih$  之比 (TTL/2ih) 实现 0.8 的水平的小型透镜系统。

[0267] 表 11 示出实施例 1 至实施例 10 的条件式 (1) ~ (8) 的值。

[0268] 【表 11】

[0269]

|                                   | 实施例1  | 实施例2  | 实施例3  | 实施例4  | 实施例5  | 实施例6  | 实施例7  | 实施例8  | 实施例9  | 实施例10 |
|-----------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 条件式(1)<br>$0.8 < TTL/2ih < 1.2$   | 7.69  | 6.97  | 7.06  | 6.97  | 6.89  | 6.74  | 6.93  | 6.77  | 6.69  | 7.37  |
| 条件式(2)<br>$0.8 < 2f/3\phi < 1.2$  | 0.84  | 0.89  | 0.91  | 0.88  | 0.92  | 0.90  | 0.89  | 0.92  | 0.87  | 0.87  |
| 条件式(3)<br>$-1.5 < f_1/f_2 < -1.2$ | -1.41 | -1.42 | -1.38 | -1.31 | -1.29 | -1.26 | -1.66 | -1.44 | -1.33 | -1.42 |
| 条件式(4)<br>$0.8 < f_1/f_2 < 1.2$   | 1.04  | 1.07  | 1.08  | 0.83  | 1.02  | 1.09  | 1.31  | 1.19  | 1.48  | 1.04  |
| 条件式(5)<br>$-1.5 < f_1/f_2 < -0.5$ | -1.37 | -1.13 | -1.40 | -0.78 | -1.13 | -1.18 | -1.31 | -1.36 | -1.82 | -1.32 |
| 条件式(6)<br>$0.0 < \phi_1 < 0.5$    | 05.37 | 05.37 | 05.37 | 05.37 | 05.37 | 05.37 | 05.37 | 05.37 | 05.37 | 05.37 |
| 条件式(7)<br>$0.0 < \phi_2 < 0.5$    | 05.37 | 05.37 | 05.37 | 05.37 | 05.37 | 05.37 | 05.37 | 05.37 | 05.37 | 05.37 |
| 条件式(8)<br>$0.0 < \phi_3 < 0.5$    | 05.37 | 05.37 | 05.37 | 05.37 | 05.37 | 05.37 | 05.37 | 05.37 | 05.37 | 05.37 |

[0270] 【产业上的可利用性】

[0271] 根据本实用新型的 7 片结构的摄像镜头,能够实现维持小型化且满足广角化,并满足高分辨率的要求的摄像镜头。尤其是通过应用于智能电视或 4K 电视等高性能产品,应用于游戏机或 PC 等信息终端设备,以及应用于具备真正的数码相机功能的智能手机或便携电话机及 PDA(Personal Digital Assistant, 个人数字助理) 等便携终端设备,能够提高该产品的性能。

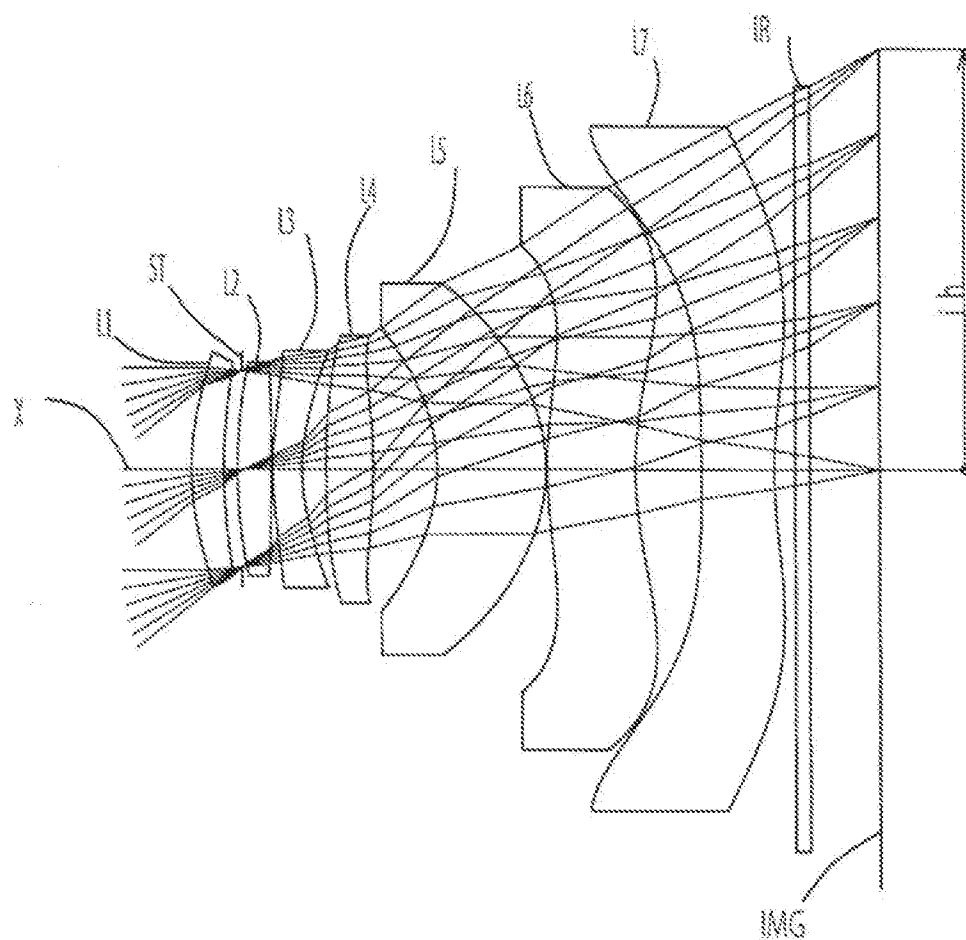


图 1

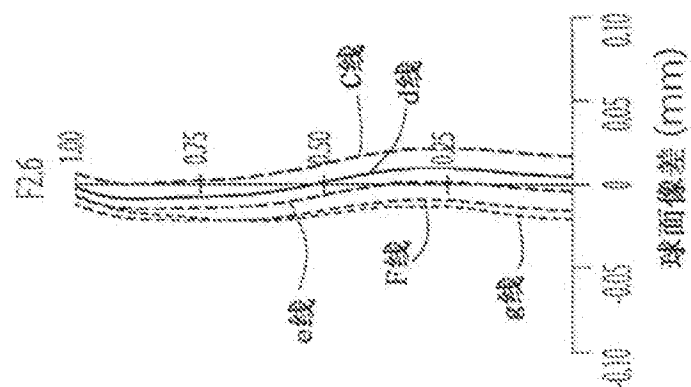


图 2

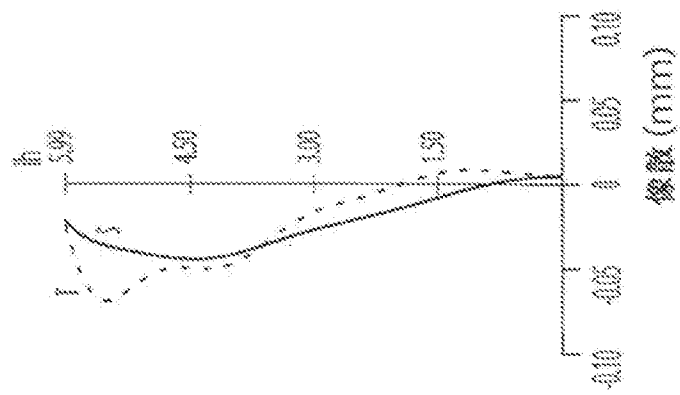


图 3

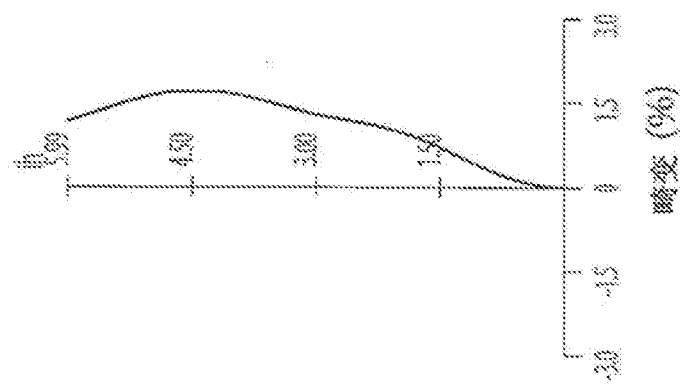


图 4

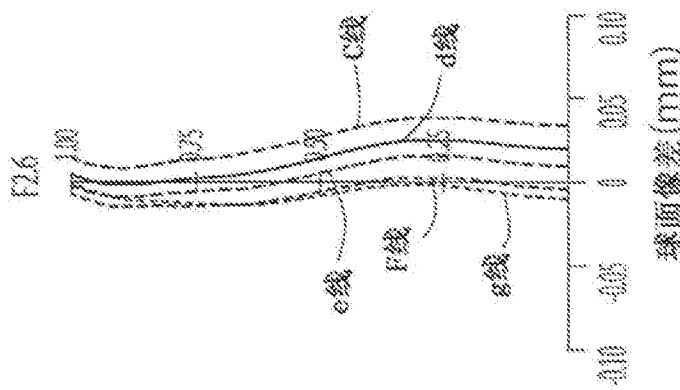


图 5

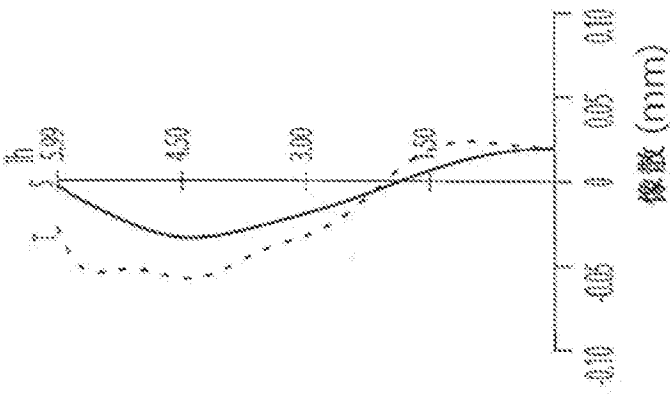


图 6

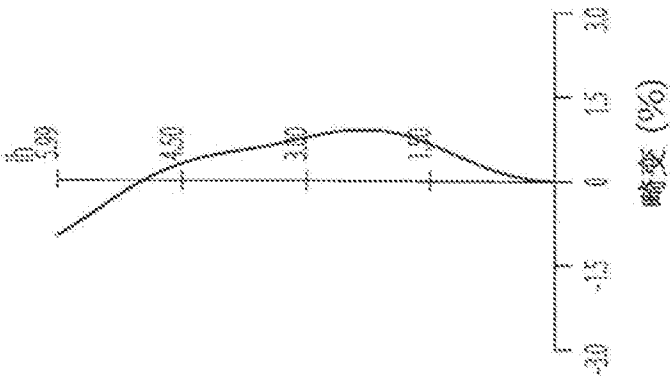


图 7

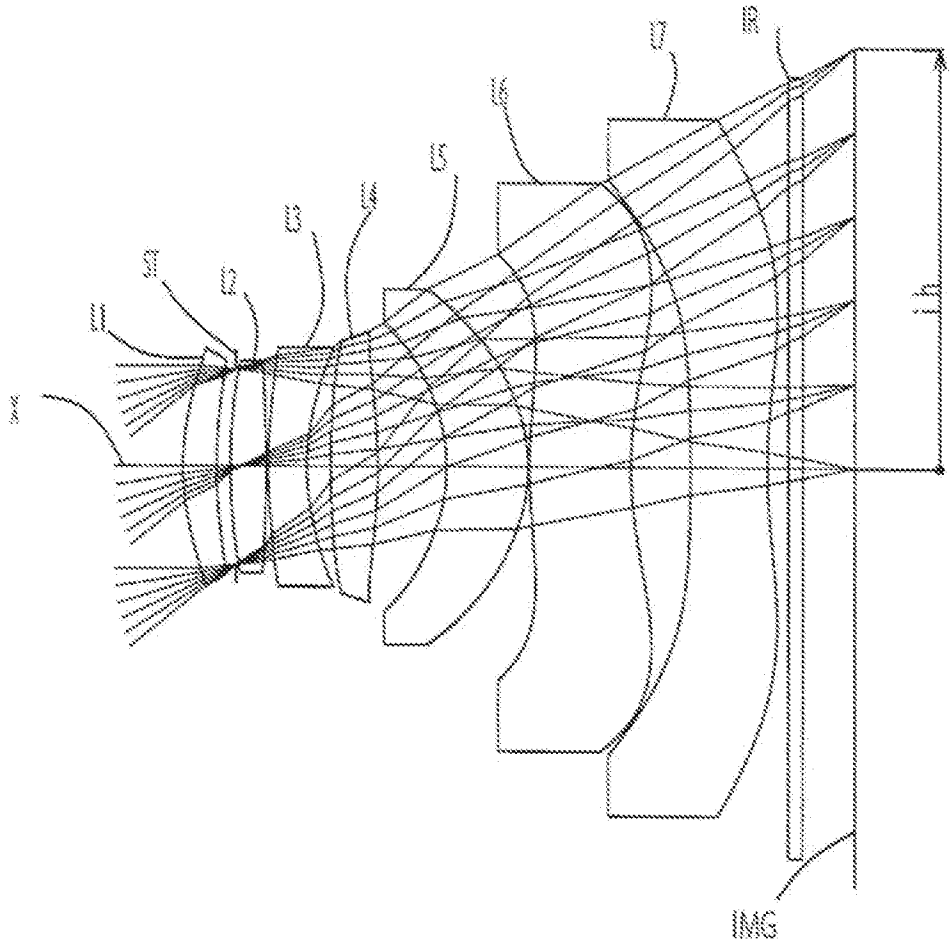


图 8

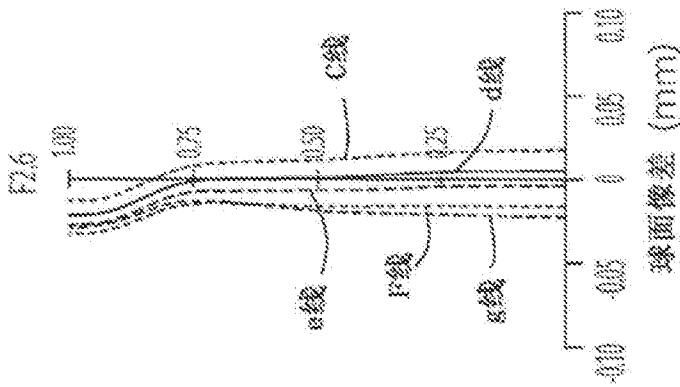


图 9

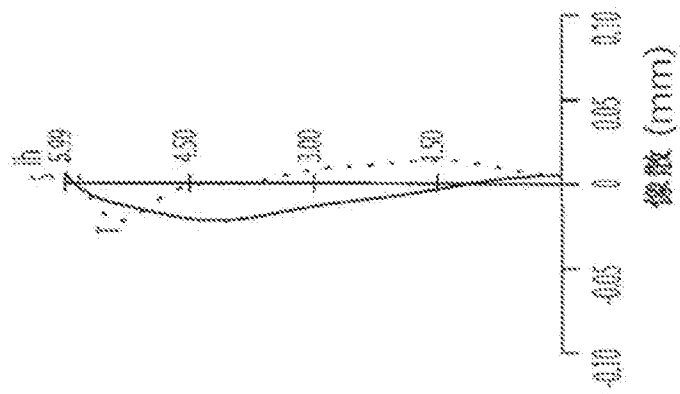


图 10

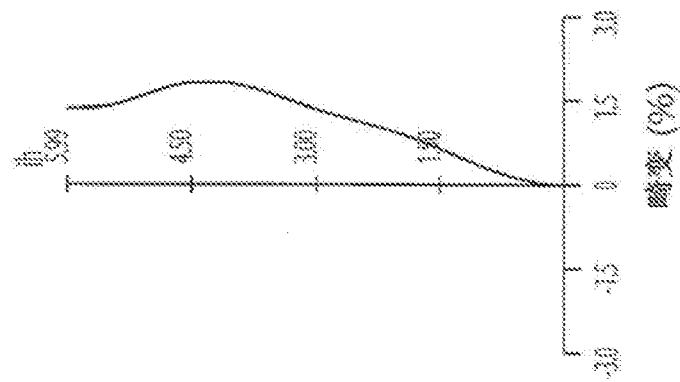


图 11

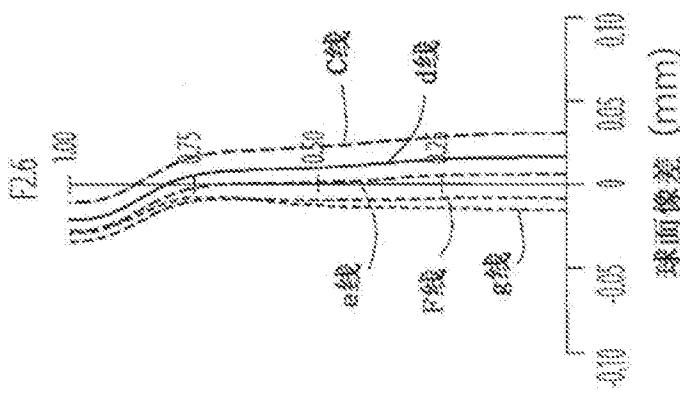


图 12

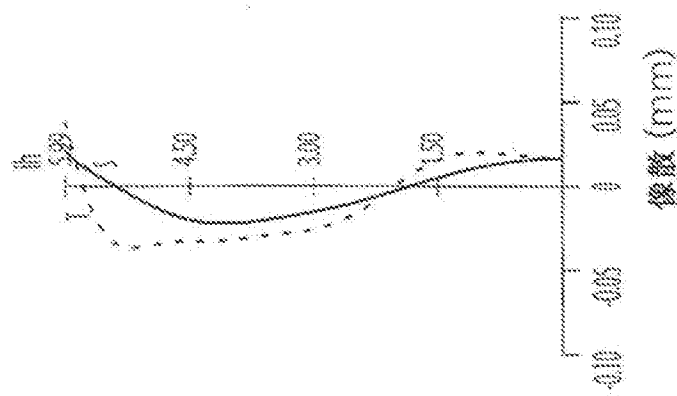


图 13

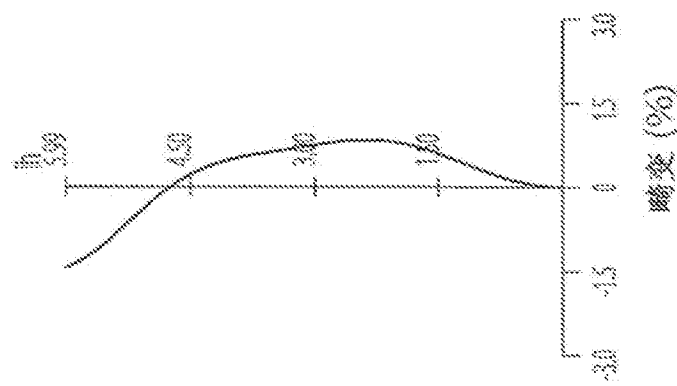


图 14

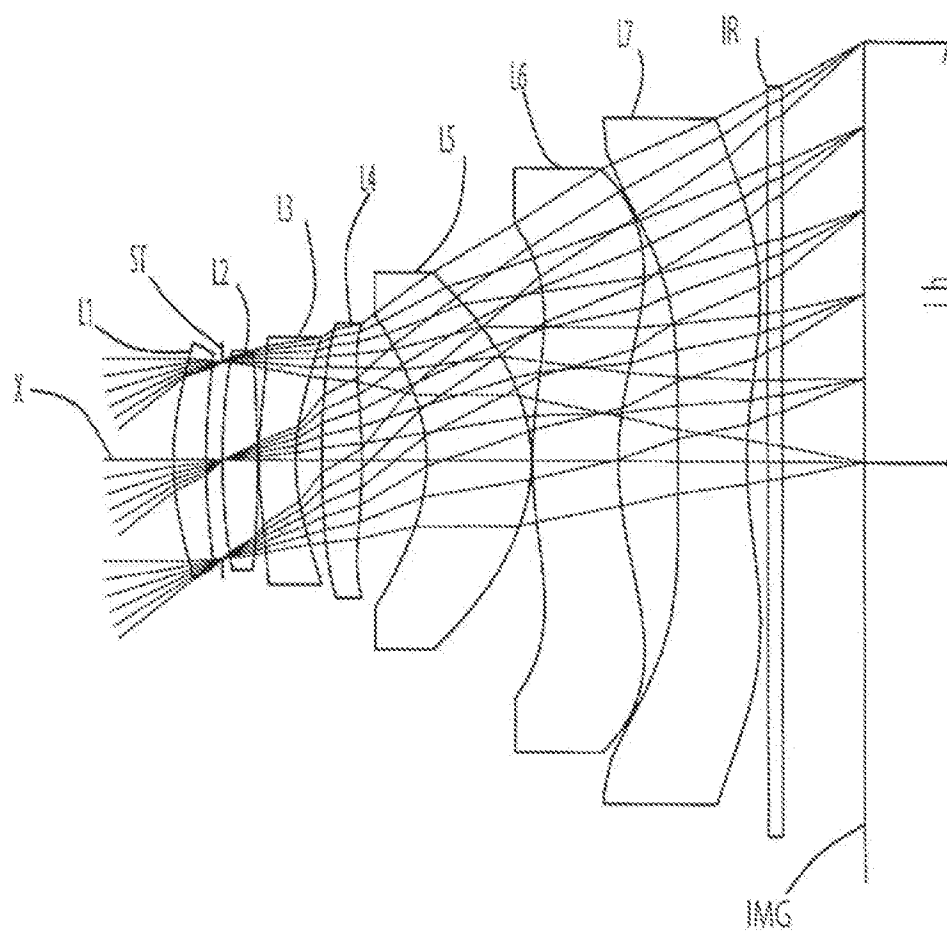


图 15

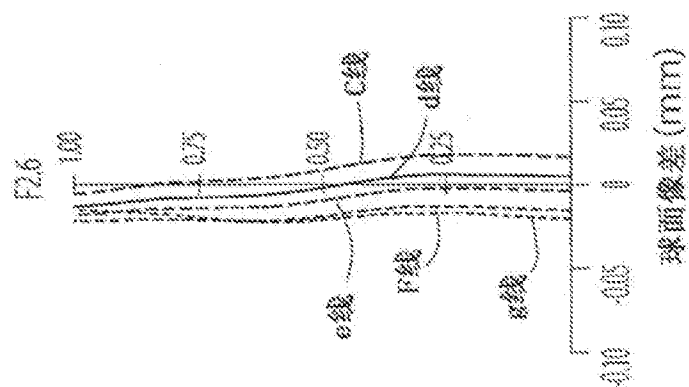


图 16

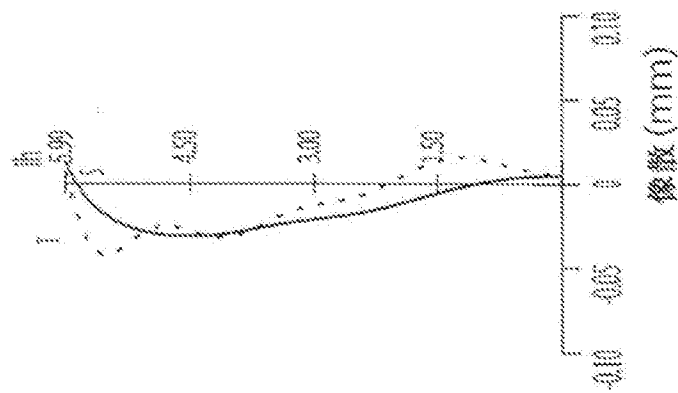


图 17

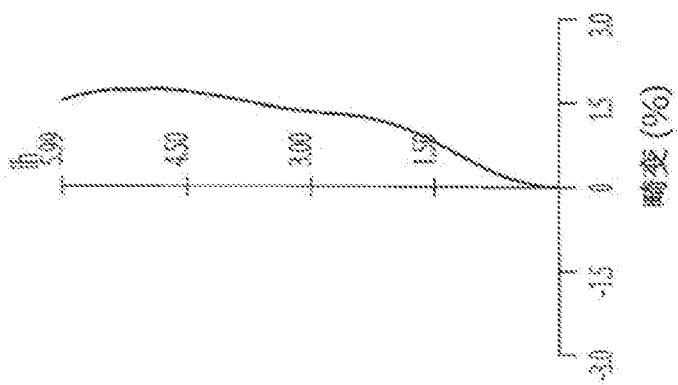


图 18

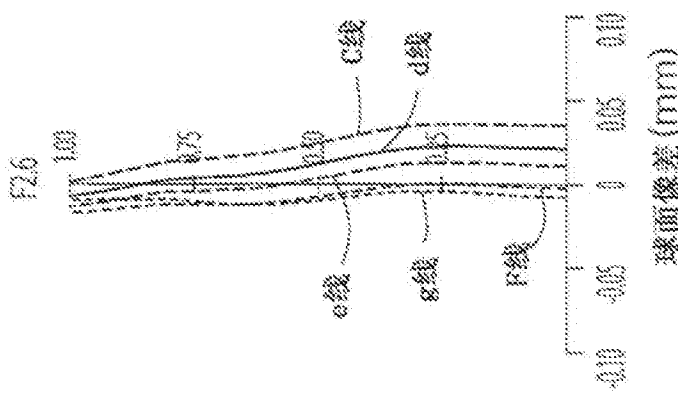


图 19

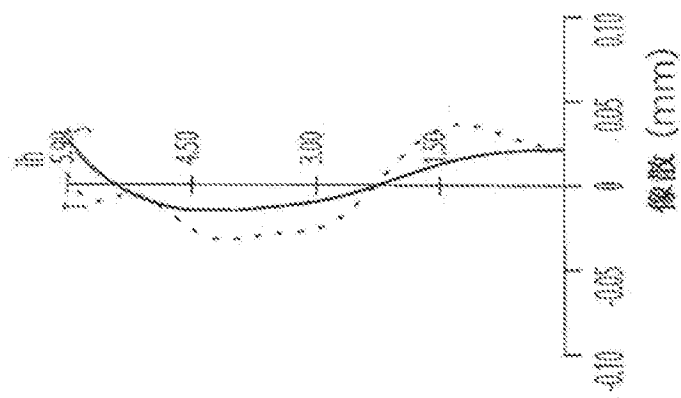


图 20

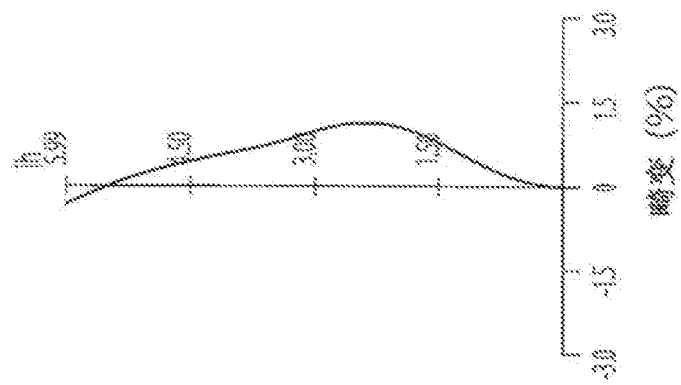


图 21

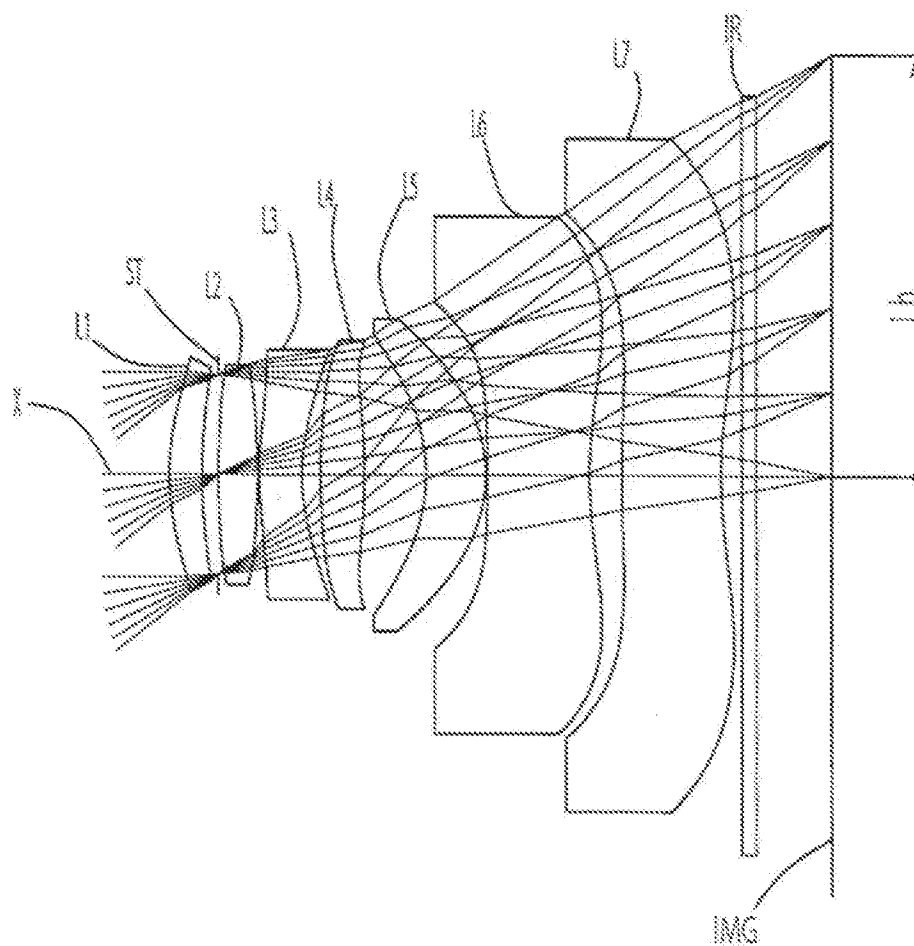


图 22

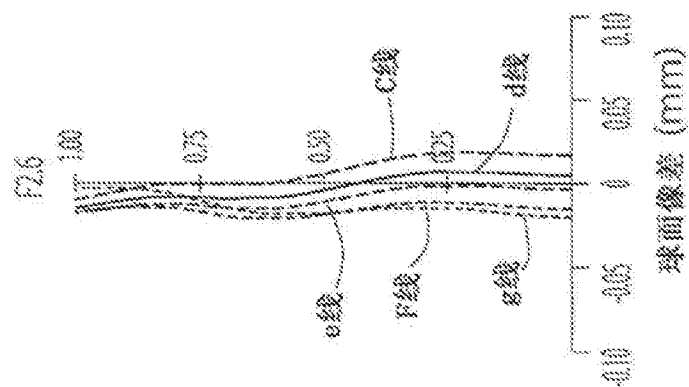


图 23

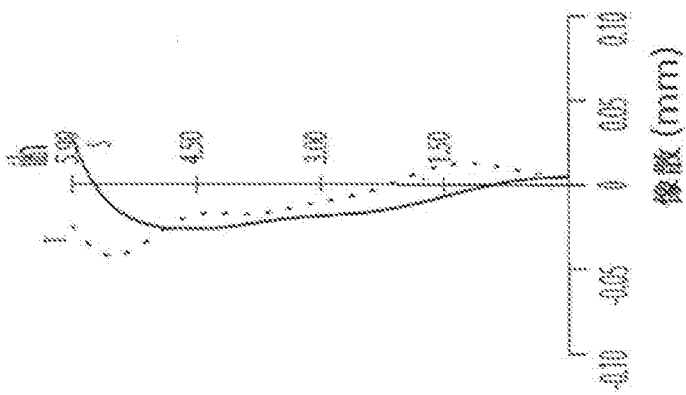


图 24

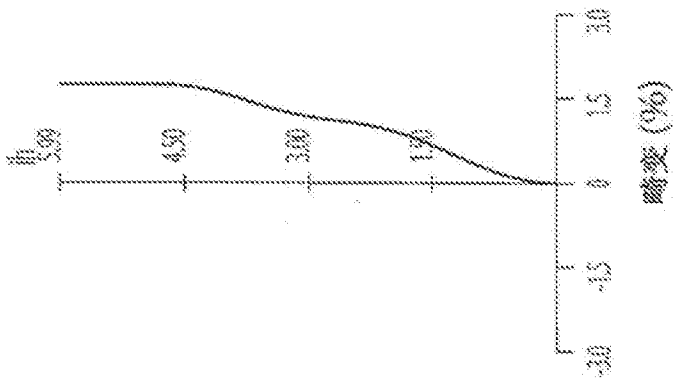


图 25

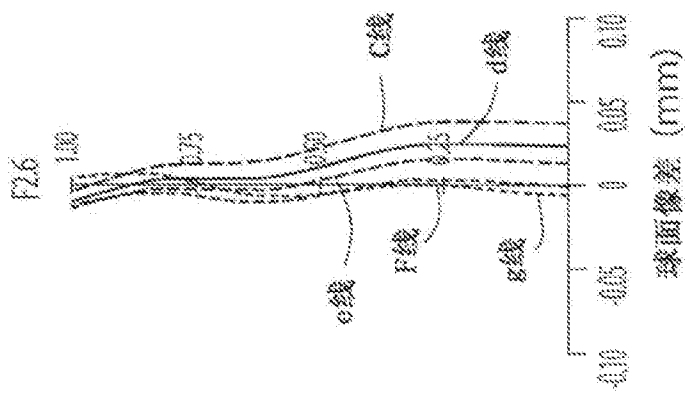


图 26

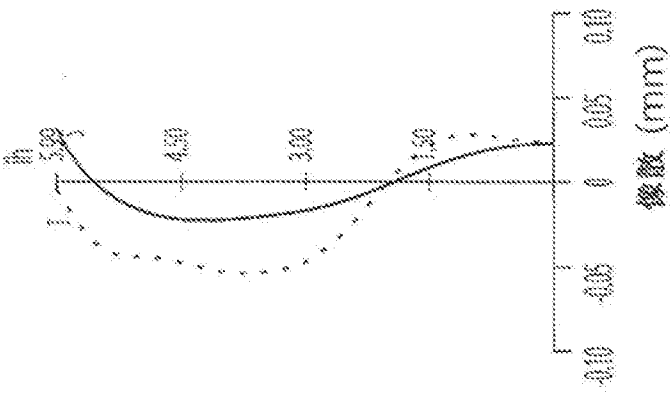


图 27

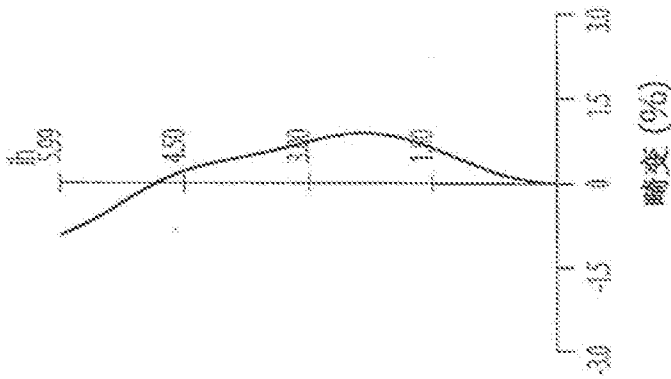


图 28

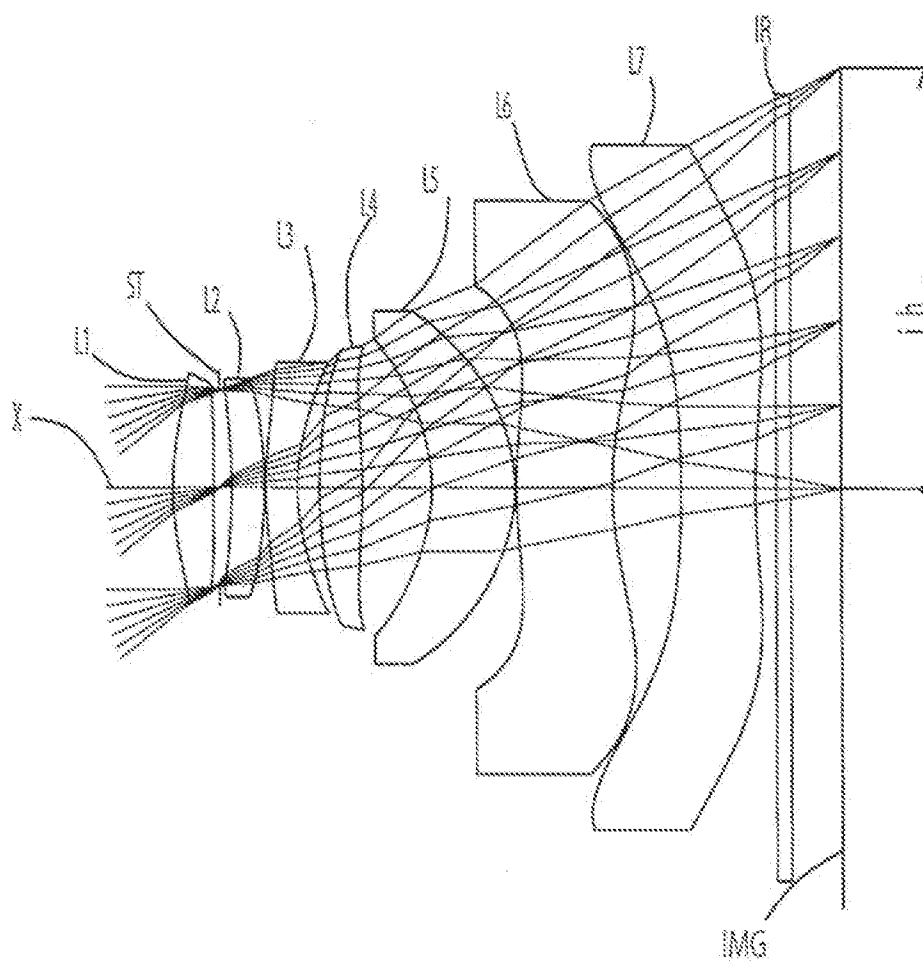


图 29

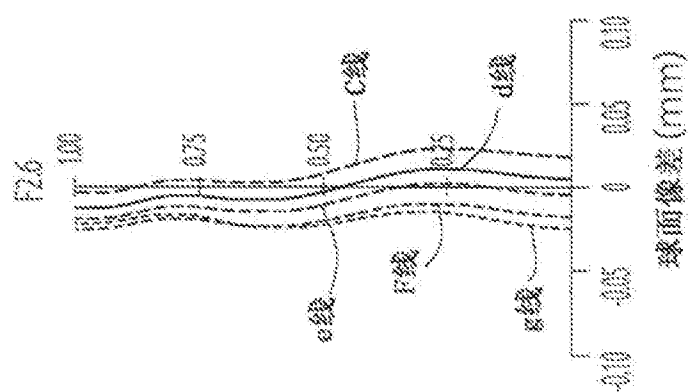


图 30

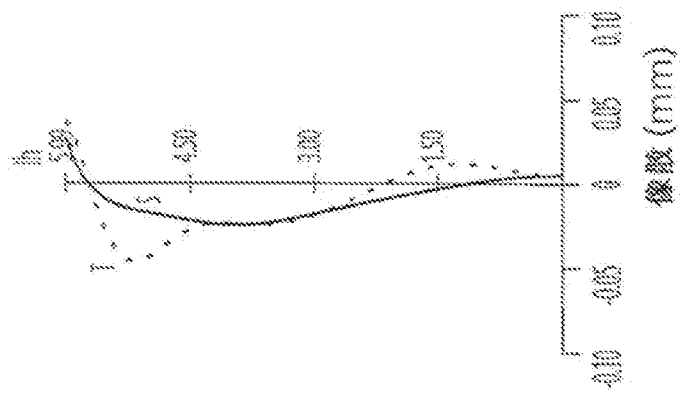


图 31

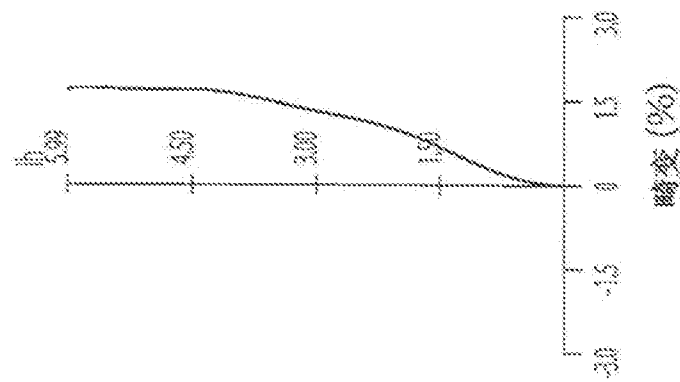


图 32

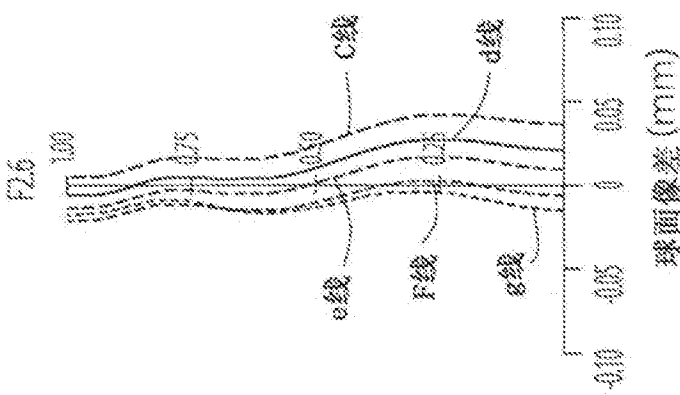


图 33

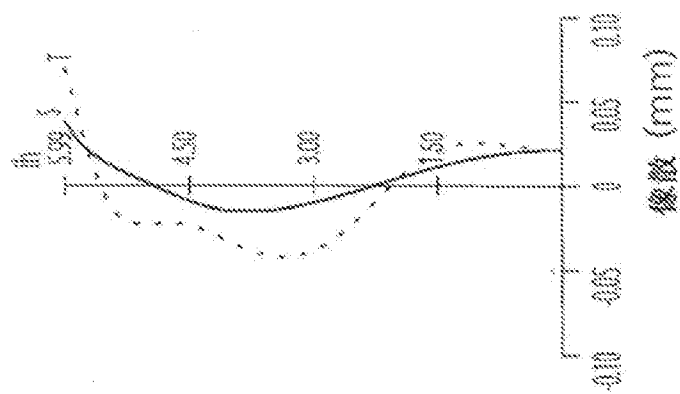


图 34

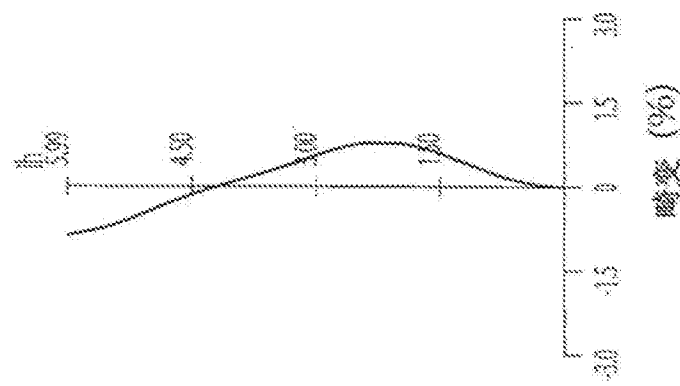


图 35

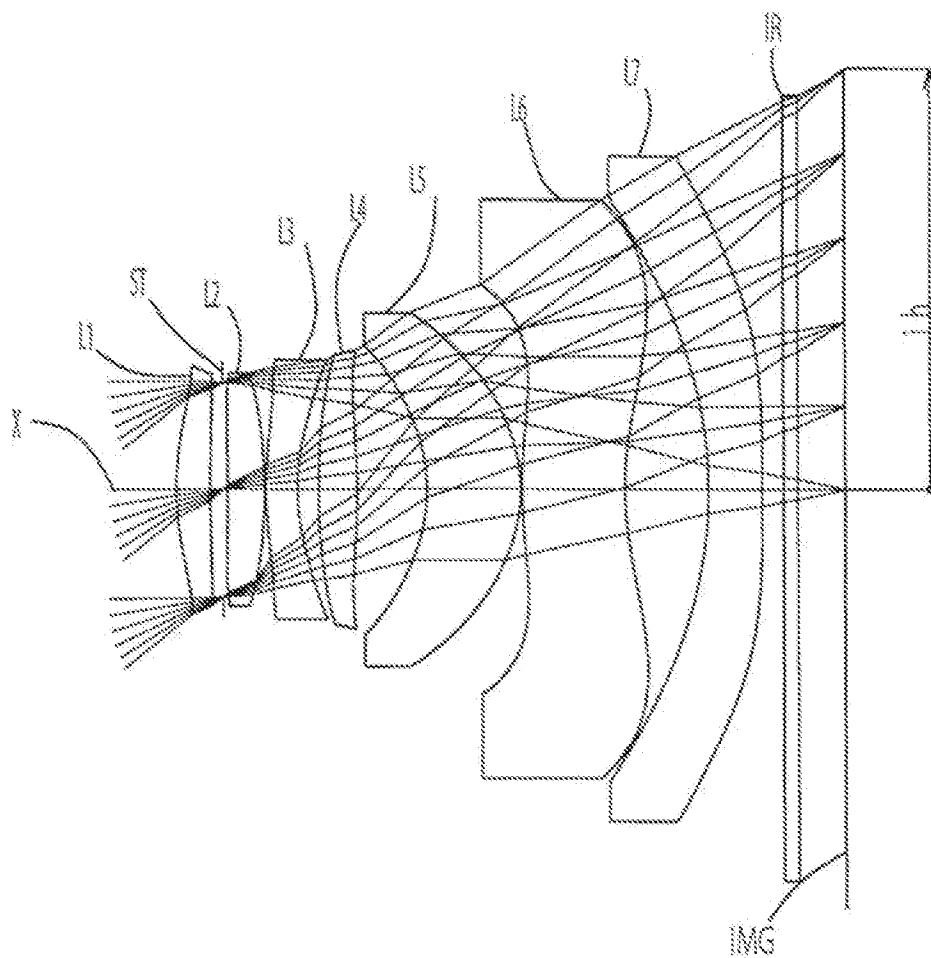


图 36

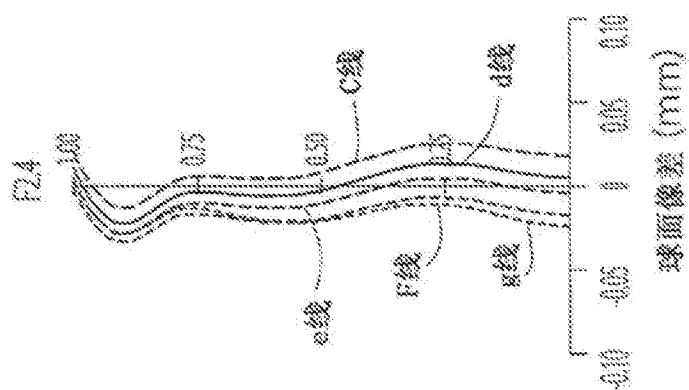


图 37

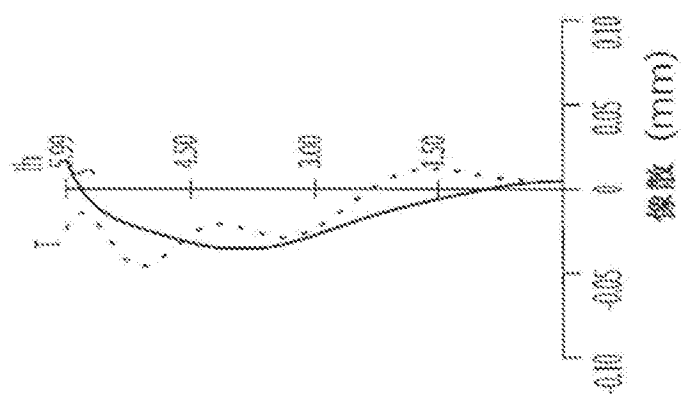


图 38

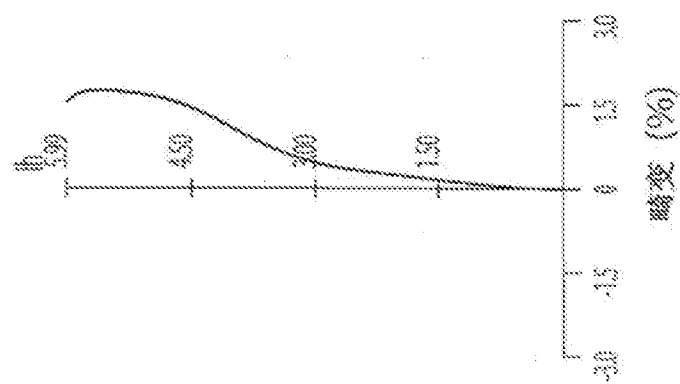


图 39

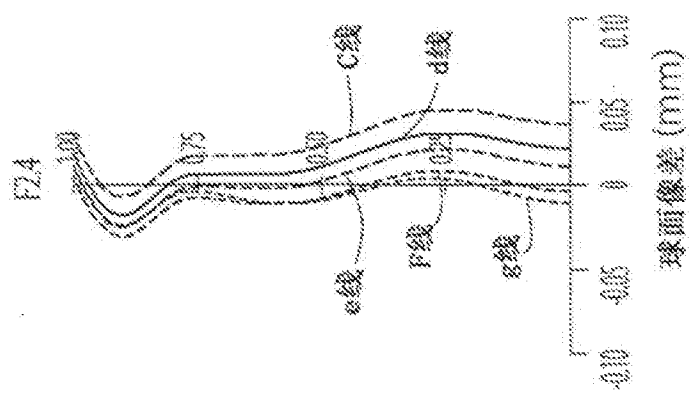


图 40

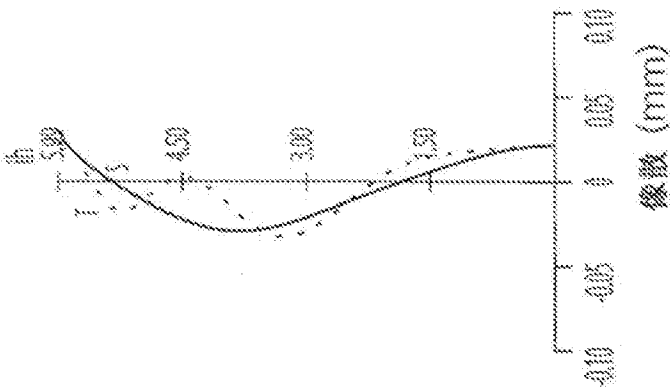


图 41

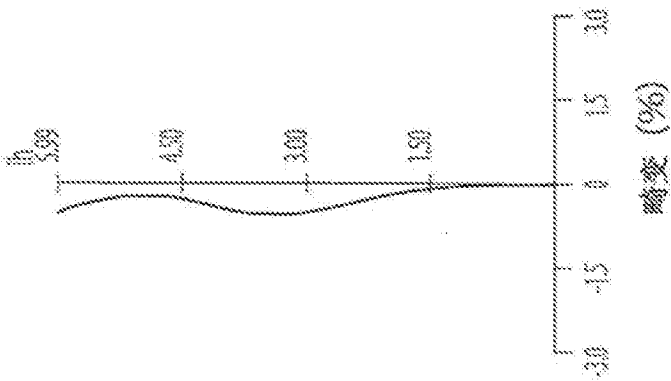


图 42

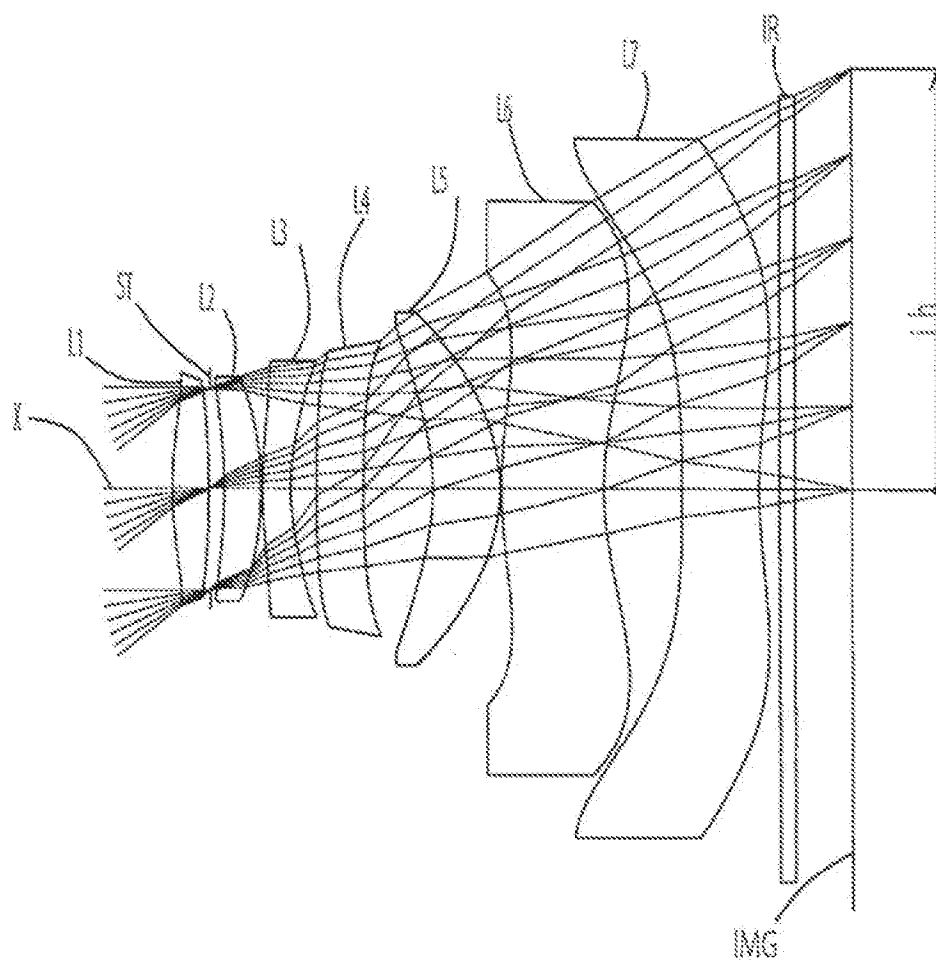


图 43

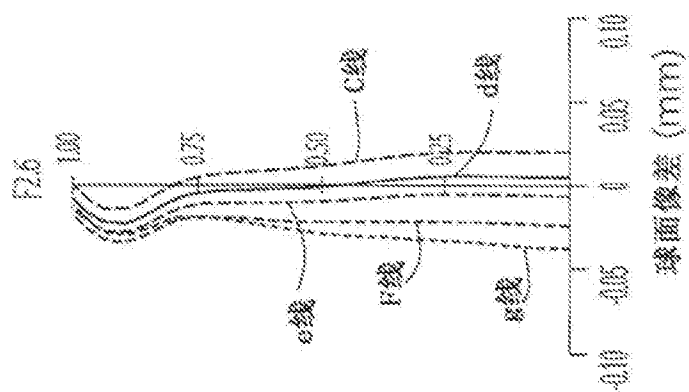


图 44

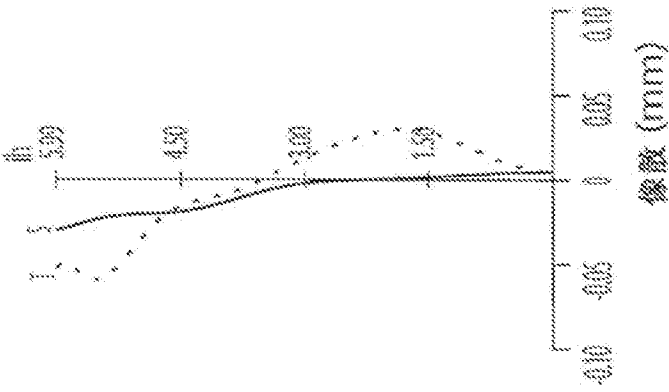


图 45

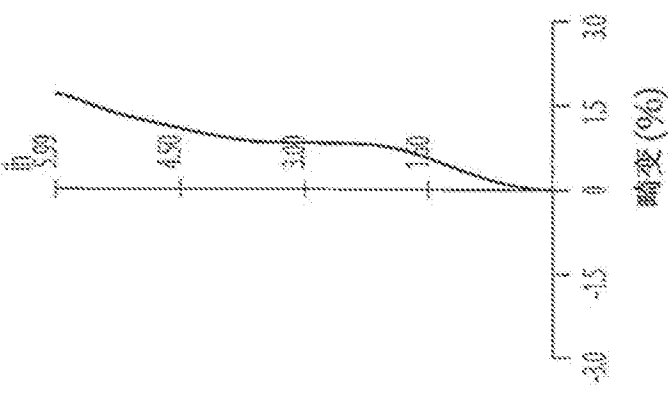


图 46

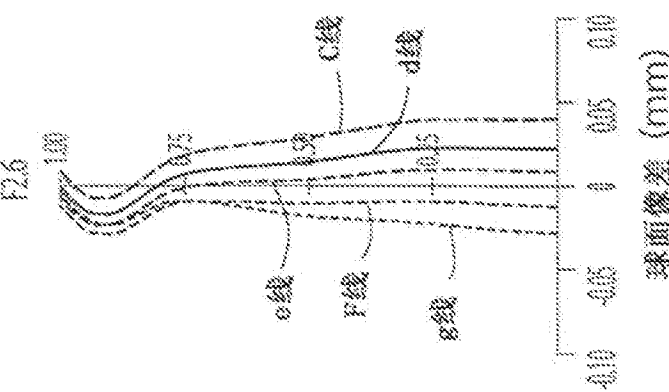


图 47

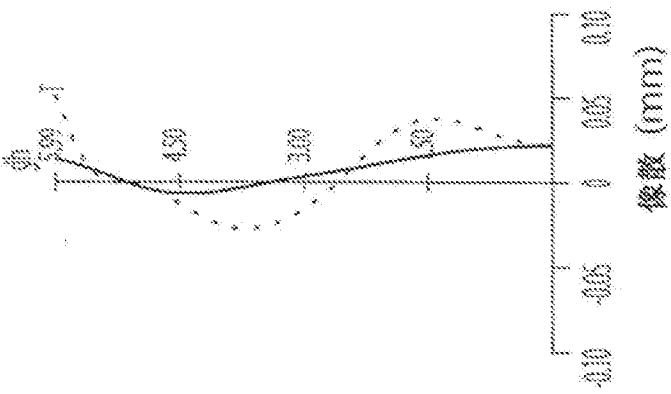


图 48

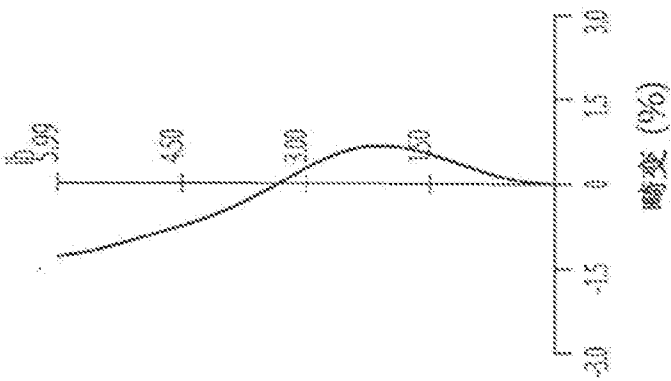


图 49

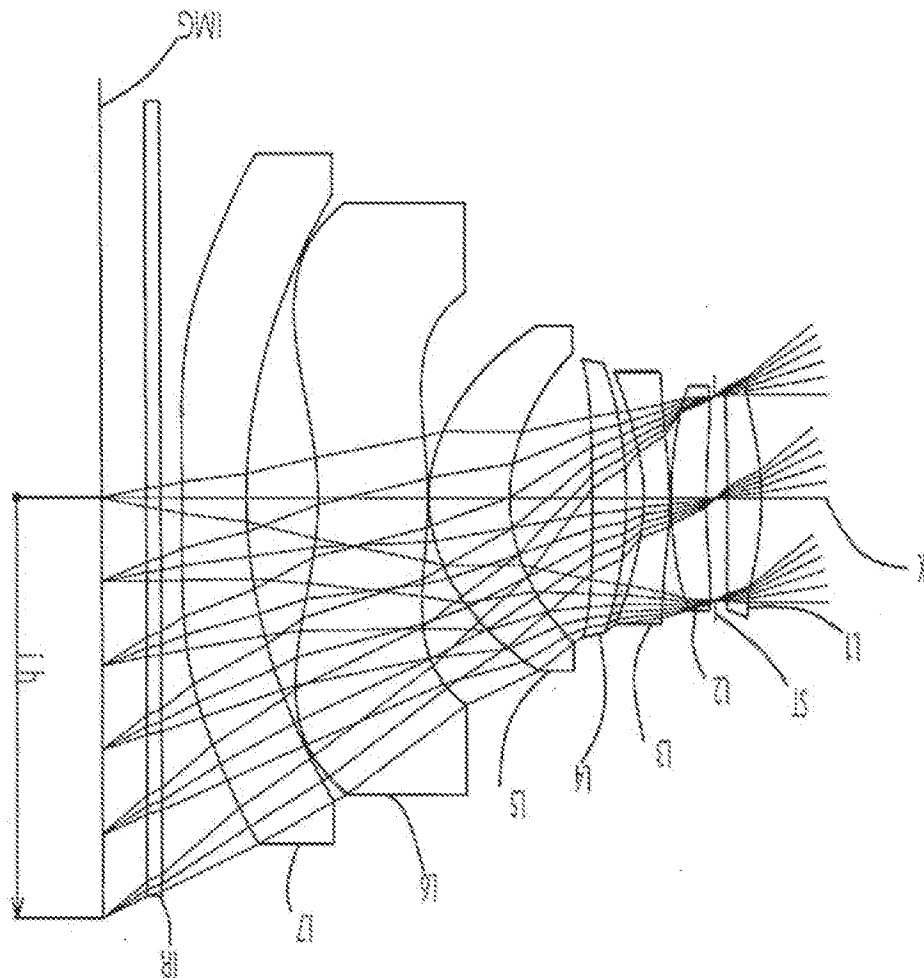


图 50

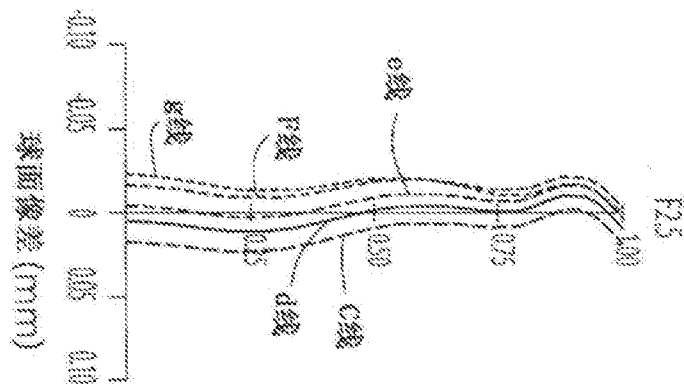


图 51

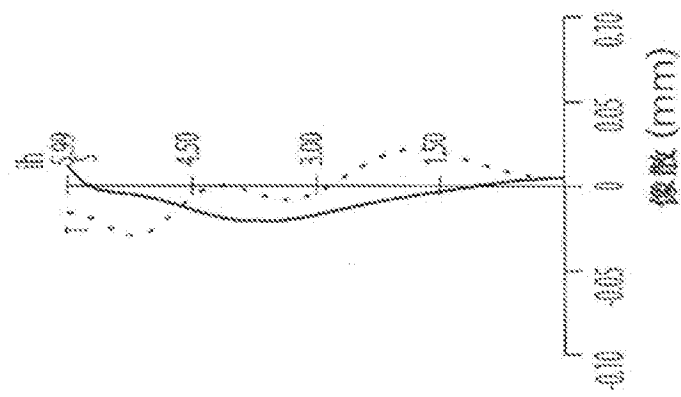


图 52

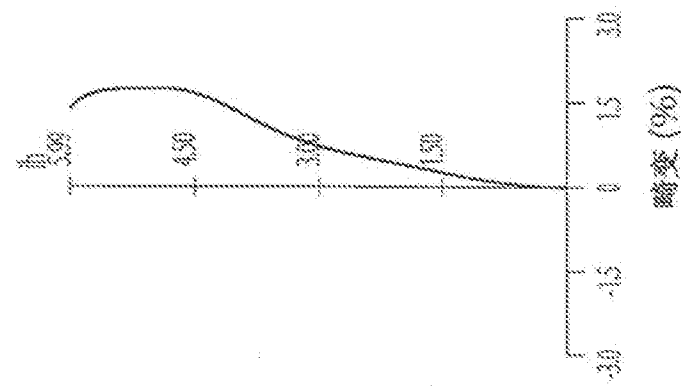


图 53

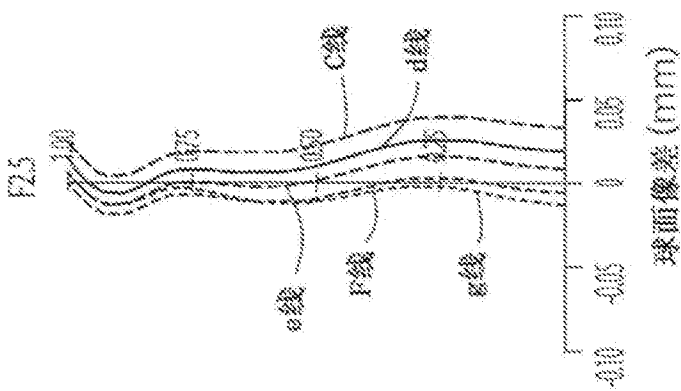


图 54

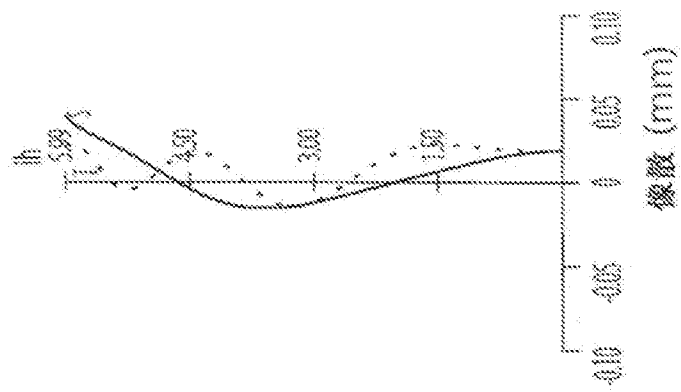


图 55

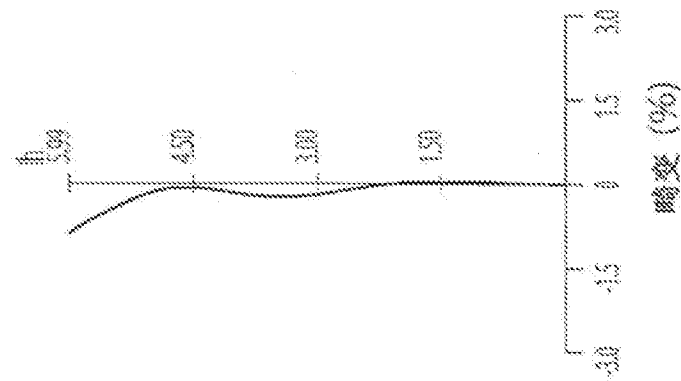


图 56

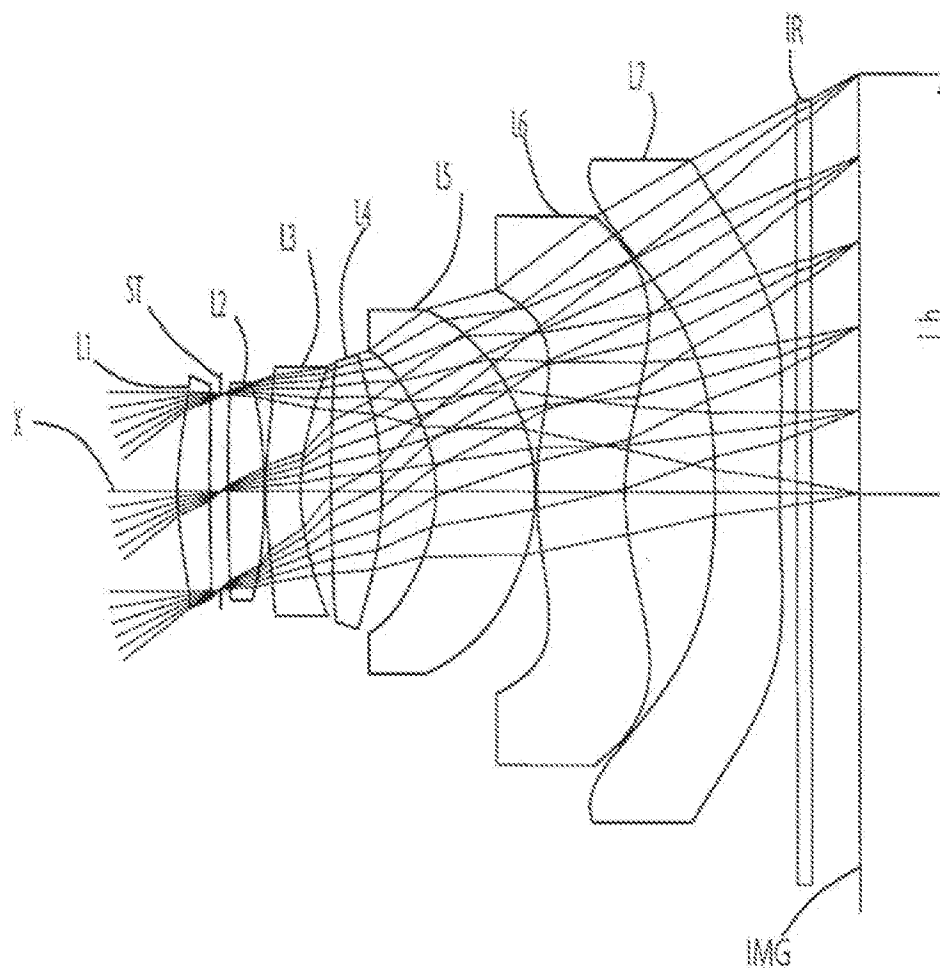


图 57

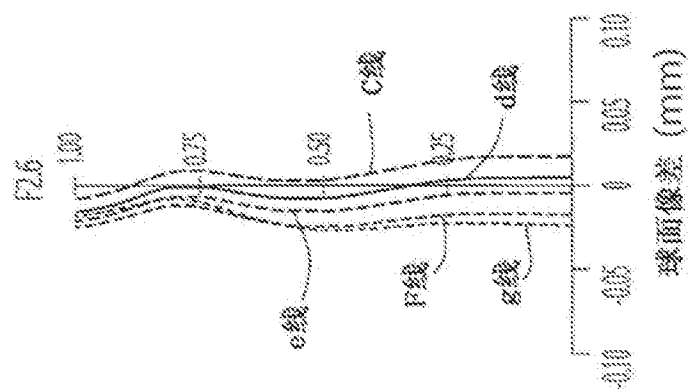


图 58

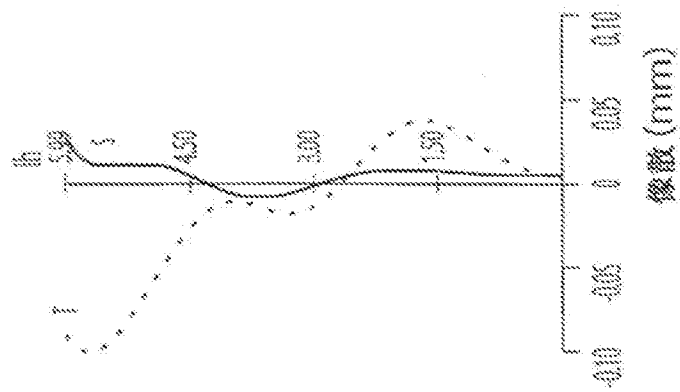


图 59

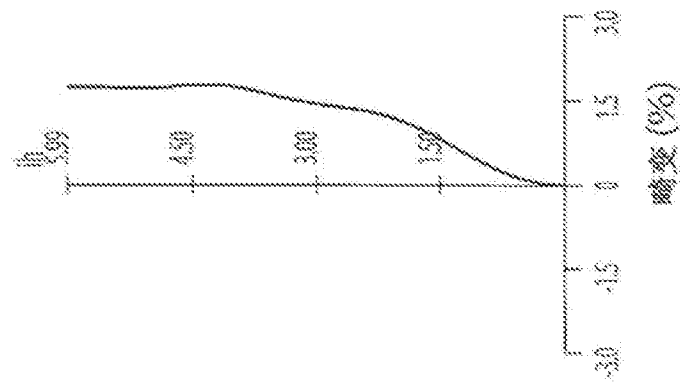


图 60

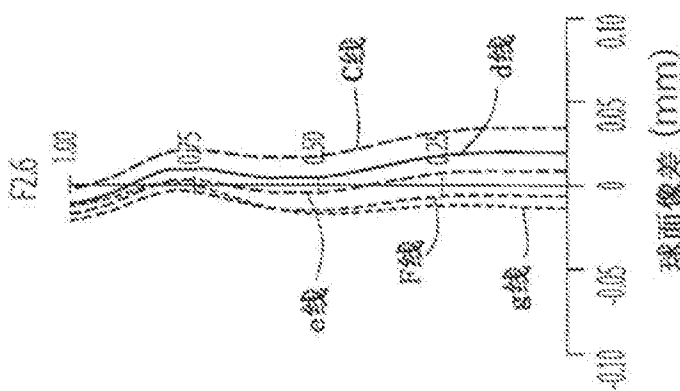


图 61

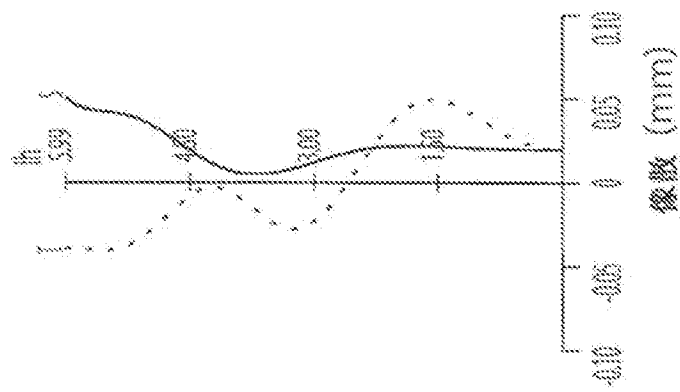


图 62

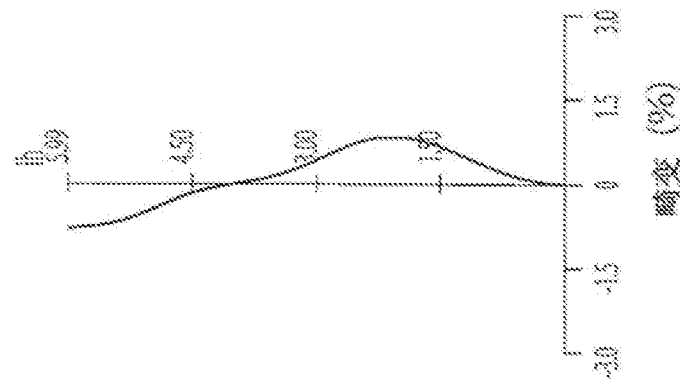


图 63

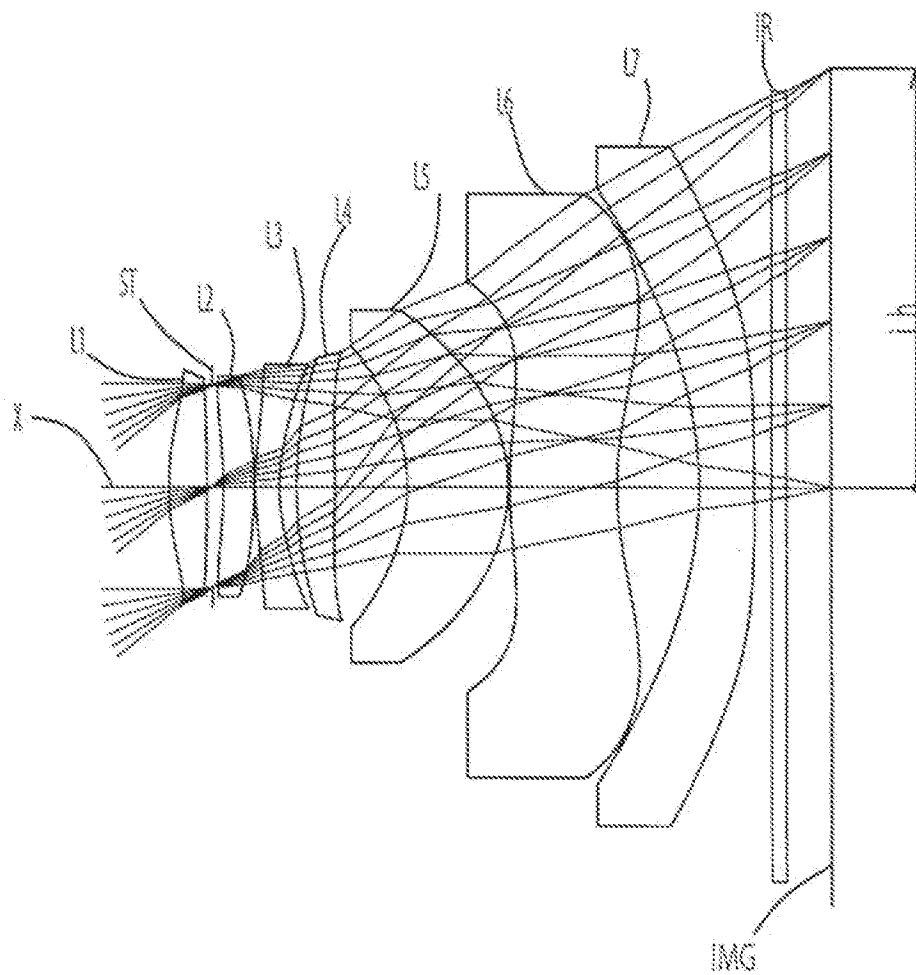


图 64

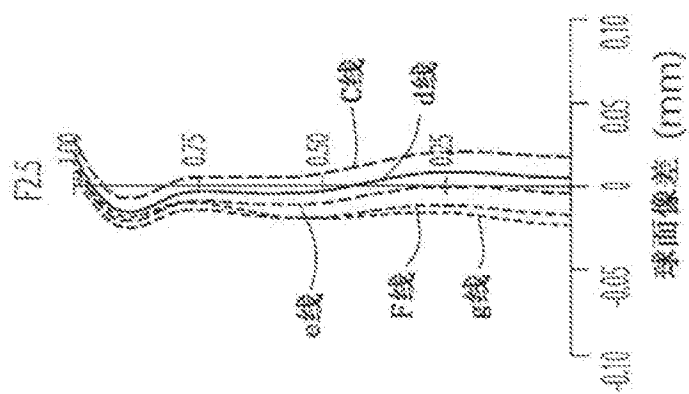


图 65

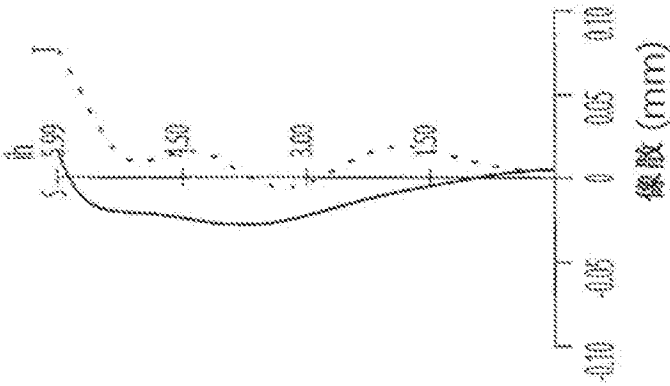


图 66

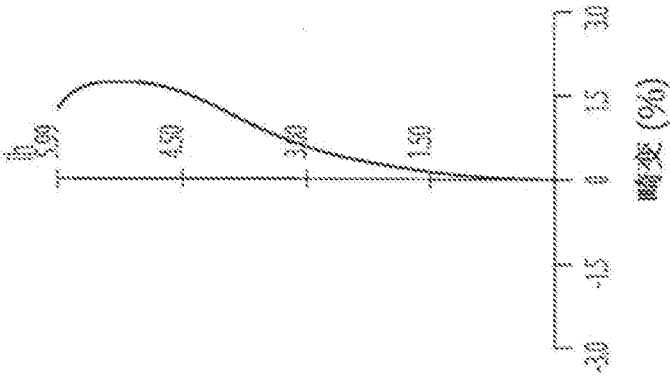


图 67

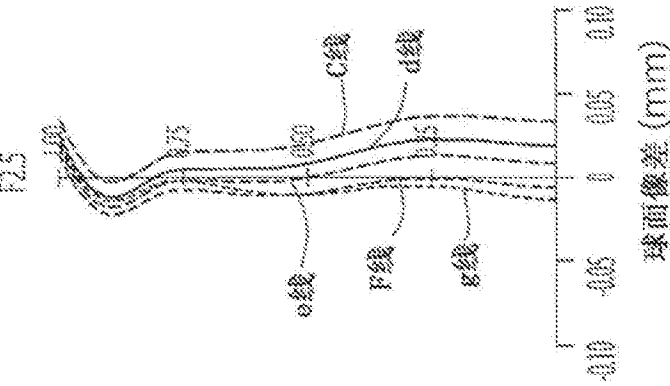


图 68

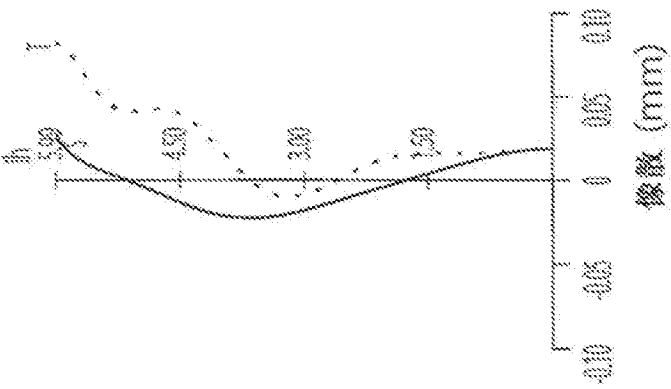


图 69

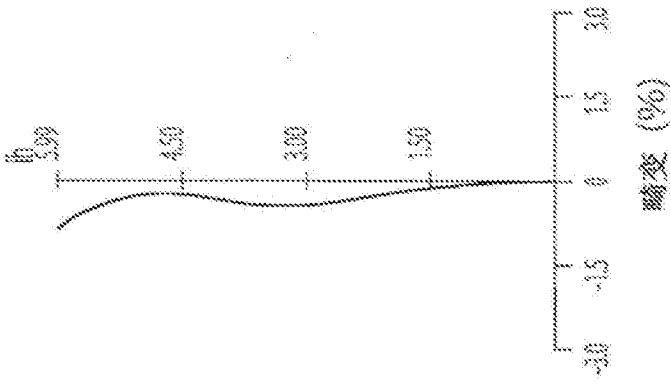


图 70



(19)中華民國智慧財產局

(12)新型說明書公告本 (11)證書號數：TW M490015 U

(45)公告日：中華民國 103 (2014) 年 11 月 11 日

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G03B29/00 (2006.01)

(30)優先權：2013/07/02 日本

2013-138595

2014/01/24 日本

2014-011158

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申請專利範圍項數：20 項 圖式數：33 共 64 頁

(54)名稱

攝像鏡頭及具備攝像鏡頭的攝像裝置

IMAGING LENS AND IMAGING APPARATUS EQUIPPED WITH THE IMAGING LENS

(57)摘要

本新型創作實現一種具有小的 F 值、已實現總長的縮短化及高解析化的攝像透鏡及包括所述攝像透鏡的攝像裝置。所述攝像透鏡實質上包含 7 片透鏡，即自物體側起依序包括：第 1 透鏡 L1，具有正折射力，使凸面朝向物體側；第 2 透鏡 L2，具有負折射力；第 3 透鏡 L3，具有負折射力；第 4 透鏡 L4；第 5 透鏡 L5，具有正折射力；第 6 透鏡 L6；第 7 透鏡 L7，具有負折射力，使凹面朝向像側，在像側的面具有至少 1 個反曲點；且，第 1 透鏡至第 7 透鏡全部為單透鏡。

An imaging lens substantially includes seven lenses, constituted by: a first lens having a positive refractive power and a convex surface toward an image side; a second lens having a negative refractive power; a third lens having a positive refractive power; a fourth lens; a fifth lens having a positive refractive power; a sixth lens; and a seventh lens having a negative refractive power, a concave surface toward an image side, and at least one inflection point in the surface toward the image side; provided in this order from an object side. All of the first lens through the seventh lens are single lenses.

|             |     |
|-------------|-----|
| 申請日期:       | 案號: |
| 類別: 公告      |     |
| (以上各欄由本局填註) |     |

# 新型專利說明書

490015

|            |                    |                  |
|------------|--------------------|------------------|
| 一、<br>新型名稱 | 中文                 | 自行車花籃之量測機構       |
|            | 英文                 |                  |
| 二、<br>創作人  | 姓名<br>(中文)         | 1. 蔣光華           |
|            | 姓名<br>(英文)         | 1.               |
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| 三、<br>申請人  | 姓名<br>(名稱)<br>(中文) | 1. 隆慶精鋼有限公司      |
|            | 姓名<br>(名稱)<br>(英文) | 1.               |
|            | 國籍                 | 1. 中華民國          |
|            | 住、居所<br>(事務所)      | 1. 彰化縣和美鎮平原路168號 |
|            | 代表人<br>姓名<br>(中文)  | 1. 許美娥           |
|            | 代表人<br>姓名<br>(英文)  | 1.               |



※ 已向

國(地區)申請專利

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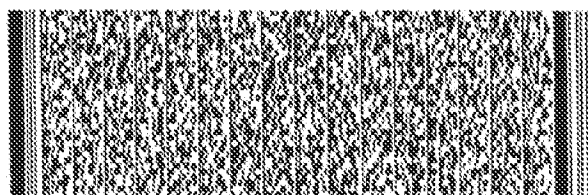
蘇 蘇

主張發先機

## 四、中文創作摘要 (創作之名稱：自行車花轂之量測機構)

本創作係有關於一種「自行車花轂之量測機構」，該量測機構係由一機座之機台上搭設一定位軸心、一托盤、一標準墊片、一迫緊件及一量錶所組成；其中定位軸心係供花轂之棘輪套筒套設定位，並於底端部搭設一彈性元件，可於壓縮時產生一回復迫緊力；該托盤係位於定位軸心頂端部，可供花轂之外套筒底端及其上滾珠定位；該標準墊片之高度係大於棘輪套筒之螺牙段高度，並恰可套設於棘輪套筒之頂端肩部緣；該迫緊件係位於托盤頂端部，並可向下壓掣抵頂珠碗蓋，使珠碗蓋得依序透過標準墊片、棘輪套筒、定位軸心，以壓縮彈性元件，進而使整體構件得向下位移；該量錶係搭設於定位環緣底端部，並可測得定位軸心之位移量至珠碗蓋與外套筒上方滾珠相互抵

## 英文創作摘要 (創作之名稱：)



四、中文創作摘要 (創作之名稱：自行車花穀之量測機構)

頂為止，並求取其平均值，再將標準墊片之高度值減去平均值後，即可求取所欲得之墊片高度者；藉此，俾使該花穀搭設墊片後，可增加其運轉之平穩及順暢度，同時可提高組裝效率，並延長樞轉壽命者。

英文創作摘要 (創作之名稱：)



## 五、創作說明 (1)

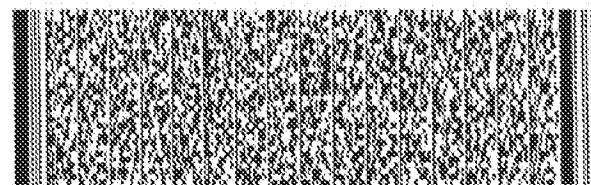
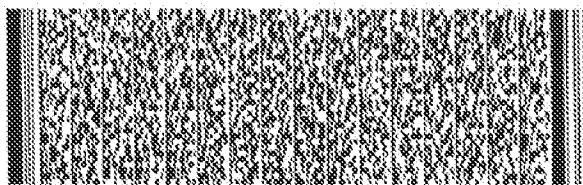
## 《創作概述》

本創作係關於一種「自行車花穀之量測機構」，尤指一種可定位及壓掣花穀棘輪套筒、外套筒及珠碗蓋之測量裝置，並透過一標準墊片之預先墊置及量測機構量錶所讀取之平均高度值，可精確地計算出棘輪套筒頂端肩部緣與珠碗蓋下方端緣間應墊設之墊片高度值，使花穀之兩珠碗結構具有適宜之配合鬆緊度，以提昇其樞轉滑移之平穩順暢度，同時提高組裝效率，並延長使用壽命，俾使整體深具創新實用性者。

## 《創作背景》

按，一般傳統的自行車花穀80結構，請參閱第七圖所示，其係具有一可供飛輪套接之外套筒81，於軸心部設有一穿伸孔811，可供一棘輪套筒82由一端穿伸，再利用一珠碗蓋83由另端鎖固，其中由於珠碗蓋83、棘輪套筒82與外套筒81兩端適當處各形成有一可供滾珠84搭設其中之珠槽831、821、812，加上棘輪套筒82外徑緣適當處設有若干棘齒(圖中未示)可與外套筒81之內徑緣相互嚙合，故使外套筒81可受飛輪驅轉，亦可產生一反向空轉運動者。

由上得知，一般花穀80欲達平穩順暢之樞轉，其間珠碗結構之安裝品質極為重要；然而，該花穀80在組合安裝時，常利用手動或氣動等輔助工具直接旋緊珠碗蓋83，由於其螺鎖之鬆緊度端憑個人之直覺，而無一定之標準，故可想見的是，其螺鎖時常發生過緊或過鬆之現象，其結果



## 五、創作說明 (2)

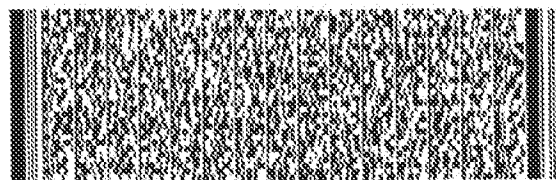
常使花穀80不是因太緊而難以平順樞轉，即是過鬆而無法發揮滾珠滑動之效用，久而久之，則造成珠碗結構及其相關搭配構件之鬆動磨損，致大幅減短花穀80之使用壽命；緣此，針對現有花穀80樞轉結構在安裝搭配上產生之缺點，係有亟待改良之必要者。

本創作人有鑑於此，即憑恃著長期對於各種花穀量測結構之研究及融會貫通之構思，而創作出一種自行車花穀之量測機構，可定位及壓掣花穀之棘輪套筒、外套筒及珠碗蓋，並透過一標準墊片之預先墊置及量測機構量錶所讀取之平均高度值，可精確地計算出棘輪套筒頂端肩部緣與珠碗蓋下方端緣間應墊設之墊片高度值，使花穀之兩珠碗結構具有適宜之配合鬆緊度，以提昇其樞轉滑移之平穩順暢度，同時提高組裝效率，並延長使用壽命，俾使整體具極佳之實用性者。

## 《創作目的》

緣此，本創作之主要目的乃在於提供一種自行車花穀之量測機構，其係將花穀適當安裝於量測機構上，再予以測量計算出花穀之棘輪套筒頂端肩部緣與珠碗蓋端緣間應墊設之墊片高度值，使其墊片安裝於花穀後，其上滾珠得受適當之抵頂壓接，俾可藉以提昇花穀樞轉滑動之平穩順暢度，同時提高組裝效率，並延長使用壽命者。

本創作之次要目的乃在於提供一種自行車花穀之量測機構，其係利用花穀之棘輪套筒與外套筒相互壓抵滾珠時



### 五、創作說明 (3)

之狀態作為量測之起始位置，透過棘輪套筒頂端肩部緣與珠碗蓋間搭設一高度大於棘輪套筒螺牙段之標準墊片，再利用量測機構之迫緊件向下壓掣珠碗蓋，使珠碗蓋、標準墊片、棘輪套筒、定位軸心整體向下移動，至珠碗蓋與其對應滾珠相互抵接之狀態作為量測之終點位置，以精確讀取並計算出其平均移動量，再將標準墊片之高度值扣除此一平均移動量，即可獲取花穀所需搭設墊片之高度值，故墊片高度之數據可輕易準確取得者。

#### 《詳細說明》

為使審查委員對本創作能進一步的瞭解，以下茲舉一較佳實施例，並配合圖示、圖號，將本創作之構成內容及其所達成的功效詳細說明如后：

#### 《圖面之簡單說明》

第一圖係為本創作量測機構之局部立體分解圖。

第二圖係為本創作量測機構之平面側視圖。

第三圖(A、B)係為本創作量測機構之量測動作圖。

第四圖係為本創作周轉量測值之分佈曲線圖。

第五圖係為本創作花穀之立體分解圖。

第六圖係為本創作花穀之側視剖面圖。

第七圖係為習用花穀之側視剖面圖。

#### 《圖號說明》



## 五、創作說明 (4)

|               |      |               |      |
|---------------|------|---------------|------|
| A . . . . .   | 量測機構 | B . . . . .   | 墊片   |
| 10 . . . . .  | 機座   | 11 . . . . .  | 機檯   |
| 20 . . . . .  | 定位軸心 |               |      |
| 21 . . . . .  | 定位環緣 | 22 . . . . .  | 彈性元件 |
| 30 . . . . .  | 托盤   | 40 . . . . .  | 標準墊片 |
| 50 . . . . .  | 迫緊件  | 60 . . . . .  | 量錶   |
| 70 . . . . .  | 花穀   |               |      |
| 71 . . . . .  | 棘輪套筒 | 711 . . . . . | 螺牙段  |
| 712 . . . . . | 肩部緣  | 72 . . . . .  | 外套筒  |
| 73 . . . . .  | 滾珠   | 74 . . . . .  | 珠碗蓋  |
| 75 . . . . .  | 滾珠   |               |      |
| 80 . . . . .  | 花穀   |               |      |
| 81 . . . . .  | 外套筒  | 811 . . . . . | 穿伸孔  |
| 812 . . . . . | 珠槽   | 82 . . . . .  | 棘輪套筒 |
| 821 . . . . . | 珠槽   | 83 . . . . .  | 珠碗蓋  |
| 831 . . . . . | 珠槽   | 84 . . . . .  | 滾珠   |

## 《具體實施例說明》

請參閱第一圖所示，係為本創作量測機構之局部立體分解圖，本創作係利用一量測機構A，使其可測量計算出花穀70之珠碗蓋74與棘輪套筒71適當鎖固時，其端緣間之問隙尺寸，以作為一墊片B高度設計時之尺寸依據，再令該墊片B搭設於此問隙中，即可使滾珠73、75受到適當之迫緊，俾使花穀70具有平穩順暢之樞轉機能者；

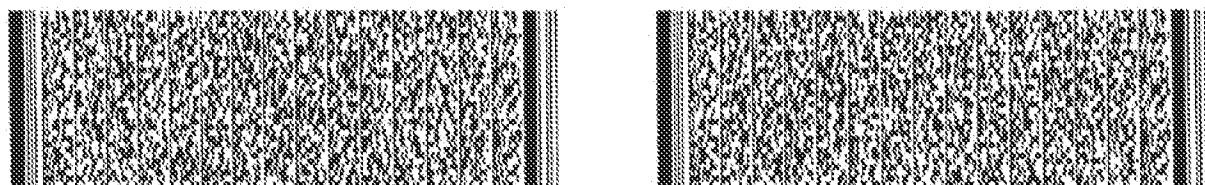


## 五、創作說明 (5)

其中，該量測機構A係由一機座10之機台11上搭設一定位軸心20、一托盤30、一標準墊片40、一迫緊件50及一量錶60所組成(請配合參閱第二圖所示)；其中定位軸心20係供花穀70棘輪套筒71套設，並設有一定位環緣21供其抵頂定位，而定位軸心20底端部則搭設一彈性元件22；該托盤30係位於定位軸心20頂端部，可供花穀之外套筒72一端及其上滾珠73定位；該標準墊片40係可為中空環體狀，且高度大於棘輪套筒71之螺牙段711高度，使其恰可套設於棘輪套筒71之頂端肩部緣712；該迫緊件50係位於托盤30頂端部，並可向下壓掣抵頂珠碗蓋74，使珠碗蓋74得透過標準墊片40抵頂棘輪套筒71、定位軸心20，同時利用定位軸心20底部彈性元件22之受力壓縮，使整體得以向下位移至珠碗蓋74與外套筒72相對端滾珠75相互抵頂為止，此時定位軸心20之定位環緣21底端部係搭設有一量錶60，故恰可量測出其移動距離者；藉此，將標準墊片40之高度值扣除量錶60之量測值，係可求得所需墊片B之高度尺寸，俾使該花穀70搭設墊片B後(請配合參閱第五、六圖所示)，可產生一較佳之樞轉功效者。

其次，上述定位軸心20底端部搭設之彈性元件22係可為一彈性壓缸或彈簧等結構型態，使定位軸心20受壓後，可對定位軸心20之定位環緣21產生一迫緊作用者。

請參閱第三圖(A、B)所示，係為本創作量測機構之量測動作圖，本創作之量測機構A安裝花穀70時，係先將花穀70之棘輪套筒71及外套筒72分別套設定位於定位軸心20



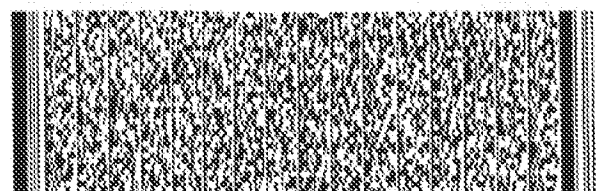
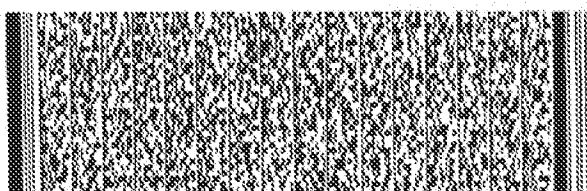
## 五、創作說明 (6)

之定位環緣21及托盤30上，並使外筒套72與棘輪套筒71恰可相互抵壓下方滾珠73，再將量錶60之探針架設抵頂於定位環緣21底端部，之後，再將標準墊片40套設於棘輪套筒71頂端肩部緣712，復搭設珠碗蓋74，再使迫緊件50向下壓掣，並依序透過珠碗蓋74、標準墊片40、棘輪套筒71及定位軸心20，以壓縮彈性元件22，進而使整體構件連動位移至珠碗蓋74與上方滾珠75相互抵頂為止，復由量錶60讀取其位移量，此時再轉動定位軸心20一圈，即可求取其轉動間各量測值之平均值(請配合參閱第四圖所示)；值得注意的是，該標準墊片40之高度值減去平均值後之數據，係代表珠碗蓋74抵頂滾珠75時，該珠碗蓋74下方端緣與棘輪套筒71頂端肩部緣712之間隙值，因此，若於此間隙中安裝一相等尺寸之墊片B，即可使珠碗蓋74鎖固抵頂墊片B之同時，珠碗蓋74與上方滾珠75、棘輪套筒71與下方滾珠73亦達最佳之抵頂狀態，以避免發生習用鎖固過程中，經常發生過鬆與過緊之現象，故藉由該測試機構A之所求得之墊片B高度值，俾使其搭設於花穀70結構後，可使其運轉更加平穩順暢，以提昇其使用品質，同時提高組裝效率，並延長使用壽命者。

茲由以上說明得知，本創作誠具有如下之諸多優點：

1. 量測精確：由於本創作之量測機構係利用定位及適當掣動花穀各部構件，再透過標準墊片、量錶之搭配，故可達到準確之測量功效，並可提高組裝效率者。

2. 樞轉平穩：由於本創作經量測計算所得之墊片高



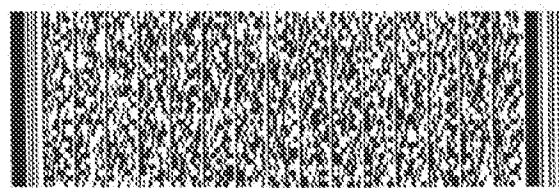
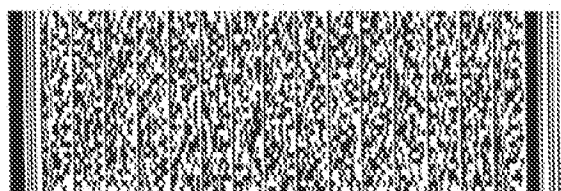
## 五、創作說明 (7)

度值，係代表花殼真實組裝中，棘輪套筒頂端肩部緣與珠碗蓋端緣之間隙尺寸，故其安裝於花殼後，可使花殼之滾珠得受最適當之抵頂力作用，俾可確保花殼具有平穩順暢之滑轉功效者。

3. 延長壽命：如上所述，由於一般花殼結構搭設本創作量測機構所求得之墊片後，可使珠碗結構具有平順之樞轉，故可藉以提昇樞轉品質，進而延長相關構件之使用壽命者。

綜上所述，本創作「自行車花殼之量測機構」，係提供一種可定位及壓掣花殼棘輪套筒、外套筒及珠碗蓋之測量裝置，並透過一標準墊片之預先墊置及量測機構量錶所讀取之平均高度值，可精確地計算出棘輪套筒頂端肩部緣與珠碗蓋下方端緣間應墊設之墊片高度值，使花殼之兩珠碗結構具有適宜之配合鬆緊度，以提昇其樞轉滑移之平穩順暢度，同時提高組裝效率，並延長使用壽命，俾使整體極具產業之實用性及成本效益者，且其構成結構又未曾見於諸書刊或公開使用，誠符合新型專利申請要件，懇請鈞局明鑑，早日准予專利，至為感禱。

需陳明者，以上所述乃是本創作之具體實施例及所運用之技術原理，若依本創作之構想所作之改變，其所產生之功能作用仍未超出說明書及圖式所涵蓋之精神時，均應在本創作之範圍內，合予陳明。



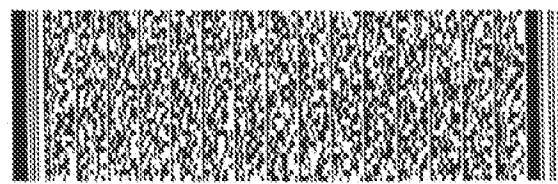
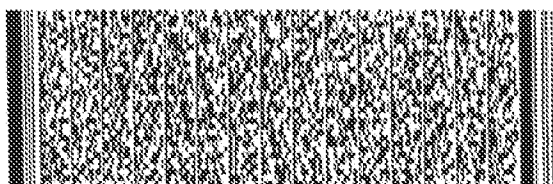
## 六、申請專利範圍

1. 一種自行車花穀之量測機構，其係由一機座之機台上搭設一定位軸心、一托盤、一標準墊片、一迫緊件及一量錶所組成；其中定位軸心係供花穀之棘輪套筒套設定位，並於底端部搭設一彈性元件，可於壓縮時產生一回復迫緊力；該托盤係位於定位軸心頂端部，可供花穀之外套筒底端及其上滾珠定位；該標準墊片之高度係大於棘輪套筒之螺牙段高度，並恰可套設於棘輪套筒之頂端肩部緣；該迫緊件係位於托盤頂端部，並可向下壓掣抵頂珠碗蓋，使珠碗蓋得依序透過標準墊片、棘輪套筒、定位軸心，以壓縮彈性元件，進而使整體構件得向下位移；該量錶係搭設於定位環緣底端部，並可測得定位軸心之位移量至珠碗蓋與外套筒上方滾珠相互抵頂為止，並求取其平均值，再將標準墊片之高度值減去平均值後，即可求取所欲得之墊片高度者；

藉由以上量測機構所求得之墊片高度值，俾使該花穀之棘輪套筒一端肩部緣與珠碗蓋間，搭設此一高度之墊片後，可增加花穀珠碗結構運轉之平穩及順暢度，同時提高組裝效率，延長樞轉壽命者。

2. 依據申請專利範圍第1項所述之自行車花穀之量測機構，其中，該彈性元件係可為一彈性壓缸或彈簧等結構型態，使定位軸心受壓後，可對其定位環緣底端部產生一適當迫緊作用者。

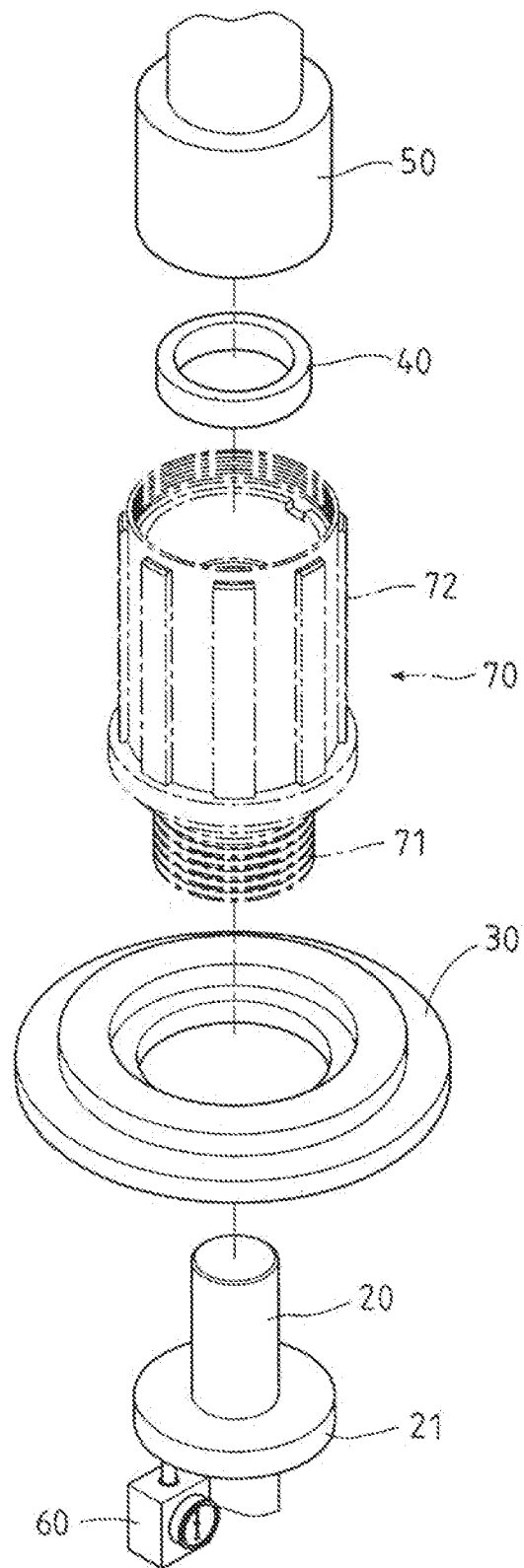
3. 依據申請專利範圍第1項所述之自行車花穀之量測機構，其中，該定位軸心之外徑緣適當處係可凸設形成



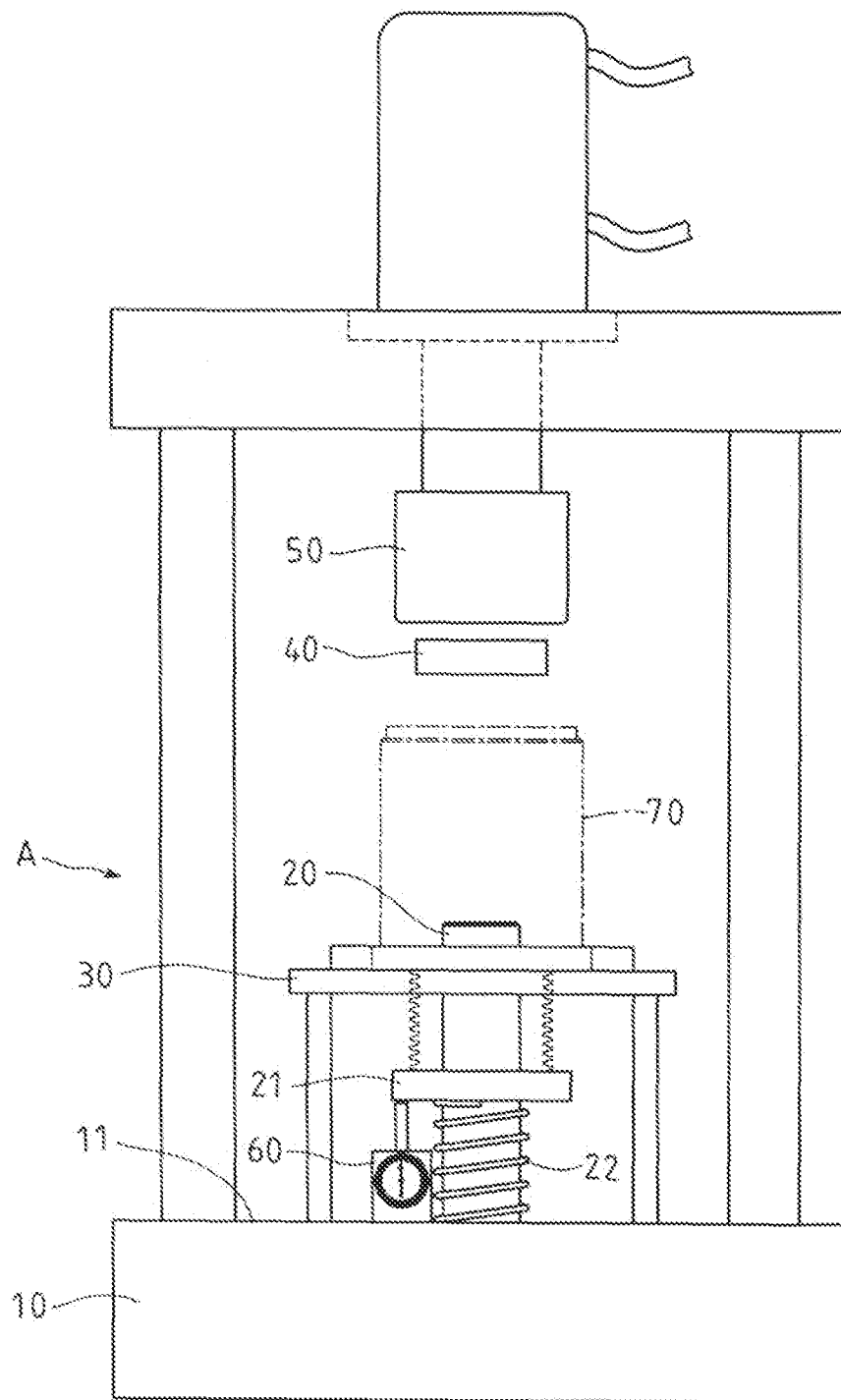
六、申請專利範圍

一定位環緣，使其上下端面可分別供棘輪套筒及量錶搭設抵頂者。

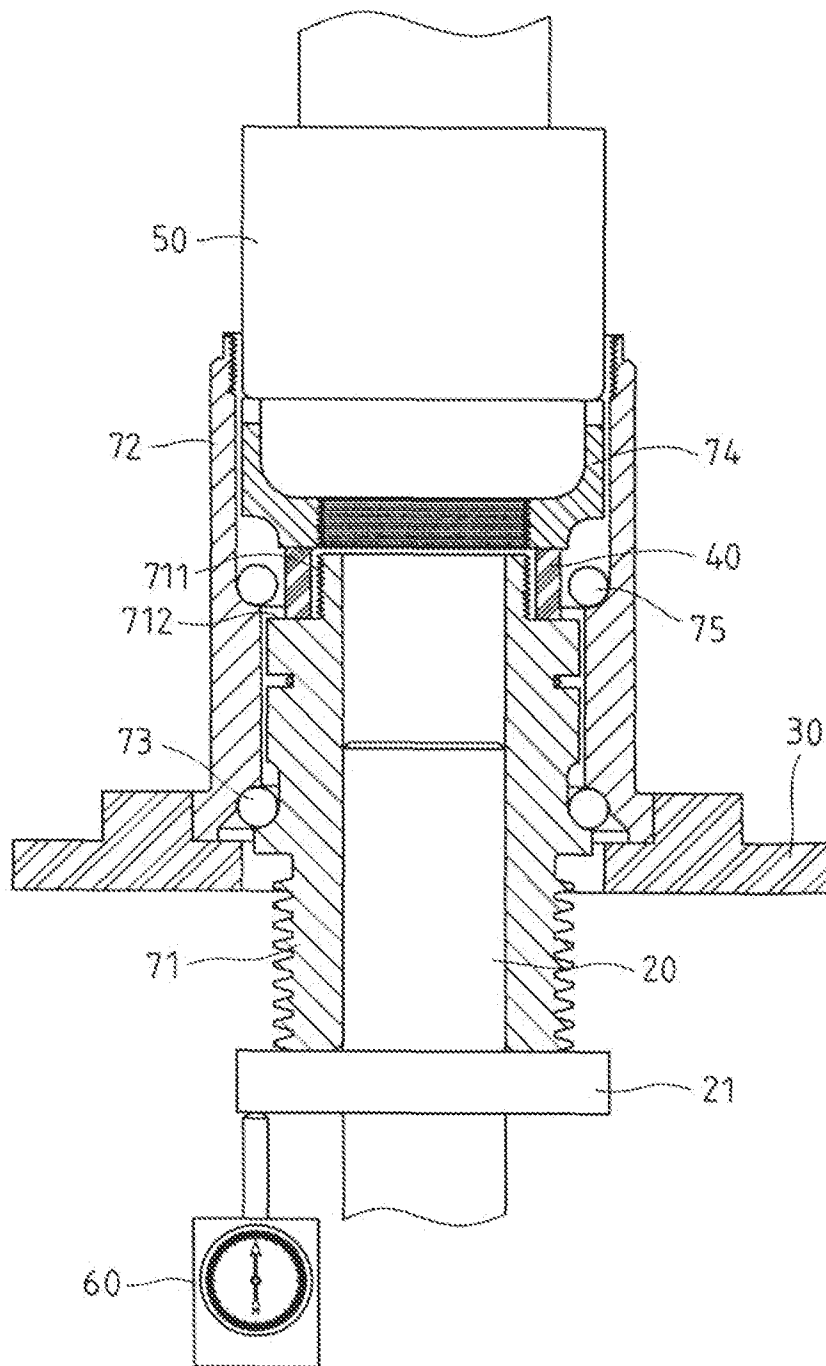




第一圖

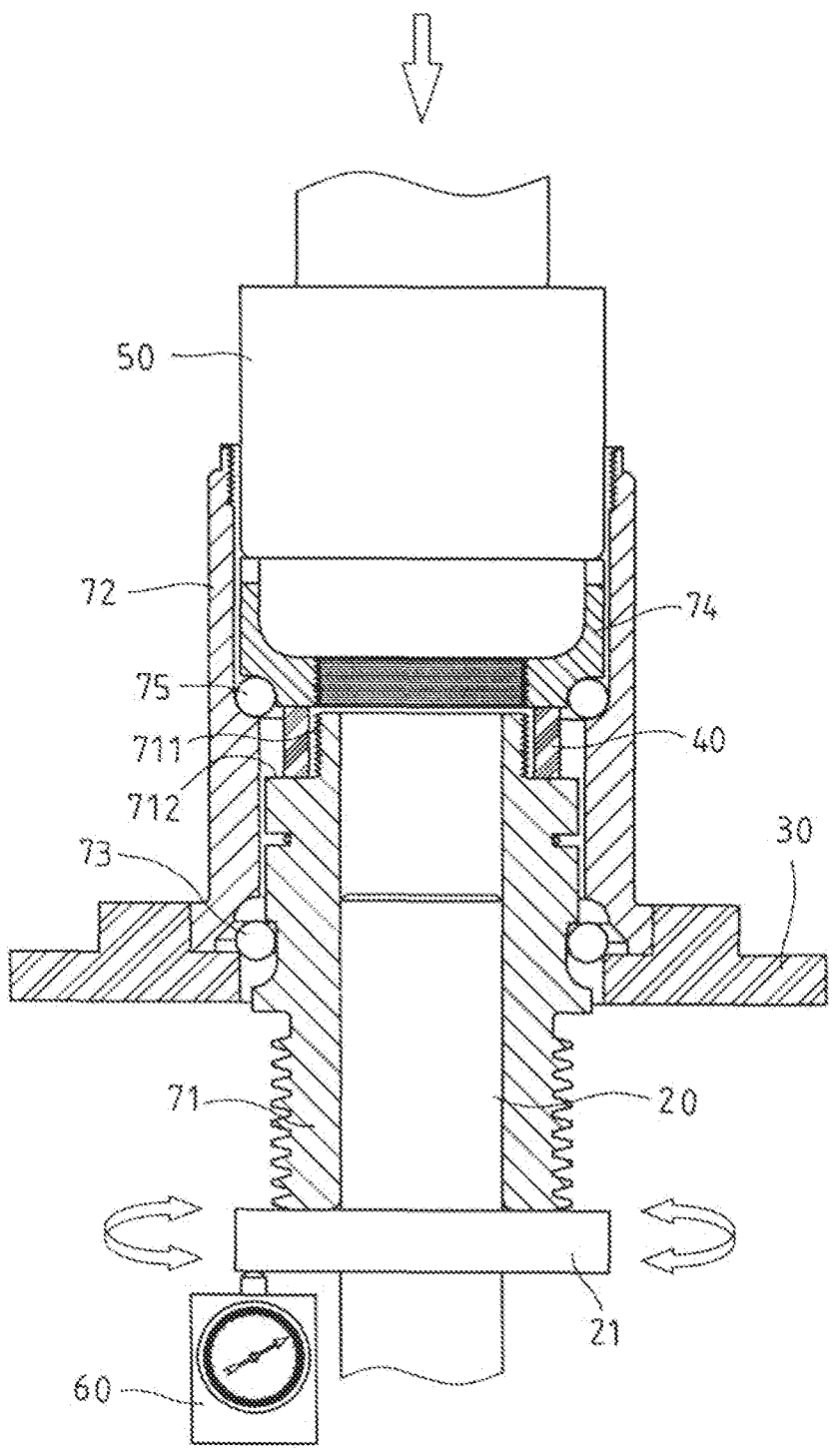


第 二 圖



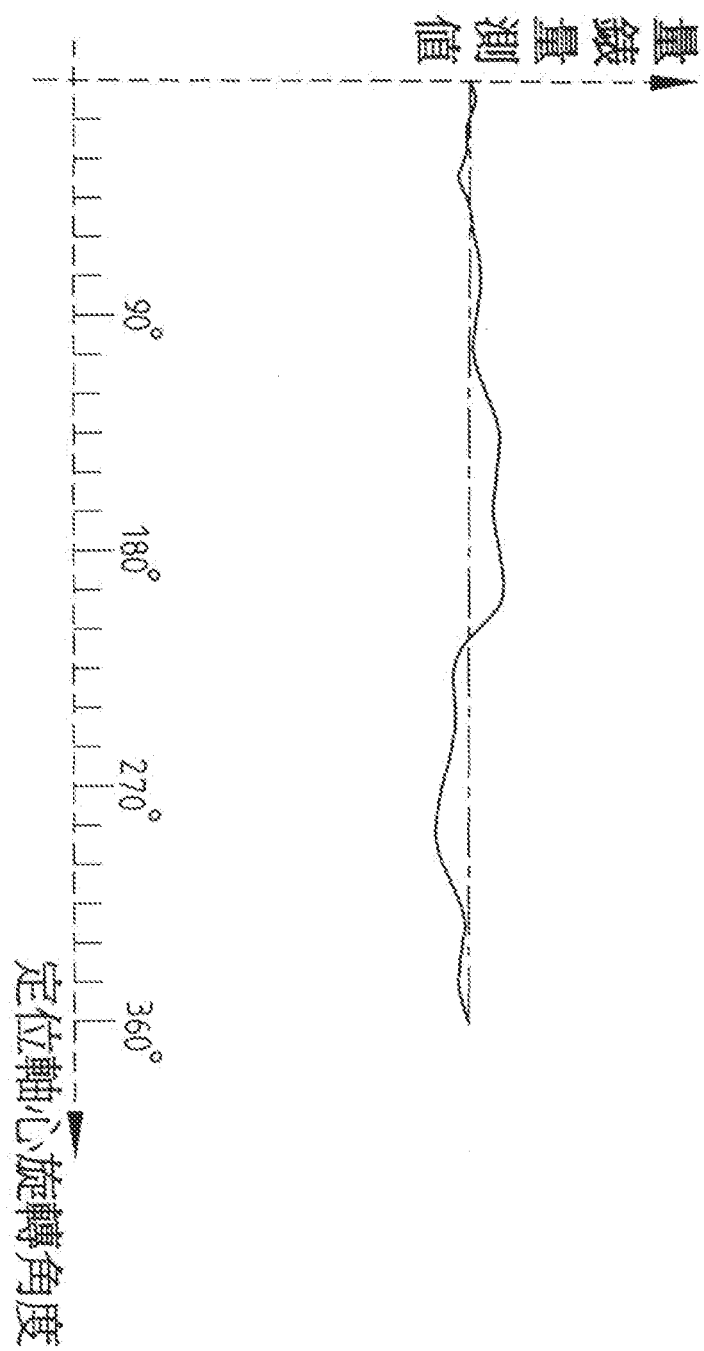
(A)

第三圖

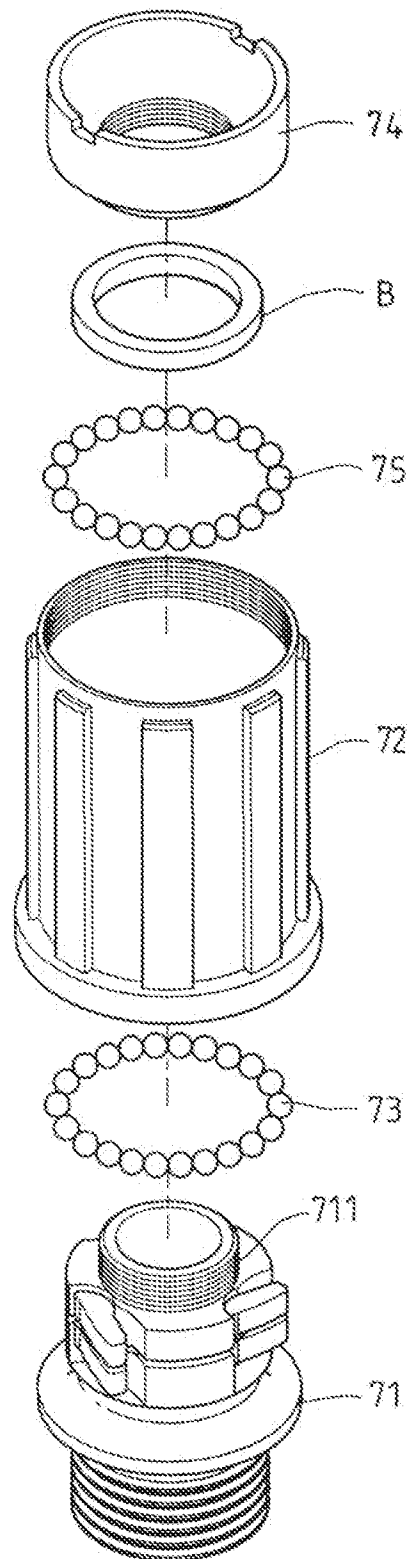


(B)

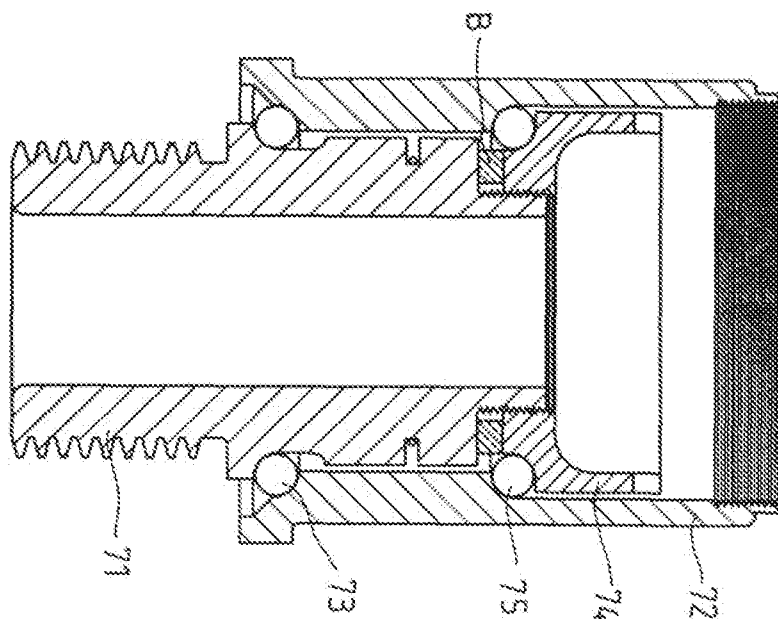
第三圖



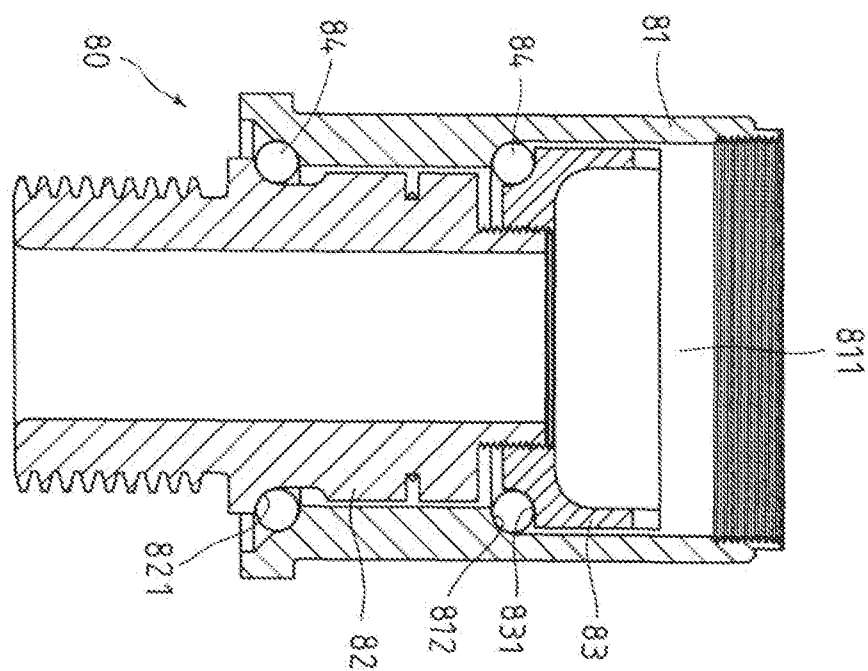
第四圖



第五圖



第六圖



第七圖

## Electronic Acknowledgement Receipt

|                                             |                                                                                 |
|---------------------------------------------|---------------------------------------------------------------------------------|
| <b>EFS ID:</b>                              | 21100711                                                                        |
| <b>Application Number:</b>                  | 14488106                                                                        |
| <b>International Application Number:</b>    |                                                                                 |
| <b>Confirmation Number:</b>                 | 2225                                                                            |
| <b>Title of Invention:</b>                  | PHOTOGRAPHING OPTICAL LENS ASSEMBLY, IMAGE CAPTURING UNIT AND ELECTRONIC DEVICE |
| <b>First Named Inventor/Applicant Name:</b> | Hsin-Hsuan HUANG                                                                |
| <b>Customer Number:</b>                     | 24728                                                                           |
| <b>Filer:</b>                               | Tim Tingkang Xia/Danielle Schubach                                              |
| <b>Filer Authorized By:</b>                 | Tim Tingkang Xia                                                                |
| <b>Attorney Docket Number:</b>              | 15042-101133                                                                    |
| <b>Receipt Date:</b>                        | 31-DEC-2014                                                                     |
| <b>Filing Date:</b>                         | 16-SEP-2014                                                                     |
| <b>Time Stamp:</b>                          | 14:50:33                                                                        |
| <b>Application Type:</b>                    | Utility under 35 USC 111(a)                                                     |

### Payment information:

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### File Listing:

| Document Number | Document Description                               | File Name             | File Size(Bytes)/<br>Message Digest                | Multi Part /.zip | Pages (if appl.) |
|-----------------|----------------------------------------------------|-----------------------|----------------------------------------------------|------------------|------------------|
| 1               | Information Disclosure Statement (IDS) Form (SB08) | 15042-1001133_IDS.pdf | 612200<br>b489de84638910dae8a292e85ca19c52aa216a85 | no               | 4                |

### Warnings:

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| 2 | Foreign Reference | CN203941337U.pdf | 5296715<br>2bfafcd9fdd934f3f211a3f741c26ed783a9ea4 | no | 37 |
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**Warnings:**

**Information:**

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| 3 | Foreign Reference | CN203965708U.pdf | 6351125<br>15b09cc67e1bec0e46d3e3119771b9173bf42786 | no | 60 |
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**Warnings:**

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| 4 | Foreign Reference | TW_M490015U.pdf | 2834522<br>e6f64fc3e1a58b10e6f5e611634364b43e473d7 | no | 21 |
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**Warnings:**

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| <b>Total Files Size (in bytes):</b> |  |  | 15094562 |  |  |
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**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.

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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.

## TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B) to identify the application to which the Power of Attorney is directed, in accordance with 37 CFR 1.5, unless the application number and filing date are identified in the Power of Attorney by Applicant form. If neither form PTO/AIA/82A nor form PTO/AIA/82B identifies the application to which the Power of Attorney is directed, the Power of Attorney will not be recognized in the application.

|                        |                                                                                 |
|------------------------|---------------------------------------------------------------------------------|
| Application Number     | 14/488,106                                                                      |
| Filing Date            | September 16, 2014                                                              |
| First Named Inventor   | Hsin-Hsuan Huang                                                                |
| Title                  | PHOTOGRAPHING OPTICAL LENS ASSEMBLY, IMAGE CAPTURING UNIT AND ELECTRONIC DEVICE |
| Art Unit               | 2872                                                                            |
| Examiner Name          | n/a                                                                             |
| Attorney Docket Number | 0115042.10018                                                                   |

### SIGNATURE of Applicant or Patent Practitioner

|                                                    |                    |                     |       |
|----------------------------------------------------|--------------------|---------------------|-------|
| Signature                                          | /Tim Tingkang Xia/ | Date (Optional)     |       |
| Name                                               | Tim Tingkang Xia   | Registration Number | 45242 |
| Title (if Applicant is a juristic entity)          |                    |                     |       |
| Applicant Name (if Applicant is a juristic entity) |                    |                     |       |

**NOTE:** This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.



\*Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.131, 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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I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

| Application Number | Filing Date |
|--------------------|-------------|
|                    |             |

(Note: The boxes above may be left blank if information is provided on form PTO/AIA/82A.)

- ☒ I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above:
- OR
- ☐ I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

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- OR

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| Firm or Individual Name |  |       |  |     |
| Address                 |  |       |  |     |
| City                    |  | State |  | Zip |
| Country                 |  |       |  |     |
| Telephone               |  | Email |  |     |

I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

- ☐ Inventor or Joint Inventor (title not required below)
- ☐ Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)
- ☒ Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)
- ☐ 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) (provide signer's title if applicant is a juristic entity)

### SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

|           |                        |                 |  |
|-----------|------------------------|-----------------|--|
| Signature | <i>Chun-Shan, Chen</i> | Date (Optional) |  |
| Name      | Chun-Shan CHEN         |                 |  |
| Title     | Manager                |                 |  |

**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. If more than one applicant, use multiple forms.

☒ Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.131, 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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|                                                                                                     |                        |                  |            |
|-----------------------------------------------------------------------------------------------------|------------------------|------------------|------------|
| <b>INFORMATION DISCLOSURE<br/>STATEMENT BY APPLICANT</b><br>( Not for submission under 37 CFR 1.99) | Application Number     |                  | 14488106   |
|                                                                                                     | Filing Date            |                  | 2014-09-16 |
|                                                                                                     | First Named Inventor   | Hsin-Hsuan Huang |            |
|                                                                                                     | Art Unit               | 2827             |            |
|                                                                                                     | Examiner Name          | N/A              |            |
|                                                                                                     | Attorney Docket Number | 0115042.10018    |            |

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| <b>INFORMATION DISCLOSURE<br/>STATEMENT BY APPLICANT</b><br>( Not for submission under 37 CFR 1.99) | Application Number     |                  | 14488106   |  |
|                                                                                                     | Filing Date            |                  | 2014-09-16 |  |
|                                                                                                     | First Named Inventor   | Hsin-Hsuan Huang |            |  |
|                                                                                                     | Art Unit               | 2827             |            |  |
|                                                                                                     | Examiner Name          | N/A              |            |  |
|                                                                                                     | Attorney Docket Number | 0115042.10018    |            |  |

|   |             |    |            |                  |  |
|---|-------------|----|------------|------------------|--|
| 6 | 20150198791 | A1 | 2015-07-16 | KUBOTA et al.    |  |
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| Filing Date            | 2014-09-16       |
| First Named Inventor   | Hsin-Hsuan Huang |
| Art Unit               | 2827             |
| Examiner Name          | N/A              |
| Attorney Docket Number | 0115042.10018    |

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| Art Unit               | 2827             |
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| Attorney Docket Number | 0115042.10018    |

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A compact camera capable of well correcting aberration, in order from an object side to an image side, includes a first lens group, a second lens group with positive refractive power and a third lens group with negative refractive power. The first lens group includes a first lens element with positive refractive power, a second lens element with negative refractive power and a third lens element with negative refractive power. The second lens group includes a fourth lens element and a fifth lens element. The third lens group includes a sixth lens element and a seventh lens element. Abbe numbers of the first through third lens elements are  $\nu d1$ ,  $\nu d2$  and  $\nu d3$ , respectively, and the following conditions are satisfied:  $40 < \nu d1 < 75$ ,  $20 < \nu d2 < 35$  and  $20 < \nu d3 < 35$ .



## (12) 实用新型专利

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公司 11243

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G02B 13/00(2006.01)

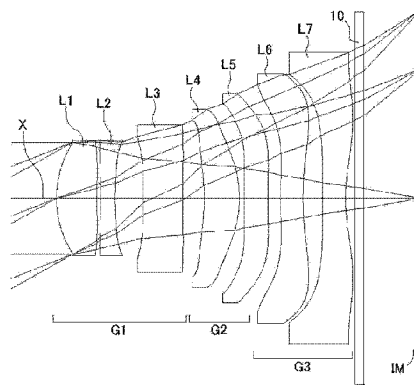
权利要求书2页 说明书26页 附图18页

(54) 实用新型名称

摄像镜头

(57) 摘要

本实用新型提供一种良好地修正各像差的小型摄像镜头。从物体侧开始依次配置正的第一透镜组(G1)、正的第二透镜组(G2)、负的第三透镜组(G3)来构成摄像镜头。第一透镜组(G1)由正的第一透镜(L1)、负的第二透镜(L2)、负的第三透镜(L3)构成。第二透镜组(G2)由第四透镜(L4)和第五透镜(L5)构成,第三透镜组(G3)由第六透镜(L6)和第七透镜(L7)构成。在将第一透镜(L1)~第三透镜(L3)的阿贝数设为 $\nu d1$ 、 $\nu d2$ 以及 $\nu d3$ 时,该摄像镜头满足以下的各条件式: $40<\nu d1<75$ 、 $20<\nu d2<35$ 、 $20<\nu d3<35$ 。



1. 一种摄像镜头,其特征在于,

从物体侧向像面侧依次配置具有正的光焦度的第一透镜组、具有正的光焦度的第二透镜组、具有负的光焦度的第三透镜组而构成,

上述第一透镜组由具有正的光焦度的第一透镜、具有负的光焦度的第二透镜、具有负的光焦度的第三透镜构成,

上述第二透镜组由第四透镜以及第五透镜构成,

上述第三透镜组由第六透镜以及第七透镜构成,

在将上述第一透镜的阿贝数设为  $v_{d1}$ ,将上述第二透镜的阿贝数设为  $v_{d2}$ ,将上述第三透镜的阿贝数设为  $v_{d3}$  时,满足:

$40 < v_{d1} < 75$ 、

$20 < v_{d2} < 35$ 、

$20 < v_{d3} < 35$ 。

2. 根据权利要求 1 所述的摄像镜头,其特征在于,

上述第四透镜具有正的光焦度,

上述第五透镜具有负的光焦度,

在将上述第四透镜的阿贝数设为  $v_{d4}$ ,将上述第五透镜的阿贝数设为  $v_{d5}$  时,满足:

$40 < v_{d4} < 75$ 、

$20 < v_{d5} < 35$ 。

3. 根据权利要求 1 或 2 所述的摄像镜头,其特征在于,

在将上述第一透镜的焦距设为  $f_1$ ,将上述第二透镜以及上述第三透镜的合成焦距设为  $f_{23}$  时,满足:

$-4.0 < f_{23}/f_1 < -1.5$ 。

4. 根据权利要求 1 或 2 所述的摄像镜头,其特征在于,

在将上述第二透镜的焦距设为  $f_2$ ,将上述第三透镜的焦距设为  $f_3$  时,满足:

$0.1 < f_2/f_3 < 0.6$ 。

5. 根据权利要求 1 或 2 所述的摄像镜头,其特征在于,

在将整个镜头系统的焦距设为  $f$ ,将上述第一透镜的焦距设为  $f_1$  时,满足:

$0.5 < f_1/f < 2.0$ 。

6. 根据权利要求 1 或 2 所述的摄像镜头,其特征在于,

在将上述第四透镜以及上述第五透镜的合成焦距设为  $f_{45}$ ,将上述第六透镜以及上述第七透镜的合成焦距设为  $f_{67}$  时,满足:

$-6.0 < f_{45}/f_{67} < -1.5$ 。

7. 根据权利要求 1 或 2 所述的摄像镜头,其特征在于,

在将整个镜头系统的焦距设为  $f$ ,将上述第六透镜以及上述第七透镜的合成焦距设为  $f_{67}$  时,满足:

$-1.7 < f_{67}/f < -0.5$ 。

8. 根据权利要求 1 或 2 所述的摄像镜头,其特征在于,

在将上述第六透镜的阿贝数设为  $v_{d6}$ ,将上述第七透镜的阿贝数设为  $v_{d7}$  时,满足:

$40 < v_{d6} < 75$ 、

$40 < v d7 < 75$ 。

9. 根据权利要求 1 或 2 所述的摄像镜头,其特征在于,

上述第四透镜具有正的光焦度,

在将整个镜头系统的焦距设为  $f$ ,将上述第四透镜的焦距设为  $f4$  时,满足:

$1.0 < f4/f < 3.0$ 。

10. 根据权利要求 1 或 2 所述的摄像镜头,其特征在于,

上述第七透镜具有负的光焦度,

在将整个镜头系统的焦距设为  $f$ ,将上述第七透镜的焦距设为  $f7$  时,满足:

$-4.0 < f7/f < -0.8$ 。

11. 根据权利要求 1 或 2 所述的摄像镜头,其特征在于,

在将整个镜头系统的焦距设为  $f$ ,将上述第二透镜和上述第三透镜之间的光轴上的距离设为  $D23$  时,满足:

$0.03 < D23/f < 0.2$ 。

12. 根据权利要求 1 或 2 所述的摄像镜头,其特征在于,

在将整个镜头系统的焦距设为  $f$ ,将上述第三透镜和上述第四透镜之间的光轴上的距离设为  $D34$  时,满足:

$0.03 < D34/f < 0.2$ 。

## 摄像镜头

### 技术领域

[0001] 本实用新型涉及在 CCD 传感器、COMS 传感器等摄像元件上形成被摄体图像的摄像镜头,涉及适合于装入在便携电话机、便携信息终端等便携设备中内置的摄像机、数码静物相机、安防摄像机、车载摄像机、网络摄像机等比较小型的摄像机的摄像镜头。

### 背景技术

[0002] 近年来,代替以通话为主体的便携电话机,向便携电话机附加了便携信息终端(PDA)或个人计算机的功能的所谓的智能手机(smart phone)得到了普及。智能手机比便携电话机具有更高功能,因此在各种应用中利用通过摄像机拍摄所得的图像。

[0003] 一般,便携电话机、智能手机的产品群从面向初级者的产品到面向高级者的产品大多由各种规格的产品构成。其中,对于装入面向高级者开发出的产品的摄像镜头,要求还能够对应近年来高像素化的摄像元件的高分辨率的镜头结构。

[0004] 作为实现高分辨率的摄像镜头的方法之一,有增加构成摄像镜头的透镜的枚数的方法。但是,这样的透镜枚数的增加容易造成摄像镜头的大型化,不利于装入上述便携电话机、智能手机等的小型摄像机。因此,目前向尽量抑制透镜枚数的方向进行了摄像镜头的开发。但是,现今摄像元件的高像素化技术明显进步,与缩短光学全长(Total Track Length)相比,摄像镜头的开发的中心正在向实现高分辨率的镜头结构转移。例如,不是如以前那样将包含摄像镜头和摄像元件的摄像单元装入便携电话机、智能手机等的内部,而是安装到这些便携电话机、智能手机等上,由此出现了得到即使与数码静物相机相比也不逊色的图像的摄像单元。

[0005] 由 7 枚透镜构成的镜头结构,由于构成摄像镜头的透镜的枚数多,所以对于摄像镜头的小型化有若干不利,但设计上的自由度高,因此存在能够平衡良好地实现各像差的良好修正、摄像镜头的小型化的可能性。作为这样的 7 枚结构的摄像镜头,例如已知专利文献 1 所记载的摄像镜头。

[0006] 专利文献 1 所记载的摄像镜头,从物体侧开始依次配置双凸形状的第一透镜、与该第一透镜接合的双凹形状的第二透镜、将凸面朝向物体侧的弯月形状的负的第三透镜、将凹面朝向物体侧的弯月形状的正的第四透镜、将凸面朝向物体侧的负的第五透镜、双凸形状的第六透镜、双凹形状的第七透镜而构成。在专利文献 1 的摄像镜头中,通过将由第一透镜至第四透镜的透镜构成的第一透镜组的焦距与由第五透镜至第七透镜的透镜构成的第二透镜组的焦距之比抑制在一定的范围内,来实现摄像镜头的小型化和各像差的良好修正。

[0007] 上述专利文献 1 所记载的摄像镜头虽然小型,但像面的修正不充分,特别是畸变比较大,因此在实现高性能的摄像镜头方面自然产生限制。在上述专利文献 1 所记载的镜头结构中,难以在实现摄像镜头的小型化的同时实现良好的像差修正。

[0008] 此外,这样的问题并不是装入便携电话机、智能手机中的摄像镜头所特有的问题,在装入数码静物相机、便携信息终端、安防摄像机、车载摄像机、网络摄像机等比较小型的

摄像机的摄像镜头中也是共通的问题。

[0009] 现有技术文献

[0010] 专利文献

[0011] 专利文献 1 : 日本特开 2012-155223 号公报

## 实用新型内容

[0012] 本实用新型的目的在于,提供一种能够实现摄像镜头的小型化和良好的像差修正的兼顾的摄像镜头。

[0013] 为了达成上述目的,本实用新型的摄像镜头从物体侧向像面侧依次配置具有正的光焦度的第一透镜组、具有正的光焦度的第二透镜组、具有负的光焦度的第三透镜组而构成。第一透镜组由具有正的光焦度的第一透镜、具有负的光焦度的第二透镜、具有负的光焦度的第三透镜构成。第二透镜组由第四透镜和第五透镜构成,第三透镜组由第六透镜和第七透镜构成。另外,在将第一透镜的阿贝数设为  $v_{d1}$ ,将第二透镜的阿贝数设为  $v_{d2}$ ,将第三透镜的阿贝数设为  $v_{d3}$  时,本实用新型的摄像镜头满足以下的条件式 (1) ~ (3)。

[0014]  $40 < v_{d1} < 75$  (1)

[0015]  $20 < v_{d2} < 35$  (2)

[0016]  $20 < v_{d3} < 35$  (3)

[0017] 本实用新型的摄像镜头为从物体侧开始依次配置具有正的光焦度的第一透镜组、同样具有正的光焦度的第二透镜组、具有负的光焦度的第三透镜组的结构,各透镜组的光焦度的排列从物体侧开始为“正、正、负”。一般从物体侧开始依次配置具有正的光焦度的透镜组和具有负的光焦度的透镜组来进行色像差的修正。在这样的镜头结构中,为了实现摄像镜头的小型化,需要增强配置在物体侧的正的透镜组的光焦度。但是,若具有正的光焦度的透镜组的光焦度增强,则大多难以进行色像差的良好修正。

[0018] 在本实用新型的摄像镜头中,通过第一透镜组和第二透镜组分担整个镜头系统的正的光焦度。因此,与具有正的光焦度的透镜组为一个的情况相比,能够将构成各透镜组的正透镜的光焦度抑制得较弱。由此,根据本实用新型的摄像镜头,良好地修正各像差中特别是色像差,能够得到高分辨率的摄像镜头所需要的良好的成像性能。另外,在本实用新型的摄像镜头中,第三透镜组具有负的光焦度,因此适当地实现了摄像镜头的小型化。

[0019] 上述第一透镜组由光焦度的排列为正、负、负的 3 枚透镜构成。这 3 枚透镜分别由满足条件式 (1) ~ (3) 的透镜材料形成,第一透镜和第二以及第三透镜为低色散的材料和高色散的材料组合。通过这样的各透镜的光焦度的排列和阿贝数的排列,在第一透镜组中适当地抑制色像差的产生,并且良好地修正所产生的色像差。此外,在本实用新型的摄像镜头中,由第二透镜和第三透镜 2 枚透镜分担负的光焦度,因此第二透镜和第三透镜各自的光焦度变得比较弱。通过这样的具有比较弱的负的光焦度的 2 枚透镜阶段性地修正各像差,因此与在第一透镜的像面侧配置了 1 枚负的透镜的镜头结构相比,更良好地修正了色像差。

[0020] 在上述结构的摄像镜头中,第四透镜具有正的光焦度,第五透镜具有负的光焦度,并且在将第四透镜的阿贝数设为  $v_{d4}$ ,将第五透镜的阿贝数设为  $v_{d5}$  时,优选满足以下的条件式 (4) 和 (5)。

[0021]  $40 < v_d4 < 75$  (4)

[0022]  $20 < v_d5 < 35$  (5)

[0023] 在本实用新型的摄像镜头中,由正负 2 枚透镜构成第二透镜组,并且由低色散的材料形成的透镜和由高色散的材料形成的透镜的组合来构成,以便满足条件式 (4) 和 (5),由此更良好地修正在第一透镜组中产生的各像差中特别是色像差。一般为了实现高分辨率的摄像镜头,需要良好地修正各像差中特别是色像差。根据本实用新型的摄像镜头,通过第一透镜组到第三透镜组的各透镜组的光焦度的排列、构成第一透镜组的 3 枚透镜的光焦度的排列以及阿贝数的排列、构成第二透镜组的 2 枚透镜的光焦度的排列和阿贝数的排列,与现有的摄像镜头相比更良好地修正色像差。

[0024] 在上述结构的摄像镜头中,优选第七透镜形成为具有负的光焦度,并且随着朝向透镜周边部正的光焦度变强的形状。

[0025] 根据第七透镜的这样的形状,不只是轴上的色像差,还良好地修正轴外的倍率色像差。另外,如公知的那样,在 CCD 传感器、CMOS 传感器等摄像元件中,预先确定了能够取入传感器的光线的入射角度的范围、即所谓的主光线角度 (CRA:Chief Ray Angle)。通过第七透镜的上述那样的透镜形状,将从摄像镜头出射的光线向像面的入射角度适当地抑制在 CRA 的范围内。由此,适当地抑制图像的周边部变暗的现象即阴影 (shading) 的发生。

[0026] 在上述结构的摄像镜头中,在将第一透镜的焦距设为  $f1$ ,将第二透镜和第三透镜的合成焦距设为  $f23$  时,优选满足以下的条件式 (6)。

[0027]  $-4.0 < f23/f1 < -1.5$  (6)

[0028] 条件式 (6) 是用于在实现摄像镜头的小型化的同时,平衡良好地将像散、像面弯曲和色像差抑制在良好的范围内的条件。若超过上限值“-1.5”,则第二透镜和第三透镜的负的光焦度相对于第一透镜的正的光焦度相对增强,因此对色像差的修正有利。但是另一方面,后焦距 (back focal length) 变长,因此难以进行摄像镜头的小型化。另外,像散的弧矢像面和子午像面都向像面侧 (正方向) 弯曲,难以修正像散,并且像面弯曲增大,因此难以得到良好的成像性能。另一方面,若低于下限值“-4.0”,则有利于摄像镜头的小型化,但后焦距变短,难以确保用于配置红外线截止滤光片等插入物的空间。另外,成像面向物体侧弯曲,因此像面弯曲增大,难以得到良好的成像性能。

[0029] 在上述结构的摄像镜头中,在将第二透镜的焦距设为  $f2$ ,将第三透镜的焦距设为  $f3$  时,优选满足以下的条件式 (7)。

[0030]  $0.1 < f2/f3 < 0.6$  (7)

[0031] 条件式 (7) 是用于良好地修正像散和像面弯曲的条件。若超过上限值“0.6”,则在第一透镜组中,接近正的第一透镜的第二透镜的负的光焦度相对地减弱,因此,像散中的子午像面向物体侧 (负方向) 弯曲而像散差增大,难以修正像散。另外,成像面向负方向弯曲,因此难以得到良好的成像性能。另一方面,若低于下限值“0.1”,则像散中的子午像面向正方向弯曲,像散差还是增大,难以修正像散。另外,成像面向正方向弯曲,因此在该情况下也难以得到良好的成像性能。

[0032] 在上述结构的摄像镜头中,在将整个镜头系统的焦距设为  $f$ ,将第一透镜的焦距设为  $f1$  时,优选满足以下的条件式 (8)。

[0033]  $0.5 < f1/f < 2.0$  (8)

[0034] 条件式 (8) 是用于在实现摄像镜头的小型化的同时,良好地修正像散、像面弯曲以及畸变的条件。另外,条件式 (8) 也是用于将从摄像镜头出射的光线向像面的入射角度抑制在 CRA 的范围内的条件。若超过上限值“2.0”,则第一透镜的正的光焦度相对于整个镜头系统的光焦度变弱,因此,正的第二透镜组的光焦度相对增强。因此,容易将从摄像镜头出射的光线向像面的入射角度抑制在 CRA 的范围内,但像散中的弧矢像面向负方向弯曲,并且像面弯曲变得修正不足(成像面向负方向弯曲),难以得到良好的成像性能。另一方面,若低于下限值“0.5”,则对摄像镜头的小型化有利,但难以确保后焦距。另外,难以将从摄像镜头出射的光线向像面的入射角度抑制在 CRA 的范围内。同时,在该情况下正的畸变增大,因此难以得到良好的成像性能。

[0035] 在上述结构的摄像镜头中,在将第四透镜和第五透镜的合成焦距设为  $f_{45}$ ,将第六透镜和第七透镜的合成焦距设为  $f_{67}$  时,优选满足以下的条件式 (9)。

$$[0036] \quad -6.0 < f_{45}/f_{67} < -1.5 \quad (9)$$

[0037] 条件式 (9) 是用于在实现摄像镜头的小型化的同时,将畸变、色像差和像面弯曲分别抑制在良好的范围内的条件。若超过上限值“-1.5”,则第三透镜组的负的光焦度相对于第二透镜组的正的光焦度相对减弱,因此需要减弱第一透镜组所具有的正的光焦度。若第一透镜组的光焦度减弱,则容易确保后焦距,但难以进行摄像镜头的小型化。另外,负的畸变和倍率色像差增大,并且像面弯曲变得修正不足,难以得到良好的成像性能。另一方面,若低于下限值“-6.0”,则对色像差的修正、像面弯曲的修正有利,但正的畸变增大,因此难以得到良好的成像性能。

[0038] 在上述结构的摄像镜头中,在将整个镜头系统的焦距设为  $f$ ,将第六透镜和第七透镜的合成焦距设为  $f_{67}$  时,优选满足以下的条件式 (10)。

$$[0039] \quad -1.7 < f_{67}/f < -0.5 \quad (10)$$

[0040] 条件式 (10) 是用于在将从摄像镜头出射的光线向像面的入射角度抑制在 CRA 的范围内的同时,平衡良好地修正畸变、色像差以及像散的条件。若超过上限值“-0.5”,则第三透镜组的光焦度相对于整个镜头系统的光焦度相对增强。因此,在图像周边部倍率色像差增大,并且正的畸变增大,难以得到良好的成像性能。另外,难以将从摄像镜头出射的光线向像面的入射角度抑制在 CRA 的范围内。另一方面,若低于下限值“-1.7”,则有利于畸变的修正,但像散中的弧矢像面向物体侧弯曲,并且倍率色像差增大,因此难以得到良好的成像性能。

[0041] 在上述结构的摄像镜头中,在将第六透镜的阿贝数设为  $v_{d6}$ ,将第七透镜的阿贝数设为  $v_{d7}$  时,优选满足以下的条件式 (11) 和 (12)。

$$[0042] \quad 40 < v_{d6} < 75 \quad (11)$$

$$[0043] \quad 40 < v_{d7} < 75 \quad (12)$$

[0044] 第六透镜和第七透镜在摄像镜头中构成最接近像面侧的第三透镜组。由条件式 (11) 和条件式 (12) 所示的低色散的材料形成第六透镜和第七透镜,由此适当地抑制各透镜中的色散,良好地修正了各像差。

[0045] 在上述结构的摄像镜头中,第四透镜具有正的光焦度,在将整个镜头系统的焦距设为  $f$ ,将第四透镜的焦距设为  $f_4$  时,优选满足以下的条件式 (13)。

$$[0046] \quad 1.0 < f_4/f < 3.0 \quad (13)$$

[0047] 条件式 (13) 是用于在实现摄像镜头的小型化的同时,良好地修正轴外的彗差和畸变的条件。另外,条件式 (13) 也是用于将从摄像镜头出射的光线向像面的入射角度抑制在 CRA 的范围内的条件。若超过上限值“3.0”,则第四透镜的正的光焦度相对于整个镜头系统的光焦度变弱,因此,为了良好地修正各像差,需要相对地增强第一透镜组的正的光焦度。在该情况下,有利于摄像镜头的小型化,但难以确保后焦距。另外,正的畸变增大,并且容易在轴外光束的子午面产生内方彗差,因此难以得到良好的成像性能。另一方面,若低于下限值“1.0”,则容易将从摄像镜头出射的光线向像面的入射角度抑制在 CRA 的范围内,但难以进行摄像镜头的小型化。另外,容易在轴外光束的弧矢面和子午面产生彗差,难以得到良好的成像性能。

[0048] 在上述结构的摄像镜头中,第七透镜具有负的光焦度,在将整个镜头系统的焦距设为  $f$ ,将第七透镜的焦距设为  $f_7$  时,优选满足以下的条件式 (14)。

$$[0049] \quad -4.0 < f_7/f < -0.8 \quad (14)$$

[0050] 条件式 (14) 是用于在实现摄像镜头的小型化的同时,良好地修正色像差和像面弯曲的条件。另外,条件式 (14) 也是用于将从摄像镜头出射的光线向像面的入射角度抑制在 CRA 的范围内的条件。若超过上限值“-0.8”,则对色像差的修正、摄像镜头的小型化有利,但像面弯曲变得修正过度(成像面向正方向弯曲),难以得到良好的成像性能。另外,难以将从摄像镜头出射的光线向像面的入射角度抑制在 CRA 的范围内。另一方面,若低于下限值“-4.0”,则容易将从摄像镜头出射的光线向像面的入射角度抑制在 CRA 的范围内,但难以进行摄像镜头的小型化。另外,在图像周边部倍率色像差增大,并且像面弯曲变得修正不足,难以得到良好的成像性能。

[0051] 在上述结构的摄像镜头中,在将整个镜头系统的焦距设为  $f$ ,将第二透镜和第三透镜之间的光轴上的距离设为  $D_{23}$  时,优选满足以下的条件式 (15)。

$$[0052] \quad 0.03 < D_{23}/f < 0.2 \quad (15)$$

[0053] 条件式 (15) 是用于在实现摄像镜头的小型化的同时,良好地修正像面弯曲、畸变以及色像差的条件。若超过上限值“0.2”,则有利于摄像镜头的小型化,但难以确保后焦距。另外,正的畸变增大,并且像面弯曲变得修正过度。同时,在图像周边部倍率色像差增大,难以得到良好的成像性能。另一方面,若低于下限值“0.03”,则容易确保后焦距,但像面弯曲变得修正不足,并且倍率色像差增大,难以得到良好的成像性能。

[0054] 在上述结构的摄像镜头中,在将整个镜头系统的焦距设为  $f$ ,将第三透镜和第四透镜之间的光轴上的距离设为  $D_{34}$  时,优选满足以下的条件式 (16)。

$$[0055] \quad 0.03 < D_{34}/f < 0.2 \quad (16)$$

[0056] 条件式 (16) 是用于平衡良好地将像面弯曲、畸变以及倍率色像差抑制在良好的范围内的条件。若超过上限值“0.2”,则容易修正在图像周边部产生的倍率色像差,但像面弯曲变得修正不足,并且正的畸变增大,因此难以得到良好的成像性能。另一方面,若低于下限值“0.03”,则容易确保后焦距,但像面弯曲变得修正过度,难以得到良好的成像性能。

[0057] 根据本实用新型的摄像镜头,能够提供一种小型的摄像镜头,其良好地修正了各像差,具有高分辨率,并且特别适合于装入小型的摄像机。

## 附图说明

[0058] 图 1 是关于本实用新型的一个实施方式,表示数值实施例 1 的摄像镜头的概要结构的截面图。

[0059] 图 2 是表示图 1 所示的摄像镜头的横像差的像差图。

[0060] 图 3 是表示图 1 所示的摄像镜头的球面像差、像散、畸变的像差图。

[0061] 图 4 是关于本实用新型的一个实施方式,表示数值实施例 2 的摄像镜头的概要结构的截面图。

[0062] 图 5 是表示图 4 所示的摄像镜头的横像差的像差图。

[0063] 图 6 是表示图 4 所示的摄像镜头的球面像差、像散、畸变的像差图。

[0064] 图 7 是关于本实用新型的一个实施方式,表示数值实施例 3 的摄像镜头的概要结构的截面图。

[0065] 图 8 是表示图 7 所示的摄像镜头的横像差的像差图。

[0066] 图 9 是表示图 7 所示的摄像镜头的球面像差、像散、畸变的像差图。

[0067] 图 10 是关于本实用新型的一个实施方式,表示数值实施例 4 的摄像镜头的概要结构的截面图。

[0068] 图 11 是表示图 10 所示的摄像镜头的横像差的像差图。

[0069] 图 12 是表示图 10 所示的摄像镜头的球面像差、像散、畸变的像差图。

[0070] 图 13 是关于本实用新型的一个实施方式,表示数值实施例 5 的摄像镜头的概要结构的截面图。

[0071] 图 14 是表示图 13 所示的摄像镜头的横像差的像差图。

[0072] 图 15 是表示图 13 所示的摄像镜头的球面像差、像散、畸变的像差图。

[0073] 图 16 是关于本实用新型的一个实施方式,表示数值实施例 6 的摄像镜头的概要结构的截面图。

[0074] 图 17 是表示图 16 所示的摄像镜头的横像差的像差图。

[0075] 图 18 是表示图 16 所示的摄像镜头的球面像差、像散、畸变的像差图。

[0076] 符号说明

[0077] G1 :第一透镜组

[0078] G2 :第二透镜组

[0079] G3 :第三透镜组

[0080] L1 :第一透镜

[0081] L2 :第二透镜

[0082] L3 :第三透镜

[0083] L4 :第四透镜

[0084] L5 :第五透镜

[0085] L6 :第六透镜

[0086] L7 :第七透镜

[0087] 10 :滤光片

## 具体实施方式

[0088] 以下,参照附图详细说明对本实用新型具体化所得的一个实施方式。

[0089] 图 1、图 4、图 7、图 10、图 13 以及图 16 是表示本实施方式的数值实施例 1 ~ 6 的摄像镜头的概要结构的截面图。任意一个数值实施例的基本镜头结构都相同,因此,在此参照数值实施例 1 的概要截面图来说明本实施方式的摄像镜头的镜头结构。

[0090] 如图 1 所示,本实施方式的摄像镜头从物体侧向像面侧依次排列具有正的光焦度的第一透镜组 G1、具有正的光焦度的第二透镜组 G2、具有负的光焦度的第三透镜组 G3 而构成。在第三透镜组 G3 和摄像元件的像面 TM 之间配置滤光片 10。也可以省略该滤光片 10。

[0091] 第一透镜组 G1 从物体侧开始依次由具有正的光焦度的第一透镜 L1、具有负的光焦度的第二透镜 L2、具有负的光焦度的第三透镜 L3 构成。第一透镜 L1 是物体侧的面的曲率半径  $r_1$  和像面侧的面的曲率半径  $r_2$  都为正的形状,形成在光轴 X 的附近将凸面朝向物体侧的弯月透镜的形状。该第一透镜 L1 的形状并不限于本数值实施例 1 的形状。作为第一透镜 L1 的其他形状的一个例子,在数值实施例 6 中表示曲率半径  $r_1$  和曲率半径  $r_2$  都为负的形状、即在光轴 X 的附近为将凹面朝向物体侧的弯月透镜的形状的例子。除此以外,作为第一透镜 L1 的形状,也可以是曲率半径  $r_2$  为负的形状、即在光轴附近为双凸透镜的形状。此外,为了更有效地实现摄像镜头的小型化,优选将第一透镜 L1 形成为在光轴附近将凸面朝向物体侧的弯月透镜的形状。

[0092] 第二透镜 L2 是物体侧的面的曲率半径  $r_3$  为负、像面侧的面的曲率半径  $r_4$  为正的形状,形成在光轴 X 的附近为双凹透镜的形状。此外,第二透镜 L2 的形状并不限于本数值实施例 1 的形状。第二透镜 L2 的形状是像面侧的面的曲率半径  $r_4$  为正的形状即可,也可以是曲率半径  $r_3$  为正的形状、即在光轴 X 的附近将凸面朝向物体侧的弯月透镜的形状。数值实施例 2 ~ 6 是第二透镜 L2 的形状为在光轴 X 的附近将凸面朝向物体侧的弯月透镜的形状的例子。

[0093] 第三透镜 L3 是物体侧的面的曲率半径  $r_5$  为负、像面侧的面的曲率半径  $r_6$  为正的形状,形成在光轴 X 的附近为双凹透镜的形状。该第三透镜 L3 的形状也不限于本数值实施例 1 的形状。数值实施例 3 是第三透镜 L3 的形状是曲率半径  $r_5$  和曲率半径  $r_6$  都为负的形状、即在光轴 X 的附近将凹面朝向物体侧的弯月透镜的形状的例子,数值实施例 6 是第三透镜 L3 的形状是曲率半径  $r_5$  和曲率半径  $r_6$  都为正的形状、即在光轴 X 的附近将凸面朝向物体侧的弯月透镜的形状的例子。

[0094] 第二透镜组 G2 从物体侧开始依次由具有正的光焦度的第四透镜 L4、具有负的光焦度的第五透镜 L5 构成。其中,第四透镜 L4 是物体侧的面的曲率半径  $r_7$  和像面侧的面的曲率半径  $r_8$  都为负的形状,形成在光轴 X 的附近将凹面朝向物体侧的弯月透镜的形状。第四透镜 L4 只要光焦度为正,则能够形成为各种形状。作为第四透镜 L4 的形状,例如也可以是曲率半径  $r_7$  和曲率半径  $r_8$  都为正的形状、即在光轴 X 的附近将凸面朝向物体侧的弯月透镜的形状。数值实施例 6 是第四透镜 L4 的形状为在光轴 X 的附近将凸面朝向物体侧的弯月透镜的形状的例子。

[0095] 另一方面,第五透镜 L5 是物体侧的面的曲率半径  $r_9$  和像面侧的面的曲率半径  $r_{10}$  都为正的形状,形成在光轴 X 的附近将凸面朝向物体侧的弯月透镜的形状。该第五透镜 L5 的光焦度也可以为正。此外,从各像差的良好修正的观点出发,优选第四透镜 L4 和第五透镜 L5 的光焦度不相同。

[0096] 第三透镜组 G3 从物体侧开始依次由具有负的光焦度的第六透镜 L6、具有负的光

焦度的第七透镜 L7 构成。第六透镜 L6 是物体侧的面的曲率半径  $r_{11}$  和像面侧的面的曲率半径  $r_{12}$  都为正的形状,形成在光轴 X 的附近将凸面朝向物体侧的弯月透镜的形状。另外,第七透镜 L7 是物体侧的面的曲率半径  $r_{13}$  和像面侧的面的曲率半径  $r_{14}$  都为正的形状,形成在光轴 X 的附近将凸面朝向物体侧的弯月透镜的形状。此外,第六透镜 L6 的光焦度也可以为正。数值实施例 2 是第六透镜 L6 的光焦度为正的例子。

[0097] 在上述第六透镜 L6 和第七透镜 L7 中,物体侧的面和像面侧的面形成成为具有拐点的非球面形状,并且形成成为随着从光轴 X 朝向透镜周边部正的光焦度变强的形状。通过第六透镜 L6 和第七透镜 L7 所具有的这样的形状,不只是轴上的色像差,还良好地修正轴外的倍率色像差,并且适当地将从摄像镜头出射的光线向像面 IM 的入射角度抑制在 CRA (CRA : Chief Ray Angle) 的范围内。

[0098] 此外,在本数值实施例 1 的摄像镜头中,第六透镜 L6 和第七透镜 L7 的物体侧的面和像面侧的面的两个面形成成为具有拐点的非球面形状,但未必需要这两个面都形成成为具有拐点的非球面形状。即使具有拐点的非球面形状的面只是这些面中的某一个,也能够将这双方的透镜或一个透镜形成成为随着从光轴 X 朝向透镜周边部正的光焦度变强的形状的透镜。另外,根据所要求的光学性能、摄像镜头的小型化的程度,未必需要对第六透镜 L6 和第七透镜 L7 设置拐点。

[0099] 本实施方式的摄像镜头满足以下所示的条件式 (1) ~ (16)。

$$[0100] \quad 40 < v_{d1} < 75 \quad (1)$$

$$[0101] \quad 20 < v_{d2} < 35 \quad (2)$$

$$[0102] \quad 20 < v_{d3} < 35 \quad (3)$$

$$[0103] \quad 40 < v_{d4} < 75 \quad (4)$$

$$[0104] \quad 20 < v_{d5} < 35 \quad (5)$$

$$[0105] \quad -4.0 < f_{23}/f_1 < -1.5 \quad (6)$$

$$[0106] \quad 0.1 < f_2/f_3 < 0.6 \quad (7)$$

$$[0107] \quad 0.5 < f_1/f < 2.0 \quad (8)$$

$$[0108] \quad -6.0 < f_{45}/f_{67} < -1.5 \quad (9)$$

$$[0109] \quad -1.7 < f_{67}/f < -0.5 \quad (10)$$

$$[0110] \quad 40 < v_{d6} < 75 \quad (11)$$

$$[0111] \quad 40 < v_{d7} < 75 \quad (12)$$

$$[0112] \quad 1.0 < f_4/f < 3.0 \quad (13)$$

$$[0113] \quad -4.0 < f_7/f < -0.8 \quad (14)$$

$$[0114] \quad 0.03 < D_{23}/f < 0.2 \quad (15)$$

$$[0115] \quad 0.03 < D_{34}/f < 0.2 \quad (16)$$

[0116] 其中,

[0117]  $v_{d1}$ : 第一透镜 L1 的阿贝数

[0118]  $v_{d2}$ : 第二透镜 L2 的阿贝数

[0119]  $v_{d3}$ : 第三透镜 L3 的阿贝数

[0120]  $v_{d4}$ : 第四透镜 L4 的阿贝数

[0121]  $v_{d5}$ : 第五透镜 L5 的阿贝数

[0122]  $v d_6$ :第六透镜 L6 的阿贝数

[0123]  $v d_7$ :第七透镜 L7 的阿贝数

[0124]  $f$ :整个镜头系统的焦距

[0125]  $f_1$ :第一透镜 L1 的焦距

[0126]  $f_2$ :第二透镜 L2 的焦距

[0127]  $f_3$ :第三透镜 L3 的焦距

[0128]  $f_4$ :第四透镜 L4 的焦距

[0129]  $f_7$ :第七透镜 L7 的焦距

[0130]  $f_{23}$ :第二透镜 L2 和第三透镜 L3 的合成焦距

[0131]  $f_{45}$ :第四透镜 L4 和第五透镜 L5 的合成焦距

[0132]  $f_{67}$ :第六透镜 L6 和第七透镜 L7 的合成焦距

[0133]  $D_{23}$ :第二透镜 L2 和第三透镜 L3 之间的光轴上的距离

[0134]  $D_{34}$ :第三透镜 L3 和第四透镜 L4 之间的光轴上的距离

[0135] 此外,不需要满足上述各条件式的全部,通过单独地满足上述各条件式,能够分别得到与各条件式对应的作用效果。

[0136] 在本实施方式中,用非球面形成了各透镜的透镜面。在设光轴方向的轴为 Z,与光轴垂直的方向的高度为 H,圆锥系数为 k,非球面系数为  $A_4$ 、 $A_6$ 、 $A_8$ 、 $A_{10}$ 、 $A_{12}$ 、 $A_{14}$ 、 $A_{16}$  时,通过下式表示这些透镜面所采用的非球面形状。

[0137] 式 1

[0138]

$$Z = \frac{\frac{H^2}{R}}{1 + \sqrt{1 - (k+1) \frac{H^2}{R^2}}} + A_4 H^4 + A_6 H^6 + A_8 H^8 + A_{10} H^{10} + A_{12} H^{12} + A_{14} H^{14} + A_{16} H^{16}$$

[0139] 接着,表示本实施方式的摄像镜头的数值实施例。在各数值实施例中, $f$  表示整个镜头系统的焦距, $F_{no}$  表示 F 值, $\omega$  表示半视场角。 $i$  表示从物体侧开始数的面编号, $r$  表示曲率半径, $d$  表示光轴上的透镜面之间的距离(面间隔), $nd$  表示折射率, $v d$  表示阿贝数。此外,附加了\*(星号)的符号的面编号表示是非球面。

[0140] 数值实施例 1

[0141] 以下表示基本镜头数据。

[0142]  $f = 7.18\text{mm}$ 、 $F_{no} = 3.0$ 、 $\omega = 29.1^\circ$

[0143] 单位 mm

[0144] 面数据

[0145]

| 面编号 i<br>(物面)                                                                                                                   | r        | d            | nd     | $\nu$ d           |
|---------------------------------------------------------------------------------------------------------------------------------|----------|--------------|--------|-------------------|
|                                                                                                                                 | $\infty$ | $\infty$     |        |                   |
| 1* (光阑)                                                                                                                         | 2.137    | 0.876        | 1.5346 | 56.1 (= $\nu$ d1) |
| 2*                                                                                                                              | 12.503   | 0.082        |        |                   |
| 3*                                                                                                                              | -525.874 | 0.315        | 1.6355 | 24.0 (= $\nu$ d2) |
| 4*                                                                                                                              | 8.206    | 0.602 (=D23) |        |                   |
| 5*                                                                                                                              | -116.694 | 0.856        | 1.6355 | 24.0 (= $\nu$ d3) |
| 6*                                                                                                                              | 19.254   | 0.464 (=D34) |        |                   |
| [0146]                                                                                                                          |          |              |        |                   |
| 7*                                                                                                                              | -4.712   | 0.762        | 1.5346 | 56.1 (= $\nu$ d4) |
| 8*                                                                                                                              | -2.361   | 0.105        |        |                   |
| 9*                                                                                                                              | 17.655   | 0.510        | 1.6355 | 24.0 (= $\nu$ d5) |
| 10*                                                                                                                             | 13.764   | 0.279        |        |                   |
| 11*                                                                                                                             | 12.387   | 0.483        | 1.5346 | 56.1 (= $\nu$ d6) |
| 12*                                                                                                                             | 6.010    | 0.418        |        |                   |
| 13*                                                                                                                             | 33.769   | 0.500        | 1.5346 | 56.1 (= $\nu$ d7) |
| 14*                                                                                                                             | 3.536    | 0.200        |        |                   |
| 15                                                                                                                              | $\infty$ | 0.200        | 1.5168 | 64.2              |
| 16                                                                                                                              | $\infty$ | 1.249        |        |                   |
| (像面)                                                                                                                            | $\infty$ |              |        |                   |
| [0147] 非球面数据                                                                                                                    |          |              |        |                   |
| [0148] 第1面                                                                                                                      |          |              |        |                   |
| [0149] $k = 0.000$ , $A_4 = -1.269\text{E-}03$ , $A_6 = -1.041\text{E-}03$ , $A_8 = -6.082\text{E-}04$ ,                        |          |              |        |                   |
| [0150] $A_{10} = -1.066\text{E-}03$ , $A_{12} = 5.675\text{E-}04$ , $A_{14} = -3.136\text{E-}04$ , $A_{16} = -1.053\text{E-}04$ |          |              |        |                   |
| [0151] 第2面                                                                                                                      |          |              |        |                   |
| [0152] $k = 0.000$ , $A_4 = -7.459\text{E-}02$ , $A_6 = 3.177\text{E-}02$ , $A_8 = -1.722\text{E-}04$ ,                         |          |              |        |                   |
| [0153] $A_{10} = -2.787\text{E-}03$ , $A_{12} = -1.500\text{E-}03$ , $A_{14} = -2.828\text{E-}04$ , $A_{16} = 2.980\text{E-}04$ |          |              |        |                   |
| [0154] 第3面                                                                                                                      |          |              |        |                   |
| [0155] $k = 0.000$ , $A_4 = -7.996\text{E-}02$ , $A_6 = 6.597\text{E-}02$ , $A_8 = -5.343\text{E-}03$ ,                         |          |              |        |                   |
| [0156] $A_{10} = -3.986\text{E-}03$ , $A_{12} = -6.224\text{E-}04$ , $A_{14} = 5.170\text{E-}04$ , $A_{16} = 8.386\text{E-}05$  |          |              |        |                   |
| [0157] 第4面                                                                                                                      |          |              |        |                   |
| [0158] $k = 0.000$ , $A_4 = -2.982\text{E-}02$ , $A_6 = 4.276\text{E-}02$ , $A_8 = -2.541\text{E-}03$ ,                         |          |              |        |                   |
| [0159] $A_{10} = -2.635\text{E-}03$ , $A_{12} = 1.060\text{E-}03$ , $A_{14} = 2.993\text{E-}04$ , $A_{16} = 4.110\text{E-}04$   |          |              |        |                   |

- [0160] 第 5 面
- [0161]  $k = 0.000$ ,  $A_4 = -5.158\text{E-}02$ ,  $A_6 = 2.715\text{E-}03$ ,  $A_8 = -1.639\text{E-}03$ ,
- [0162]  $A_{10} = 1.341\text{E-}03$ ,  $A_{12} = 8.514\text{E-}04$ ,  $A_{14} = 5.026\text{E-}05$ ,  $A_{16} = -3.478\text{E-}05$
- [0163] 第 6 面
- [0164]  $k = 0.000$ ,  $A_4 = -1.784\text{E-}02$ ,  $A_6 = 1.970\text{E-}03$ ,  $A_8 = 2.539\text{E-}04$ ,
- [0165]  $A_{10} = -3.310\text{E-}04$ ,  $A_{12} = -1.014\text{E-}04$ ,  $A_{14} = 2.088\text{E-}04$ ,  $A_{16} = -4.369\text{E-}05$
- [0166] 第 7 面
- [0167]  $k = 0.000$ ,  $A_4 = 2.912\text{E-}02$ ,  $A_6 = -7.102\text{E-}03$ ,  $A_8 = 5.929\text{E-}03$ ,
- [0168]  $A_{10} = -2.531\text{E-}04$ ,  $A_{12} = -3.260\text{E-}03$ ,  $A_{14} = 1.780\text{E-}03$ ,  $A_{16} = -3.061\text{E-}04$
- [0169] 第 8 面
- [0170]  $k = 0.000$ ,  $A_4 = 8.806\text{E-}03$ ,  $A_6 = 9.910\text{E-}03$ ,  $A_8 = -4.654\text{E-}04$ ,
- [0171]  $A_{10} = -3.451\text{E-}03$ ,  $A_{12} = 2.664\text{E-}03$ ,  $A_{14} = -6.962\text{E-}04$ ,  $A_{16} = 5.407\text{E-}05$
- [0172] 第 9 面
- [0173]  $k = 0.000$ ,  $A_4 = -3.991\text{E-}02$ ,  $A_6 = 8.162\text{E-}03$ ,  $A_8 = -5.350\text{E-}03$ ,
- [0174]  $A_{10} = -9.445\text{E-}05$ ,  $A_{12} = 9.071\text{E-}04$ ,  $A_{14} = -2.112\text{E-}04$ ,  $A_{16} = 1.218\text{E-}05$
- [0175] 第 10 面
- [0176]  $k = 0.000$ ,  $A_4 = -3.411\text{E-}02$ ,  $A_6 = -1.380\text{E-}03$ ,  $A_8 = -6.512\text{E-}05$ ,
- [0177]  $A_{10} = 1.677\text{E-}05$ ,  $A_{12} = 1.676\text{E-}05$ ,  $A_{14} = 2.441\text{E-}06$ ,  $A_{16} = -6.710\text{E-}07$
- [0178] 第 11 面
- [0179]  $k = 0.000$ ,  $A_4 = -3.657\text{E-}02$ ,  $A_6 = 9.329\text{E-}04$ ,  $A_8 = 1.629\text{E-}04$ ,
- [0180]  $A_{10} = 1.382\text{E-}05$ ,  $A_{12} = 2.057\text{E-}06$ ,  $A_{14} = 3.601\text{E-}07$ ,  $A_{16} = -8.717\text{E-}08$
- [0181] 第 12 面
- [0182]  $k = 0.000$ ,  $A_4 = -1.325\text{E-}02$ ,  $A_6 = -1.573\text{E-}04$ ,  $A_8 = -8.403\text{E-}05$ ,
- [0183]  $A_{10} = -9.963\text{E-}07$ ,  $A_{12} = -1.366\text{E-}06$ ,  $A_{14} = -1.165\text{E-}07$ ,  $A_{16} = 3.426\text{E-}08$
- [0184] 第 13 面
- [0185]  $k = 0.000$ ,  $A_4 = -2.772\text{E-}02$ ,  $A_6 = 7.343\text{E-}03$ ,  $A_8 = -1.330\text{E-}03$ ,
- [0186]  $A_{10} = 1.028\text{E-}04$ ,  $A_{12} = -1.210\text{E-}05$ ,  $A_{14} = 1.664\text{E-}06$ ,  $A_{16} = -7.563\text{E-}08$
- [0187] 第 14 面
- [0188]  $k = 0.000$ ,  $A_4 = -5.223\text{E-}02$ ,  $A_6 = 9.961\text{E-}03$ ,  $A_8 = -1.759\text{E-}03$ ,
- [0189]  $A_{10} = 2.358\text{E-}04$ ,  $A_{12} = -2.025\text{E-}05$ ,  $A_{14} = 9.640\text{E-}07$ ,  $A_{16} = -2.007\text{E-}08$
- [0190]  $f1 = 4.68\text{mm}$
- [0191]  $f2 = -12.71\text{mm}$
- [0192]  $f3 = -25.94\text{mm}$
- [0193]  $f4 = 7.95\text{mm}$
- [0194]  $f5 = -103.56\text{mm}$
- [0195]  $f6 = -22.43\text{mm}$
- [0196]  $f7 = -7.43\text{mm}$
- [0197]  $f23 = -8.31\text{mm}$
- [0198]  $f45 = 8.51\text{mm}$

[0199]  $f_{67} = -5.49\text{mm}$

[0200] 以下表示各条件式的值。

[0201]  $f_{23}/f_1 = -1.77$

[0202]  $f_2/f_3 = 0.49$

[0203]  $f_1/f = 0.65$

[0204]  $f_{45}/f_{67} = -1.55$

[0205]  $f_{67}/f = -0.77$

[0206]  $f_4/f = 1.11$

[0207]  $f_7/f = -1.04$

[0208]  $D_{23}/f = 0.084$

[0209]  $D_{34}/f = 0.065$

[0210] 这样,本数值实施例 1 的摄像镜头满足上述各条件式。从第一透镜 L1 的物体侧的面到像面 IM 为止的光轴上的距离(滤光片 10 是空气换算长度)是 7.83mm,实现了摄像镜头的小型化。

[0211] 图 2 关于数值实施例 1 的摄像镜头,分为子午方向和弧矢方向表示出与各像高相对于最大像高的比 H(以下称为“像高比 H”)对应的横像差(在图 5、图 8、图 11、图 14 以及图 17 中也相同)。另外,图 3 关于数值实施例 1 的摄像镜头,分别表示出球面像差(mm)、像散(mm)以及畸变(%)。在这些像差图中,在横像差图和球面像差图中表示出与 g 线(436nm)、d 线(588nm)、C 线(656nm)的各波长对应的像差量,在像散图中分别表示出弧矢像面 S 的像差量和子午像面 T 的像差量(在图 6、图 9、图 12、图 15 以及图 18 中也相同)。如图 2 和图 3 所示,通过本数值实施例 1 的摄像镜头良好地修正了各像差。

[0212] 数值实施例 2

[0213] 以下表示基本镜头数据。

[0214]  $f = 5.44\text{mm}$ 、 $F_{\text{no}} = 2.2$ 、 $\omega = 36.3^\circ$

[0215] 单位 mm

[0216] 面数据

[0217]

| 面编号 i   | r        | d            | nd     | $\nu$ d           |
|---------|----------|--------------|--------|-------------------|
| (物面)    | $\infty$ | $\infty$     |        |                   |
| 1* (光阑) | 2.037    | 0.916        | 1.5346 | 56.1 (= $\nu$ d1) |
| 2*      | 17.722   | 0.056        |        |                   |
| 3*      | 89.558   | 0.297        | 1.6355 | 24.0 (= $\nu$ d2) |
| 4*      | 9.329    | 0.397 (=D23) |        |                   |
| 5*      | -43.041  | 0.579        | 1.6355 | 24.0 (= $\nu$ d3) |
| 6*      | 252.636  | 0.291 (=D34) |        |                   |
| 7*      | -4.082   | 0.780        | 1.5346 | 56.1 (= $\nu$ d4) |
| 8*      | -2.345   | 0.037        |        |                   |
| 9*      | 30.893   | 0.510        | 1.6355 | 24.0 (= $\nu$ d5) |
| 10*     | 9.990    | 0.208        |        |                   |
| 11*     | 7.396    | 0.561        | 1.5346 | 56.1 (= $\nu$ d6) |
| 12*     | 7.529    | 0.236        |        |                   |
| 13*     | 35.369   | 0.500        | 1.5346 | 56.1 (= $\nu$ d7) |
| 14*     | 3.585    | 0.200        |        |                   |
| 15      | $\infty$ | 0.200        | 1.5168 | 64.2              |
| 16      | $\infty$ | 0.832        |        |                   |
| (像面)    | $\infty$ |              |        |                   |

[0218] 非球面数据

[0219] 第1面

[0220]  $k = 0.000$ ,  $A_4 = 1.278\text{E-}03$ ,  $A_6 = -1.344\text{E-}03$ ,  $A_8 = -6.049\text{E-}04$ ,

[0221]  $A_{10} = -9.928\text{E-}04$ ,  $A_{12} = 5.549\text{E-}04$ ,  $A_{14} = -3.389\text{E-}04$ ,  $A_{16} = -1.053\text{E-}04$

[0222] 第2面

[0223]  $k = 0.000$ ,  $A_4 = -7.369\text{E-}02$ ,  $A_6 = 3.182\text{E-}02$ ,  $A_8 = -2.362\text{E-}04$ ,

[0224]  $A_{10} = -2.772\text{E-}03$ ,  $A_{12} = -1.452\text{E-}03$ ,  $A_{14} = -2.374\text{E-}04$ ,  $A_{16} = 3.103\text{E-}04$

[0225] 第3面

[0226]  $k = 0.000$ ,  $A_4 = -8.231\text{E-}02$ ,  $A_6 = 6.611\text{E-}02$ ,  $A_8 = -5.107\text{E-}03$ ,

[0227]  $A_{10} = -3.861\text{E-}03$ ,  $A_{12} = -5.837\text{E-}04$ ,  $A_{14} = 5.444\text{E-}04$ ,  $A_{16} = 1.194\text{E-}04$

[0228] 第4面

[0229]  $k = 0.000$ ,  $A_4 = -2.913\text{E-}02$ ,  $A_6 = 4.127\text{E-}02$ ,  $A_8 = -2.459\text{E-}03$ ,

[0230]  $A_{10} = -2.343\text{E-}03$ ,  $A_{12} = 1.134\text{E-}03$ ,  $A_{14} = 2.487\text{E-}04$ ,  $A_{16} = 3.403\text{E-}04$

[0231] 第5面

- [0232]  $k = 0.000$ ,  $A_4 = -5.270\text{E-}02$ ,  $A_6 = 3.670\text{E-}03$ ,  $A_8 = -1.855\text{E-}03$ ,  
[0233]  $A_{10} = 9.253\text{E-}04$ ,  $A_{12} = 6.531\text{E-}04$ ,  $A_{14} = 5.241\text{E-}05$ ,  $A_{16} = 3.456\text{E-}05$   
[0234] 第 6 面  
[0235]  $k = 0.000$ ,  $A_4 = -1.418\text{E-}02$ ,  $A_6 = 2.764\text{E-}03$ ,  $A_8 = 6.929\text{E-}04$ ,  
[0236]  $A_{10} = -1.418\text{E-}04$ ,  $A_{12} = -2.387\text{E-}05$ ,  $A_{14} = 2.459\text{E-}04$ ,  $A_{16} = -2.662\text{E-}05$   
[0237] 第 7 面  
[0238]  $k = 0.000$ ,  $A_4 = 3.184\text{E-}02$ ,  $A_6 = -6.312\text{E-}03$ ,  $A_8 = 5.993\text{E-}03$ ,  
[0239]  $A_{10} = -2.065\text{E-}04$ ,  $A_{12} = -3.225\text{E-}03$ ,  $A_{14} = 1.791\text{E-}03$ ,  $A_{16} = -3.069\text{E-}04$   
[0240] 第 8 面  
[0241]  $k = 0.000$ ,  $A_4 = 9.352\text{E-}03$ ,  $A_6 = 9.939\text{E-}03$ ,  $A_8 = -3.373\text{E-}04$ ,  
[0242]  $A_{10} = -3.412\text{E-}03$ ,  $A_{12} = 2.668\text{E-}03$ ,  $A_{14} = -6.963\text{E-}04$ ,  $A_{16} = 5.389\text{E-}05$   
[0243] 第 9 面  
[0244]  $k = 0.000$ ,  $A_4 = -4.199\text{E-}02$ ,  $A_6 = 7.392\text{E-}03$ ,  $A_8 = -5.501\text{E-}03$ ,  
[0245]  $A_{10} = -1.110\text{E-}04$ ,  $A_{12} = 9.072\text{E-}04$ ,  $A_{14} = -2.104\text{E-}04$ ,  $A_{16} = 1.245\text{E-}05$   
[0246] 第 10 面  
[0247]  $k = 0.000$ ,  $A_4 = -3.196\text{E-}02$ ,  $A_6 = -8.737\text{E-}04$ ,  $A_8 = 3.452\text{E-}05$ ,  
[0248]  $A_{10} = 2.494\text{E-}05$ ,  $A_{12} = 1.701\text{E-}05$ ,  $A_{14} = 2.379\text{E-}06$ ,  $A_{16} = -6.898\text{E-}07$   
[0249] 第 11 面  
[0250]  $k = 0.000$ ,  $A_4 = -3.494\text{E-}02$ ,  $A_6 = 9.838\text{E-}04$ ,  $A_8 = 1.285\text{E-}04$ ,  
[0251]  $A_{10} = 1.041\text{E-}05$ ,  $A_{12} = 1.781\text{E-}06$ ,  $A_{14} = 3.140\text{E-}07$ ,  $A_{16} = -1.017\text{E-}07$   
[0252] 第 12 面  
[0253]  $k = 0.000$ ,  $A_4 = -1.149\text{E-}02$ ,  $A_6 = 1.483\text{E-}04$ ,  $A_8 = -8.259\text{E-}05$ ,  
[0254]  $A_{10} = -4.430\text{E-}06$ ,  $A_{12} = -1.733\text{E-}06$ ,  $A_{14} = -1.292\text{E-}07$ ,  $A_{16} = 3.717\text{E-}08$   
[0255] 第 13 面  
[0256]  $k = 0.000$ ,  $A_4 = -2.715\text{E-}02$ ,  $A_6 = 8.014\text{E-}03$ ,  $A_8 = -1.326\text{E-}03$ ,  
[0257]  $A_{10} = 1.028\text{E-}04$ ,  $A_{12} = -1.206\text{E-}05$ ,  $A_{14} = 1.663\text{E-}06$ ,  $A_{16} = -7.748\text{E-}08$   
[0258] 第 14 面  
[0259]  $k = 0.000$ ,  $A_4 = -4.908\text{E-}02$ ,  $A_6 = 9.595\text{E-}03$ ,  $A_8 = -1.765\text{E-}03$ ,  
[0260]  $A_{10} = 2.358\text{E-}04$ ,  $A_{12} = -2.026\text{E-}05$ ,  $A_{14} = 9.640\text{E-}07$ ,  $A_{16} = -1.996\text{E-}08$   
[0261]  $f1 = 4.22\text{mm}$   
[0262]  $f2 = -16.41\text{mm}$   
[0263]  $f3 = -57.82\text{mm}$   
[0264]  $f4 = 8.91\text{mm}$   
[0265]  $f5 = -23.45\text{mm}$   
[0266]  $f6 = 317.09\text{mm}$   
[0267]  $f7 = -7.50\text{mm}$   
[0268]  $f23 = -12.71\text{mm}$   
[0269]  $f45 = 14.46\text{mm}$   
[0270]  $f67 = -7.92\text{mm}$

[0271] 以下表示各条件式的值。

[0272]  $f_{23}/f_1 = -3.01$

[0273]  $f_2/f_3 = 0.28$

[0274]  $f_1/f = 0.78$

[0275]  $f_{45}/f_{67} = -1.83$

[0276]  $f_{67}/f = -1.46$

[0277]  $f_4/f = 1.64$

[0278]  $f_7/f = -1.38$

[0279]  $D_{23}/f = 0.073$

[0280]  $D_{34}/f = 0.053$

[0281] 这样,本数值实施例 2 的摄像镜头满足上述各条件式。从第一透镜 L1 的物体侧的面到像面 IM 为止的光轴上的距离(滤光片 10 是空气换算长度)是 6.53mm,实现了摄像镜头的小型化。

[0282] 图 5 关于数值实施例 2 的摄像镜头,表示出与像高比 H 对应的横像差,图 6 分别表示出球面像差(mm)、像散(mm)以及畸变(%)。如图 5 和图 6 所示,通过本数值实施例 2 的摄像镜头也良好地修正了各像差。

[0283] 数值实施例 3

[0284] 以下表示基本镜头数据。

[0285]  $f = 6.32\text{mm}$ 、 $F_{\text{No}} = 2.6$ 、 $\omega = 32.3^\circ$

[0286] 单位 mm

[0287] 面数据

[0288]

| 面编号 i   | r        | d            | nd     | $\nu$ d           |
|---------|----------|--------------|--------|-------------------|
| (物面)    | $\infty$ | $\infty$     |        |                   |
| 1* (光阑) | 2.081    | 0.680        | 1.5346 | 56.1 (= $\nu$ d1) |
| 2*      | 20.921   | 0.080        |        |                   |
| 3*      | 70.779   | 0.290        | 1.6355 | 24.0 (= $\nu$ d2) |
| 4*      | 8.233    | 1.201 (=D23) |        |                   |
| 5*      | -7.147   | 0.343        | 1.6355 | 24.0 (= $\nu$ d3) |
| 6*      | -10.623  | 0.221 (=D34) |        |                   |
| 7*      | -6.248   | 0.414        | 1.5346 | 56.1 (= $\nu$ d4) |
| 8*      | -3.507   | 0.047        |        |                   |
| 9*      | 17.703   | 0.510        | 1.6355 | 24.0 (= $\nu$ d5) |
| 10*     | 8.206    | 0.283        |        |                   |
| 11*     | 11.066   | 0.677        | 1.5346 | 56.1 (= $\nu$ d6) |
| 12*     | 8.979    | 0.247        |        |                   |
| 13*     | 33.195   | 0.963        | 1.5346 | 56.1 (= $\nu$ d7) |
| 14*     | 3.725    | 0.200        |        |                   |
| 15      | $\infty$ | 0.200        | 1.5168 | 64.2              |
| 16      | $\infty$ | 0.628        |        |                   |
| (像面)    | $\infty$ |              |        |                   |

[0289] 非球面数据

[0290] 第1面

[0291]  $k = 0.000$ ,  $A_4 = 2.316\text{E-}03$ ,  $A_6 = -6.966\text{E-}04$ ,  $A_8 = -8.666\text{E-}04$ ,

[0292]  $A_{10} = -8.910\text{E-}04$ ,  $A_{12} = 7.588\text{E-}04$ ,  $A_{14} = -3.174\text{E-}04$ ,  $A_{16} = -3.121\text{E-}04$

[0293] 第2面

[0294]  $k = 0.000$ ,  $A_4 = -6.708\text{E-}02$ ,  $A_6 = 3.193\text{E-}02$ ,  $A_8 = 1.178\text{E-}04$ ,

[0295]  $A_{10} = -3.199\text{E-}03$ ,  $A_{12} = -1.616\text{E-}03$ ,  $A_{14} = -1.742\text{E-}04$ ,  $A_{16} = 3.390\text{E-}04$

[0296] 第3面

[0297]  $k = 0.000$ ,  $A_4 = -7.504\text{E-}02$ ,  $A_6 = 6.484\text{E-}02$ ,  $A_8 = -7.363\text{E-}03$ ,

[0298]  $A_{10} = -4.744\text{E-}03$ ,  $A_{12} = -6.707\text{E-}04$ ,  $A_{14} = 6.906\text{E-}04$ ,  $A_{16} = 3.379\text{E-}04$

[0299] 第4面

[0300]  $k = 0.000$ ,  $A_4 = -5.473\text{E-}03$ ,  $A_6 = 4.021\text{E-}02$ ,  $A_8 = -4.702\text{E-}03$ ,

[0301]  $A_{10} = -2.717\text{E-}03$ ,  $A_{12} = 1.284\text{E-}03$ ,  $A_{14} = 3.257\text{E-}04$ ,  $A_{16} = 7.159\text{E-}05$

[0302] 第5面

- [0303]  $k = 0.000$ ,  $A_4 = -3.325E-02$ ,  $A_6 = 7.261E-03$ ,  $A_8 = 4.647E-04$ ,
- [0304]  $A_{10} = 1.109E-03$ ,  $A_{12} = 2.867E-04$ ,  $A_{14} = -1.887E-05$ ,  $A_{16} = -2.570E-05$
- [0305] 第 6 面
- [0306]  $k = 0.000$ ,  $A_4 = -4.105E-02$ ,  $A_6 = 3.279E-05$ ,  $A_8 = 1.900E-03$ ,
- [0307]  $A_{10} = 2.365E-04$ ,  $A_{12} = 3.118E-05$ ,  $A_{14} = 2.388E-04$ ,  $A_{16} = -2.065E-05$
- [0308] 第 7 面
- [0309]  $k = 0.000$ ,  $A_4 = -9.376E-03$ ,  $A_6 = -1.369E-02$ ,  $A_8 = 7.969E-03$ ,
- [0310]  $A_{10} = -4.465E-06$ ,  $A_{12} = -3.255E-03$ ,  $A_{14} = 1.808E-03$ ,  $A_{16} = -2.768E-04$
- [0311] 第 8 面
- [0312]  $k = 0.000$ ,  $A_4 = -6.996E-03$ ,  $A_6 = 1.005E-02$ ,  $A_8 = -1.165E-03$ ,
- [0313]  $A_{10} = -3.518E-03$ ,  $A_{12} = 2.675E-03$ ,  $A_{14} = -6.821E-04$ ,  $A_{16} = 5.876E-05$
- [0314] 第 9 面
- [0315]  $k = 0.000$ ,  $A_4 = -2.105E-02$ ,  $A_6 = 2.209E-03$ ,  $A_8 = -4.117E-03$ ,
- [0316]  $A_{10} = -1.343E-04$ ,  $A_{12} = 8.072E-04$ ,  $A_{14} = -2.255E-04$ ,  $A_{16} = 1.704E-05$
- [0317] 第 10 面
- [0318]  $k = 0.000$ ,  $A_4 = -1.872E-02$ ,  $A_6 = -1.529E-03$ ,  $A_8 = -4.349E-05$ ,
- [0319]  $A_{10} = 1.085E-05$ ,  $A_{12} = 1.560E-05$ ,  $A_{14} = 2.371E-06$ ,  $A_{16} = -6.171E-07$
- [0320] 第 11 面
- [0321]  $k = 0.000$ ,  $A_4 = -3.607E-02$ ,  $A_6 = 1.638E-03$ ,  $A_8 = 1.660E-04$ ,
- [0322]  $A_{10} = 1.373E-05$ ,  $A_{12} = 1.855E-06$ ,  $A_{14} = 2.700E-07$ ,  $A_{16} = -1.163E-07$
- [0323] 第 12 面
- [0324]  $k = 0.000$ ,  $A_4 = -1.004E-02$ ,  $A_6 = -8.471E-04$ ,  $A_8 = 9.471E-05$ ,
- [0325]  $A_{10} = 2.438E-06$ ,  $A_{12} = -1.674E-06$ ,  $A_{14} = -1.484E-07$ ,  $A_{16} = 2.570E-08$
- [0326] 第 13 面
- [0327]  $k = 0.000$ ,  $A_4 = -2.975E-02$ ,  $A_6 = 8.262E-03$ ,  $A_8 = -1.318E-03$ ,
- [0328]  $A_{10} = 1.029E-04$ ,  $A_{12} = -1.209E-05$ ,  $A_{14} = 1.657E-06$ ,  $A_{16} = -7.825E-08$
- [0329] 第 14 面
- [0330]  $k = 0.000$ ,  $A_4 = -4.975E-02$ ,  $A_6 = 9.427E-03$ ,  $A_8 = -1.767E-03$ ,
- [0331]  $A_{10} = 2.350E-04$ ,  $A_{12} = -2.032E-05$ ,  $A_{14} = 9.663E-07$ ,  $A_{16} = -1.916E-08$
- [0332]  $f1 = 4.27\text{mm}$
- [0333]  $f2 = -14.69\text{mm}$
- [0334]  $f3 = -35.74\text{mm}$
- [0335]  $f4 = 14.21\text{mm}$
- [0336]  $f5 = -24.58\text{mm}$
- [0337]  $f6 = -100.39\text{mm}$
- [0338]  $f7 = -7.94\text{mm}$
- [0339]  $f23 = -10.26\text{mm}$
- [0340]  $f45 = 32.66\text{mm}$
- [0341]  $f67 = -7.44\text{mm}$

[0342] 以下表示各条件式的值。

[0343]  $f_{23}/f_1 = -2.40$

[0344]  $f_2/f_3 = 0.41$

[0345]  $f_1/f = 0.68$

[0346]  $f_{45}/f_{67} = -4.39$

[0347]  $f_{67}/f = -1.18$

[0348]  $f_4/f = 2.25$

[0349]  $f_7/f = -1.26$

[0350]  $D_{23}/f = 0.19$

[0351]  $D_{34}/f = 0.035$

[0352] 这样,本数值实施例3的摄像镜头满足上述各条件式。从第一透镜L1的物体侧的面到像面IM为止的光轴上的距离(滤光片10是空气换算长度)是6.92mm,实现了摄像镜头的小型化。

[0353] 图8关于数值实施例3的摄像镜头,表示出与像高比H对应的横像差,图9分别表示出球面像差(mm)、像散(mm)以及畸变(%)。如图8和图9所示,通过本数值实施例3的摄像镜头也良好地修正了各像差。

[0354] 数值实施例4

[0355] 以下表示基本镜头数据。

[0356]  $f = 6.58\text{mm}$ 、 $F_{\text{No}} = 2.7$ 、 $\omega = 31.3^\circ$

[0357] 单位 mm

[0358] 面数据

[0359]

| 面编号 i  | r        | d           | nd     | $\nu d$           |
|--------|----------|-------------|--------|-------------------|
| (物面)   | $\infty$ | $\infty$    |        |                   |
| 1*(光阑) | 2.094    | 0.709       | 1.5346 | 56.1(= $\nu d1$ ) |
| 2*     | 18.265   | 0.091       |        |                   |
| 3*     | 149.869  | 0.286       | 1.6355 | 24.0(= $\nu d2$ ) |
| 4*     | 8.321    | 0.332(=D23) |        |                   |
| 5*     | -44.743  | 0.474       | 1.6355 | 24.0(= $\nu d3$ ) |
| 6*     | 631.923  | 1.233(=D34) |        |                   |
| 7*     | -12.494  | 0.352       | 1.5346 | 56.1(= $\nu d4$ ) |
| 8*     | -4.802   | 0.037       |        |                   |
| 9*     | 20.999   | 0.510       | 1.6355 | 24.0(= $\nu d5$ ) |
| 10*    | 8.539    | 0.294       |        |                   |
| 11*    | 12.428   | 0.580       | 1.5346 | 56.1(= $\nu d6$ ) |

[0360]

|      |          |       |        |                   |
|------|----------|-------|--------|-------------------|
| 12*  | 8.742    | 0.303 |        |                   |
| 13*  | 22.998   | 0.523 | 1.5346 | 56.1 (= $\nu$ d7) |
| 14*  | 3.749    | 0.200 |        |                   |
| 15   | $\infty$ | 0.200 | 1.5168 | 64.2              |
| 16   | $\infty$ | 0.867 |        |                   |
| (像面) | $\infty$ |       |        |                   |

[0361] 非球面数据

[0362] 第1面

[0363]  $k = 0.000$ ,  $A_4 = -7.892E-04$ ,  $A_6 = -1.001E-03$ ,  $A_8 = -1.142E-03$ ,[0364]  $A_{10} = -1.165E-03$ ,  $A_{12} = 6.915E-04$ ,  $A_{14} = -2.917E-04$ ,  $A_{16} = -2.805E-04$ 

[0365] 第2面

[0366]  $k = 0.000$ ,  $A_4 = -7.015E-02$ ,  $A_6 = 3.117E-02$ ,  $A_8 = -4.145E-04$ ,[0367]  $A_{10} = -3.478E-03$ ,  $A_{12} = -1.637E-03$ ,  $A_{14} = -1.442E-04$ ,  $A_{16} = 3.801E-04$ 

[0368] 第3面

[0369]  $k = 0.000$ ,  $A_4 = -7.109E-02$ ,  $A_6 = 6.425E-02$ ,  $A_8 = -7.337E-03$ ,[0370]  $A_{10} = -4.771E-03$ ,  $A_{12} = -7.589E-04$ ,  $A_{14} = 6.636E-04$ ,  $A_{16} = 3.497E-04$ 

[0371] 第4面

[0372]  $k = 0.000$ ,  $A_4 = -1.703E-02$ ,  $A_6 = 4.106E-02$ ,  $A_8 = -5.205E-03$ ,[0373]  $A_{10} = -2.994E-03$ ,  $A_{12} = 1.503E-03$ ,  $A_{14} = 5.453E-04$ ,  $A_{16} = 1.614E-04$ 

[0374] 第5面

[0375]  $k = 0.000$ ,  $A_4 = -4.694E-02$ ,  $A_6 = 4.353E-03$ ,  $A_8 = 6.064E-04$ ,[0376]  $A_{10} = 1.506E-03$ ,  $A_{12} = 5.856E-04$ ,  $A_{14} = 1.643E-04$ ,  $A_{16} = 1.317E-04$ 

[0377] 第6面

[0378]  $k = 0.000$ ,  $A_4 = -3.486E-02$ ,  $A_6 = 1.909E-03$ ,  $A_8 = 2.397E-03$ ,[0379]  $A_{10} = 2.932E-04$ ,  $A_{12} = -1.362E-05$ ,  $A_{14} = 1.947E-04$ ,  $A_{16} = -3.844E-05$ 

[0380] 第7面

[0381]  $k = 0.000$ ,  $A_4 = -1.544E-02$ ,  $A_6 = -1.150E-02$ ,  $A_8 = 7.726E-03$ ,[0382]  $A_{10} = -3.196E-04$ ,  $A_{12} = -3.360E-03$ ,  $A_{14} = 1.780E-03$ ,  $A_{16} = -2.839E-04$ 

[0383] 第8面

[0384]  $k = 0.000$ ,  $A_4 = -9.514E-03$ ,  $A_6 = 8.817E-03$ ,  $A_8 = -1.361E-03$ ,[0385]  $A_{10} = -3.560E-03$ ,  $A_{12} = 2.668E-03$ ,  $A_{14} = -6.826E-04$ ,  $A_{16} = 6.002E-05$ 

[0386] 第9面

[0387]  $k = 0.000$ ,  $A_4 = -1.786E-02$ ,  $A_6 = 6.056E-03$ ,  $A_8 = -4.587E-03$ ,[0388]  $A_{10} = -2.595E-04$ ,  $A_{12} = 8.166E-04$ ,  $A_{14} = -2.182E-04$ ,  $A_{16} = 1.859E-05$ 

[0389] 第10面

[0390]  $k = 0.000$ ,  $A_4 = -1.829E-02$ ,  $A_6 = -1.818E-03$ ,  $A_8 = -9.221E-05$ ,

[0391]  $A_{10} = 9.675\text{E-}06$ ,  $A_{12} = 1.590\text{E-}05$ ,  $A_{14} = 2.459\text{E-}06$ ,  $A_{16} = -5.978\text{E-}07$

[0392] 第 11 面

[0393]  $k = 0.000$ ,  $A_4 = -3.668\text{E-}02$ ,  $A_6 = 1.601\text{E-}03$ ,  $A_8 = 1.713\text{E-}04$ ,

[0394]  $A_{10} = 1.451\text{E-}05$ ,  $A_{12} = 1.972\text{E-}06$ ,  $A_{14} = 2.845\text{E-}07$ ,  $A_{16} = -1.146\text{E-}07$

[0395] 第 12 面

[0396]  $k = 0.000$ ,  $A_4 = -7.337\text{E-}03$ ,  $A_6 = -8.988\text{E-}04$ ,  $A_8 = 7.228\text{E-}05$ ,

[0397]  $A_{10} = 2.606\text{E-}07$ ,  $A_{12} = -1.753\text{E-}06$ ,  $A_{14} = -1.417\text{E-}07$ ,  $A_{16} = 2.780\text{E-}08$

[0398] 第 13 面

[0399]  $k = 0.000$ ,  $A_4 = -3.009\text{E-}02$ ,  $A_6 = 8.104\text{E-}03$ ,  $A_8 = -1.311\text{E-}03$ ,

[0400]  $A_{10} = 1.031\text{E-}04$ ,  $A_{12} = -1.212\text{E-}05$ ,  $A_{14} = 1.653\text{E-}06$ ,  $A_{16} = -7.866\text{E-}08$

[0401] 第 14 面

[0402]  $k = 0.000$ ,  $A_4 = -5.724\text{E-}02$ ,  $A_6 = 9.863\text{E-}03$ ,  $A_8 = -1.759\text{E-}03$ ,

[0403]  $A_{10} = 2.354\text{E-}04$ ,  $A_{12} = -2.034\text{E-}05$ ,  $A_{14} = 9.676\text{E-}07$ ,  $A_{16} = -1.898\text{E-}08$

[0404]  $f_1 = 4.36\text{mm}$

[0405]  $f_2 = -13.87\text{mm}$

[0406]  $f_3 = -65.73\text{mm}$

[0407]  $f_4 = 14.36\text{mm}$

[0408]  $f_5 = -23.01\text{mm}$

[0409]  $f_6 = -58.33\text{mm}$

[0410]  $f_7 = -8.46\text{mm}$

[0411]  $f_{23} = -11.41\text{mm}$

[0412]  $f_{45} = 36.40\text{mm}$

[0413]  $f_{67} = -7.41\text{mm}$

[0414] 以下表示各条件式的值。

[0415]  $f_{23}/f_1 = -2.62$

[0416]  $f_2/f_3 = 0.21$

[0417]  $f_1/f = 0.66$

[0418]  $f_{45}/f_{67} = -4.91$

[0419]  $f_{67}/f = -1.13$

[0420]  $f_4/f = 2.18$

[0421]  $f_7/f = -1.29$

[0422]  $D_{23}/f = 0.050$

[0423]  $D_{34}/f = 0.19$

[0424] 这样,本数值实施例 4 的摄像镜头满足上述各条件式。从第一透镜 L1 的物体侧的面到像面 IM 为止的光轴上的距离(滤光片 10 是空气换算长度)是 6.92mm,实现了摄像镜头的小型化。

[0425] 图 11 关于数值实施例 4 的摄像镜头,表示出与像高比 H 对应的横像差,图 12 分别表示出球面像差(mm)、像散(mm)以及畸变(%)。如图 11 和图 12 所示,通过本数值实施例 4 的摄像镜头也良好地修正了各像差。

[0426] 数值实施例 5

[0427] 以下表示基本镜头数据。

[0428]  $f = 5.58\text{mm}$ 、 $Fno = 2.3$ 、 $\omega = 35.6^\circ$

[0429] 单位 mm

[0430] 面数据

[0431]

| 面编号 i   | r        | d            | nd     | $\nu$ d           |
|---------|----------|--------------|--------|-------------------|
| (物面)    | $\infty$ | $\infty$     |        |                   |
| 1* (光阑) | 1.975    | 0.875        | 1.5346 | 56.1 (= $\nu$ d1) |
| 2*      | 21.088   | 0.056        |        |                   |
| 3*      | 64.594   | 0.300        | 1.6355 | 24.0 (= $\nu$ d2) |
| 4*      | 7.407    | 0.425 (=D23) |        |                   |
| 5*      | -36.756  | 0.518        | 1.6355 | 24.0 (= $\nu$ d3) |
| [0432]  |          |              |        |                   |
| 6*      | 71.409   | 0.204 (=D34) |        |                   |
| 7*      | -13.891  | 0.481        | 1.5346 | 56.1 (= $\nu$ d4) |
| 8*      | -4.859   | 0.138        |        |                   |
| 9*      | 12.382   | 0.510        | 1.6355 | 24.0 (= $\nu$ d5) |
| 10*     | 6.912    | 0.224        |        |                   |
| 11*     | 27.816   | 0.601        | 1.5346 | 56.1 (= $\nu$ d6) |
| 12*     | 8.508    | 0.231        |        |                   |
| 13*     | 7.135    | 0.995        | 1.5346 | 56.1 (= $\nu$ d7) |
| 14*     | 3.387    | 0.200        |        |                   |
| 15      | $\infty$ | 0.200        | 1.5168 | 64.2              |
| 16      | $\infty$ | 0.576        |        |                   |
| (像面)    | $\infty$ |              |        |                   |

[0433] 非球面数据

[0434] 第 1 面

[0435]  $k = 0.000$ ,  $A_4 = 4.278\text{E-}04$ ,  $A_6 = -1.403\text{E-}03$ ,  $A_8 = -4.651\text{E-}04$ ,

[0436]  $A_{10} = -1.011\text{E-}03$ ,  $A_{12} = 7.232\text{E-}04$ ,  $A_{14} = -2.463\text{E-}04$ ,  $A_{16} = -2.287\text{E-}04$

[0437] 第 2 面

[0438]  $k = 0.000$ ,  $A_4 = -6.203\text{E-}02$ ,  $A_6 = 3.291\text{E-}02$ ,  $A_8 = -2.600\text{E-}03$ ,

[0439]  $A_{10} = -4.935\text{E-}03$ ,  $A_{12} = -1.725\text{E-}03$ ,  $A_{14} = 1.706\text{E-}04$ ,  $A_{16} = 4.540\text{E-}04$

- [0440] 第 3 面
- [0441]  $k = 0.000$ ,  $A_4 = -6.750E-02$ ,  $A_6 = 6.133E-02$ ,  $A_8 = -8.453E-03$ ,
- [0442]  $A_{10} = -5.173E-03$ ,  $A_{12} = -9.866E-04$ ,  $A_{14} = 6.041E-04$ ,  $A_{16} = 4.871E-04$
- [0443] 第 4 面
- [0444]  $k = 0.000$ ,  $A_4 = -1.742E-02$ ,  $A_6 = 3.662E-02$ ,  $A_8 = -2.816E-03$ ,
- [0445]  $A_{10} = -2.223E-03$ ,  $A_{12} = 1.767E-03$ ,  $A_{14} = 6.276E-04$ ,  $A_{16} = 1.073E-04$
- [0446] 第 5 面
- [0447]  $k = 0.000$ ,  $A_4 = -4.626E-02$ ,  $A_6 = 6.154E-03$ ,  $A_8 = 4.691E-03$ ,
- [0448]  $A_{10} = 2.075E-03$ ,  $A_{12} = 5.021E-04$ ,  $A_{14} = -1.188E-04$ ,  $A_{16} = -2.322E-05$
- [0449] 第 6 面
- [0450]  $k = 0.000$ ,  $A_4 = -4.184E-02$ ,  $A_6 = 4.595E-03$ ,  $A_8 = 6.699E-03$ ,
- [0451]  $A_{10} = 3.035E-04$ ,  $A_{12} = -7.876E-05$ ,  $A_{14} = 2.209E-04$ ,  $A_{16} = 1.587E-05$
- [0452] 第 7 面
- [0453]  $k = 0.000$ ,  $A_4 = -3.634E-03$ ,  $A_6 = -3.239E-03$ ,  $A_8 = 6.387E-03$ ,
- [0454]  $A_{10} = -2.848E-04$ ,  $A_{12} = -3.207E-03$ ,  $A_{14} = 1.763E-03$ ,  $A_{16} = -2.880E-04$
- [0455] 第 8 面
- [0456]  $k = 0.000$ ,  $A_4 = 1.463E-02$ ,  $A_6 = 7.468E-03$ ,  $A_8 = -1.421E-03$ ,
- [0457]  $A_{10} = -3.737E-03$ ,  $A_{12} = 2.610E-03$ ,  $A_{14} = -6.962E-04$ ,  $A_{16} = 6.206E-05$
- [0458] 第 9 面
- [0459]  $k = 0.000$ ,  $A_4 = -1.642E-02$ ,  $A_6 = -2.897E-03$ ,  $A_8 = -2.927E-03$ ,
- [0460]  $A_{10} = -1.681E-04$ ,  $A_{12} = 7.413E-04$ ,  $A_{14} = -2.229E-04$ ,  $A_{16} = 2.081E-05$
- [0461] 第 10 面
- [0462]  $k = 0.000$ ,  $A_4 = -2.260E-02$ ,  $A_6 = -1.110E-03$ ,  $A_8 = -2.878E-05$ ,
- [0463]  $A_{10} = 1.538E-05$ ,  $A_{12} = 1.588E-05$ ,  $A_{14} = 2.340E-06$ ,  $A_{16} = -6.326E-07$
- [0464] 第 11 面
- [0465]  $k = 0.000$ ,  $A_4 = -2.844E-02$ ,  $A_6 = 1.759E-03$ ,  $A_8 = 1.481E-04$ ,
- [0466]  $A_{10} = 1.121E-05$ ,  $A_{12} = 1.397E-06$ ,  $A_{14} = 2.517E-07$ ,  $A_{16} = -1.012E-07$
- [0467] 第 12 面
- [0468]  $k = 0.000$ ,  $A_4 = -6.661E-03$ ,  $A_6 = -6.014E-04$ ,  $A_8 = -6.966E-06$ ,
- [0469]  $A_{10} = 3.555E-06$ ,  $A_{12} = -6.631E-08$ ,  $A_{14} = -1.040E-07$ ,  $A_{16} = 1.185E-08$
- [0470] 第 13 面
- [0471]  $k = 0.000$ ,  $A_4 = -3.493E-02$ ,  $A_6 = 8.293E-03$ ,  $A_8 = -1.304E-03$ ,
- [0472]  $A_{10} = 1.039E-04$ ,  $A_{12} = -1.200E-05$ ,  $A_{14} = 1.657E-06$ ,  $A_{16} = -7.841E-08$
- [0473] 第 14 面
- [0474]  $k = 0.000$ ,  $A_4 = -4.589E-02$ ,  $A_6 = 8.687E-03$ ,  $A_8 = -1.777E-03$ ,
- [0475]  $A_{10} = 2.358E-04$ ,  $A_{12} = -2.035E-05$ ,  $A_{14} = 9.675E-07$ ,  $A_{16} = -1.964E-08$
- [0476]  $f1 = 4.01\text{mm}$
- [0477]  $f2 = -13.19\text{mm}$
- [0478]  $f3 = -38.11\text{mm}$

[0479]  $f_4 = 13.72_{\text{mm}}$

[0480] f5 = -25.55mm

[0481] f6 = -23.18mm

[0482] f7 = -13.29mm

[0483] f23 = -9.70mm

[0484]  $f_{45} = 27.98\text{mm}$

[0485] f67 = -8.13mm

[0486] 以下表示各条件式的值。

[0487]  $f_{23}/f_1 = -2.42$

[0488]  $f_2/f_3 = 0.35$

[0489]  $f_1/f = 0.72$

[0490]  $f_{45}/f_{67} = -3.44$

[0491]  $f_{67}/f = -1.46$

[0492]  $f_4/f = 2.46$

[0493]  $f_7/f = -2.38$

[0494]  $D_{23}/f = 0.076$

[0495]  $D34/f = 0.037$

[0496] 这样,本数值实施例 5 的摄像镜头满足上述各条件式。从第一透镜 L1 的物体侧的面到像面 IM 为止的光轴上的距离(滤光片 10 是空气换算长度)是 6.47mm,实现了摄像镜头的小型化。

[0497] 图 14 关于数值实施例 5 的摄像镜头,表示出与像高比 H 对应的横像差,图 15 分别表示出球面像差 (mm)、像散 (mm) 以及畸变 (%)。如图 14 和图 15 所示,通过本数值实施例 5 的摄像镜头也良好地修正了各像差。

[0498] 数值实施例 6

[0499] 以下表示基本镜头数据。

[0500]  $f = 7.33\text{mm}$ 、 $F_{\text{No}} = 4.1$ 、 $\omega = 28.6^\circ$

[0501] 単位 mm

[0502] 面数据

[0503]

面编号 i                  r                  d                  nd                  v d

[0504]

| (物面)    | $\infty$ | $\infty$     |        |                   |
|---------|----------|--------------|--------|-------------------|
| 1* (光阑) | -44.829  | 0.512        | 1.5346 | 56.1 (= $\nu$ d1) |
| 2*      | -6.136   | 0.020        |        |                   |
| 3*      | 5.874    | 0.214        | 1.6355 | 24.0 (= $\nu$ d2) |
| 4*      | 4.901    | 0.293 (=D23) |        |                   |
| 5*      | 37.489   | 0.298        | 1.6355 | 24.0 (= $\nu$ d3) |
| 6*      | 23.846   | 0.256 (=D34) |        |                   |
| 7*      | 4.515    | 0.669        | 1.5346 | 56.1 (= $\nu$ d4) |
| 8*      | 41.011   | 1.923        |        |                   |
| 9*      | 5.751    | 0.510        | 1.6355 | 24.0 (= $\nu$ d5) |
| 10*     | 5.095    | 0.607        |        |                   |
| 11*     | 8.203    | 1.236        | 1.5346 | 56.1 (= $\nu$ d6) |
| 12*     | 5.378    | 0.995        |        |                   |
| 13*     | 36.754   | 0.547        | 1.5346 | 56.1 (= $\nu$ d7) |
| 14*     | 3.631    | 0.200        |        |                   |
| 15      | $\infty$ | 0.200        | 1.5168 | 64.2              |
| 16      | $\infty$ | 0.282        |        |                   |
| (像面)    | $\infty$ |              |        |                   |

[0505] 非球面数据

[0506] 第1面

[0507]  $k = 0.000$ ,  $A_4 = -1.873E-02$ ,  $A_6 = -1.109E-02$ ,  $A_8 = -4.570E-03$ ,

[0508]  $A_{10} = 5.137E-04$ ,  $A_{12} = 3.727E-03$ ,  $A_{14} = 1.298E-03$ ,  $A_{16} = -1.706E-03$

[0509] 第2面

[0510]  $k = 0.000$ ,  $A_4 = -8.151E-02$ ,  $A_6 = 2.883E-02$ ,  $A_8 = -4.255E-03$ ,

[0511]  $A_{10} = -2.454E-03$ ,  $A_{12} = -6.209E-04$ ,  $A_{14} = 1.801E-04$ ,  $A_{16} = 1.428E-03$

[0512] 第3面

[0513]  $k = 0.000$ ,  $A_4 = -7.671E-02$ ,  $A_6 = 4.679E-02$ ,  $A_8 = -1.249E-02$ ,

[0514]  $A_{10} = -3.500E-03$ ,  $A_{12} = 9.848E-04$ ,  $A_{14} = 8.817E-04$ ,  $A_{16} = -2.798E-04$

[0515] 第4面

[0516]  $k = 0.000$ ,  $A_4 = -4.097E-02$ ,  $A_6 = 2.460E-02$ ,  $A_8 = -6.438E-03$ ,

[0517]  $A_{10} = -3.589E-03$ ,  $A_{12} = 2.222E-04$ ,  $A_{14} = -1.119E-04$ ,  $A_{16} = 2.542E-04$

[0518] 第5面

[0519]  $k = 0.000$ ,  $A_4 = -6.469E-02$ ,  $A_6 = 1.564E-02$ ,  $A_8 = 2.618E-03$ ,

- [0520]  $A_{10} = -8.544\text{E-}04$ ,  $A_{12} = -7.128\text{E-}04$ ,  $A_{14} = -6.448\text{E-}05$ ,  $A_{16} = 2.675\text{E-}04$
- [0521] 第 6 面
- [0522]  $k = 0.000$ ,  $A_4 = -4.461\text{E-}02$ ,  $A_6 = 6.629\text{E-}04$ ,  $A_8 = 3.310\text{E-}03$ ,
- [0523]  $A_{10} = 3.010\text{E-}04$ ,  $A_{12} = -2.561\text{E-}04$ ,  $A_{14} = 4.397\text{E-}05$ ,  $A_{16} = -1.793\text{E-}07$
- [0524] 第 7 面
- [0525]  $k = 0.000$ ,  $A_4 = 5.814\text{E-}03$ ,  $A_6 = -1.035\text{E-}02$ ,  $A_8 = 4.677\text{E-}03$ ,
- [0526]  $A_{10} = -1.371\text{E-}04$ ,  $A_{12} = -2.909\text{E-}03$ ,  $A_{14} = 1.885\text{E-}03$ ,  $A_{16} = -4.024\text{E-}04$
- [0527] 第 8 面
- [0528]  $k = 0.000$ ,  $A_4 = -7.255\text{E-}03$ ,  $A_6 = 1.787\text{E-}03$ ,  $A_8 = -8.541\text{E-}04$ ,
- [0529]  $A_{10} = -3.526\text{E-}03$ ,  $A_{12} = 2.579\text{E-}03$ ,  $A_{14} = -7.317\text{E-}04$ ,  $A_{16} = 5.890\text{E-}05$
- [0530] 第 9 面
- [0531]  $k = 0.000$ ,  $A_4 = -2.248\text{E-}02$ ,  $A_6 = 5.783\text{E-}04$ ,  $A_8 = -2.280\text{E-}03$ ,
- [0532]  $A_{10} = -4.753\text{E-}04$ ,  $A_{12} = 7.297\text{E-}04$ ,  $A_{14} = -2.310\text{E-}04$ ,  $A_{16} = 2.496\text{E-}05$
- [0533] 第 10 面
- [0534]  $k = 0.000$ ,  $A_4 = -1.820\text{E-}02$ ,  $A_6 = -1.371\text{E-}03$ ,  $A_8 = -3.740\text{E-}06$ ,
- [0535]  $A_{10} = 2.744\text{E-}05$ ,  $A_{12} = 1.287\text{E-}05$ ,  $A_{14} = 2.924\text{E-}06$ ,  $A_{16} = -6.523\text{E-}07$
- [0536] 第 11 面
- [0537]  $k = 0.000$ ,  $A_4 = -2.330\text{E-}02$ ,  $A_6 = 9.404\text{E-}04$ ,  $A_8 = 1.272\text{E-}04$ ,
- [0538]  $A_{10} = 1.381\text{E-}06$ ,  $A_{12} = 8.022\text{E-}07$ ,  $A_{14} = 2.478\text{E-}07$ ,  $A_{16} = -7.384\text{E-}08$
- [0539] 第 12 面
- [0540]  $k = 0.000$ ,  $A_4 = -1.368\text{E-}02$ ,  $A_6 = -5.267\text{E-}04$ ,  $A_8 = 2.149\text{E-}05$ ,
- [0541]  $A_{10} = 6.717\text{E-}06$ ,  $A_{12} = -9.850\text{E-}07$ ,  $A_{14} = -1.166\text{E-}07$ ,  $A_{16} = 1.921\text{E-}08$
- [0542] 第 13 面
- [0543]  $k = 0.000$ ,  $A_4 = -4.044\text{E-}02$ ,  $A_6 = 8.363\text{E-}03$ ,  $A_8 = -1.297\text{E-}03$ ,
- [0544]  $A_{10} = 1.043\text{E-}04$ ,  $A_{12} = -1.196\text{E-}05$ ,  $A_{14} = 1.664\text{E-}06$ ,  $A_{16} = -7.712\text{E-}08$
- [0545] 第 14 面
- [0546]  $k = 0.000$ ,  $A_4 = -4.735\text{E-}02$ ,  $A_6 = 8.446\text{E-}03$ ,  $A_8 = -1.735\text{E-}03$ ,
- [0547]  $A_{10} = 2.391\text{E-}04$ ,  $A_{12} = -2.016\text{E-}05$ ,  $A_{14} = 9.641\text{E-}07$ ,  $A_{16} = -2.056\text{E-}08$
- [0548]  $f1 = 13.24\text{mm}$
- [0549]  $f2 = -50.93\text{mm}$
- [0550]  $f3 = -103.98\text{mm}$
- [0551]  $f4 = 9.43\text{mm}$
- [0552]  $f5 = -100.75\text{mm}$
- [0553]  $f6 = -34.46\text{mm}$
- [0554]  $f7 = -7.58\text{mm}$
- [0555]  $f23 = -34.17\text{mm}$
- [0556]  $f45 = 9.73\text{mm}$
- [0557]  $f67 = -6.28\text{mm}$
- [0558] 以下表示各条件式的值。

[0559]  $f_{23}/f_1 = -2.58$

[0560]  $f_2/f_3 = 0.49$

[0561]  $f_1/f = 1.81$

[0562]  $f_{45}/f_{67} = -1.55$

[0563]  $f_{67}/f = -0.86$

[0564]  $f_4/f = 1.29$

[0565]  $f_7/f = -1.03$

[0566]  $D_{23}/f = 0.040$

[0567]  $D_{34}/f = 0.035$

[0568] 这样,本数值实施例6的摄像镜头满足上述各条件式。从第一透镜L1的物体侧的面到像面IM为止的光轴上的距离(滤光片10是空气换算长度)是8.69mm,实现了摄像镜头的小型化。

[0569] 图17关于数值实施例6的摄像镜头,表示出与像高比H对应的横像差,图18分别表示出球面像差(mm)、像散(mm)以及畸变(%)。如图17和图18所示,通过本数值实施例6的摄像镜头也良好地修正了各像差。

[0570] 根据以上说明的本实施方式的摄像镜头,能够实现 $70^\circ$ 以上的广视场角( $2\omega$ )。顺便说,上述数值实施例1~6的摄像镜头具有 $57.2^\circ \sim 72.6^\circ$ 的广视场角。根据本实施方式的摄像镜头,能够拍摄比现有的摄像镜头更广的范围。

[0571] 另外,近年来,由于通过图像处理来放大通过摄像镜头得到的图像的任意区域的数字变焦技术的进步,高像素的摄像元件和高分辨率的摄像镜头组合起来的情况变多。在这样的高像素的摄像元件中,由于各像素的感光面积减小,因此所拍摄的图像有变暗的倾向。作为用于对其进行修正的方法,有使用电路提高摄像元件的感光灵敏度的方法。但是,若感光灵敏度提高,则不直接有助于图像形成的噪声成分也被放大,因此新需要用于降低噪声的电路。数值实施例1~5的摄像镜头的 $F_{no}$ 成为 $2.2 \sim 3.0$ 这样的小的值。根据本实施方式的摄像镜头,即使不设置上述电路等也能够得到足够明亮的图像。

[0572] 因此,在将上述实施方式的摄像镜头应用于内置在便携电话机、便携信息终端以及智能手机等便携设备中的摄像机、数码静物相机、安防摄像机、车载摄像机、网络摄像机等的摄像光学系统的情况下,能够实现该摄像机的高功能化和小型化的兼顾。

[0573] 产业利用性

[0574] 本实用新型能够应用于在内置于便携电话机、智能手机、便携信息终端等便携设备中的摄像机、数码静物相机、安防摄像机、车载摄像机、网络摄像机等比较小型的摄像机中装入的摄像镜头。

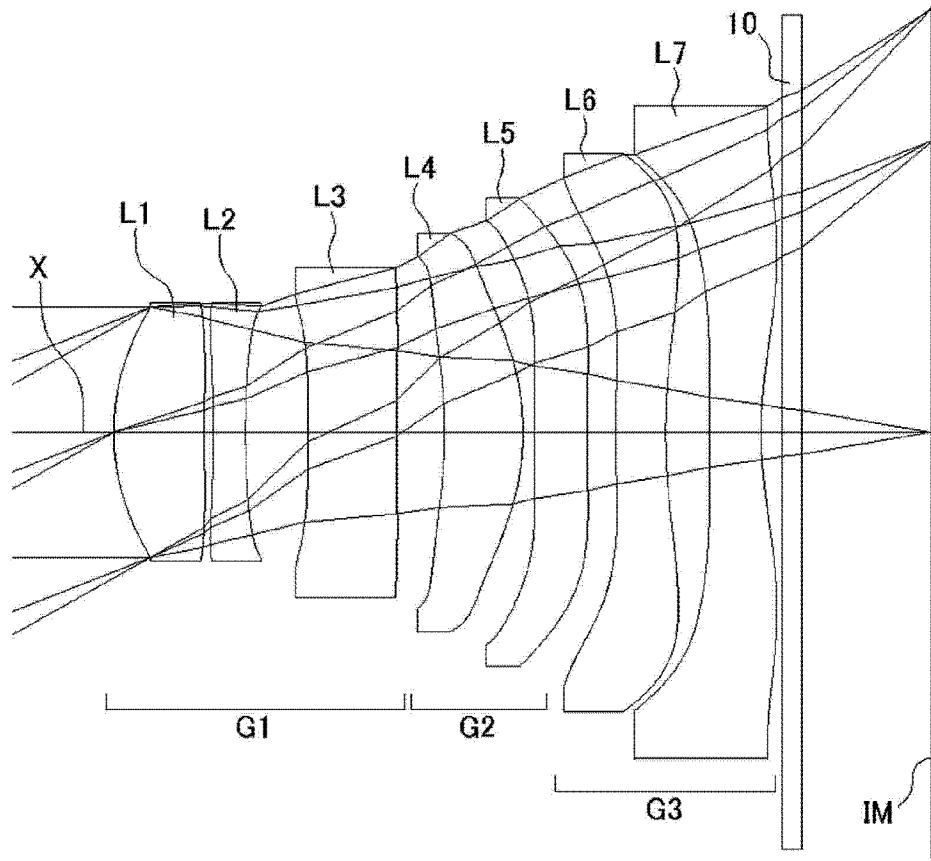


图 1

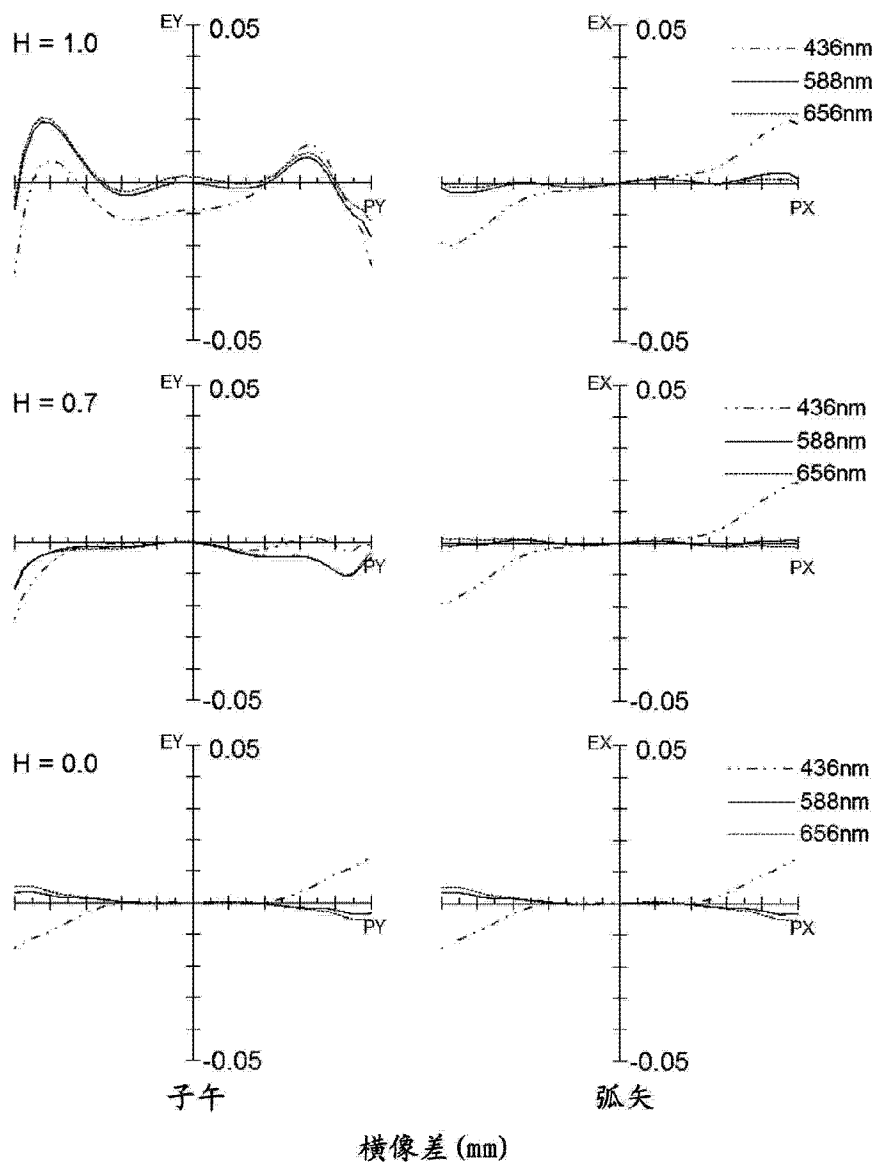


图 2

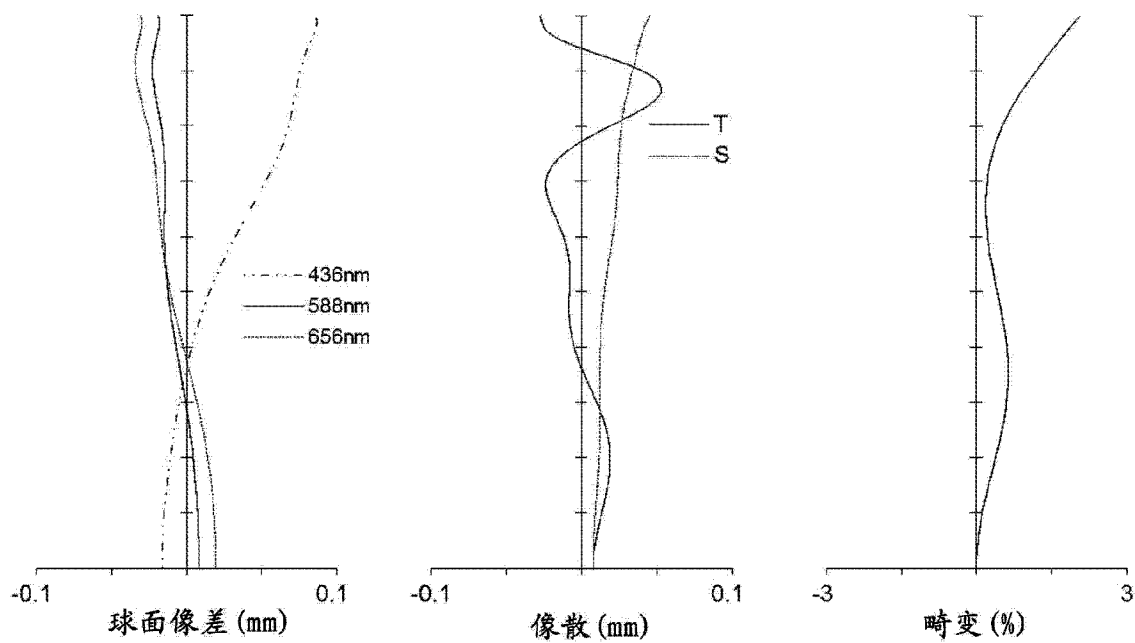


图 3

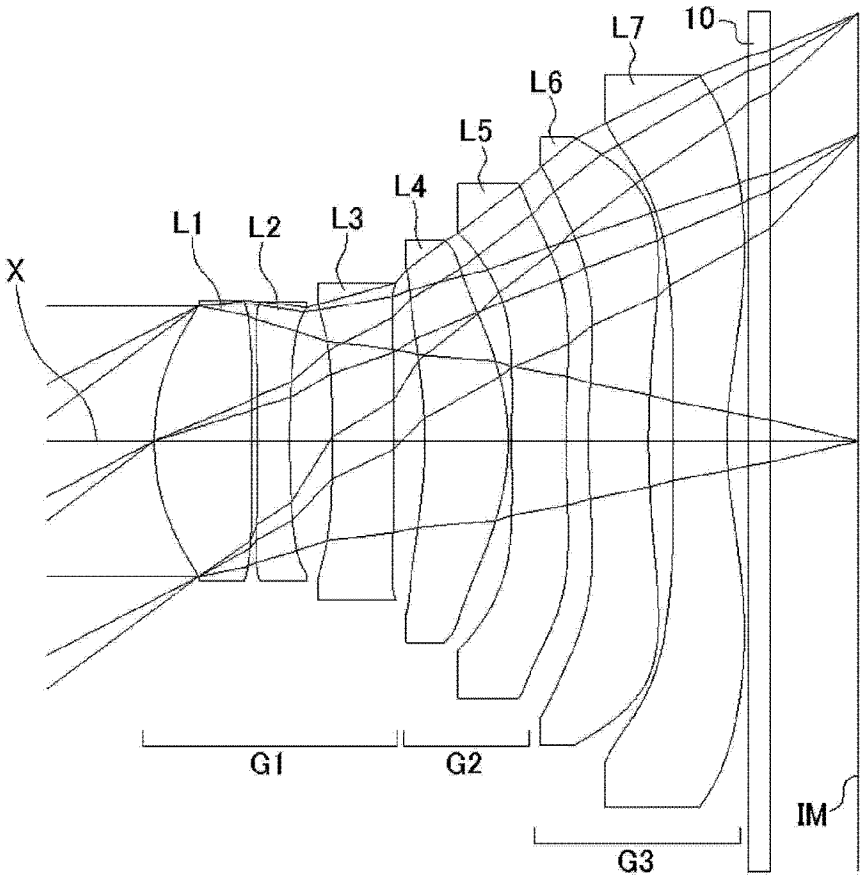


图 4

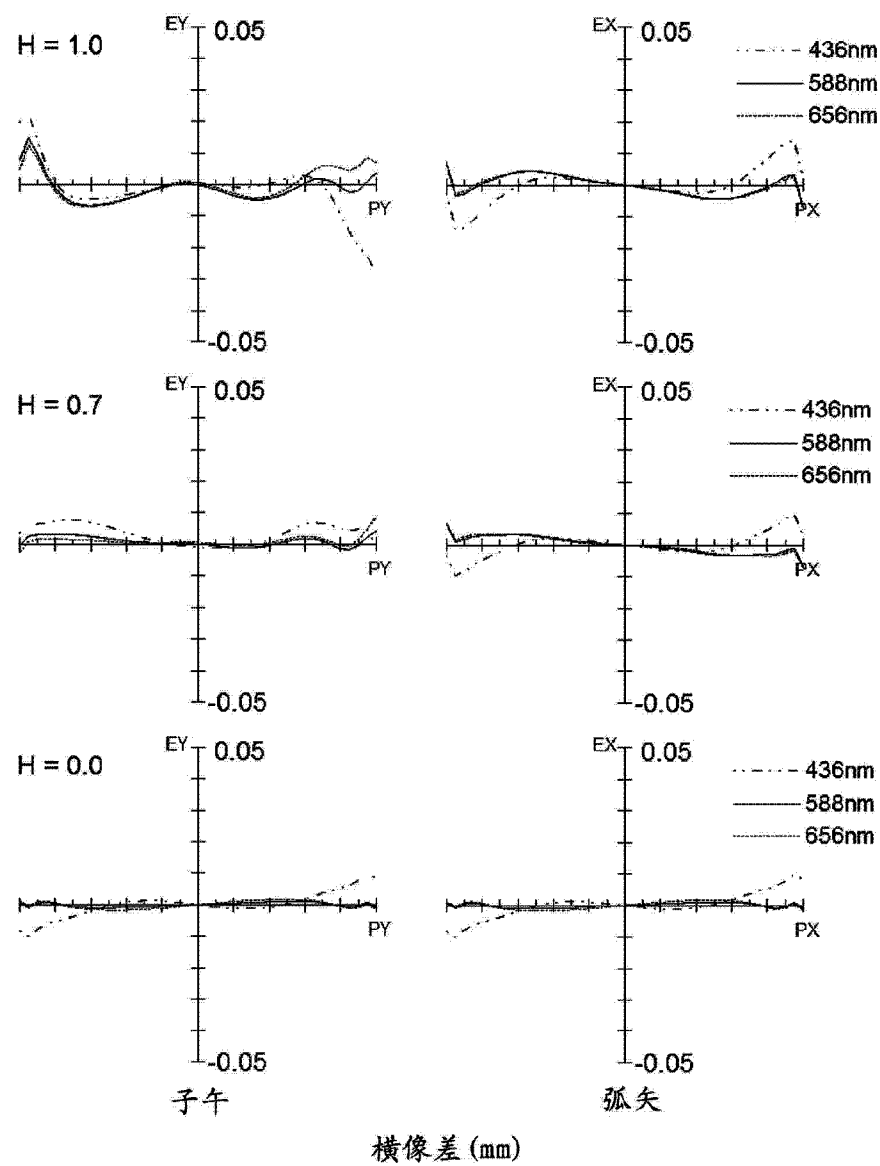


图 5

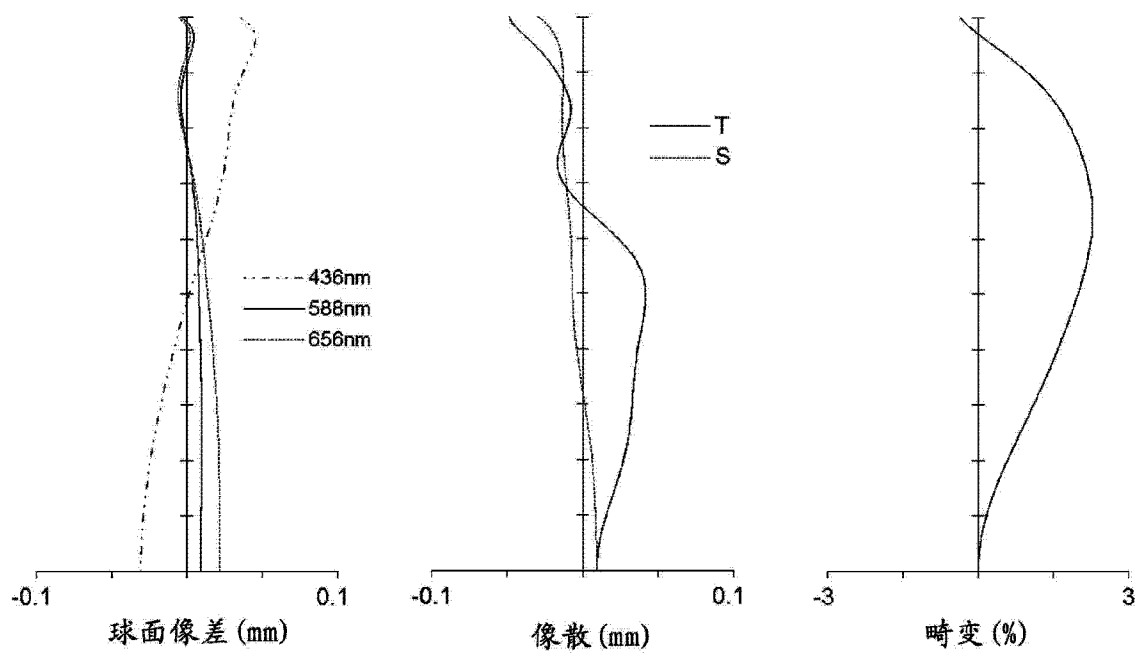


图 6

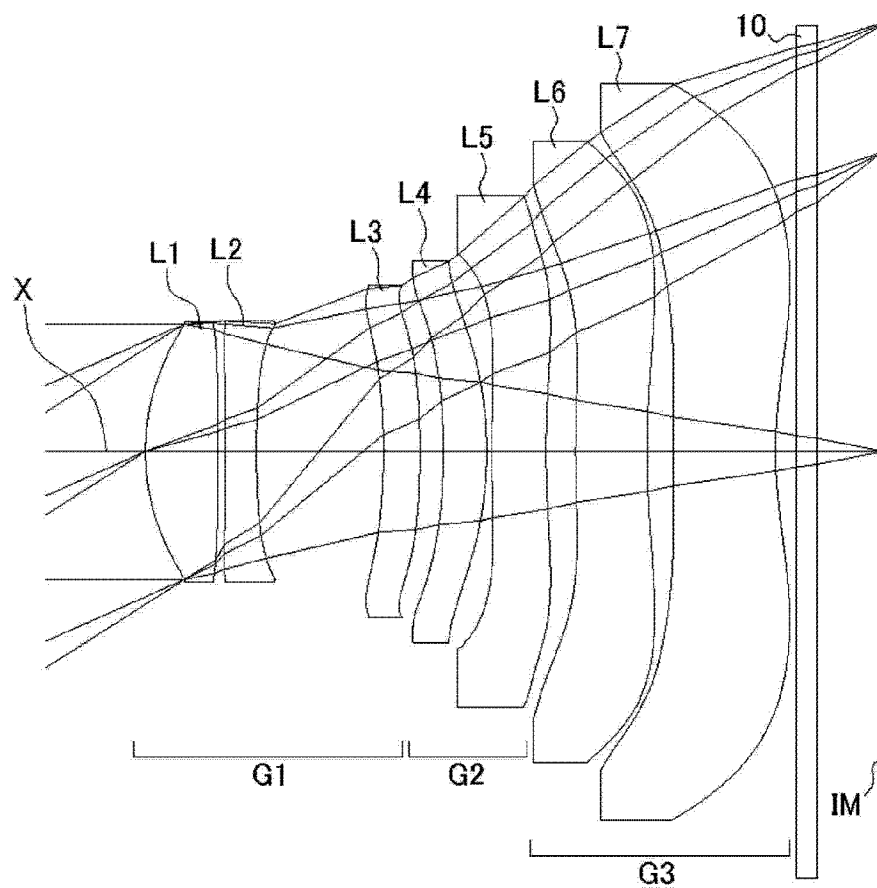


图 7

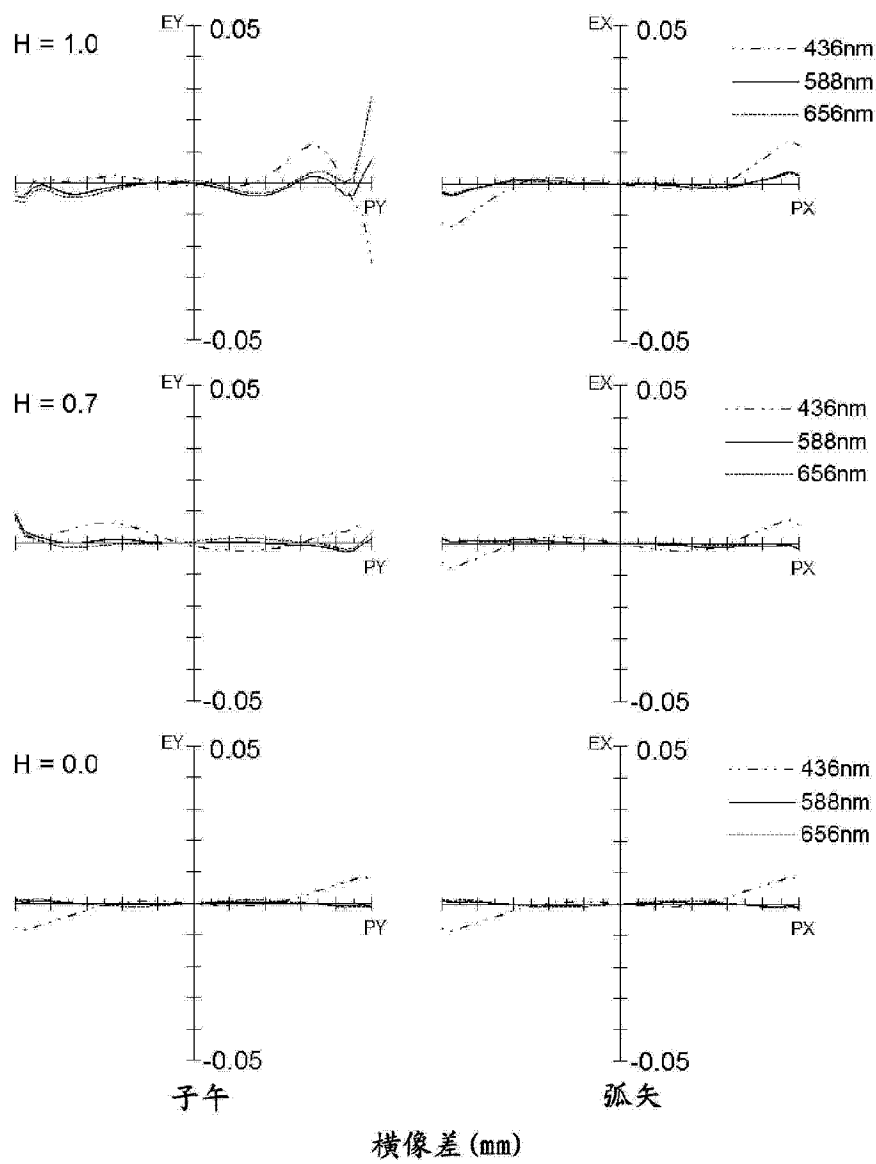


图 8

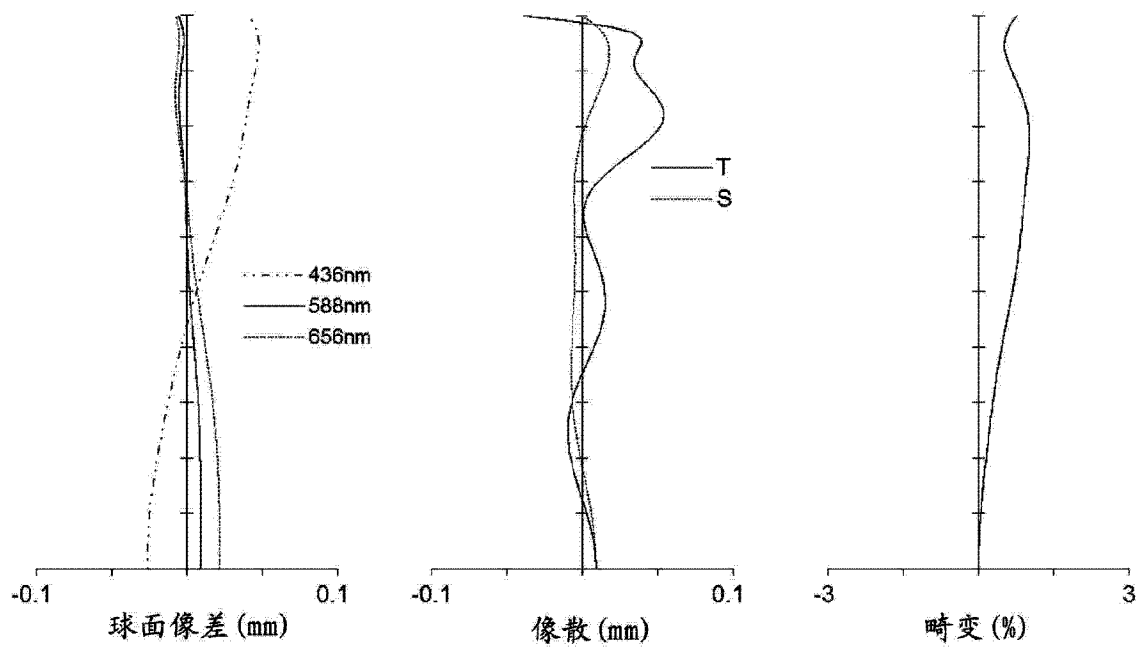


图 9

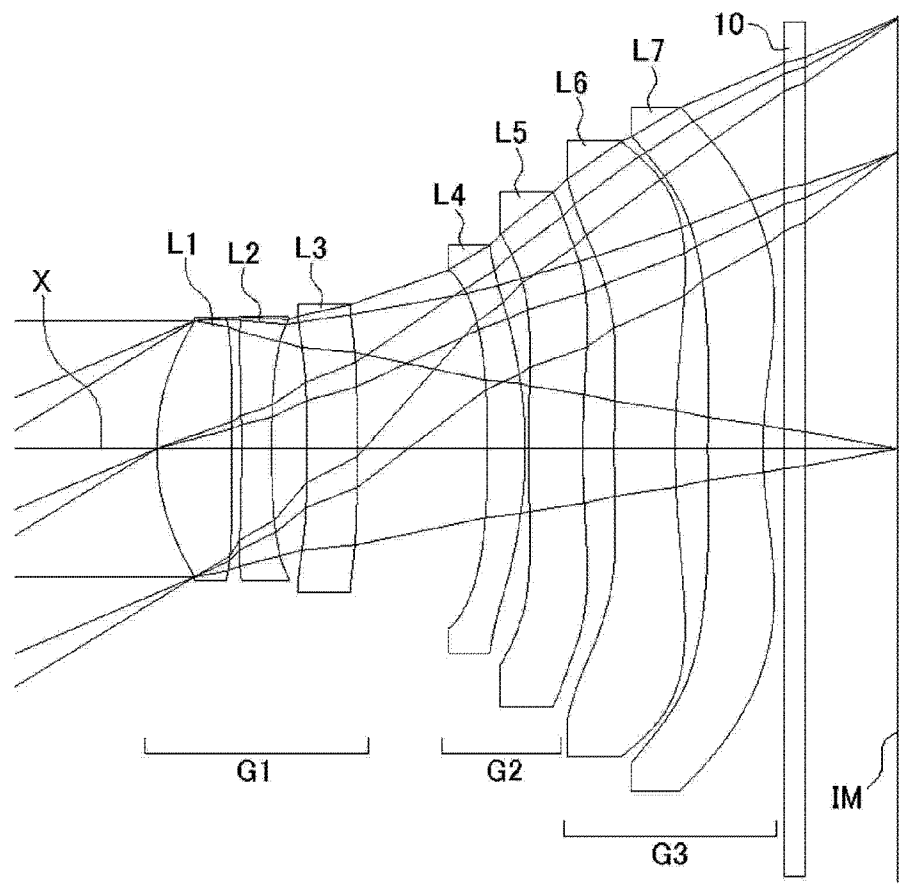


图 10

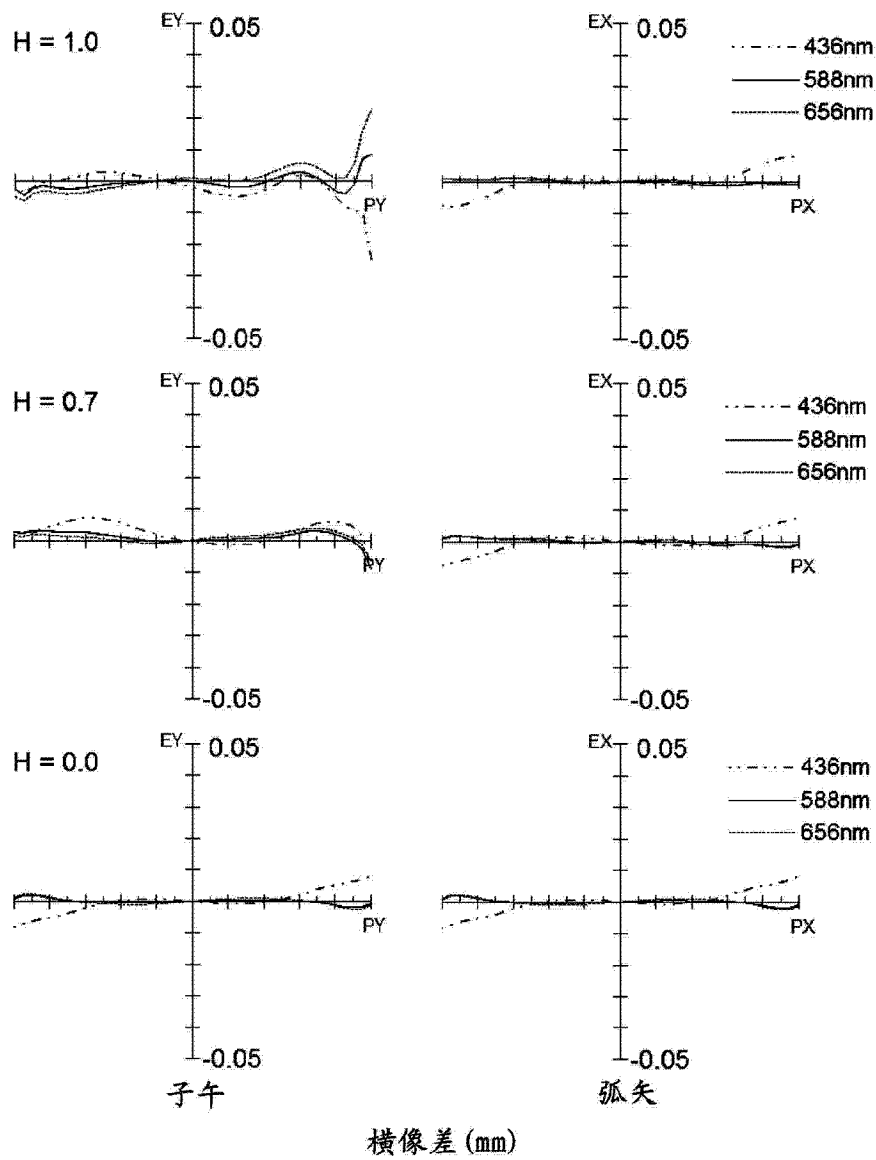


图 11

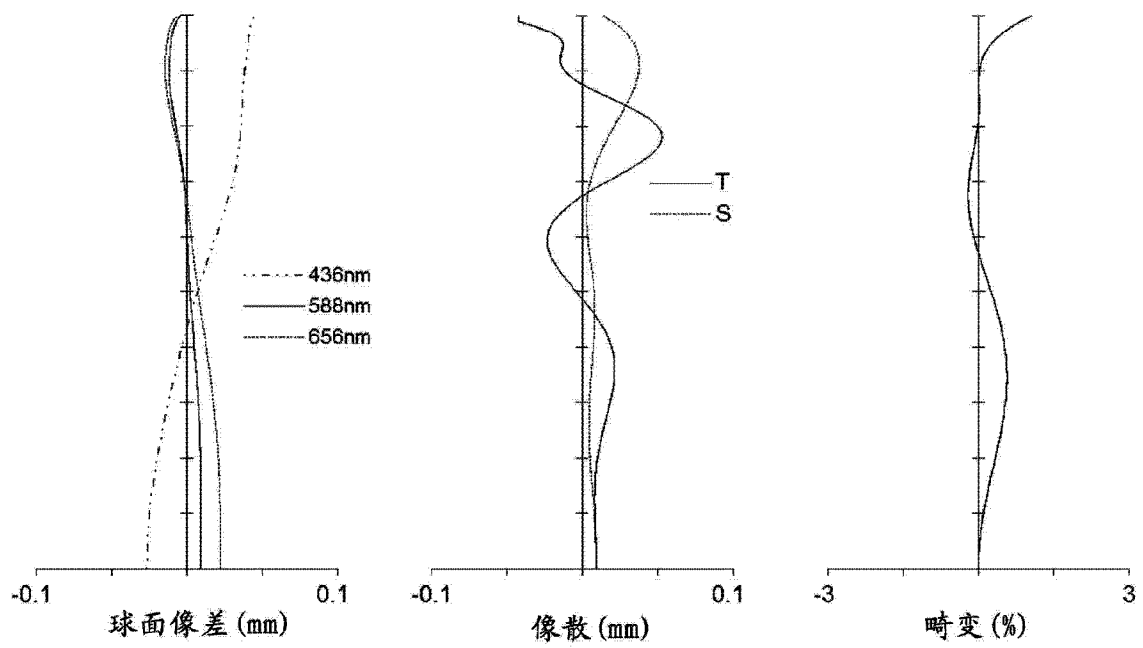


图 12

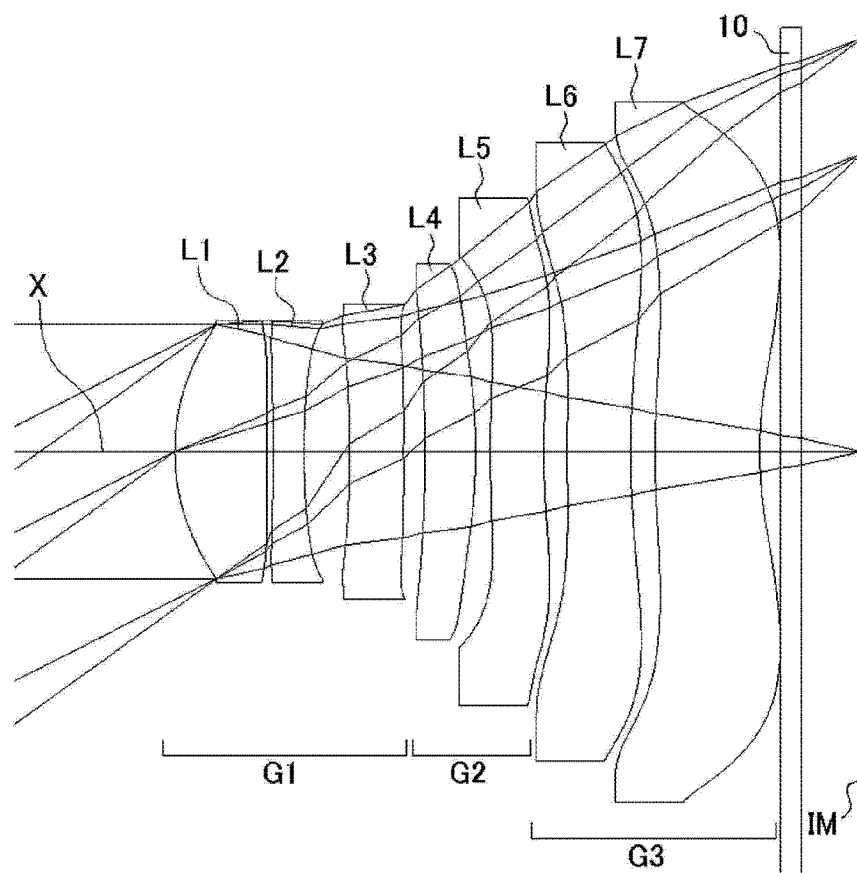


图 13

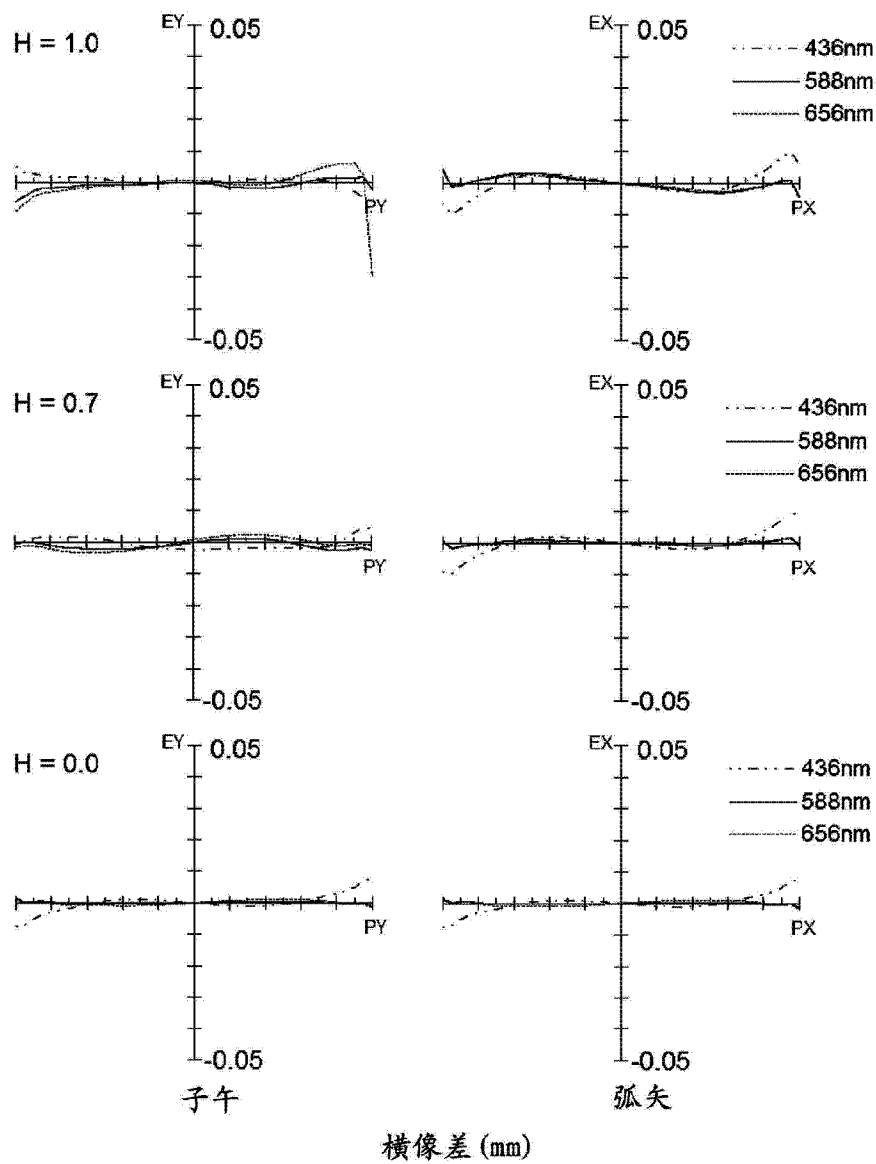


图 14

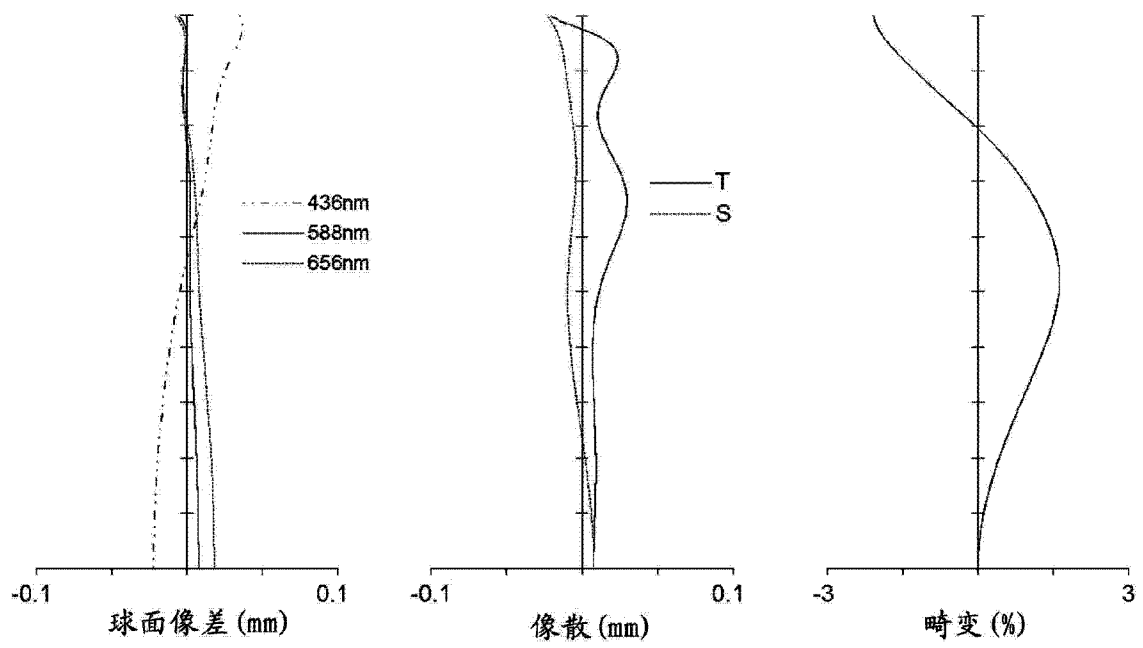


图 15

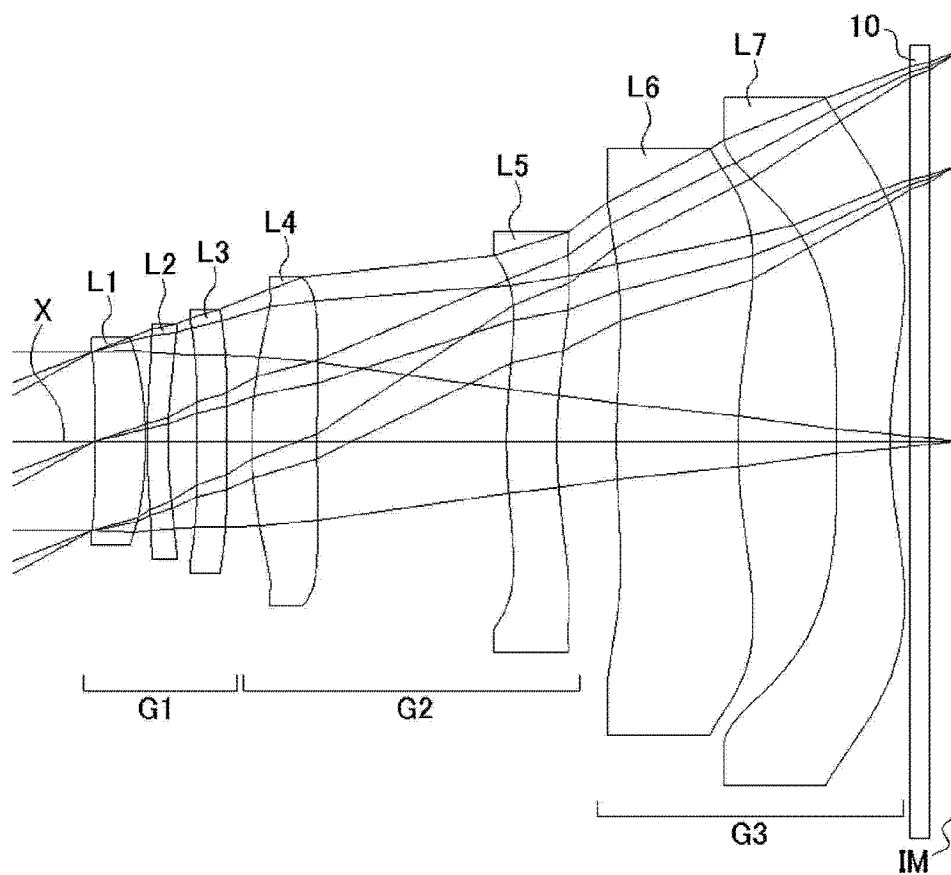


图 16

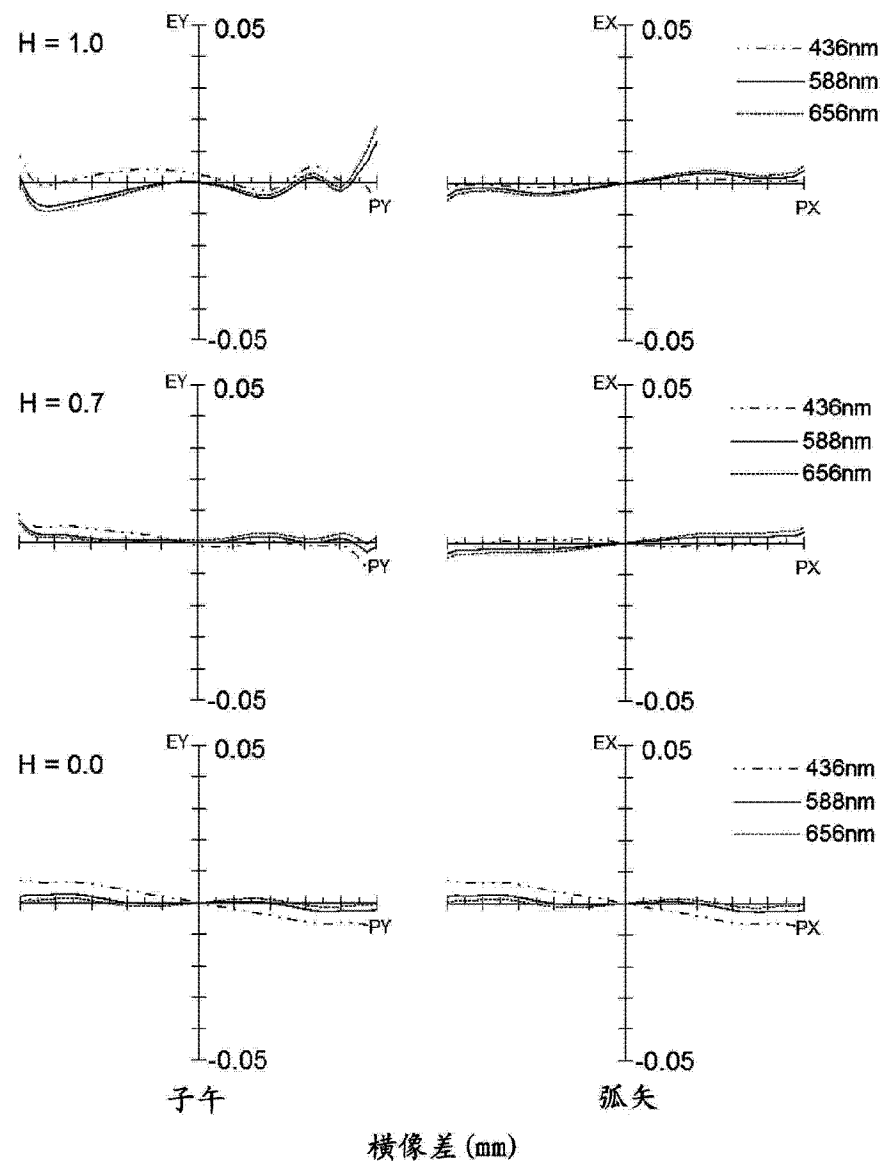


图 17

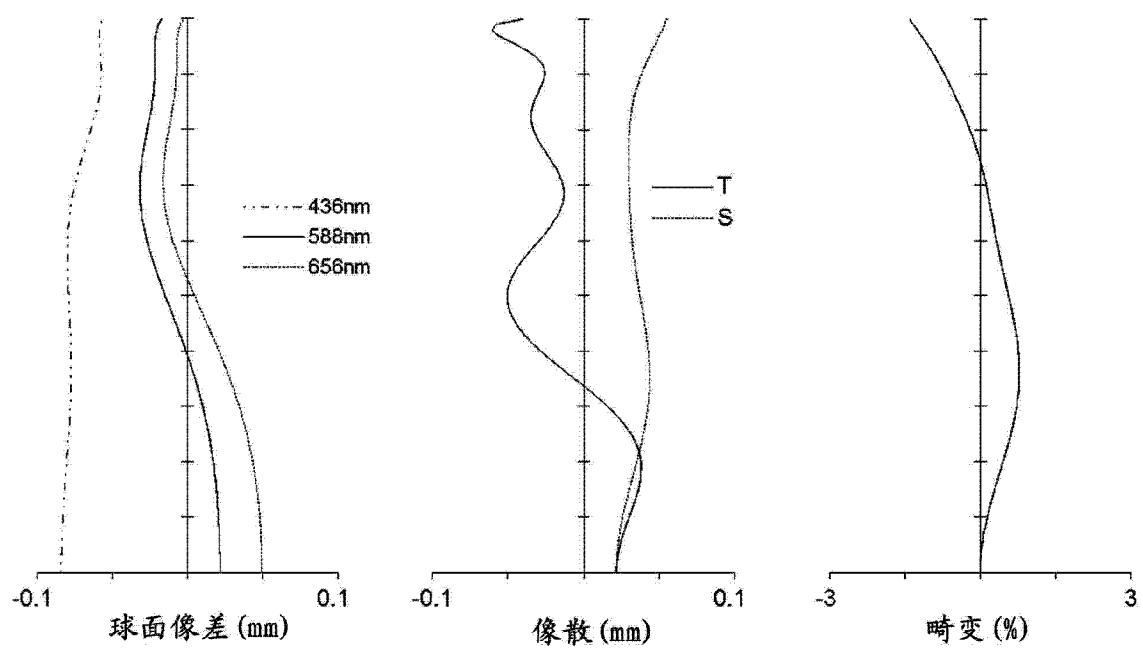


图 18

A compact camera capable of well correcting aberration, in order from an object side to an image side, includes a first lens group, a second lens group with positive refractive power and a third lens group with negative refractive power. The first lens group includes a first lens element with positive refractive power, a second lens element with negative refractive power and a third lens element with positive refractive power. The second lens group includes a fourth lens element with positive refractive power and a fifth lens element with positive refractive power. The third lens group includes a sixth lens element and a seventh lens element. Abbe numbers of the first through fifth lens elements are  $\nu d1$ ,  $\nu d2$ ,  $\nu d3$ ,  $\nu d4$  and  $\nu d5$ , respectively, and the following conditions are satisfied:  $40 < \nu d1 < 75$ ;  $20 < \nu d2 < 35$ ;  $40 < \nu d3 < 75$ ;  $40 < \nu d4 < 75$ ; and  $20 < \nu d5 < 35$ .



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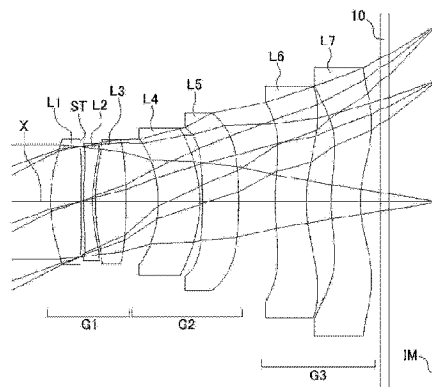
权利要求书2页 说明书27页 附图17页

(54) 实用新型名称

摄像镜头

(57) 摘要

本实用新型提供一种良好地修正各像差的小型摄像镜头。从物体侧开始依次配置正的第一透镜组(G1)、正的第二透镜组(G2)和负的第三透镜组(G3)来构成摄像镜头。第一透镜组(G1)由正的第一透镜(L1)、负的第二透镜(L2)和正的第三透镜(L3)构成。第二透镜组(G2)由正的第四透镜(L4)和正的第五透镜(L5)构成,第三透镜组(G3)由第六透镜(L6)和第七透镜(L7)构成。在将第一透镜(L1)~第三透镜(L3)、第四透镜(L4)以及第五透镜(L5)的阿贝数设为 $\nu d1$ 、 $\nu d2$ 、 $\nu d3$ 、 $\nu d4$ 以及 $\nu d5$ 时,该摄像镜头满足以下的各条件式。 $40<\nu d1<75$ 、 $20<\nu d2<35$ 、 $40<\nu d3<75$ 、 $40<\nu d4<75$ 、 $20<\nu d5<35$ 。



1. 一种摄像镜头,其特征在于,

从物体侧向像面侧依次配置具有正的光焦度的第一透镜组、具有正的光焦度的第二透镜组和具有负的光焦度的第三透镜组而构成,

上述第一透镜组由具有正的光焦度的第一透镜、具有负的光焦度的第二透镜和具有正的光焦度的第三透镜构成,

上述第二透镜组由具有正的光焦度的第四透镜和具有正的光焦度的第五透镜构成,

上述第三透镜组由第六透镜和第七透镜构成,

在将上述第一透镜的阿贝数设为  $v_{d1}$ ,将上述第二透镜的阿贝数设为  $v_{d2}$ ,将上述第三透镜的阿贝数设为  $v_{d3}$ ,将上述第四透镜的阿贝数设为  $v_{d4}$ ,将上述第五透镜的阿贝数设为  $v_{d5}$  时,满足:

$$40 < v_{d1} < 75$$

$$20 < v_{d2} < 35$$

$$40 < v_{d3} < 75$$

$$40 < v_{d4} < 75$$

$$20 < v_{d5} < 35。$$

2. 根据权利要求 1 所述的摄像镜头,其特征在于,

上述第六透镜和上述第七透镜都具有负的光焦度,

在将上述第六透镜的阿贝数设为  $v_{d6}$ ,将上述第七透镜的阿贝数设为  $v_{d7}$  时,满足:

$$20 < v_{d6} < 35$$

$$40 < v_{d7} < 75。$$

3. 根据权利要求 1 或 2 所述的摄像镜头,其特征在于,

在将上述第一透镜的焦距设为  $f_1$ ,将上述第三透镜的焦距设为  $f_3$  时,满足:

$$0.3 < f_3/f_1 < 3.0。$$

4. 根据权利要求 1 或 2 所述的摄像镜头,其特征在于,

在将上述第二透镜的焦距设为  $f_2$ ,将上述第三透镜的焦距设为  $f_3$  时,满足:

$$-3.0 < f_2/f_3 < -0.3。$$

5. 根据权利要求 1 或 2 所述的摄像镜头,其特征在于,

在将整个镜头系统的焦距设为  $f$ ,将上述第四透镜的焦距设为  $f_4$  时,满足:

$$4.5 < f_4/f < 9.0。$$

6. 根据权利要求 1 或 2 所述的摄像镜头,其特征在于,

在将整个镜头系统的焦距设为  $f$ ,将上述第四透镜和上述第五透镜的合成焦距设为  $f_{45}$  时,满足:

$$1.5 < f_{45}/f < 5.0。$$

7. 根据权利要求 1 或 2 所述的摄像镜头,其特征在于,

在将整个镜头系统的焦距设为  $f$ ,将上述第五透镜和上述第六透镜之间的光轴上的距离设为  $D_{56}$  时,满足:

$$0.05 < D_{56}/f < 0.25。$$

8. 根据权利要求 1 或 2 所述的摄像镜头,其特征在于,

在将整个镜头系统的焦距设为  $f$ ,将上述第七透镜的焦距设为  $f_7$  时,满足:

$-4.0 < f_7/f < -1.0$ 。

9. 根据权利要求 1 或 2 所述的摄像镜头,其特征在于,

在将上述第四透镜和上述第五透镜的合成焦距设为  $f_{45}$ ,将上述第六透镜和上述第七透镜的合成焦距设为  $f_{67}$  时,满足:

$-6.0 < f_{45}/f_{67} < -1.5$ 。

10. 根据权利要求 1 或 2 所述的摄像镜头,其特征在于,

在将整个镜头系统的焦距设为  $f$ ,将上述第三透镜和上述第四透镜之间的光轴上的距离设为  $D_{34}$  时,满足:

$0.05 < D_{34}/f < 0.3$ 。

11. 根据权利要求 1 或 2 所述的摄像镜头,其特征在于,

在将上述第六透镜的焦距设为  $f_6$ ,将上述第七透镜的焦距设为  $f_7$  时,满足:

$0.7 < f_6/f_7 < 1.4$ 。

## 摄像镜头

### 技术领域

[0001] 本实用新型涉及在 CCD 传感器、COMS 传感器等摄像元件上形成被摄体图像的摄像镜头,涉及适合于装入在便携电话机、便携信息终端等便携设备中内置的摄像机、数码静物相机、安防摄像机、车载摄像机、网络摄像机等比较小型的摄像机的摄像镜头。

### 背景技术

[0002] 近年来,代替以通话为主体的便携电话机,向便携电话机附加了便携信息终端(PDA)或个人计算机的功能的所谓的智能手机(smart phone)得到了普及。智能手机比便携电话机具有更高功能,因此在各种应用中利用通过摄像机拍摄所得的图像。

[0003] 一般,便携电话机、智能手机的产品群从面向初级者的产品到面向高级者的产品大多由各种规格的产品构成。其中,对于装入面向高级者开发出的产品的摄像镜头,要求还能够对应近年来高像素化的摄像元件的高分辨率的镜头结构。

[0004] 作为实现高分辨率的摄像镜头的方法之一,有增加构成摄像镜头的透镜的枚数的方法,但透镜枚数的增加容易造成摄像镜头的大型化,因此,透镜枚数多的镜头结构,不利于装入上述便携电话机、智能手机等的小型摄像机。因此,向尽量抑制透镜枚数的方向进行了摄像镜头的开发。但是,在摄像元件的高像素化技术明显进步的现今,在摄像镜头的开发中与缩短光学全长(Total Track Length)相比,开发的中心正在向实现高分辨率的镜头结构转移。作为一个例子,出现了不是如以前那样将包含摄像镜头和摄像元件的摄像单元装入便携电话机、智能手机等的内部,而是安装到这些便携电话机、智能手机等上,由此得到即使与数码静物相机相比也不逊色的图像的摄像单元。

[0005] 由 7 枚透镜构成的镜头结构,由于构成摄像镜头的透镜的枚数多,所以对于摄像镜头的小型化有若干不利,但设计上的自由度高,因此存在能够平衡良好地实现各像差的良好修正、摄像镜头的小型化的可能性。作为这样的 7 枚结构的摄像镜头,例如已知专利文献 1 所记载的摄像镜头。

[0006] 专利文献 1 所记载的摄像镜头,从物体侧开始依次配置双凸形状的第一透镜、与该第一透镜接合的双凹形状的第二透镜、将凸面朝向物体侧的弯月形状的负的第三透镜、将凹面朝向物体侧的弯月形状的正的第四透镜、将凸面朝向物体侧的负的第五透镜、双凸形状的第六透镜、双凹形状的第七透镜而构成。在专利文献 1 的摄像镜头中,通过将由第一透镜至第四透镜的透镜构成的第一透镜组的焦距与由第五透镜至第七透镜的透镜构成的第二透镜组的焦距之比抑制在一定的范围内,来实现摄像镜头的小型化和各像差的良好修正。

[0007] 但是,上述专利文献 1 所记载的摄像镜头虽然小型,但像面的修正不充分,特别是畸变比较大,因此在实现高性能的摄像镜头方面自然产生限制。在上述专利文献 1 所记载的镜头结构中,难以在实现摄像镜头的小型化的同时实现良好的像差修正。

[0008] 此外,这样的问题并不是装入便携电话机、智能手机中的摄像镜头所特有的问题,在装入数码静物相机、便携信息终端、安防摄像机、车载摄像机、网络摄像机等比较小型的

摄像机的摄像镜头中也是共通的问题。

[0009] 现有技术文献

[0010] 专利文献

[0011] 专利文献 1 : 日本特开 2012-155223 号公报

### 实用新型内容

[0012] 本实用新型的目的在于,提供一种能够实现摄像镜头的小型化和良好的像差修正的兼顾的摄像镜头。

[0013] 为了达成上述目的,本实用新型的摄像镜头从物体侧向像面侧依次配置具有正的光焦度的第一透镜组、具有正的光焦度的第二透镜组、具有负的光焦度的第三透镜组而构成。第一透镜组由具有正的光焦度的第一透镜、具有负的光焦度的第二透镜、具有正的光焦度的第三透镜构成。第二透镜组由具有正的光焦度的第四透镜和具有正的光焦度的第五透镜构成,另外,第三透镜组由第六透镜和第七透镜构成。另外,在将第一透镜的阿贝数设为  $v_{d1}$ ,将第二透镜的阿贝数设为  $v_{d2}$ ,将第三透镜的阿贝数设为  $v_{d3}$ ,将第四透镜的阿贝数设为  $v_{d4}$ ,将第五透镜的阿贝数设为  $v_{d5}$  时,本实用新型的摄像镜头满足以下的条件式 (1) ~ (5)。

[0014]  $40 < v_{d1} < 75$  (1)

[0015]  $20 < v_{d2} < 35$  (2)

[0016]  $40 < v_{d3} < 75$  (3)

[0017]  $40 < v_{d4} < 75$  (4)

[0018]  $20 < v_{d5} < 35$  (5)

[0019] 本实用新型的摄像镜头为从物体侧开始依次配置具有正的光焦度的第一透镜组、同样具有正的光焦度的第二透镜组、具有负的光焦度的第三透镜组的结构,为各透镜组的光焦度的排列从物体侧开始为“正、正、负”的镜头结构。一般通过从物体侧开始依次具有正的光焦度的透镜组和具有负的光焦度的透镜组的组合来进行色像差的修正。在这样的镜头结构中,为了实现摄像镜头的小型化,需要增强配置在物体侧的正的透镜组的光焦度。但是,若具有正的光焦度的透镜组的光焦度增强,则大多难以进行色像差的良好修正。

[0020] 在本实用新型的摄像镜头中,通过第一透镜组和第二透镜组分担整个镜头系统的正的光焦度。因此,与具有正的光焦度的透镜组为一个的情况相比,能够将构成各透镜组的正透镜的光焦度抑制得较弱。由此,根据本实用新型的摄像镜头,良好地修正各像差中特别是色像差,能够得到高分辨率的摄像镜头所需要的良好的成像性能。另外,在本实用新型的摄像镜头中,第三透镜组具有负的光焦度,因此适当地实现了摄像镜头的小型化。

[0021] 上述第一透镜组由光焦度的排列为正、负、正的 3 枚透镜构成。这 3 枚透镜分别由满足条件式 (1) ~ (3) 的透镜材料形成。通过这样的各透镜的光焦度的排列和阿贝数的排列,在第一透镜组中适当地抑制色像差的产生,并且良好地修正所产生的色像差。

[0022] 另外,在本实用新型的摄像镜头中,第二透镜组由 2 枚正透镜构成,并且由高色散的透镜材料和低色散的透镜材料的组合构成,以便满足上述条件式 (4) 和 (5)。因此,更良好地修正在第一透镜组中产生的各像差中特别是色像差。一般为了实现高分辨率的摄像镜头,需要良好地修正各像差中特别是色像差。根据本实用新型的摄像镜头,通过第一透镜组

到第三透镜组的各透镜组的光焦度的排列、构成第一透镜组的 3 枚透镜的光焦度的排列以及阿贝数的排列、构成第二透镜组的 2 枚正透镜的阿贝数的排列,与现有的摄像镜头相比更良好地修正色像差。

[0023] 在上述结构的摄像镜头中,第六透镜和第七透镜都具有负的光焦度,在将第六透镜的阿贝数设为  $v_{d6}$ ,将第七透镜的阿贝数设为  $v_{d7}$  时,优选满足以下的条件式 (6) 和 (7)。

$$[0024] \quad 20 < v_{d6} < 35 \quad (6)$$

$$[0025] \quad 40 < v_{d7} < 75 \quad (7)$$

[0026] 本实用新型的摄像镜头的第三透镜组由 2 枚负透镜构成,并且由低色散的透镜材料和高色散的透镜材料的组合构成,以便满足上述条件式 (6) 和 (7)。因此,更良好地修正在第一透镜组和第二透镜组中产生的各像差中特别是色像差。

[0027] 在上述结构的摄像镜头中,在将第一透镜的焦距设为  $f_1$ ,将第三透镜的焦距设为  $f_3$  时,优选满足以下的条件式 (8)。

$$[0028] \quad 0.3 < f_3/f_1 < 3.0 \quad (8)$$

[0029] 条件式 (8) 是用于在实现摄像镜头的小型化的同时,良好地修正像散以及像面弯曲的条件。若超过上限值“3.0”,则在第一透镜组中第三透镜的正的光焦度变弱,因此,为了修正像差,需要增强同样具有正的光焦度的第一透镜的正的光焦度。在该情况下,有利于摄像镜头的小型化,但后焦距 (back focal length) 变短,因此难以确保用于配置红外线截止滤光片等插入物的空间。另外,像散中弧矢像面向像面侧 (正侧) 弯曲,因此图像周边部向像面侧弯曲,难以得到良好的成像性能。另一方面,若低于下限值“0.3”,则容易确保后焦距,但难以进行摄像镜头的小型化。另外,在图像周边部子午像面向物体侧 (负侧) 弯曲,因此像散差增大,在该情况下,也难以得到良好的成像性能。

[0030] 在上述结构的摄像镜头中,在将第二透镜的焦距设为  $f_2$ ,将第三透镜的焦距设为  $f_3$  时,优选满足以下的条件式 (9)。

$$[0031] \quad -3.0 < f_2/f_3 < -0.3 \quad (9)$$

[0032] 条件式 (9) 是用于在实现摄像镜头的小型化的同时,分别将色像差、像面弯曲以及像散平衡良好地抑制在理想的范围内的条件。若超过上限值“-0.3”,则第二透镜的负的光焦度相对于第三透镜的正的光焦度相对地变强,因此,有利于确保后焦距、修正轴上色像差,但难以进行摄像镜头的小型化。另外,在图像周边部成像面向像面侧弯曲,因此像面弯曲成为修正过度的状态,并且像散差增大。因此,难以得到良好的成像性能。另一方面,若低于下限值“-3.0”,则有利于摄像镜头的小型化,但难以确保后焦距。另外,像散差增大,并且在图像周边部成像面向物体侧弯曲,像面弯曲成为修正不足的状态。轴上色像差和倍率色像差也分别增大,因此在该情况下也难以得到良好的成像性能。

[0033] 在上述结构的摄像镜头中,在将整个镜头系统的焦距设为  $f$ ,将第四透镜的焦距设为  $f_4$  时,优选满足以下的条件式 (10)。

$$[0034] \quad 4.5 < f_4/f < 9.0 \quad (10)$$

[0035] 条件式 (10) 是用于在良好地修正轴上色像差的同时抑制成像面的弯曲的条件。若超过上限值“9.0”,则第四透镜所具有的正的光焦度相对于整个镜头系统的光焦度减弱。由此,容易修正轴上色像差,但在图像周边部子午像面弯曲,因此难以抑制成像面的弯曲。

另一方面,若低于下限值“4.5”,则第四透镜的正的光焦度相对于整个镜头系统的光焦度变强,因此整个镜头系统的焦距变短,难以确保后焦距。此外,若要在这样第四透镜的光焦度强的状态下,通过减弱其他具有正的光焦度的透镜的光焦度,或增强具有负的光焦度的透镜的光焦度来抑制焦距的缩短,则造成像散差的增大,难以抑制成像面的弯曲。

[0036] 在上述结构的摄像镜头中,在将整个镜头系统的焦距设为  $f$ ,将第四透镜和第五透镜的合成焦距设为  $f_{45}$  时,优选满足以下的条件式 (11)。

$$[0037] \quad 1.5 < f_{45}/f < 5.0 \quad (11)$$

[0038] 条件式 (11) 是用于在实现摄像镜头的小型化的同时,良好地修正像面弯曲和像散的条件。若超过上限值“5.0”,则第二透镜组的正的光焦度相对于整个镜头系统的光焦度减弱,因此,为了修正像差,需要增强第一透镜组的正的光焦度。其结果是有利于像散的修正、摄像镜头的小型化,但难以确保后焦距。另外,成像面向像面侧弯曲,因此难以得到良好的成像性能。此外,针对第二透镜组的正的光焦度的弱化,若要通过减弱第二透镜组的负的光焦度来修正像差,则有利于倍率色像差的修正,但像散差增大,难以得到良好的成像性能。另一方面,若低于下限值“1.5”,则第二透镜组的正的光焦度相对于整个镜头系统的光焦度增强,因此像散差增大,难以得到良好的成像性能。

[0039] 在上述结构的摄像镜头中,在将第四透镜和第五透镜的合成焦距设为  $f_{45}$ ,将第六透镜和第七透镜的合成焦距设为  $f_{67}$  时,优选满足以下的条件式 (12)。

$$[0040] \quad -6.0 < f_{45}/f_{67} < -1.5 \quad (12)$$

[0041] 条件式 (12) 是用于在实现摄像镜头的小型化的同时,良好地修正色像差和像散的条件。另外,该条件式 (12) 也是用于抑制从摄像镜头出射的光线向摄像元件的像面的入射角度的条件。如公知的那样,在 CCD 传感器、CMOS 传感器等摄像元件中,预先确定了能够取入传感器的光线的入射角度的范围、即所谓的主光线角度 (CRA:Chief Ray Angle)。通过将将从摄像镜头出射的光线向像面的入射角度抑制在 CRA 的范围内,能够适当地抑制图像的周边部变暗的现象即阴影 (shading) 的发生。

[0042] 若在条件式 (12) 中超过上限值“-1.5”,则容易将从摄像镜头出射的光线向像面的入射角度抑制在 CRA 的范围内,并且容易确保后焦距,另一方面,难以进行摄像镜头的小型化。另外,像散中弧矢像面向像面侧弯曲,因此难以得到良好的成像性能。另一方面,若低于下限值“-6.0”,则对摄像镜头的小型化有利,但难以确保后焦距。而且,也难以将从摄像镜头出射的光线向像面的入射角度抑制在 CRA 的范围内。另外,像散中子午像面向物体侧弯曲,因此像散差增大,难以得到良好的成像性能。

[0043] 在上述结构的摄像镜头中,在将整个镜头系统的焦距设为  $f$ ,将第三透镜和第四透镜之间的光轴上的距离设为  $D_{34}$  时,优选满足以下的条件式 (13)。

$$[0044] \quad 0.05 < D_{34}/f < 0.3 \quad (13)$$

[0045] 条件式 (13) 是用于在将从摄像镜头出射的光线向摄像元件的像面的入射角度抑制在 CRA 的范围内,良好地修正像散和畸变的条件。若超过上限值“0.3”,则难以将从摄像镜头出射的光线向像面的入射角度抑制在 CRA 的范围内。另外,像散中弧矢像面向像面侧弯曲,因此像散差增大,像面弯曲成为修正过度的状态。因此,难以得到良好的成像性能。另一方面,若低于下限值“0.05”,则容易将从摄像镜头出射的光线向像面的入射角度抑制在 CRA 的范围内,但负的畸变增大,并且像散中弧矢像面向物体侧弯曲,在该情况下,

也难以得到良好的成像性能。

[0046] 在上述结构的摄像镜头中,在将整个镜头系统的焦距设为  $f$ ,将第五透镜和第六透镜之间的光轴上的距离设为  $D56$  时,优选满足以下的条件式 (14)。

$$[0047] \quad 0.05 < D56/f < 0.25 \quad (14)$$

[0048] 条件式 (14) 是用于在将从摄像镜头出射的光线向摄像元件的像面的入射角度抑制在 CRA 的范围内的同时,良好地修正色像差和畸变的条件。若超过上限值“0.25”,则正的畸变增大,并且在图像周边部倍率色像差增大,因此难以得到良好的成像性能。另外,在该情况下,难以确保后焦距,并且难以将从摄像镜头出射的光线向像面的入射角度抑制在 CRA 的范围内。另一方面,若低于下限值“0.05”,则容易确保后焦距,也容易将从摄像镜头出射的光线向像面的入射角度抑制在 CRA 的范围内,但负的畸变增大,因此,难以得到良好的成像性能。

[0049] 在上述结构的摄像镜头中,在将整个镜头系统的焦距设为  $f$ ,将第七透镜的焦距设为  $f7$  时,优选满足以下的条件式 (15)。

$$[0050] \quad -4.0 < f7/f < -1.0 \quad (15)$$

[0051] 条件式 (15) 是用于平衡良好地分别将像面弯曲、像散以及色像差抑制在良好的范围内的条件。若超过上限值“-1.0”,则第七透镜所具有的负的光焦度相对于整个镜头系统的光焦度相对地变强,因此,像散差增大,并且成像面向像面侧弯曲,像面弯曲成为修正过度的状态。另外,在图像周边部倍率色像差增大,因此难以得到良好的成像性能。另一方面,若低于下限值“-4.0”,则第七透镜所具有的负的光焦度相对于整个镜头系统的光焦度相对地变弱,因此轴上色像差变得修正不足(相对于基准波长的焦点位置,短波长的焦点位置向物体侧移动),难以得到良好的成像性能。另外,在该情况下,也难以修正像散。

[0052] 在上述结构的摄像镜头中,第六透镜和第七透镜优选形成为随着从光轴朝向透镜周边部正的光焦度变强的非球面形状。

[0053] 通过将构成第三透镜组的第六透镜和第七透镜形成为随着从光轴朝向透镜周边部正的光焦度变强的非球面形状,不只是轴上的色像差,还良好地修正轴外的倍率色像差,并且适当地抑制从摄像镜头出射的光线向像面的入射角度。

[0054] 根据本实用新型的摄像镜头,能够提供一种小型的摄像镜头,其具有良好地修正了各像差的高分辨率,并且特别适合于装入小型的摄像机。

## 附图说明

[0055] 图 1 是关于本实用新型的一个实施方式,表示数值实施例 1 的摄像镜头的概要结构的截面图。

[0056] 图 2 是表示图 1 所示的摄像镜头的横像差的像差图。

[0057] 图 3 是表示图 1 所示的摄像镜头的球面像差、像散、畸变的像差图。

[0058] 图 4 是关于本实用新型的一个实施方式,表示数值实施例 2 的摄像镜头的概要结构的截面图。

[0059] 图 5 是表示图 4 所示的摄像镜头的横像差的像差图。

[0060] 图 6 是表示图 4 所示的摄像镜头的球面像差、像散、畸变的像差图。

[0061] 图 7 是关于本实用新型的一个实施方式,表示数值实施例 3 的摄像镜头的概要结

构的截面图。

[0062] 图 8 是表示图 7 所示的摄像镜头的横像差的像差图。

[0063] 图 9 是表示图 7 所示的摄像镜头的球面像差、像散、畸变的像差图。

[0064] 图 10 是关于本实用新型的一个实施方式,表示数值实施例 4 的摄像镜头的概要结构的截面图。

[0065] 图 11 是表示图 10 所示的摄像镜头的横像差的像差图。

[0066] 图 12 是表示图 10 所示的摄像镜头的球面像差、像散、畸变的像差图。

[0067] 图 13 是关于本实用新型的一个实施方式,表示数值实施例 5 的摄像镜头的概要结构的截面图。

[0068] 图 14 是表示图 13 所示的摄像镜头的横像差的像差图。

[0069] 图 15 是表示图 13 所示的摄像镜头的球面像差、像散、畸变的像差图。

[0070] 图 16 是关于本实用新型的一个实施方式,表示数值实施例 6 的摄像镜头的概要结构的截面图。

[0071] 图 17 是表示图 16 所示的摄像镜头的横像差的像差图。

[0072] 图 18 是表示图 16 所示的摄像镜头的球面像差、像散、畸变的像差图。

[0073] 符号说明

[0074] G1 :第一透镜组

[0075] G2 :第二透镜组

[0076] G3 :第三透镜组

[0077] ST :孔径光阑

[0078] L1 :第一透镜

[0079] L2 :第二透镜

[0080] L3 :第三透镜

[0081] L4 :第四透镜

[0082] L5 :第五透镜

[0083] L6 :第六透镜

[0084] L7 :第七透镜

[0085] 10 :滤光片

### 具体实施方式

[0086] 以下,参照附图详细说明对本实用新型具体化所得的一个实施方式。

[0087] 图 1、图 4、图 7、图 10、图 13 以及图 16 是表示本实施方式的数值实施例 1 ~ 6 的摄像镜头的概要结构的截面图。任意一个数值实施例的基本镜头结构都相同,因此,在此参照数值实施例 1 的概要截面图来说明本实施方式的摄像镜头的镜头结构。

[0088] 如图 1 所示,本实施方式的摄像镜头从物体侧向像面侧依次排列具有正的光焦度的第一透镜组 G1、具有正的光焦度的第二透镜组 G2、具有负的光焦度的第三透镜组 G3 而构成。在第三透镜组 G3 和摄像元件的像面 IM 之间配置滤光片 10。也可以省略该滤光片 10。

[0089] 第一透镜组 G1 从物体侧开始依次由具有正的光焦度的第一透镜 L1、孔径光阑 ST、具有负的光焦度的第二透镜 L2、具有正的光焦度的第三透镜 L3 构成。第一透镜 L1 是物体

侧的面的曲率半径  $r_1$  为正、像面侧的面的曲率半径  $r_2$  为负的形状,形成在光轴 X 的附近为双凸透镜的形状。该第一透镜 L1 的形状并不限于本数值实施例 1 的形状。第一透镜 L1 的形状只要是物体侧的面的曲率半径  $r_1$  为正的形状即可,也可以是像面侧的面的曲率半径  $r_2$  为正的形状、即在光轴 X 的附近为将凸面朝向物体侧的弯月透镜的形状。数值实施例 2、3 以及 5 是第一透镜 L1 的形状在光轴 X 的附近为将凸面朝向物体侧的弯月透镜的例子。

[0090] 第二透镜 L2 是物体侧的面的曲率半径  $r_4$  和像面侧的面的曲率半径  $r_5$  都为正的形状,形成在光轴 X 的附近将凸面朝向物体侧的弯月透镜的形状。此外,第二透镜 L2 的形状并不限于本数值实施例 1 的形状。第二透镜 L2 的形状只要是像面侧的面的曲率半径  $r_5$  为正的形状即可,也可以是物体侧的面的曲率半径  $r_4$  为负的形状、即在光轴 X 的附近为双凹透镜的形状。

[0091] 第三透镜 L3 是物体侧的面的曲率半径  $r_6$  为正、像面侧的面的曲率半径  $r_7$  为负的形状,形成在光轴 X 的附近为双凸透镜的形状。第三透镜 L3 的形状并不限于本数值实施例 1 的形状,只要是物体侧的面的曲率半径  $r_6$  为正的形状即可。第三透镜 L3 的形状也可以是像面侧的面的曲率半径  $r_7$  为正的形状、即在光轴 X 的附近为将凸面朝向物体侧的弯月透镜的形状。数值实施例 4 是第三透镜 L3 的形状在光轴 X 的附近为将凸面朝向物体侧的弯月透镜的例子。

[0092] 第二透镜组 G2 从物体侧开始依次由具有正的光焦度的第四透镜 L4、具有正的光焦度的第五透镜 L5 构成。其中,第四透镜 L4 是物体侧的面的曲率半径  $r_8$  和像面侧的面的曲率半径  $r_9$  都为负的形状,形成在光轴 X 的附近将凹面朝向物体侧的弯月透镜的形状。

[0093] 第五透镜 L5 是物体侧的面的曲率半径  $r_{10}$  和像面侧的面的曲率半径  $r_{11}$  都为负的形状,形成在光轴 X 的附近将凹面朝向物体侧的弯月透镜的形状。此外,第五透镜 L5 的形状并不限于本数值实施例 1 的形状。第五透镜 L5 的形状只要是像面侧的面的曲率半径  $r_{11}$  为负的形状即可,也可以是物体侧的面的曲率半径  $r_{10}$  为正的形状、即在光轴 X 的附近为双凸透镜的形状。数值实施例 2 是第五透镜 L5 的形状在光轴 X 的附近为双凸透镜的例子。

[0094] 第三透镜组 G3 从物体侧开始依次由具有负的光焦度的第六透镜 L6、具有负的光焦度的第七透镜 L7 构成。第六透镜 L6 是物体侧的面的曲率半径  $r_{12}$  和像面侧的面的曲率半径  $r_{13}$  都为正的形状,形成在光轴 X 的附近将凸面朝向物体侧的弯月透镜的形状。另外,第七透镜 L7 是物体侧的面的曲率半径  $r_{14}$  和像面侧的面的曲率半径  $r_{15}$  都为正的形状,形成在光轴 X 的附近将凸面朝向物体侧的弯月透镜的形状。

[0095] 在上述第六透镜 L6 和第七透镜 L7 中,将物体侧的面和像面侧的面成为具有拐点的非球面形状,并且随着从光轴 X 朝向透镜周边部正的光焦度变强的形状。通过第六透镜 L6 和第七透镜 L7 所具有的这种形状,不仅良好地修正轴上的色像差,还良好地修正轴外的倍率色像差,并且将从摄像镜头出射的光线向像面 IM 的入射角度适当地抑制在主光线角度 (CRA:Chief Ray Angle) 的范围内。

[0096] 此外,在本数值实施例 1 的摄像镜头中,将第六透镜 L6 和第七透镜 L7 的物体侧的面和像面侧的面这两个面成为具有拐点的非球面形状,但未必需要将这两个面都成为具有拐点的非球面形状。即使具有拐点的非球面形状的面只是这些面中的任意一个,也能够将这双方的透镜或一个透镜成为随着从光轴 X 朝向透镜周边部正的光焦度变强的形

状的透镜。另外,根据所要求的光学性能、摄像镜头的小型化的程度,未必需要对第六透镜 L6 和第七透镜 L7 设置拐点。

[0097] 本实施方式的摄像镜头满足以下所示的条件式 (1) ~ (15)。

[0098]  $40 < v_{d1} < 75$  (1)

[0099]  $20 < v_{d2} < 35$  (2)

[0100]  $40 < v_{d3} < 75$  (3)

[0101]  $40 < v_{d4} < 75$  (4)

[0102]  $20 < v_{d5} < 35$  (5)

[0103]  $20 < v_{d6} < 35$  (6)

[0104]  $40 < v_{d7} < 75$  (7)

[0105]  $0.3 < f3/f1 < 3.0$  (8)

[0106]  $-3.0 < f2/f3 < -0.3$  (9)

[0107]  $4.5 < f4/f < 9.0$  (10)

[0108]  $1.5 < f45/f < 5.0$  (11)

[0109]  $-6.0 < f45/f67 < -1.5$  (12)

[0110]  $0.05 < D34/f < 0.3$  (13)

[0111]  $0.05 < D56/f < 0.25$  (14)

[0112]  $-4.0 < f7/f < -1.0$  (15)

[0113] 其中,

[0114]  $v_{d1}$ :第一透镜 L1 的阿贝数

[0115]  $v_{d2}$ :第二透镜 L2 的阿贝数

[0116]  $v_{d3}$ :第三透镜 L3 的阿贝数

[0117]  $v_{d4}$ :第四透镜 L4 的阿贝数

[0118]  $v_{d5}$ :第五透镜 L5 的阿贝数

[0119]  $v_{d6}$ :第六透镜 L6 的阿贝数

[0120]  $v_{d7}$ :第七透镜 L7 的阿贝数

[0121]  $f$ :整个镜头系统的焦距

[0122]  $f1$ :第一透镜 L1 的焦距

[0123]  $f2$ :第二透镜 L2 的焦距

[0124]  $f3$ :第三透镜 L3 的焦距

[0125]  $f4$ :第四透镜 L4 的焦距

[0126]  $f7$ :第七透镜 L7 的焦距

[0127]  $f45$ :第四透镜 L4 和第五透镜 L5 的合成焦距

[0128]  $f67$ :第六透镜 L6 和第七透镜 L7 的合成焦距

[0129]  $D34$ :第三透镜 L3 和第四透镜 L4 之间的光轴 X 上的距离

[0130]  $D56$ :第三透镜 L3 和第四透镜 L4 之间的光轴 X 上的距离

[0131] 本实施方式的摄像镜头为了更良好地修正各像差而满足以下的条件式 (16)。

[0132]  $0.7 < f6/f7 < 1.4$  (16)

[0133] 条件式 (16) 是用于在将从摄像镜头出射的光线向像面 TM 的入射角度抑制在 CRA

的范围内的时候,良好地修正畸变的条件。若超过上限值“1.4”,则容易将从摄像镜头出射的光线向像面 IM 的入射角度抑制在 CRA 的范围内,但接近像面 IM 的第七透镜 L7 的光焦度变得比第六透镜 L6 的光焦度强,因此负方向的畸变增大,难以得到良好的成像性能。另一方面,若低于下限值“0.7”,则正方向的畸变增大,因此难以得到良好的成像性能。另外,难以将从摄像镜头出射的光线向像面 IM 的入射角度抑制在 CRA 的范围内。

[0134] 此外,不需要满足上述各条件式的全部,通过单独地满足上述各条件式,能够分别得到与各条件式对应的作用效果。

[0135] 在本实施方式中,用非球面形成了各透镜的透镜面。在设光轴方向的轴为 Z,与光轴垂直的方向的高度为 H,圆锥系数为 k,非球面系数为  $A_4$ 、 $A_6$ 、 $A_8$ 、 $A_{10}$ 、 $A_{12}$ 、 $A_{14}$ 、 $A_{16}$  时,通过下式表示这些透镜面所采用的非球面形状。

[0136] 式 1

[0137]

$$Z = \frac{\frac{H^2}{R}}{1 + \sqrt{1 - (k+1) \frac{H^2}{R^2}}} + A_4 H^4 + A_6 H^6 + A_8 H^8 + A_{10} H^{10} + A_{12} H^{12} + A_{14} H^{14} + A_{16} H^{16}$$

[0138] 接着,表示本实施方式的摄像镜头的数值实施例。在各数值实施例中,f 表示整个镜头系统的焦距,Fno 表示 F 值, $\omega$  表示半视场角。i 表示从物体侧开始数的面编号,r 表示曲率半径,d 表示光轴上的透镜面之间的距离(面间隔),nd 表示折射率, $v_d$  表示阿贝数。此外,附加了\*(星号)的符号的面编号表示是非球面。

[0139] 数值实施例 1

[0140] 以下表示基本镜头数据。

[0141]  $f = 11.91\text{mm}$ 、 $Fno = 2.9$ 、 $\omega = 27.1^\circ$

[0142]

单位 mm

面数据

| 面编号 i  | r        | d            | nd     | $\nu$ d           |
|--------|----------|--------------|--------|-------------------|
| (物面)   | $\infty$ | $\infty$     |        |                   |
| 1*     | 4.933    | 1.070        | 1.5346 | 56.1 (= $\nu$ d1) |
| 2*     | -930.893 | -0.035       |        |                   |
| 3 (光阑) | $\infty$ | 0.112        |        |                   |
| 4*     | 18.923   | 0.311        | 1.6355 | 24.0 (= $\nu$ d2) |
| 5*     | 5.803    | 0.113        |        |                   |
| 6*     | 9.618    | 1.053        | 1.5346 | 56.1 (= $\nu$ d3) |
| 7*     | -26.477  | 1.108 (=D34) |        |                   |
| 8*     | -4.816   | 1.452        | 1.5346 | 56.1 (= $\nu$ d4) |
| 9*     | -4.880   | 0.100        |        |                   |

[0143]

|     |          |              |        |                   |
|-----|----------|--------------|--------|-------------------|
| 10* | -20.892  | 1.258        | 1.6355 | 24.0 (= $\nu$ d5) |
| 11* | -16.143  | 1.269 (=D56) |        |                   |
| 12* | 10.109   | 1.086        | 1.6355 | 24.0 (= $\nu$ d6) |
| 13* | 5.202    | 0.858        |        |                   |
| 14* | 6.128    | 1.015        | 1.5346 | 56.1 (= $\nu$ d7) |
| 15* | 3.566    | 0.700        |        |                   |
| 16  | $\infty$ | 0.300        | 1.5168 | 64.2              |
| 17  | $\infty$ | 1.693        |        |                   |

(像面)  $\infty$ 

[0144] 非球面数据

[0145] 第1面

[0146]  $k = 0.000$ ,  $A_4 = -2.258\text{E-}03$ ,  $A_6 = -1.716\text{E-}04$ ,  $A_8 = -8.402\text{E-}05$ ,[0147]  $A_{10} = 7.188\text{E-}06$ ,  $A_{12} = -1.727\text{E-}07$ ,  $A_{14} = -5.544\text{E-}08$ ,  $A_{16} = -4.827\text{E-}09$ 

[0148] 第2面

[0149]  $k = 0.000$ ,  $A_4 = 1.813\text{E-}02$ ,  $A_6 = -1.657\text{E-}02$ ,  $A_8 = 5.660\text{E-}03$ ,[0150]  $A_{10} = -9.632\text{E-}04$ ,  $A_{12} = 3.919\text{E-}05$ ,  $A_{14} = 9.322\text{E-}06$ ,  $A_{16} = -9.282\text{E-}07$ 

[0151] 第4面

[0152]  $k = 0.000$ ,  $A_4 = 2.004\text{E-}02$ ,  $A_6 = -2.109\text{E-}02$ ,  $A_8 = 7.483\text{E-}03$ ,

- [0153]  $A_{10} = -1.366\text{E-}03, A_{12} = 7.946\text{E-}05, A_{14} = 1.008\text{E-}05, A_{16} = -1.275\text{E-}06$
- [0154] 第 5 面
- [0155]  $k = 0.000, A_4 = 1.328\text{E-}02, A_6 = -1.197\text{E-}02, A_8 = 2.756\text{E-}03,$
- [0156]  $A_{10} = -3.323\text{E-}04, A_{12} = 9.334\text{E-}06, A_{14} = 1.543\text{E-}06, A_{16} = 6.238\text{E-}09$
- [0157] 第 6 面
- [0158]  $k = 0.000, A_4 = 1.412\text{E-}02, A_6 = -7.356\text{E-}03, A_8 = 1.464\text{E-}03,$
- [0159]  $A_{10} = -1.635\text{E-}04, A_{12} = 9.896\text{E-}06, A_{14} = 3.578\text{E-}07, A_{16} = -7.427\text{E-}08$
- [0160] 第 7 面
- [0161]  $k = 0.000, A_4 = -4.229\text{E-}03, A_6 = -6.810\text{E-}04, A_8 = 2.136\text{E-}04,$
- [0162]  $A_{10} = -1.640\text{E-}05, A_{12} = -8.553\text{E-}07, A_{14} = -3.664\text{E-}07, A_{16} = 1.570\text{E-}08$
- [0163] 第 8 面
- [0164]  $k = 0.000, A_4 = -7.525\text{E-}03, A_6 = 4.344\text{E-}04, A_8 = 1.460\text{E-}04,$
- [0165]  $A_{10} = -4.222\text{E-}05, A_{12} = -2.416\text{E-}07, A_{14} = 2.207\text{E-}07, A_{16} = 2.681\text{E-}08$
- [0166] 第 9 面
- [0167]  $k = 0.000, A_4 = -1.153\text{E-}03, A_6 = 4.237\text{E-}04, A_8 = -3.266\text{E-}06,$
- [0168]  $A_{10} = 1.184\text{E-}06, A_{12} = -1.703\text{E-}06, A_{14} = 6.357\text{E-}08, A_{16} = 2.051\text{E-}08$
- [0169] 第 10 面
- [0170]  $k = 0.000, A_4 = -2.682\text{E-}03, A_6 = -4.429\text{E-}04, A_8 = -8.312\text{E-}05,$
- [0171]  $A_{10} = 2.024\text{E-}06, A_{12} = -9.278\text{E-}07, A_{14} = -1.690\text{E-}08, A_{16} = 5.362\text{E-}09$
- [0172] 第 11 面
- [0173]  $k = 0.000, A_4 = -2.770\text{E-}03, A_6 = -5.065\text{E-}04, A_8 = 7.597\text{E-}06,$
- [0174]  $A_{10} = -1.210\text{E-}06, A_{12} = 3.920\text{E-}08, A_{14} = 4.009\text{E-}09, A_{16} = -4.901\text{E-}11$
- [0175] 第 12 面
- [0176]  $k = 0.000, A_4 = -7.263\text{E-}03, A_6 = -2.582\text{E-}06, A_8 = -1.576\text{E-}06,$
- [0177]  $A_{10} = 3.658\text{E-}07, A_{12} = 1.955\text{E-}08, A_{14} = 6.544\text{E-}10, A_{16} = -1.041\text{E-}10$
- [0178] 第 13 面
- [0179]  $k = 0.000, A_4 = -7.953\text{E-}03, A_6 = 1.117\text{E-}04, A_8 = 1.769\text{E-}06,$
- [0180]  $A_{10} = -1.619\text{E-}07, A_{12} = 1.220\text{E-}09, A_{14} = -7.531\text{E-}11, A_{16} = 1.176\text{E-}12$
- [0181] 第 14 面
- [0182]  $k = 0.000, A_4 = -1.499\text{E-}02, A_6 = 4.386\text{E-}04, A_8 = 4.879\text{E-}07,$
- [0183]  $A_{10} = 1.022\text{E-}07, A_{12} = -2.511\text{E-}09, A_{14} = -4.879\text{E-}10, A_{16} = 6.044\text{E-}12$
- [0184] 第 15 面
- [0185]  $k = -5.275, A_4 = -7.965\text{E-}03, A_6 = 3.077\text{E-}04, A_8 = -7.619\text{E-}06,$
- [0186]  $A_{10} = 1.795\text{E-}07, A_{12} = 8.605\text{E-}09, A_{14} = -5.893\text{E-}10, A_{16} = 8.607\text{E-}12$
- [0187]  $f1 = 9.18\text{mm}$
- [0188]  $f2 = -13.29\text{mm}$
- [0189]  $f3 = 13.33\text{mm}$
- [0190]  $f4 = 99.43\text{mm}$
- [0191]  $f5 = 101.31\text{mm}$

[0192]  $f_6 = -18.45\text{mm}$

[0193]  $f_7 = -18.52\text{mm}$

[0194]  $f_{45} = 48.43\text{mm}$

[0195]  $f_{67} = -8.78\text{mm}$

[0196] 以下表示各条件式的值。

[0197]  $f_3/f_1 = 1.45$

[0198]  $f_2/f_3 = -1.00$

[0199]  $f_4/f = 8.35$

[0200]  $f_{45}/f = 4.07$

[0201]  $f_{45}/f_{67} = -5.51$

[0202]  $D_{34}/f = 0.09$

[0203]  $D_{56}/f = 0.11$

[0204]  $f_7/f = -1.55$

[0205]  $f_2/f_1 = -1.45$

[0206]  $f_6/f_7 = 1.00$

[0207] 这样,本数值实施例 1 的摄像镜头满足上述各条件式。从第一透镜 L1 的物体侧的面到像面 IM 为止的光轴上的距离(滤光片 10 是空气换算长度)是 13.36mm,实现了摄像镜头的小型化。

[0208] 图 2 关于数值实施例 1 的摄像镜头,分为子午方向和弧矢方向表示出与各像高相对于最大像高的比 H(以下称为“像高比 H”)对应的横像差(在图 5、图 8、图 11、图 14 以及图 17 中也相同)。另外,图 3 关于数值实施例 1 的摄像镜头,分别表示出球面像差(mm)、像散(mm)以及畸变(%)。在这些像差图中,在横像差图和球面像差图中表示出与 g 线(435.84nm)、c 线(546.07nm)、C 线(656.27nm)的各波长对应的像差量,在像散图中分别表示出弧矢像面 S 的像差量和子午像面 T 的像差量(在图 6、图 9、图 12、图 15 以及图 18 中也相同)。如图 2 和图 3 所示,根据本数值实施例 1 的摄像镜头,良好地修正了各像差。

[0209] 数值实施例 2

[0210] 以下表示基本镜头数据。

[0211]  $f = 11.12\text{mm}$ 、 $F_{\text{no}} = 2.4$ 、 $\omega = 28.7^\circ$

[0212]

单位 mm

面数据

| 面编号 i  | r        | d            | nd     | $\nu$ d           |
|--------|----------|--------------|--------|-------------------|
| (物面)   | $\infty$ | $\infty$     |        |                   |
| 1*     | 5.672    | 2.085        | 1.5346 | 56.1 (= $\nu$ d1) |
| 2*     | 13.631   | -0.0003      |        |                   |
| 3 (光阑) | $\infty$ | 0.105        |        |                   |
| 4*     | 40.182   | 0.382        | 1.6355 | 24.0 (= $\nu$ d2) |
| 5*     | 6.117    | 0.049        |        |                   |
| 6*     | 5.905    | 0.762        | 1.5346 | 56.1 (= $\nu$ d3) |
| 7*     | -38.291  | 0.990 (=D34) |        |                   |
| 8*     | -3.431   | 0.350        | 1.5346 | 56.1 (= $\nu$ d4) |
| 9*     | -3.240   | 0.108        |        |                   |
| 10*    | 84.917   | 0.616        | 1.6355 | 24.0 (= $\nu$ d5) |
| 11*    | -58.992  | 1.736 (=D56) |        |                   |
| 12*    | 7.052    | 1.350        | 1.6355 | 24.0 (= $\nu$ d6) |
| 13*    | 4.789    | 1.526        |        |                   |
| 14*    | 4.948    | 1.105        | 1.5346 | 56.1 (= $\nu$ d7) |
| 15*    | 3.686    | 0.680        |        |                   |
| 16     | $\infty$ | 0.300        | 1.5168 | 64.2              |
| 17     | $\infty$ | 1.414        |        |                   |
| (像面)   | $\infty$ |              |        |                   |

- [0213] 非球面数据
- [0214] 第 1 面
- [0215]  $k = 0.000, A_4 = -1.916E-03, A_6 = -2.614E-04, A_8 = -4.202E-05,$
- [0216]  $A_{10} = 9.800E-06, A_{12} = -5.793E-07, A_{14} = -1.528E-07, A_{16} = 1.302E-08$
- [0217] 第 2 面
- [0218]  $k = 0.000, A_4 = 1.459E-02, A_6 = -1.720E-02, A_8 = 5.644E-03,$
- [0219]  $A_{10} = -9.641E-04, A_{12} = 4.106E-05, A_{14} = 9.797E-06, A_{16} = -9.797E-07$
- [0220] 第 4 面
- [0221]  $k = 0.000, A_4 = 2.300E-02, A_6 = -2.066E-02, A_8 = 7.394E-03,$
- [0222]  $A_{10} = -1.370E-03, A_{12} = 8.034E-05, A_{14} = 1.017E-05, A_{16} = -1.197E-06$

- [0223] 第 5 面
- [0224]  $k = 0.000$ ,  $A_4 = 1.452\text{E-}02$ ,  $A_6 = -1.176\text{E-}02$ ,  $A_8 = 2.846\text{E-}03$ ,
- [0225]  $A_{10} = -3.407\text{E-}04$ ,  $A_{12} = 7.751\text{E-}06$ ,  $A_{14} = 1.645\text{E-}06$ ,  $A_{16} = 4.227\text{E-}08$
- [0226] 第 6 面
- [0227]  $k = 0.000$ ,  $A_4 = 9.445\text{E-}03$ ,  $A_6 = -7.185\text{E-}03$ ,  $A_8 = 1.433\text{E-}03$ ,
- [0228]  $A_{10} = -1.523\text{E-}04$ ,  $A_{12} = 1.116\text{E-}05$ ,  $A_{14} = 2.227\text{E-}07$ ,  $A_{16} = -1.217\text{E-}07$
- [0229] 第 7 面
- [0230]  $k = 0.000$ ,  $A_4 = -1.799\text{E-}03$ ,  $A_6 = -3.115\text{E-}04$ ,  $A_8 = 1.941\text{E-}04$ ,
- [0231]  $A_{10} = -1.459\text{E-}05$ ,  $A_{12} = -3.805\text{E-}07$ ,  $A_{14} = -4.646\text{E-}07$ ,  $A_{16} = -5.256\text{E-}08$
- [0232] 第 8 面
- [0233]  $k = 0.000$ ,  $A_4 = -1.097\text{E-}02$ ,  $A_6 = 1.037\text{E-}03$ ,  $A_8 = 2.046\text{E-}04$ ,
- [0234]  $A_{10} = -3.179\text{E-}05$ ,  $A_{12} = 9.872\text{E-}07$ ,  $A_{14} = 3.226\text{E-}07$ ,  $A_{16} = 2.150\text{E-}08$
- [0235] 第 9 面
- [0236]  $k = 0.000$ ,  $A_4 = -2.374\text{E-}04$ ,  $A_6 = 7.402\text{E-}04$ ,  $A_8 = 6.618\text{E-}05$ ,
- [0237]  $A_{10} = 9.578\text{E-}06$ ,  $A_{12} = -8.457\text{E-}07$ ,  $A_{14} = 1.366\text{E-}07$ ,  $A_{16} = 3.483\text{E-}08$
- [0238] 第 10 面
- [0239]  $k = 0.000$ ,  $A_4 = 8.502\text{E-}05$ ,  $A_6 = -6.845\text{E-}04$ ,  $A_8 = -3.961\text{E-}05$ ,
- [0240]  $A_{10} = 7.821\text{E-}06$ ,  $A_{12} = -3.182\text{E-}07$ ,  $A_{14} = -2.580\text{E-}08$ ,  $A_{16} = -1.121\text{E-}08$
- [0241] 第 11 面
- [0242]  $k = 0.000$ ,  $A_4 = -3.546\text{E-}03$ ,  $A_6 = -1.316\text{E-}04$ ,  $A_8 = -5.946\text{E-}06$ ,
- [0243]  $A_{10} = -1.087\text{E-}06$ ,  $A_{12} = 8.261\text{E-}09$ ,  $A_{14} = -8.166\text{E-}09$ ,  $A_{16} = -1.513\text{E-}09$
- [0244] 第 12 面
- [0245]  $k = 0.000$ ,  $A_4 = -2.321\text{E-}03$ ,  $A_6 = -1.480\text{E-}04$ ,  $A_8 = 1.069\text{E-}05$ ,
- [0246]  $A_{10} = 5.462\text{E-}08$ ,  $A_{12} = -1.313\text{E-}08$ ,  $A_{14} = 4.805\text{E-}10$ ,  $A_{16} = -2.217\text{E-}11$
- [0247] 第 13 面
- [0248]  $k = 0.000$ ,  $A_4 = -5.114\text{E-}03$ ,  $A_6 = 9.282\text{E-}05$ ,  $A_8 = -4.615\text{E-}06$ ,
- [0249]  $A_{10} = -1.475\text{E-}08$ ,  $A_{12} = 1.042\text{E-}08$ ,  $A_{14} = -8.901\text{E-}11$ ,  $A_{16} = -1.395\text{E-}11$
- [0250] 第 14 面
- [0251]  $k = 0.000$ ,  $A_4 = -1.462\text{E-}02$ ,  $A_6 = 5.096\text{E-}04$ ,  $A_8 = -6.553\text{E-}06$ ,
- [0252]  $A_{10} = 2.050\text{E-}08$ ,  $A_{12} = -1.745\text{E-}08$ ,  $A_{14} = -7.332\text{E-}10$ ,  $A_{16} = 6.119\text{E-}11$
- [0253] 第 15 面
- [0254]  $k = -3.374$ ,  $A_4 = -8.463\text{E-}03$ ,  $A_6 = 4.184\text{E-}04$ ,  $A_8 = -1.373\text{E-}05$ ,
- [0255]  $A_{10} = 1.279\text{E-}07$ ,  $A_{12} = 1.100\text{E-}08$ ,  $A_{14} = -5.270\text{E-}10$ ,  $A_{16} = 7.656\text{E-}12$
- [0256]  $f1 = 16.65\text{mm}$
- [0257]  $f2 = -11.40\text{mm}$
- [0258]  $f3 = 9.63\text{mm}$
- [0259]  $f4 = 66.37\text{mm}$
- [0260]  $f5 = 54.86\text{mm}$
- [0261]  $f6 = -30.56\text{mm}$

[0262]  $f_7 = -38.90\text{mm}$

[0263]  $f_{45} = 29.54\text{mm}$

[0264]  $f_{67} = -16.33\text{mm}$

[0265] 以下表示各条件式的值。

[0266]  $f_3/f_1 = 0.58$

[0267]  $f_2/f_3 = -1.18$

[0268]  $f_4/f = 5.97$

[0269]  $f_{45}/f = 2.66$

[0270]  $f_{45}/f_{67} = -1.81$

[0271]  $D_{34}/f = 0.09$

[0272]  $D_{56}/f = 0.16$

[0273]  $f_7/f = -3.50$

[0274]  $f_2/f_1 = -0.68$

[0275]  $f_6/f_7 = 0.79$

[0276] 这样,本数值实施例 2 的摄像镜头满足上述各条件式。从第一透镜 L1 的物体侧的面到像面 TM 为止的光轴上的距离(滤光片 10 是空气换算长度)是 13.46mm,实现了摄像镜头的小型化。

[0277] 图 5 关于数值实施例 2 的摄像镜头,表示出与像高比 H 对应的横像差,图 6 分别表示出球面像差(mm)、像散(mm)以及畸变(%)。如图 5 和图 6 所示,根据本数值实施例 2 的摄像镜头也良好地修正了各像差。

[0278] 数值实施例 3

[0279] 以下表示基本镜头数据。

[0280]  $f = 9.16\text{mm}$ 、 $F_{\text{no}} = 2.2$ 、 $\omega = 33.6^\circ$

[0281]

单位 mm

面数据

| 面编号 i  | r        | d            | nd     | $\nu$ d           |
|--------|----------|--------------|--------|-------------------|
| (物面)   | $\infty$ | $\infty$     |        |                   |
| 1*     | 4.686    | 1.560        | 1.5346 | 56.1 (= $\nu$ d1) |
| 2*     | 44.083   | -0.003       |        |                   |
| 3 (光阑) | $\infty$ | 0.105        |        |                   |
| 4*     | 9.892    | 0.859        | 1.6355 | 24.0 (= $\nu$ d2) |
| 5*     | 5.248    | 0.157        |        |                   |
| 6*     | 9.581    | 0.717        | 1.5346 | 56.1 (= $\nu$ d3) |
| 7*     | -35.654  | 0.786 (=D34) |        |                   |
| 8*     | -4.605   | 0.788        | 1.5346 | 56.1 (= $\nu$ d4) |
| 9*     | -4.271   | 0.030        |        |                   |
| 10*    | -12.412  | 1.699        | 1.6355 | 24.0 (= $\nu$ d5) |
| 11*    | -10.957  | 0.942 (=D56) |        |                   |
| 12*    | 9.961    | 0.965        | 1.6355 | 24.0 (= $\nu$ d6) |
| 13*    | 5.142    | 0.623        |        |                   |
| 14*    | 5.891    | 1.292        | 1.5346 | 56.1 (= $\nu$ d7) |
| 15*    | 3.732    | 0.700        |        |                   |
| 16     | $\infty$ | 0.300        | 1.5168 | 64.2              |
| 17     | $\infty$ | 0.400        |        |                   |
| (像面)   | $\infty$ |              |        |                   |

[0282] 非球面数据

[0283] 第1面

[0284]  $k = 0.000$ ,  $A_4 = -5.228\text{E-}04$ ,  $A_6 = 5.257\text{E-}05$ ,  $A_8 = -7.167\text{E-}05$ ,[0285]  $A_{10} = 6.642\text{E-}06$ ,  $A_{12} = -2.064\text{E-}07$ ,  $A_{14} = -1.718\text{E-}08$ ,  $A_{16} = -3.672\text{E-}09$ 

[0286] 第2面

[0287]  $k = 0.000$ ,  $A_4 = 1.706\text{E-}02$ ,  $A_6 = -1.665\text{E-}02$ ,  $A_8 = 5.716\text{E-}03$ ,[0288]  $A_{10} = -9.533\text{E-}04$ ,  $A_{12} = 4.016\text{E-}05$ ,  $A_{14} = 9.227\text{E-}06$ ,  $A_{16} = -1.010\text{E-}06$ 

[0289] 第4面

[0290]  $k = 0.000$ ,  $A_4 = 1.824\text{E-}02$ ,  $A_6 = -2.073\text{E-}02$ ,  $A_8 = 7.501\text{E-}03$ ,[0291]  $A_{10} = -1.362\text{E-}03$ ,  $A_{12} = 8.090\text{E-}05$ ,  $A_{14} = 1.019\text{E-}05$ ,  $A_{16} = -1.349\text{E-}06$

- [0292] 第 5 面
- [0293]  $k = 0.000$ ,  $A_4 = 1.418\text{E-}02$ ,  $A_6 = -1.191\text{E-}02$ ,  $A_8 = 2.763\text{E-}03$ ,
- [0294]  $A_{10} = -3.305\text{E-}04$ ,  $A_{12} = 9.678\text{E-}06$ ,  $A_{14} = 1.516\text{E-}06$ ,  $A_{16} = -3.088\text{E-}08$
- [0295] 第 6 面
- [0296]  $k = 0.000$ ,  $A_4 = 1.439\text{E-}02$ ,  $A_6 = -7.365\text{E-}03$ ,  $A_8 = 1.463\text{E-}03$ ,
- [0297]  $A_{10} = -1.649\text{E-}04$ ,  $A_{12} = 9.715\text{E-}06$ ,  $A_{14} = 3.826\text{E-}07$ ,  $A_{16} = -5.052\text{E-}08$
- [0298] 第 7 面
- [0299]  $k = 0.000$ ,  $A_4 = -4.115\text{E-}03$ ,  $A_6 = -4.089\text{E-}04$ ,  $A_8 = 2.326\text{E-}04$ ,
- [0300]  $A_{10} = -1.364\text{E-}05$ ,  $A_{12} = -4.022\text{E-}07$ ,  $A_{14} = -3.544\text{E-}07$ ,  $A_{16} = 2.426\text{E-}10$
- [0301] 第 8 面
- [0302]  $k = 0.000$ ,  $A_4 = -8.156\text{E-}03$ ,  $A_6 = 7.335\text{E-}04$ ,  $A_8 = 1.820\text{E-}04$ ,
- [0303]  $A_{10} = -3.874\text{E-}05$ ,  $A_{12} = 9.548\text{E-}08$ ,  $A_{14} = 2.413\text{E-}07$ ,  $A_{16} = 3.202\text{E-}08$
- [0304] 第 9 面
- [0305]  $k = 0.000$ ,  $A_4 = -3.284\text{E-}03$ ,  $A_6 = 1.711\text{E-}04$ ,  $A_8 = -3.665\text{E-}05$ ,
- [0306]  $A_{10} = -1.211\text{E-}06$ ,  $A_{12} = -1.670\text{E-}06$ ,  $A_{14} = 1.315\text{E-}07$ ,  $A_{16} = 3.488\text{E-}08$
- [0307] 第 10 面
- [0308]  $k = 0.000$ ,  $A_4 = -3.774\text{E-}03$ ,  $A_6 = -1.071\text{E-}03$ ,  $A_8 = -1.090\text{E-}04$ ,
- [0309]  $A_{10} = -1.136\text{E-}06$ ,  $A_{12} = -1.366\text{E-}06$ ,  $A_{14} = -6.579\text{E-}08$ ,  $A_{16} = -7.522\text{E-}09$
- [0310] 第 11 面
- [0311]  $k = 0.000$ ,  $A_4 = -1.977\text{E-}03$ ,  $A_6 = -3.375\text{E-}04$ ,  $A_8 = 5.840\text{E-}06$ ,
- [0312]  $A_{10} = -9.285\text{E-}07$ ,  $A_{12} = 9.105\text{E-}08$ ,  $A_{14} = 7.992\text{E-}09$ ,  $A_{16} = 1.009\text{E-}11$
- [0313] 第 12 面
- [0314]  $k = 0.000$ ,  $A_4 = -5.918\text{E-}03$ ,  $A_6 = -1.970\text{E-}05$ ,  $A_8 = 2.285\text{E-}06$ ,
- [0315]  $A_{10} = 2.484\text{E-}07$ ,  $A_{12} = 6.113\text{E-}09$ ,  $A_{14} = 6.331\text{E-}10$ ,  $A_{16} = -6.092\text{E-}11$
- [0316] 第 13 面
- [0317]  $k = 0.000$ ,  $A_4 = -7.396\text{E-}03$ ,  $A_6 = 8.056\text{E-}05$ ,  $A_8 = 2.029\text{E-}06$ ,
- [0318]  $A_{10} = -9.873\text{E-}08$ ,  $A_{12} = 3.717\text{E-}09$ ,  $A_{14} = -5.325\text{E-}11$ ,  $A_{16} = -5.178\text{E-}12$
- [0319] 第 14 面
- [0320]  $k = 0.000$ ,  $A_4 = -1.274\text{E-}02$ ,  $A_6 = 4.084\text{E-}04$ ,  $A_8 = -7.883\text{E-}07$ ,
- [0321]  $A_{10} = 4.755\text{E-}08$ ,  $A_{12} = -4.159\text{E-}09$ ,  $A_{14} = -4.673\text{E-}10$ ,  $A_{16} = 1.490\text{E-}11$
- [0322] 第 15 面
- [0323]  $k = -4.383$ ,  $A_4 = -5.567\text{E-}03$ ,  $A_6 = 2.400\text{E-}04$ ,  $A_8 = -9.162\text{E-}06$ ,
- [0324]  $A_{10} = 1.827\text{E-}07$ ,  $A_{12} = 9.388\text{E-}09$ ,  $A_{14} = -5.768\text{E-}10$ ,  $A_{16} = 8.323\text{E-}12$
- [0325]  $f1 = 9.67\text{mm}$
- [0326]  $f2 = -18.95\text{mm}$
- [0327]  $f3 = 14.20\text{mm}$
- [0328]  $f4 = 60.48\text{mm}$
- [0329]  $f5 = 101.17\text{mm}$
- [0330]  $f6 = -18.14\text{mm}$

[0331]  $f_7 = -24.06\text{mm}$

[0332]  $f_{45} = 38.45\text{mm}$

[0333]  $f_{67} = -9.69\text{mm}$

[0334] 以下表示各条件式的值。

[0335]  $f_3/f_1 = 1.47$

[0336]  $f_2/f_3 = -1.33$

[0337]  $f_4/f = 6.60$

[0338]  $f_{45}/f = 4.20$

[0339]  $f_{45}/f_{67} = -3.97$

[0340]  $D_{34}/f = 0.09$

[0341]  $D_{56}/f = 0.10$

[0342]  $f_7/f = -2.63$

[0343]  $f_2/f_1 = -1.96$

[0344]  $f_6/f_7 = 0.75$

[0345] 这样,本数值实施例 3 的摄像镜头满足上述各条件式。从第一透镜 L1 的物体侧的面到像面 TM 为止的光轴上的距离(滤光片 10 是空气换算长度)是 11.82mm,实现了摄像镜头的小型化。

[0346] 图 8 关于数值实施例 3 的摄像镜头,表示出与像高比 H 对应的横像差,图 9 分别表示出球面像差(mm)、像散(mm)以及畸变(%)。如图 8 和图 9 所示,根据本数值实施例 3 的摄像镜头也良好地修正了各像差。

[0347] 数值实施例 4

[0348] 以下表示基本镜头数据。

[0349]  $f = 11.52\text{mm}$ 、 $F_{\text{no}} = 2.8$ 、 $\omega = 27.9^\circ$

[0350]

单位 mm

面数据

| 面编号 i  | r        | d            | nd     | $\nu$ d           |
|--------|----------|--------------|--------|-------------------|
| (物面)   | $\infty$ | $\infty$     |        |                   |
| 1*     | 5.117    | 1.025        | 1.5346 | 56.1 (= $\nu$ d1) |
| 2*     | -53.792  | -0.065       |        |                   |
| 3 (光阑) | $\infty$ | 0.121        |        |                   |
| 4*     | 33.647   | 0.385        | 1.6355 | 24.0 (= $\nu$ d2) |
| 5*     | 6.316    | 0.111        |        |                   |
| 6*     | 11.172   | 0.746        | 1.5346 | 56.1 (= $\nu$ d3) |
| 7*     | 261.521  | 0.961 (=D34) |        |                   |
| 8*     | -4.905   | 1.202        | 1.5346 | 56.1 (= $\nu$ d4) |
| 9*     | -4.564   | 0.100        |        |                   |
| 10*    | -63.334  | 1.035        | 1.6355 | 24.0 (= $\nu$ d5) |
| 11*    | -18.755  | 2.149 (=D56) |        |                   |
| [0351] |          |              |        |                   |
| 12*    | 8.382    | 1.036        | 1.6355 | 24.0 (= $\nu$ d6) |
| 13*    | 5.211    | 1.755        |        |                   |
| 14*    | 7.275    | 0.599        | 1.5346 | 56.1 (= $\nu$ d7) |
| 15*    | 4.224    | 0.700        |        |                   |
| 16     | $\infty$ | 0.300        | 1.5168 | 64.2              |
| 17     | $\infty$ | 1.259        |        |                   |
| (像面)   | $\infty$ |              |        |                   |

[0352] 非球面数据

[0353] 第1面

[0354]  $k = 0.000$ ,  $A_4 = -2.207\text{E-}03$ ,  $A_6 = -6.989\text{E-}05$ ,  $A_8 = -7.646\text{E-}05$ ,

[0355]  $A_{10} = 6.537\text{E-}06$ ,  $A_{12} = -4.816\text{E-}07$ ,  $A_{14} = -8.199\text{E-}08$ ,  $A_{16} = 3.638\text{E-}09$

[0356] 第2面

[0357]  $k = 0.000$ ,  $A_4 = 1.851\text{E-}02$ ,  $A_6 = -1.657\text{E-}02$ ,  $A_8 = 5.668\text{E-}03$ ,

[0358]  $A_{10} = -9.618\text{E-}04$ ,  $A_{12} = 3.914\text{E-}05$ ,  $A_{14} = 9.359\text{E-}06$ ,  $A_{16} = -9.285\text{E-}07$

[0359] 第4面

[0360]  $k = 0.000$ ,  $A_4 = 2.025\text{E-}02$ ,  $A_6 = -2.097\text{E-}02$ ,  $A_8 = 7.489\text{E-}03$ ,

- [0361]  $A_{10} = -1.365E-03, A_{12} = 7.992E-05, A_{14} = 1.014E-05, A_{16} = -1.285E-06$
- [0362] 第 5 面
- [0363]  $k = 0.000, A_4 = 1.323E-02, A_6 = -1.195E-02, A_8 = 2.773E-03,$
- [0364]  $A_{10} = -3.309E-04, A_{12} = 9.229E-06, A_{14} = 1.525E-06, A_{16} = 2.021E-08$
- [0365] 第 6 面
- [0366]  $k = 0.000, A_4 = 1.386E-02, A_6 = -7.321E-03, A_8 = 1.465E-03,$
- [0367]  $A_{10} = -1.613E-04, A_{12} = 1.051E-05, A_{14} = 4.523E-07, A_{16} = -7.458E-08$
- [0368] 第 7 面
- [0369]  $k = 0.000, A_4 = -4.107E-03, A_6 = -6.095E-04, A_8 = 2.313E-04,$
- [0370]  $A_{10} = -1.564E-05, A_{12} = -1.063E-06, A_{14} = -4.057E-07, A_{16} = 1.971E-08$
- [0371] 第 8 面
- [0372]  $k = 0.000, A_4 = -7.452E-03, A_6 = 2.441E-04, A_8 = 1.544E-04,$
- [0373]  $A_{10} = -4.022E-05, A_{12} = -1.261E-07, A_{14} = 2.097E-07, A_{16} = 2.056E-08$
- [0374] 第 9 面
- [0375]  $k = 0.000, A_4 = -1.153E-03, A_6 = 4.274E-04, A_8 = -1.137E-05,$
- [0376]  $A_{10} = 5.141E-07, A_{12} = -1.679E-06, A_{14} = 6.825E-08, A_{16} = 2.075E-08$
- [0377] 第 10 面
- [0378]  $k = 0.000, A_4 = -2.008E-03, A_6 = -5.326E-04, A_8 = -6.927E-05,$
- [0379]  $A_{10} = 3.698E-06, A_{12} = -9.083E-07, A_{14} = -2.415E-08, A_{16} = 2.387E-09$
- [0380] 第 11 面
- [0381]  $k = 0.000, A_4 = -2.664E-03, A_6 = -4.928E-04, A_8 = 6.485E-06,$
- [0382]  $A_{10} = -1.390E-06, A_{12} = 2.179E-08, A_{14} = 2.943E-09, A_{16} = 2.577E-11$
- [0383] 第 12 面
- [0384]  $k = 0.000, A_4 = -7.128E-03, A_6 = -1.704E-06, A_8 = -2.063E-06,$
- [0385]  $A_{10} = 3.368E-07, A_{12} = 1.676E-08, A_{14} = 5.661E-10, A_{16} = -9.290E-11$
- [0386] 第 13 面
- [0387]  $k = 0.000, A_4 = -7.959E-03, A_6 = 1.161E-04, A_8 = 1.846E-06,$
- [0388]  $A_{10} = -1.411E-07, A_{12} = 2.493E-09, A_{14} = -4.883E-11, A_{16} = -1.244E-12$
- [0389] 第 14 面
- [0390]  $k = 0.000, A_4 = -1.477E-02, A_6 = 4.361E-04, A_8 = 2.104E-07,$
- [0391]  $A_{10} = 9.535E-08, A_{12} = -2.529E-09, A_{14} = -4.606E-10, A_{16} = 1.104E-11$
- [0392] 第 15 面
- [0393]  $k = -5.017, A_4 = -8.878E-03, A_6 = 3.107E-04, A_8 = -7.809E-06,$
- [0394]  $A_{10} = 1.765E-07, A_{12} = 8.693E-09, A_{14} = -5.836E-10, A_{16} = 8.814E-12$
- [0395]  $f1 = 8.79\text{mm}$
- [0396]  $f2 = -12.30\text{mm}$
- [0397]  $f3 = 21.81\text{mm}$
- [0398]  $f4 = 55.06\text{mm}$
- [0399]  $f5 = 41.55\text{mm}$

- [0400]  $f_6 = -24.82\text{mm}$   
[0401]  $f_7 = -20.22\text{mm}$   
[0402]  $f_{45} = 22.80\text{mm}$   
[0403]  $f_{67} = -10.77\text{mm}$   
[0404] 以下表示各条件式的值。  
[0405]  $f_3/f_1 = 2.48$   
[0406]  $f_2/f_3 = -0.56$   
[0407]  $f_4/f = 4.78$   
[0408]  $f_{45}/f = 1.98$   
[0409]  $f_{45}/f_{67} = -2.12$   
[0410]  $D_{34}/f = 0.08$   
[0411]  $D_{56}/f = 0.19$   
[0412]  $f_7/f = -1.76$   
[0413]  $f_2/f_1 = -1.40$   
[0414]  $f_6/f_7 = 1.23$

[0415] 这样,本数值实施例 4 的摄像镜头满足上述各条件式。从第一透镜 L1 的物体侧的面到像面 IM 为止的光轴上的距离(滤光片 10 是空气换算长度)是 13.32mm,实现了摄像镜头的小型化。

[0416] 图 11 关于数值实施例 4 的摄像镜头,表示出与像高比 H 对应的横像差,图 12 分别表示出球面像差(mm)、像散(mm)以及畸变(%)。如图 11 和图 12 所示,根据本数值实施例 4 的摄像镜头也良好地修正了各像差。

- [0417] 数值实施例 5  
[0418] 以下表示基本镜头数据。  
[0419]  $f = 8.67\text{mm}$ 、 $F_{\text{no}} = 2.2$ 、 $\omega = 35.1^\circ$   
[0420]

单位 mm

面数据

| 面编号 i | r        | d        | nd     | $\nu d$            |
|-------|----------|----------|--------|--------------------|
| (物面)  | $\infty$ | $\infty$ |        |                    |
| 1*    | 4.768    | 1.225    | 1.5346 | 56.1(= $\nu d_1$ ) |
| 2*    | 13.787   | 0.006    |        |                    |
| 3(光阑) | $\infty$ | 0.121    |        |                    |
| 4*    | 9.112    | 1.131    | 1.6355 | 24.0(= $\nu d_2$ ) |

[0421]

|      |          |              |        |                   |
|------|----------|--------------|--------|-------------------|
| 5*   | 5.264    | 0.174        |        |                   |
| 6*   | 6.739    | 0.562        | 1.5346 | 56.1 (= $\nu$ d3) |
| 7*   | -18.422  | 0.894 (=D34) |        |                   |
| 8*   | -4.360   | 1.120        | 1.5346 | 56.1 (= $\nu$ d4) |
| 9*   | -4.203   | 0.023        |        |                   |
| 10*  | -13.261  | 1.306        | 1.6355 | 24.0 (= $\nu$ d5) |
| 11*  | -11.418  | 0.915 (=D56) |        |                   |
| 12*  | 9.779    | 1.044        | 1.6355 | 24.0 (= $\nu$ d6) |
| 13*  | 5.107    | 0.545        |        |                   |
| 14*  | 6.050    | 1.172        | 1.5346 | 56.1 (= $\nu$ d7) |
| 15*  | 3.667    | 0.680        |        |                   |
| 16   | $\infty$ | 0.300        | 1.5168 | 64.2              |
| 17   | $\infty$ | 0.392        |        |                   |
| (像面) | $\infty$ |              |        |                   |

[0422] 非球面数据

[0423] 第1面

[0424]  $k = 0.000$ ,  $A_4 = -1.442E-04$ ,  $A_6 = -4.252E-04$ ,  $A_8 = -5.829E-05$ ,

[0425]  $A_{10} = 7.729E-06$ ,  $A_{12} = -7.729E-07$ ,  $A_{14} = -2.721E-07$ ,  $A_{16} = 2.173E-08$

[0426] 第2面

[0427]  $k = 0.000$ ,  $A_4 = 1.225E-02$ ,  $A_6 = -1.770E-02$ ,  $A_8 = 5.696E-03$ ,

[0428]  $A_{10} = -8.952E-04$ ,  $A_{12} = 4.534E-05$ ,  $A_{14} = 5.387E-06$ ,  $A_{16} = -6.549E-07$

[0429] 第4面

[0430]  $k = 0.000$ ,  $A_4 = 1.248E-02$ ,  $A_6 = -2.005E-02$ ,  $A_8 = 7.570E-03$ ,

[0431]  $A_{10} = -1.470E-03$ ,  $A_{12} = 1.137E-04$ ,  $A_{14} = 1.042E-05$ ,  $A_{16} = -1.989E-06$

[0432] 第5面

[0433]  $k = 0.000$ ,  $A_4 = 4.826E-03$ ,  $A_6 = -1.017E-02$ ,  $A_8 = 2.627E-03$ ,

[0434]  $A_{10} = -3.251E-04$ ,  $A_{12} = 9.698E-06$ ,  $A_{14} = 1.282E-06$ ,  $A_{16} = -3.440E-08$

[0435] 第6面

[0436]  $k = 0.000$ ,  $A_4 = 3.529E-03$ ,  $A_6 = -7.102E-03$ ,  $A_8 = 1.423E-03$ ,

[0437]  $A_{10} = -1.676E-04$ ,  $A_{12} = 1.021E-05$ ,  $A_{14} = 5.379E-07$ ,  $A_{16} = -5.165E-09$

[0438] 第7面

[0439]  $k = 0.000$ ,  $A_4 = -3.710E-03$ ,  $A_6 = -2.157E-04$ ,  $A_8 = 2.360E-04$ ,

[0440]  $A_{10} = -5.668E-06$ ,  $A_{12} = 1.774E-07$ ,  $A_{14} = 1.109E-07$ ,  $A_{16} = 3.634E-08$

[0441] 第8面

[0442]  $k = 0.000$ ,  $A_4 = -3.150E-03$ ,  $A_6 = 1.430E-03$ ,  $A_8 = 1.997E-04$ ,

- [0443]  $A_{10} = -3.485\text{E-}05$ ,  $A_{12} = -3.109\text{E-}07$ ,  $A_{14} = 2.738\text{E-}07$ ,  $A_{16} = 1.097\text{E-}08$
- [0444] 第 9 面
- [0445]  $k = 0.000$ ,  $A_4 = -3.571\text{E-}03$ ,  $A_6 = 2.703\text{E-}04$ ,  $A_8 = -1.163\text{E-}05$ ,
- [0446]  $A_{10} = 1.381\text{E-}06$ ,  $A_{12} = -1.482\text{E-}06$ ,  $A_{14} = -2.457\text{E-}08$ ,  $A_{16} = 1.603\text{E-}08$
- [0447] 第 10 面
- [0448]  $k = 0.000$ ,  $A_4 = -7.473\text{E-}03$ ,  $A_6 = -8.908\text{E-}04$ ,  $A_8 = -1.243\text{E-}04$ ,
- [0449]  $A_{10} = 5.264\text{E-}06$ ,  $A_{12} = -5.447\text{E-}07$ ,  $A_{14} = -1.393\text{E-}07$ ,  $A_{16} = 2.669\text{E-}08$
- [0450] 第 11 面
- [0451]  $k = 0.000$ ,  $A_4 = -3.477\text{E-}03$ ,  $A_6 = -4.574\text{E-}04$ ,  $A_8 = 1.270\text{E-}05$ ,
- [0452]  $A_{10} = 7.131\text{E-}08$ ,  $A_{12} = 1.551\text{E-}07$ ,  $A_{14} = 2.009\text{E-}08$ ,  $A_{16} = -1.129\text{E-}09$
- [0453] 第 12 面
- [0454]  $k = 0.000$ ,  $A_4 = -7.052\text{E-}03$ ,  $A_6 = 3.262\text{E-}05$ ,  $A_8 = 4.109\text{E-}06$ ,
- [0455]  $A_{10} = 3.024\text{E-}07$ ,  $A_{12} = 2.279\text{E-}09$ ,  $A_{14} = -2.325\text{E-}10$ ,  $A_{16} = -1.801\text{E-}11$
- [0456] 第 13 面
- [0457]  $k = 0.000$ ,  $A_4 = -7.766\text{E-}03$ ,  $A_6 = 1.105\text{E-}04$ ,  $A_8 = -3.842\text{E-}07$ ,
- [0458]  $A_{10} = -9.066\text{E-}08$ ,  $A_{12} = 5.815\text{E-}09$ ,  $A_{14} = -4.823\text{E-}11$ ,  $A_{16} = -5.462\text{E-}12$
- [0459] 第 14 面
- [0460]  $k = 0.000$ ,  $A_4 = -1.216\text{E-}02$ ,  $A_6 = 3.947\text{E-}04$ ,  $A_8 = -1.379\text{E-}06$ ,
- [0461]  $A_{10} = 3.881\text{E-}08$ ,  $A_{12} = -3.941\text{E-}09$ ,  $A_{14} = -4.418\text{E-}10$ ,  $A_{16} = 1.538\text{E-}11$
- [0462] 第 15 面
- [0463]  $k = -3.754$ ,  $A_4 = -6.588\text{E-}03$ ,  $A_6 = 3.515\text{E-}04$ ,  $A_8 = -1.117\text{E-}05$ ,
- [0464]  $A_{10} = 1.138\text{E-}07$ ,  $A_{12} = 1.115\text{E-}08$ ,  $A_{14} = -5.171\text{E-}10$ ,  $A_{16} = 6.563\text{E-}12$
- [0465]  $f1 = 13.02\text{mm}$
- [0466]  $f2 = -22.14\text{mm}$
- [0467]  $f3 = 9.30\text{mm}$
- [0468]  $f4 = 62.66\text{mm}$
- [0469]  $f5 = 101.37\text{mm}$
- [0470]  $f6 = -18.42\text{mm}$
- [0471]  $f7 = -21.01\text{mm}$
- [0472]  $f45 = 38.47\text{mm}$
- [0473]  $f67 = -9.32\text{mm}$
- [0474] 以下表示各条件式的值。
- [0475]  $f3/f1 = 0.71$
- [0476]  $f2/f3 = -2.38$
- [0477]  $f4/f = 7.23$
- [0478]  $f45/f = 4.44$
- [0479]  $f45/f67 = -4.13$
- [0480]  $D34/f = 0.10$
- [0481]  $D56/f = 0.11$

[0482]  $f_7/f = -2.42$

[0483]  $f_2/f_1 = -1.70$

[0484]  $f_6/f_7 = 0.88$

[0485] 这样,本数值实施例 5 的摄像镜头满足上述各条件式。从第一透镜 L1 的物体侧的面到像面 IM 为止的光轴上的距离(滤光片 10 是空气换算长度)是 11.51mm,实现了摄像镜头的小型化。

[0486] 图 14 关于数值实施例 5 的摄像镜头,表示出与像高比 H 对应的横像差,图 15 分别表示出球面像差(mm)、像散(mm)以及畸变(%)。如图 14 和图 15 所示,根据本数值实施例 5 的摄像镜头也良好地修正了各像差。

[0487] 数值实施例 6

[0488] 以下表示基本镜头数据。

[0489]  $f = 8.40\text{mm}$ 、 $F_{no} = 2.2$ 、 $\omega = 36.0^\circ$

[0490]

单位 mm

[0491]

## 面数据

| 面编号 i  | r        | d            | nd     | $\nu$ d           |
|--------|----------|--------------|--------|-------------------|
| (物面)   | $\infty$ | $\infty$     |        |                   |
| 1*     | 7.658    | 1.100        | 1.5346 | 56.1 (= $\nu$ d1) |
| 2*     | -53.073  | -0.069       |        |                   |
| 3 (光阑) | $\infty$ | 0.106        |        |                   |
| 4*     | 16.879   | 0.380        | 1.6355 | 24.0 (= $\nu$ d2) |
| 5*     | 6.417    | 0.076        |        |                   |
| 6*     | 9.768    | 0.933        | 1.5346 | 56.1 (= $\nu$ d3) |
| 7*     | -10.747  | 2.035 (=D34) |        |                   |
| 8*     | -3.282   | 0.515        | 1.5346 | 56.1 (= $\nu$ d4) |
| 9*     | -3.135   | 0.030        |        |                   |
| 10*    | -49.303  | 0.923        | 1.6355 | 24.0 (= $\nu$ d5) |
| 11*    | -27.983  | 0.694 (=D56) |        |                   |
| 12*    | 8.841    | 1.211        | 1.6355 | 24.0 (= $\nu$ d6) |
| 13*    | 5.141    | 0.767        |        |                   |
| 14*    | 5.521    | 1.198        | 1.5346 | 56.1 (= $\nu$ d7) |
| 15*    | 3.529    | 0.680        |        |                   |
| 16     | $\infty$ | 0.300        | 1.5168 | 64.2              |
| 17     | $\infty$ | 0.418        |        |                   |
| (像面)   | $\infty$ |              |        |                   |

[0492] 非球面数据

[0493] 第 1 面

[0494]  $k = 0.000$ ,  $A_4 = -4.156\text{E-}03$ ,  $A_6 = -5.223\text{E-}05$ ,  $A_8 = -5.968\text{E-}05$ ,[0495]  $A_{10} = 1.006\text{E-}05$ ,  $A_{12} = 6.018\text{E-}08$ ,  $A_{14} = -3.837\text{E-}08$ ,  $A_{16} = -6.205\text{E-}09$ 

[0496] 第 2 面

[0497]  $k = 0.000$ ,  $A_4 = 1.712\text{E-}02$ ,  $A_6 = -1.648\text{E-}02$ ,  $A_8 = 5.700\text{E-}03$ ,[0498]  $A_{10} = -9.584\text{E-}04$ ,  $A_{12} = 3.864\text{E-}05$ ,  $A_{14} = 9.170\text{E-}06$ ,  $A_{16} = -9.202\text{E-}07$ 

[0499] 第 4 面

[0500]  $k = 0.000$ ,  $A_4 = 1.915\text{E-}02$ ,  $A_6 = -2.128\text{E-}02$ ,  $A_8 = 7.442\text{E-}03$ ,[0501]  $A_{10} = -1.369\text{E-}03$ ,  $A_{12} = 7.994\text{E-}05$ ,  $A_{14} = 1.026\text{E-}05$ ,  $A_{16} = -1.252\text{E-}06$ 

[0502] 第 5 面

- [0503]  $k = 0.000, A_4 = 1.316E-02, A_6 = -1.210E-02, A_8 = 2.743E-03,$   
[0504]  $A_{10} = -3.303E-04, A_{12} = 1.025E-05, A_{14} = 1.712E-06, A_{16} = 1.496E-08$   
[0505] 第 6 面  
[0506]  $k = 0.000, A_4 = 1.443E-02, A_6 = -7.325E-03, A_8 = 1.468E-03,$   
[0507]  $A_{10} = -1.653E-04, A_{12} = 9.429E-06, A_{14} = 3.314E-07, A_{16} = -5.385E-08$   
[0508] 第 7 面  
[0509]  $k = 0.000, A_4 = -2.920E-03, A_6 = -6.142E-04, A_8 = 2.006E-04,$   
[0510]  $A_{10} = -1.681E-05, A_{12} = -5.885E-07, A_{14} = -3.186E-07, A_{16} = 1.411E-08$   
[0511] 第 8 面  
[0512]  $k = 0.000, A_4 = -5.868E-03, A_6 = 4.981E-04, A_8 = 1.644E-04,$   
[0513]  $A_{10} = -3.745E-05, A_{12} = 3.196E-07, A_{14} = 2.464E-07, A_{16} = 1.890E-08$   
[0514] 第 9 面  
[0515]  $k = 0.000, A_4 = -2.778E-03, A_6 = 5.034E-04, A_8 = -1.365E-06,$   
[0516]  $A_{10} = 3.204E-07, A_{12} = -1.817E-06, A_{14} = 6.919E-08, A_{16} = 2.640E-08$   
[0517] 第 10 面  
[0518]  $k = 0.000, A_4 = -2.145E-03, A_6 = -7.136E-04, A_8 = -7.507E-05,$   
[0519]  $A_{10} = 4.838E-06, A_{12} = -8.803E-07, A_{14} = -5.411E-08, A_{16} = -3.818E-09$   
[0520] 第 11 面  
[0521]  $k = 0.000, A_4 = -1.111E-03, A_6 = -4.709E-04, A_8 = 1.734E-06,$   
[0522]  $A_{10} = -1.459E-06, A_{12} = 5.712E-08, A_{14} = 7.257E-09, A_{16} = 2.782E-10$   
[0523] 第 12 面  
[0524]  $k = 0.000, A_4 = -4.802E-03, A_6 = 2.466E-05, A_8 = -1.921E-07,$   
[0525]  $A_{10} = 1.754E-07, A_{12} = 5.647E-09, A_{14} = 6.112E-10, A_{16} = -6.960E-11$   
[0526] 第 13 面  
[0527]  $k = 0.000, A_4 = -6.235E-03, A_6 = 6.105E-05, A_8 = 2.172E-06,$   
[0528]  $A_{10} = -1.096E-07, A_{12} = 3.182E-09, A_{14} = -5.783E-11, A_{16} = -4.904E-12$   
[0529] 第 14 面  
[0530]  $k = 0.000, A_4 = -1.286E-02, A_6 = 4.059E-04, A_8 = -7.829E-07,$   
[0531]  $A_{10} = 4.146E-08, A_{12} = -4.337E-09, A_{14} = -4.785E-10, A_{16} = 1.473E-11$   
[0532] 第 15 面  
[0533]  $k = -3.781, A_4 = -5.334E-03, A_6 = 2.322E-04, A_8 = -9.022E-06,$   
[0534]  $A_{10} = 1.882E-07, A_{12} = 9.396E-09, A_{14} = -5.765E-10, A_{16} = 8.140E-12$   
[0535]  $f1 = 12.60\text{mm}$   
[0536]  $f2 = -16.52\text{mm}$   
[0537]  $f3 = 9.73\text{mm}$   
[0538]  $f4 = 59.00\text{mm}$   
[0539]  $f5 = 100.14\text{mm}$   
[0540]  $f6 = -22.14\text{mm}$   
[0541]  $f7 = -23.14\text{mm}$

[0542]  $f_{45} = 36.69\text{mm}$

[0543]  $f_{67} = -10.76\text{mm}$

[0544] 以下表示各条件式的值。

[0545]  $f_3/f_1 = 0.77$

[0546]  $f_2/f_3 = -1.70$

[0547]  $f_4/f = 7.02$

[0548]  $f_{45}/f = 4.37$

[0549]  $f_{45}/f_{67} = -3.41$

[0550]  $D_{34}/f = 0.24$

[0551]  $D_{56}/f = 0.08$

[0552]  $f_7/f = -2.75$

[0553]  $f_2/f_1 = -1.31$

[0554]  $f_6/f_7 = 0.96$

[0555] 这样,本数值实施例 6 的摄像镜头满足上述各条件式。从第一透镜 L1 的物体侧的面到像面 IM 为止的光轴上的距离(滤光片 10 是空气换算长度)是 11.19mm,实现了摄像镜头的小型化。

[0556] 图 17 关于数值实施例 6 的摄像镜头,表示出与像高比 H 对应的横像差,图 18 分别表示出球面像差(mm)、像散(mm)以及畸变(%)。如图 17 和图 18 所示,根据本数值实施例 6 的摄像镜头也良好地修正了各像差。

[0557] 根据以上说明的本实施方式的摄像镜头,能够实现  $70^\circ$  以上的广视场角( $2\omega$ )。顺便说,上述数值实施例 1~6 的摄像镜头具有  $54.2^\circ \sim 72.0^\circ$  的广视场角。根据本实施方式的摄像镜头,能够拍摄比现有的摄像镜头更广的范围。

[0558] 另外,近年来,由于通过图像处理来放大通过摄像镜头得到的图像的任意区域的数字变焦技术的进步,高像素的摄像元件和高分辨率的摄像镜头组合起来的情况变多。在这样的高像素的摄像元件中,由于各像素的感光面积减小,因此所拍摄的图像有变暗的倾向。作为用于对其进行修正的方法,有使用电路提高摄像元件的感光灵敏度的方法。但是,若感光灵敏度提高,则不直接有助于图像形成的噪声成分也被放大,因此新需要用于降低噪声的电路。数值实施例 1~6 的摄像镜头的  $F_{no}$  成为  $2.2 \sim 2.9$  这样的小的值。根据本实施方式的摄像镜头,即使不设置上述电路等也能够得到足够明亮的图像。

[0559] 因此,在将上述实施方式的摄像镜头应用于内置在便携电话机、便携信息终端以及智能手机等便携设备中的摄像机、数码静物相机、安防摄像机、车载摄像机、网络摄像机等的摄像光学系统的情况下,能够实现该摄像机等的高功能化和小型化的兼顾。

[0560] 产业利用性

[0561] 本实用新型能够应用于在内置于便携电话机、智能手机、便携信息终端等便携设备中的摄像机、数码静物相机、安防摄像机、车载摄像机、网络摄像机等比较小型的摄像机中装入的摄像镜头。

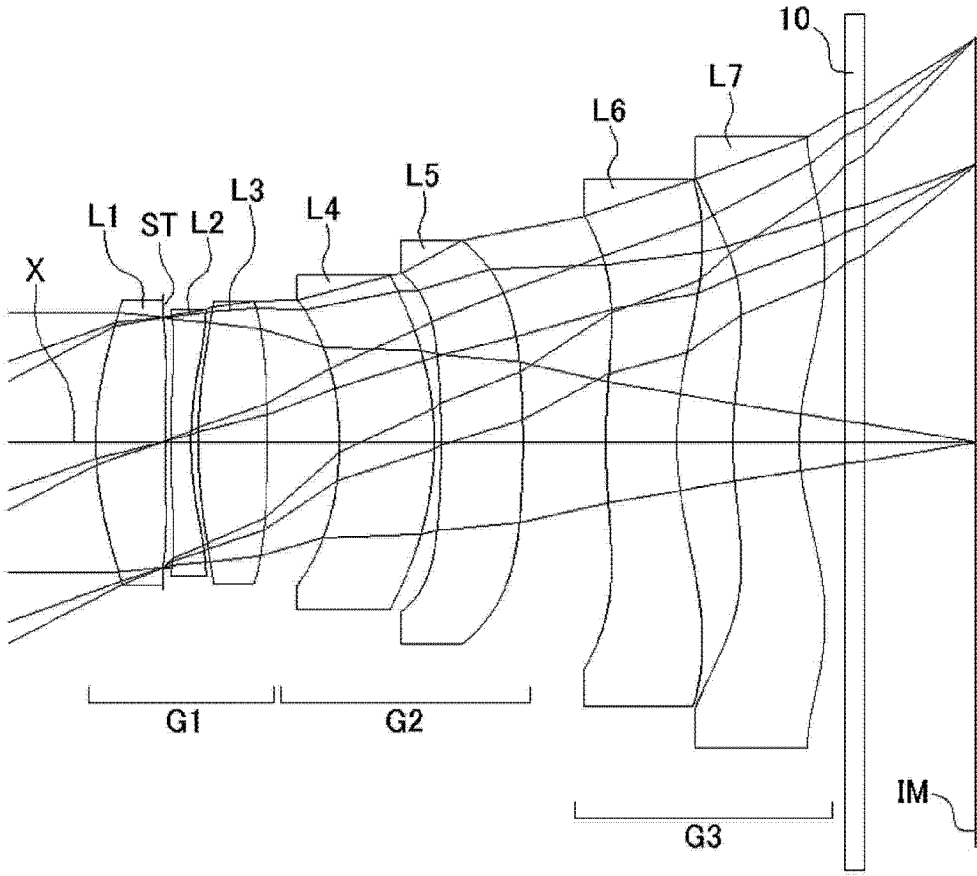


图 1

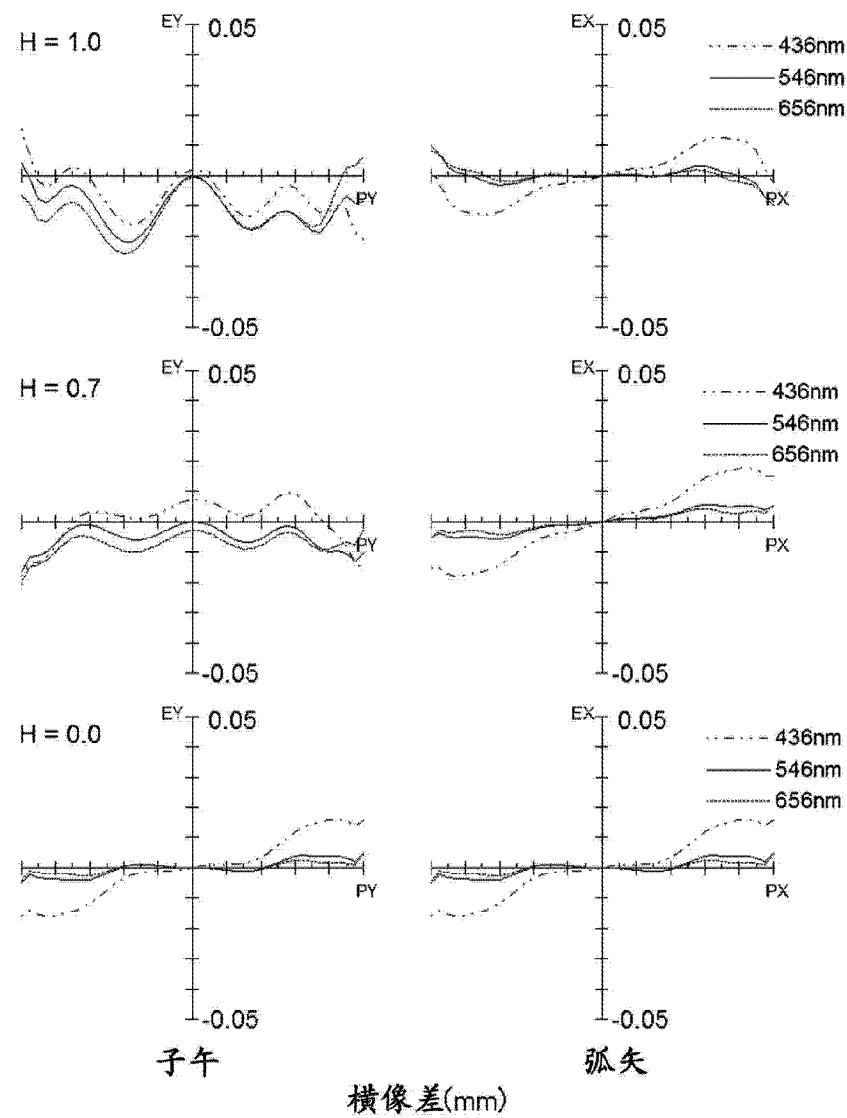


图 2

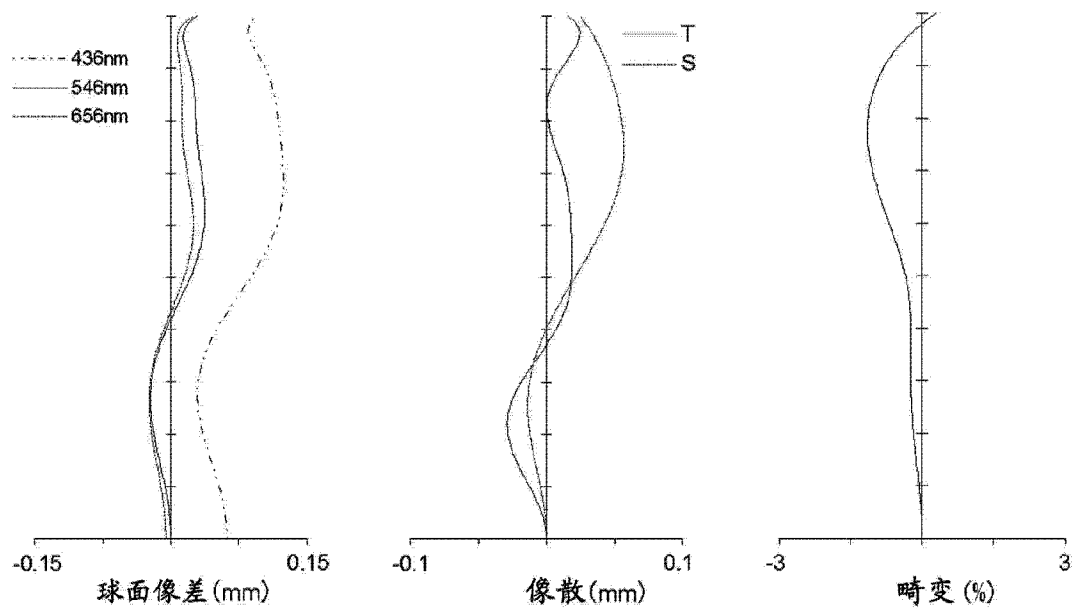


图 3

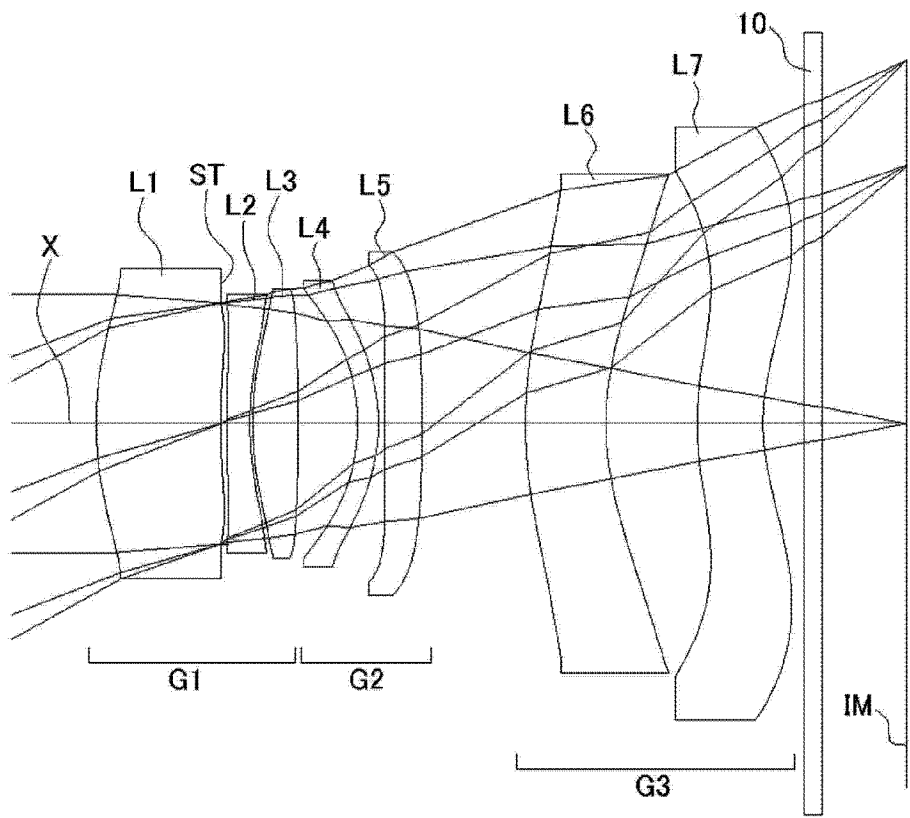


图 4

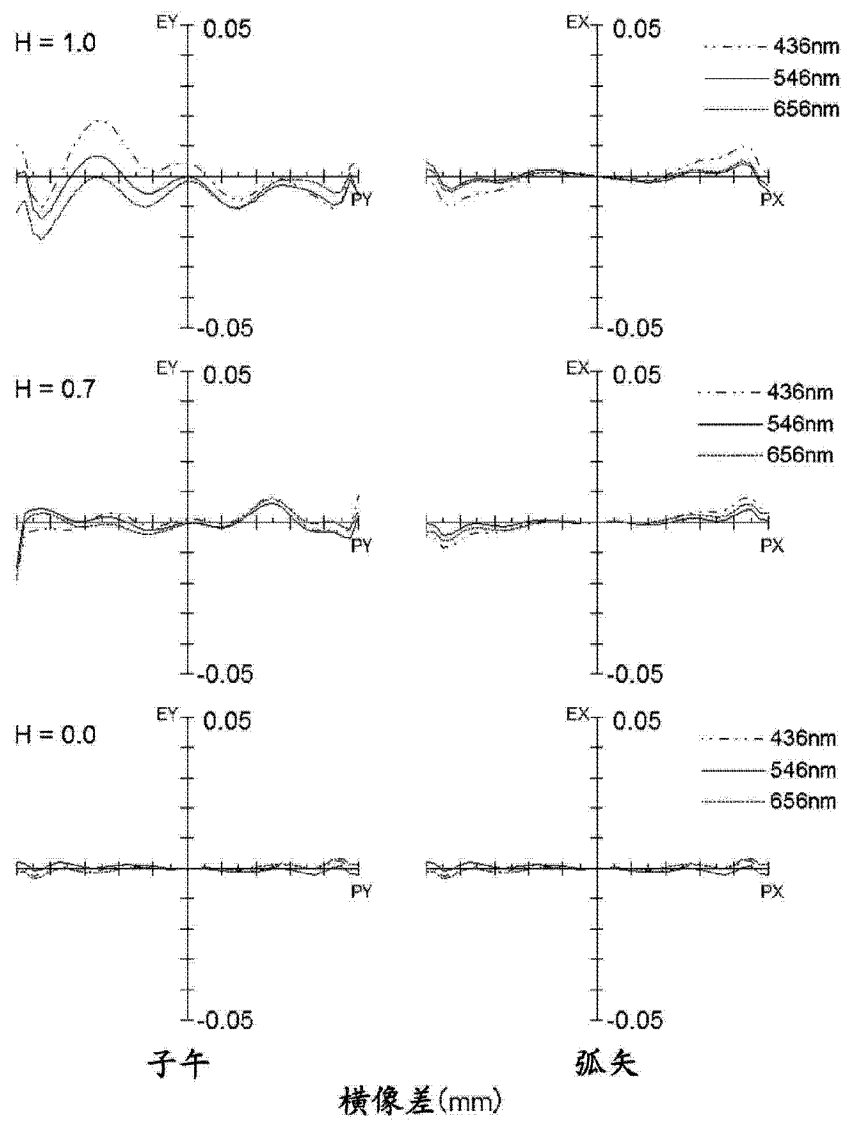


图 5

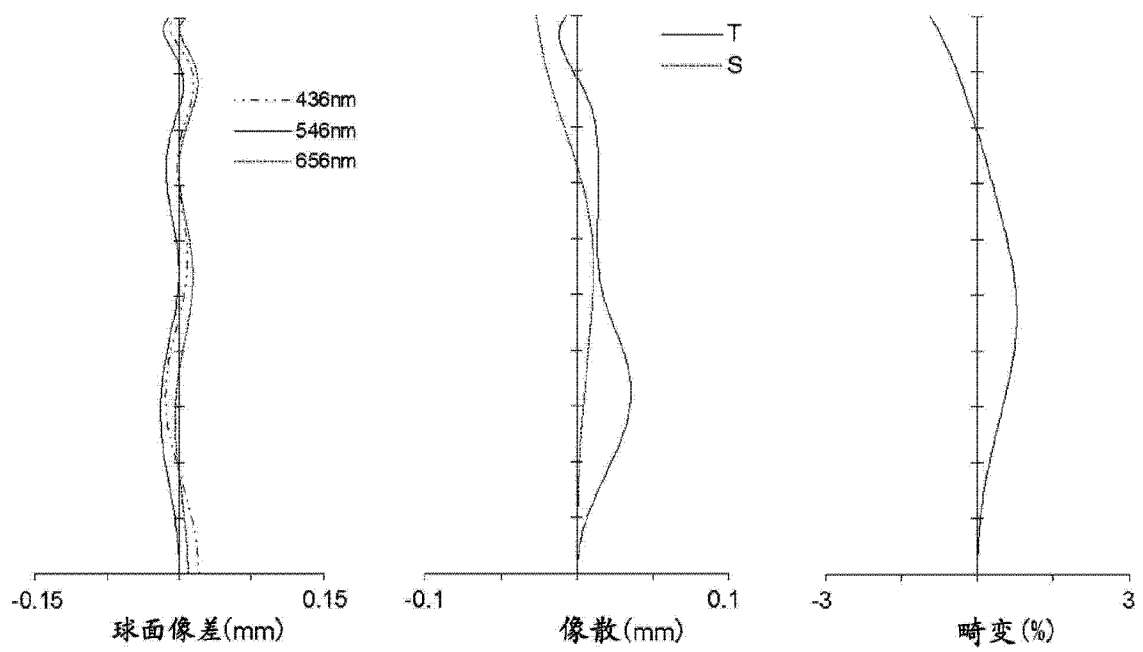


图 6

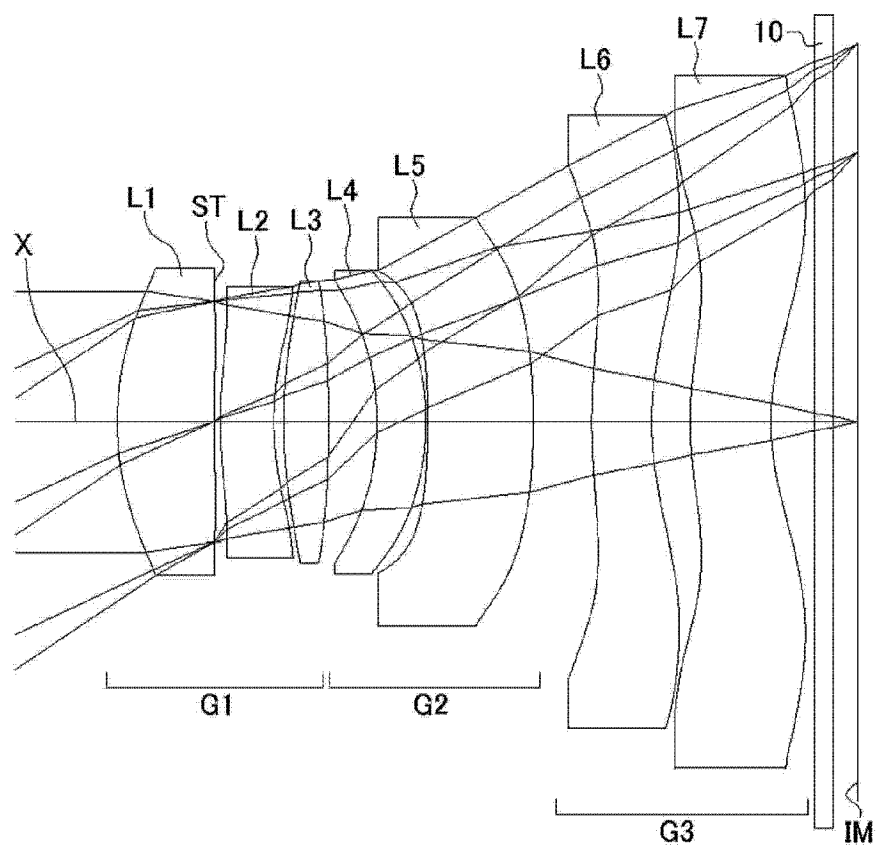


图 7

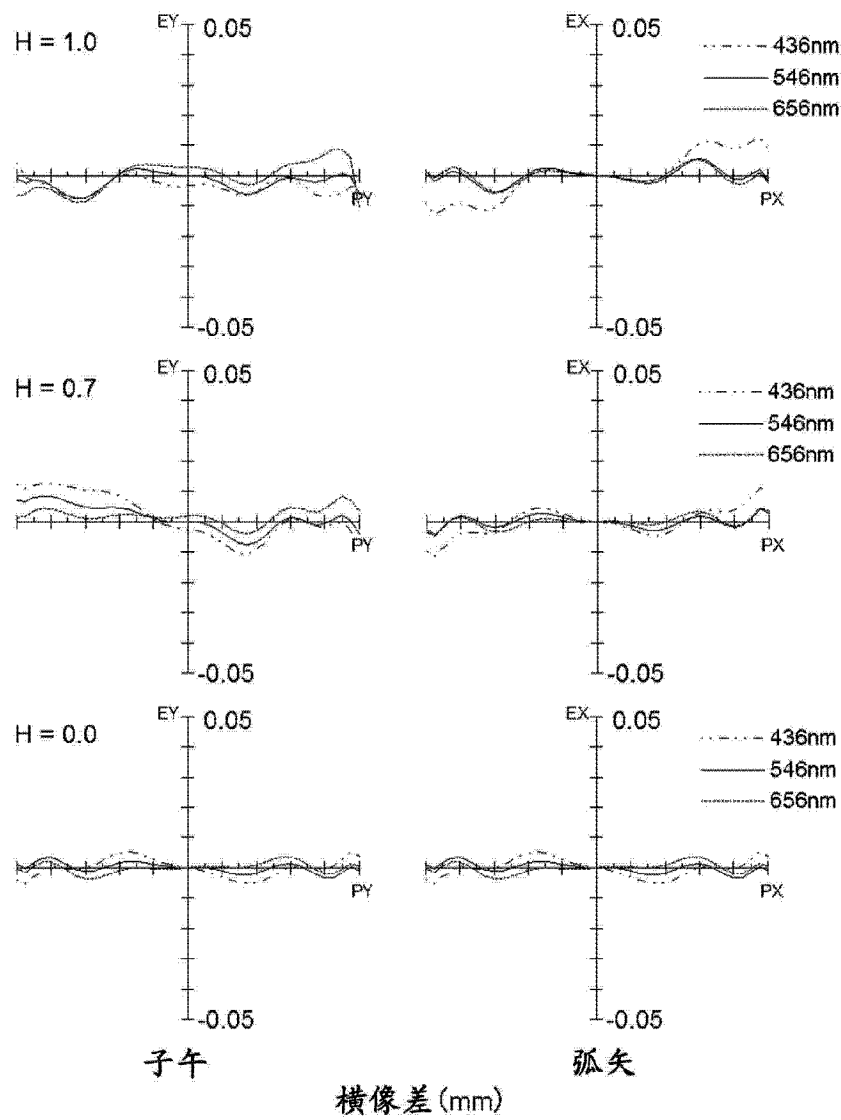


图 8

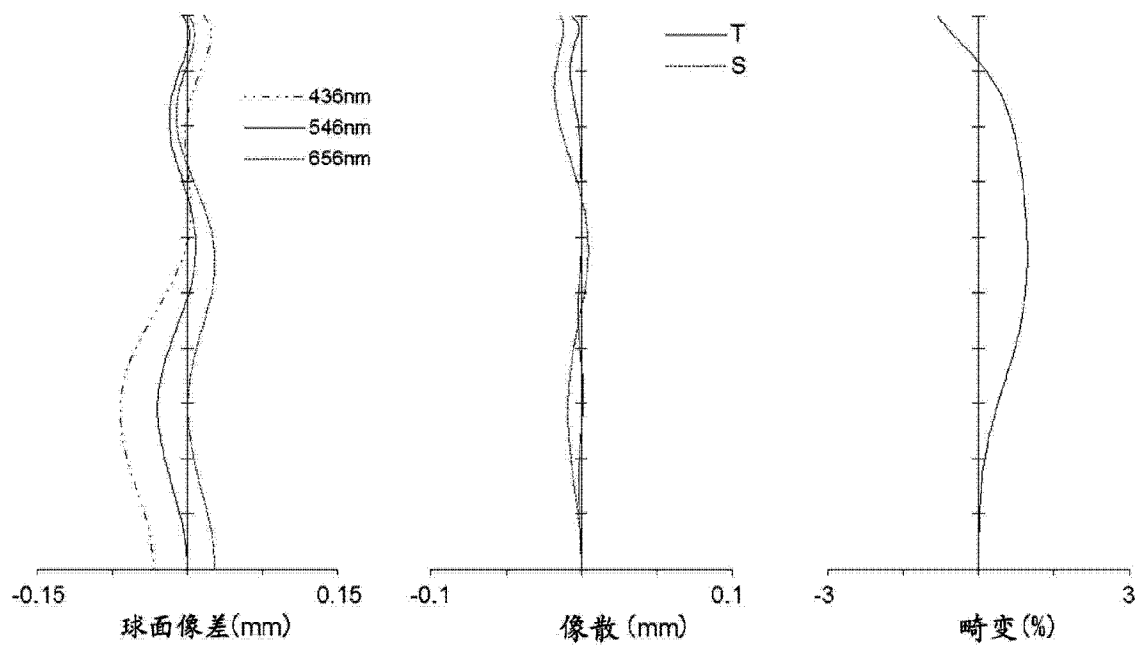


图 9

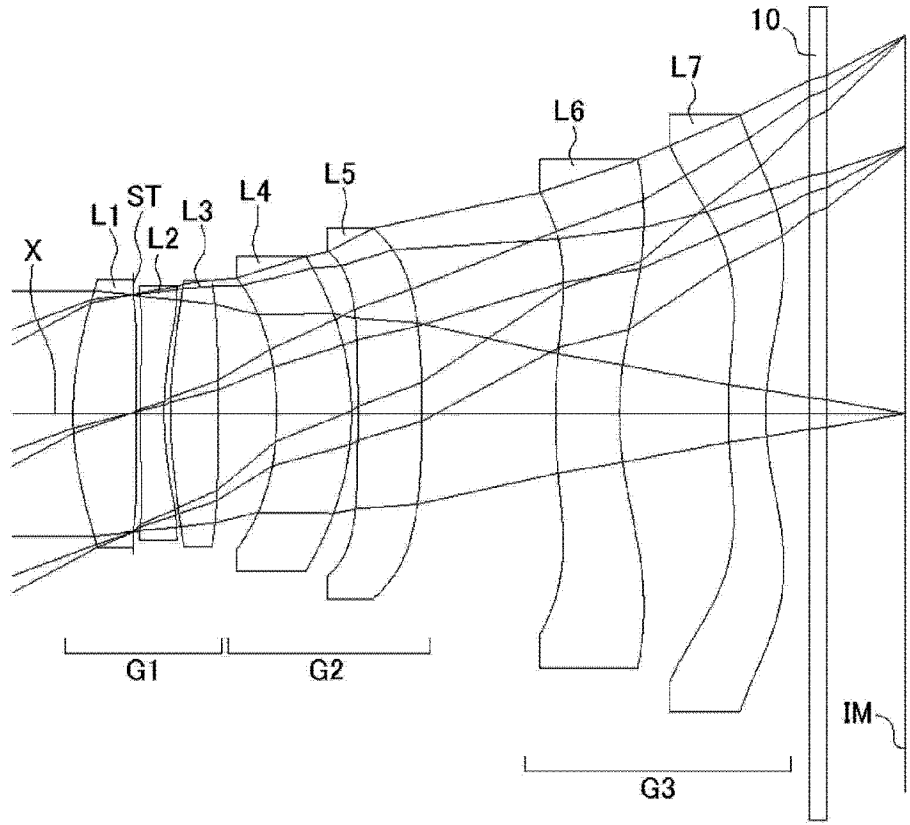


图 10

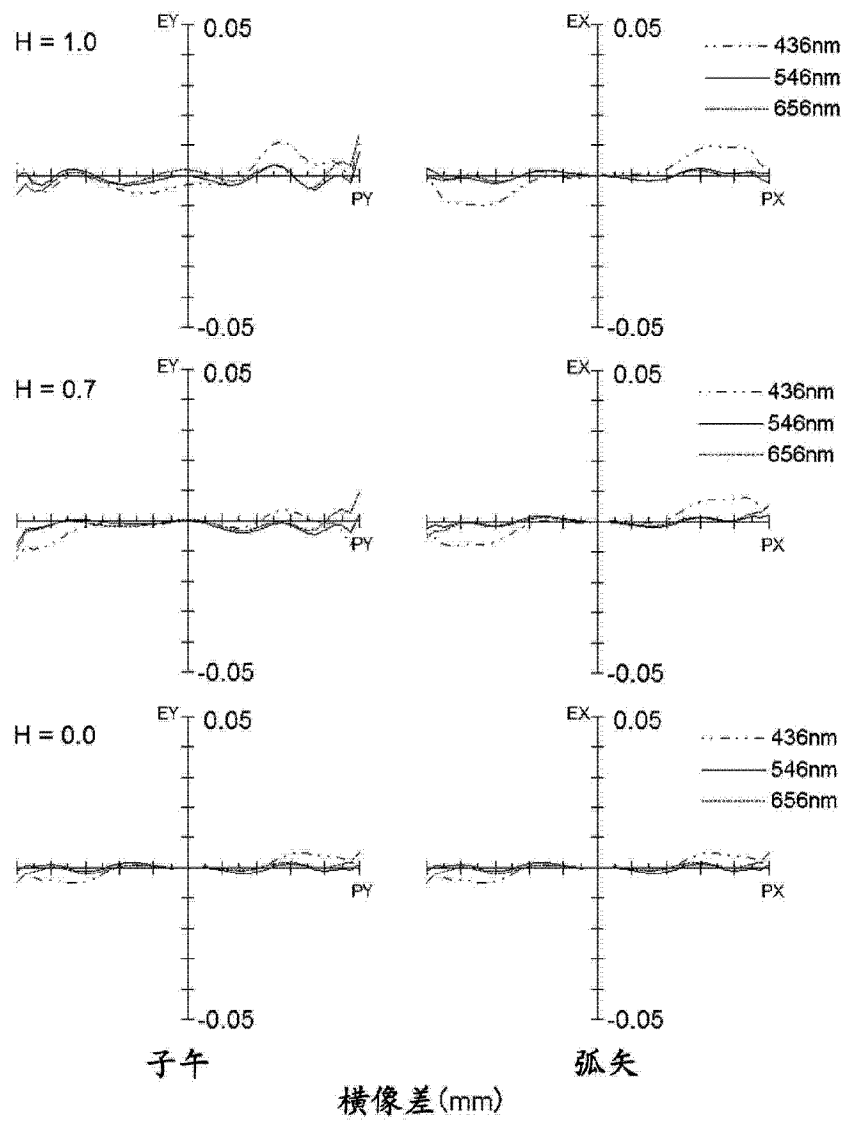


图 11

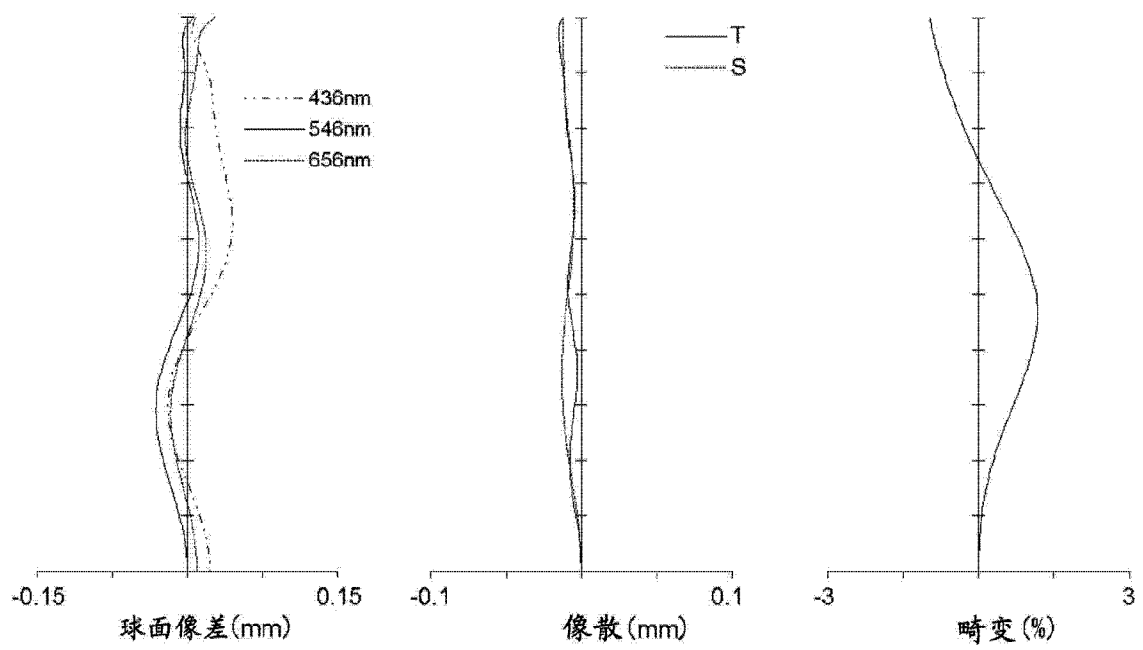


图 12

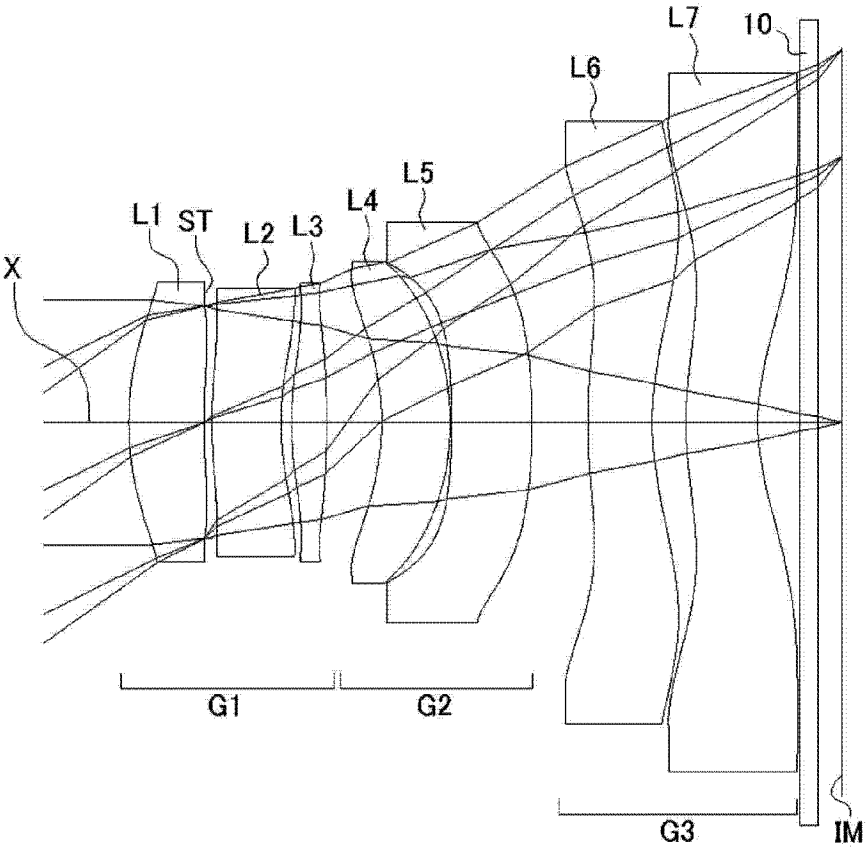


图 13

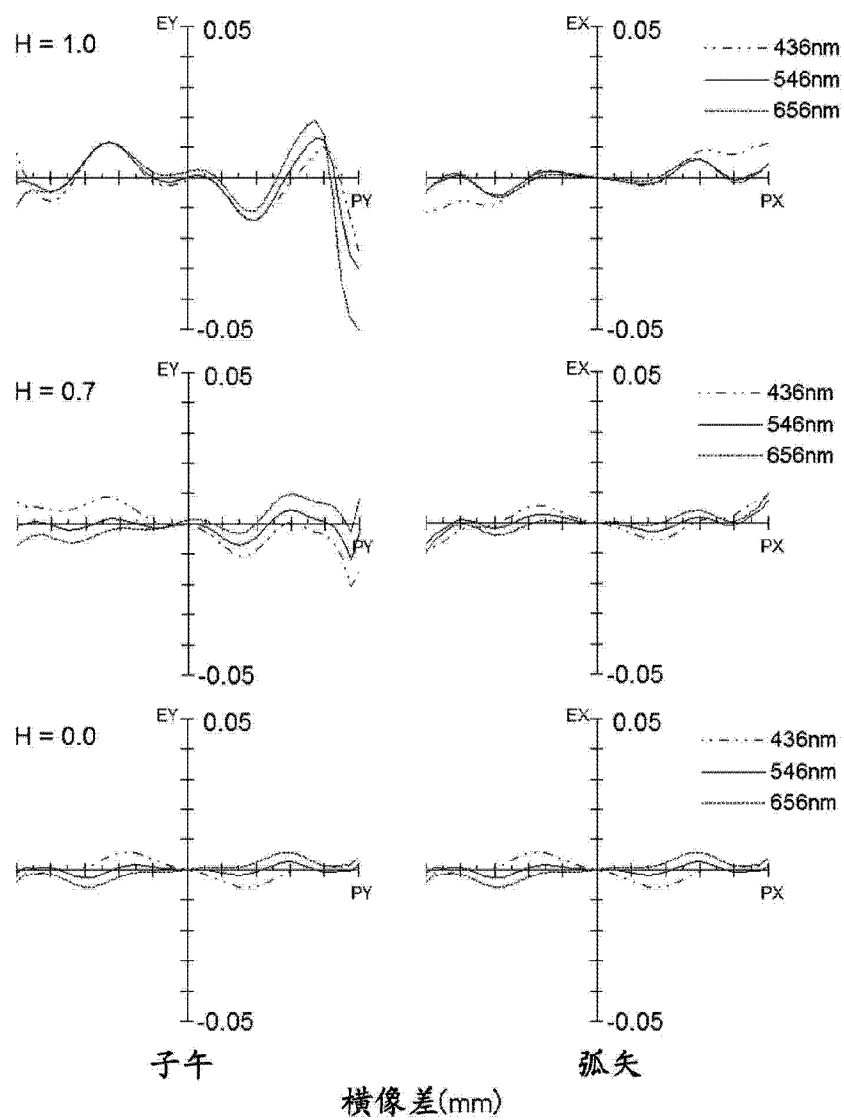


图 14

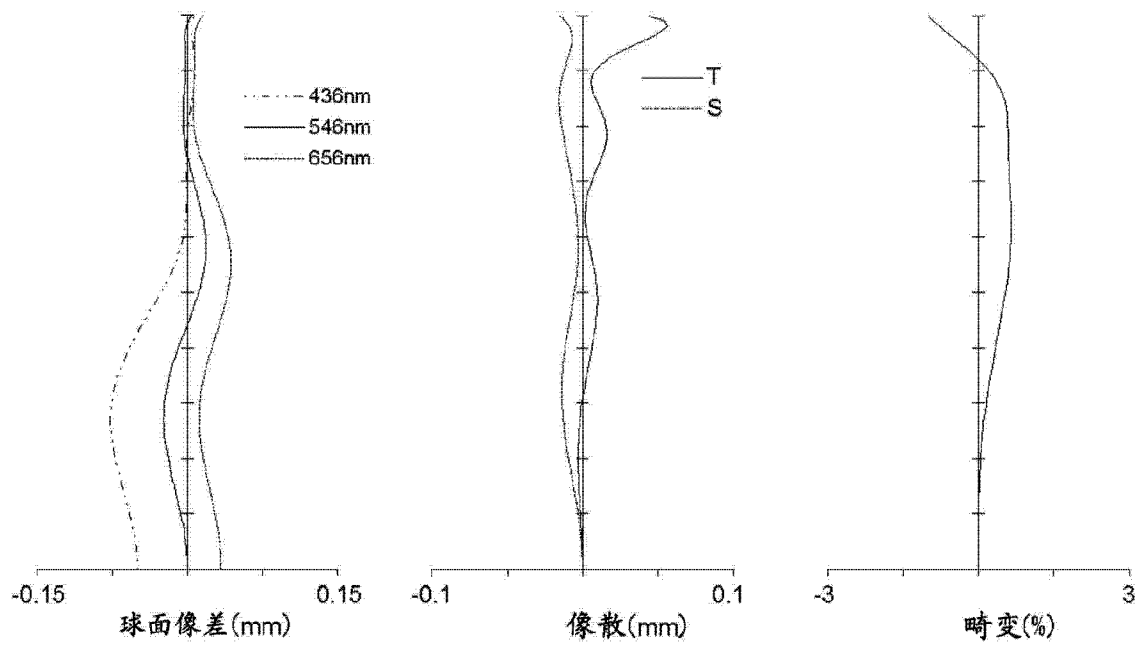


图 15

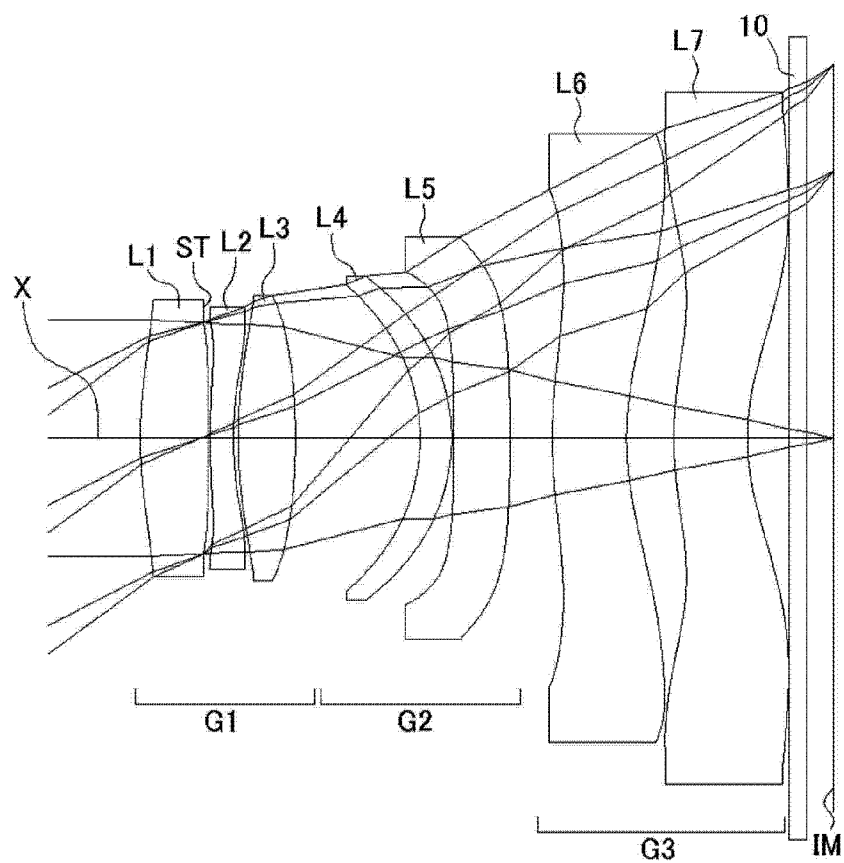


图 16

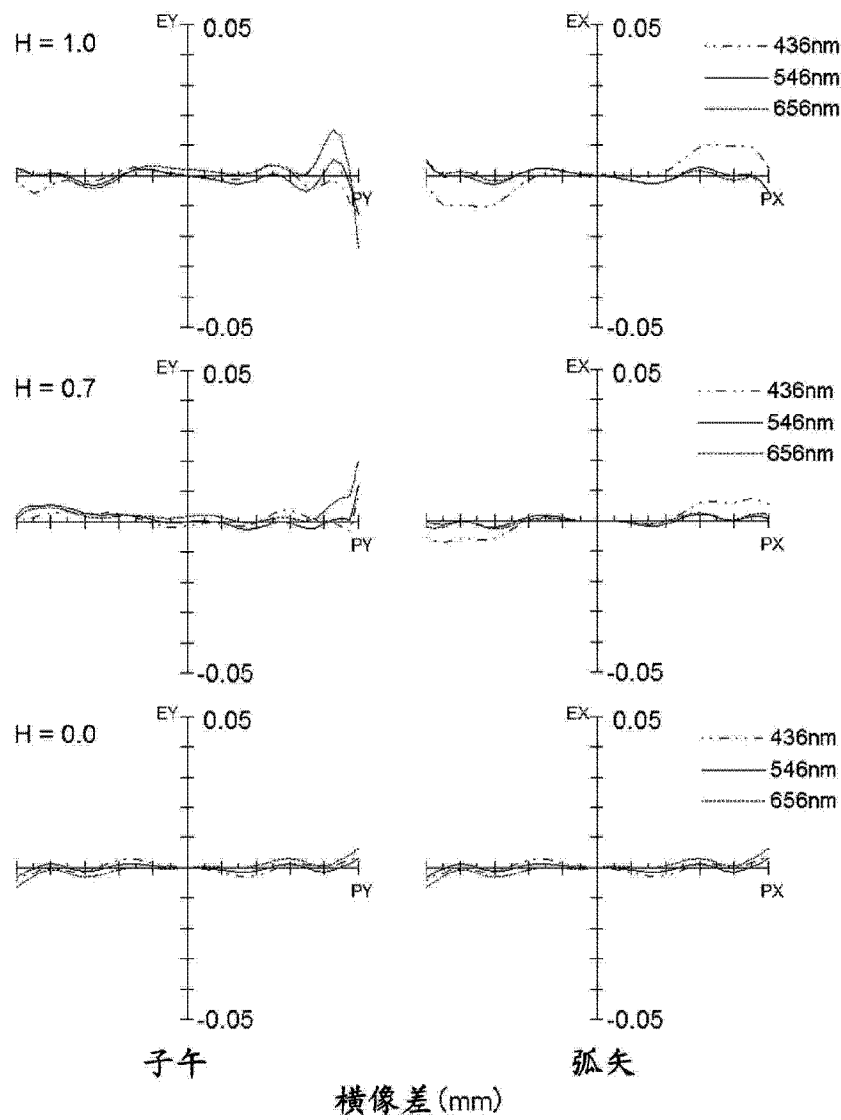


图 17

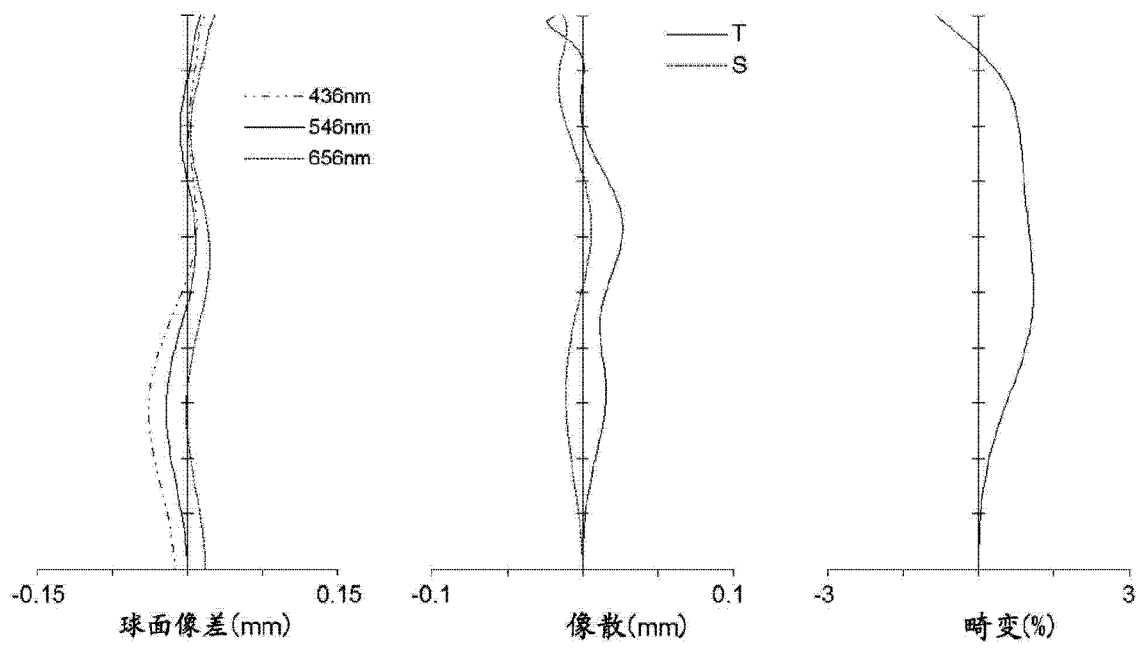


图 18

## Electronic Acknowledgement Receipt

|                                             |                                                                                 |
|---------------------------------------------|---------------------------------------------------------------------------------|
| <b>EFS ID:</b>                              | 23266156                                                                        |
| <b>Application Number:</b>                  | 14488106                                                                        |
| <b>International Application Number:</b>    |                                                                                 |
| <b>Confirmation Number:</b>                 | 2225                                                                            |
| <b>Title of Invention:</b>                  | PHOTOGRAPHING OPTICAL LENS ASSEMBLY, IMAGE CAPTURING UNIT AND ELECTRONIC DEVICE |
| <b>First Named Inventor/Applicant Name:</b> | Hsin-Hsuan HUANG                                                                |
| <b>Customer Number:</b>                     | 24728                                                                           |
| <b>Filer:</b>                               | Tim Tingkang Xia/Debby Yew                                                      |
| <b>Filer Authorized By:</b>                 | Tim Tingkang Xia                                                                |
| <b>Attorney Docket Number:</b>              | 15042-101133                                                                    |
| <b>Receipt Date:</b>                        | 20-AUG-2015                                                                     |
| <b>Filing Date:</b>                         | 16-SEP-2014                                                                     |
| <b>Time Stamp:</b>                          | 15:37:06                                                                        |
| <b>Application Type:</b>                    | Utility under 35 USC 111(a)                                                     |

### Payment information:

|                        |    |
|------------------------|----|
| Submitted with Payment | no |
|------------------------|----|

### File Listing:

| Document Number | Document Description | File Name            | File Size(Bytes)/<br>Message Digest                | Multi Part /.zip | Pages (if appl.) |
|-----------------|----------------------|----------------------|----------------------------------------------------|------------------|------------------|
| 1               | Power of Attorney    | 0115042101133POA.pdf | 202898<br>72ac040ccf2ccaaba9158c68282778449834f7f3 | no               | 2                |

### Warnings:

### Information:

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                       |                      |                                                     |    |    |
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| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Information Disclosure Statement (IDS)<br>Form (SB08) | 0115042101133IDS.pdf | 637105<br>85609436949da5336a72073d6ddb56e2b9e1fbb   | no | 5  |
| <b>Warnings:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                       |                      |                                                     |    |    |
| <b>Information:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                       |                      |                                                     |    |    |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Foreign Reference                                     | CN204188865U.pdf     | 2024370<br>cb863b249b539ad3fc2e8abac52e9f4092090027 | no | 48 |
| <b>Warnings:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                       |                      |                                                     |    |    |
| <b>Information:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                       |                      |                                                     |    |    |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Foreign Reference                                     | CN204188870.pdf      | 2119665<br>23a8bb7fec224fff8920b8642852461bfa5b0946 | no | 48 |
| <b>Warnings:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                       |                      |                                                     |    |    |
| <b>Information:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                       |                      |                                                     |    |    |
| <b>Total Files Size (in bytes):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                       |                      | 4984038                                             |    |    |
| <p><b>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.</b></p> <p><b><u>New Applications Under 35 U.S.C. 111</u></b><br/> <b>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.</b></p> <p><b><u>National Stage of an International Application under 35 U.S.C. 371</u></b><br/> <b>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.</b></p> <p><b><u>New International Application Filed with the USPTO as a Receiving Office</u></b><br/> <b>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.</b></p> |                                                       |                      |                                                     |    |    |



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| APPLICATION NUMBER | FILING OR 371(C) DATE | FIRST NAMED APPLICANT | ATTY. DOCKET NO./TITLE |
|--------------------|-----------------------|-----------------------|------------------------|
| 14/488,106         | 09/16/2014            | Hsin-Hsuan HUANG      | 0115042.10018          |

**CONFIRMATION NO. 2225**

**POA ACCEPTANCE LETTER**

21874  
Locke Lord LLP  
P.O. BOX 55874  
BOSTON, MA 02205



Date Mailed: 08/31/2015

**NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY**

This is in response to the Power of Attorney filed 08/20/2015.

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.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at (571) 272-4000 or (571) 272-4200 or 1-888-786-0101.

/dtdinh/



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| APPLICATION NUMBER | FILING OR 371(C) DATE | FIRST NAMED APPLICANT | ATTY. DOCKET NO./TITLE |
|--------------------|-----------------------|-----------------------|------------------------|
| 14/488,106         | 09/16/2014            | Hsin-Hsuan HUANG      | 15042-101133           |

**CONFIRMATION NO. 2225**

**POWER OF ATTORNEY NOTICE**



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

Date Mailed: 08/31/2015

**NOTICE REGARDING CHANGE OF POWER OF ATTORNEY**

This is in response to the Power of Attorney filed 08/20/2015.

- The Power of Attorney to you in this application has been revoked by the applicant. Future correspondence will be mailed to the new address of record(37 CFR 1.33).

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at (571) 272-4000 or (571) 272-4200 or 1-888-786-0101.

/dtdinh/



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| APPLICATION NO.                                      | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO.  | CONFIRMATION NO. |
|------------------------------------------------------|-------------|----------------------|----------------------|------------------|
| 14/488,106                                           | 09/16/2014  | Hsin-Hsuan HUANG     | 0115042.10018        | 2225             |
| 21874                                                | 7590        | 10/22/2015           | EXAMINER             |                  |
| Locke Lord LLP<br>P.O. BOX 55874<br>BOSTON, MA 02205 |             |                      | ALEXANDER, WILLIAM R |                  |
|                                                      |             |                      | ART UNIT             | PAPER NUMBER     |
|                                                      |             |                      | 2872                 |                  |
|                                                      |             |                      | NOTIFICATION DATE    | DELIVERY MODE    |
|                                                      |             |                      | 10/22/2015           | ELECTRONIC       |

**Please find below and/or attached an Office communication concerning this application or proceeding.**

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

patent@lockelord.com

|                              |                                         |                                          |                                                   |
|------------------------------|-----------------------------------------|------------------------------------------|---------------------------------------------------|
| <b>Office Action Summary</b> | <b>Application No.</b><br>14/488,106    | <b>Applicant(s)</b><br>HUANG, HSIN-HSUAN |                                                   |
|                              | <b>Examiner</b><br>WILLIAM R. ALEXANDER | <b>Art Unit</b><br>2872                  | <b>AIA (First Inventor to File) Status</b><br>Yes |

**-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --**

### Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

### Status

- 1) ☒ Responsive to communication(s) filed on 9/16/2014.  
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on \_\_\_\_\_.
- 2a) ☐ This action is **FINAL**.                      2b) ☒ This action is non-final.
- 3) ☐ 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.
- 4) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

### Disposition of Claims\*

- 5) ☒ Claim(s) 1-39 is/are pending in the application.  
5a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 6) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 7) ☒ Claim(s) 1-39 is/are rejected.
- 8) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 9) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

\* If any claims have been determined allowable, 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](http://www.uspto.gov/patents/init_events/pph/index.jsp) or send an inquiry to [PPHfeedback@uspto.gov](mailto:PPHfeedback@uspto.gov).

### Application Papers

- 10) ☒ The specification is objected to by the Examiner.
- 11) ☒ The drawing(s) filed on 9/16/2014 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

### Priority under 35 U.S.C. § 119

- 12) ☒ 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)).

\*\* See the attached detailed Office action for a list of the certified copies not received.

### Attachment(s)

- |                                                                                                                                                                            |                                                                                         |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892)                                                                                                | 3) <input type="checkbox"/> Interview Summary (PTO-413)<br>Paper No(s)/Mail Date. _____ |
| 2) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b)<br>Paper No(s)/Mail Date <u>9/16/2014, 12/31/2014, 8/20/2015</u> | 4) <input type="checkbox"/> Other: _____                                                |

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

## **DETAILED ACTION**

### ***Specification***

2. The lengthy specification has not been checked to the extent necessary to determine the presence of all possible minor errors. Applicant's cooperation is requested in correcting any errors of which applicant may become aware in the specification.

### ***Information Disclosure Statement***

3. The information disclosure statements (IDS) submitted on 9/16/2014, 12/31/2014, 8/20/2015 were considered by the examiner.

### ***Claim Rejections - 35 USC § 112***

- a. The following is a quotation of 35 U.S.C. 112(b):  
(b) CONCLUSION.—The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.

The following is a quotation of 35 U.S.C. 112 (pre-AIA), second paragraph:  
The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

4. Claims 1-39 are rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention.

5. Specifically regarding Claims 1, 16, 24 and 36 are indefinite and fail to particularly point out and distinctly claim what the inventor regards as the invention because the phrase "critical point" is not defined within the claim. Examiner suggests including the definition of "critical point" from the specification in claims 1, 16, 24 and 36, or explicitly state that the definition in the specification is a special definition (i.e. critical point as defined in this application is a point at which the tangent to the surface at that point is perpendicular to the optical axis).

***Claim Rejections - 35 USC § 103***

In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis for the rejection will not be considered a new ground of rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:

A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102 of this title, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103 are summarized as follows:

- Determining the scope and contents of the prior art.

- Ascertaining the differences between the prior art and the claims at issue.
- Resolving the level of ordinary skill in the pertinent art.
- Considering objective evidence present in the application indicating obviousness or nonobviousness.

**6. Claims 1-13, 15, 17, 18, 21-25, 27, 29-31, 33-35, 38, and 39 are rejected under 35 U.S.C. 103 as being unpatentable over Baik (US 2015/0103414) in view of Tsai et al. (US 8,599,495).**

**7. Regarding Claim 1,** Baik discloses a photographing optical lens assembly comprising, in order from an object side to an image side: a first lens (Example 5, Fig. 13; 10) element having positive (Example 5, Paragraph 0116, line 11) refractive power; a second lens (Example 5, Fig. 13; 20) element having refractive power (Example 5, Paragraph 0116, line 12); a third lens (Example 5, Fig. 13; 30) element having refractive power (Example 5, Paragraph 0116, line 13); a fourth lens (Example 5, Fig. 13; 40) element having refractive power (Example 5, Paragraph 0116, line 14); a fifth lens (Example 5, Fig. 13; 50) element having refractive power (Example 5, Paragraph 0116, lines 14-15); a sixth lens (Example 5, Fig. 13; 60) element with refractive power having an image-side surface being concave in a paraxial region thereof (Example 5, Paragraph 0116, line 15, Table 9, surface 12), wherein both of an object-side surface and the image-side surface of the sixth lens element are aspheric (Example 5, Paragraph 0117, Lines 4-5, Table 10, Surfaces 12 and 13), and the image-side surface of the sixth lens element has at least one inflection point (Example 5, Fig. 13; image side of 60, Table 10, surface 13); and a seventh lens (Example 5, Fig. 13; 70) element

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with refractive power (Example 5, Paragraph 0116, line 16) having an image-side surface being concave (Example 5, Table 9, surface 14) in a paraxial region thereof, wherein both of an object-side surface and the image-side surface of the seventh lens element are aspheric (Example 5, Paragraph 0117, Lines 4-5, Table 10, Surfaces 14 and 15), and the image-side surface of the seventh lens element has at least one inflection point (Example 5, Fig. 13; image side of 70, Table 10, surface 15); a focal length of the first lens element is  $f_1$ , a focal length of the seventh lens element is  $f_7$ , and the following condition is satisfied: and  $|f_1/f_7| < 3.0$  (Example 5, Paragraph 0116,  $|4.584/-6.829| = 0.67$  which is less than 3.0).

8. Baik does not specifically disclose wherein a vertical distance between a non-axial critical point on the image-side surface of the seventh lens element and an optical axis is  $Y_{c72}$ , a focal length of the photographing optical lens assembly is  $f$ , and the following condition is satisfied  $0.1 < Y_{c72}/f < 0.9$ .

9. However Tsai et al., in the same field of endeavor, teaches wherein a vertical distance between a non-axial critical point on the image-side surface of the seventh lens element and an optical axis is  $Y_{c72}$ , a focal length of the photographing optical lens assembly is  $f$ , and the following condition is satisfied  $0.1 < Y_{c72}/f < 0.9$  ('495, Col. 2, lines 32-43) for the purpose of providing a compact lens design.

10. Therefore, it would have been obvious to one of ordinary skill in the art before the effective filing date to have the photographing optical lens of Baik with the wherein a vertical distance between a non-axial critical point on the image-side surface of the seventh lens element and an optical axis is  $Y_{c72}$ , a focal length of the photographing

optical lens assembly is  $f$ , and the following condition is satisfied  $0.1 < Y_{c72}/f < 0.9$  of Tsai et al. for the purpose of providing a compact lens design.

11. **Regarding Claim 2**, Baik in view of Tsai et al. discloses as is set forth above and Baik further discloses wherein the object-side surface of the sixth lens element is convex in a paraxial region thereof ('414, Example 5, Fig. 13; 60, Table 9, surface 11).

12. **Regarding Claim 3**, Baik in view of Tsai et al. discloses as is set forth above and Baik further discloses wherein the second lens element has negative refractive power ('414, Example 5, Fig. 13; 20, Paragraph 0116, line 12).

13. **Regarding Claim 4**, Baik in view of Tsai et al. discloses as is set forth above and Baik further discloses wherein the fifth lens element has an object-side surface being concave in a paraxial region thereof ('414, Example 5, Fig. 13; 50, Table 9, surface 9).

14. **Regarding Claim 5**, Baik in view of Tsai et al. discloses as is set forth above and Baik further discloses wherein the object-side surface of the seventh lens element is convex in a paraxial region thereof ('414, Example 5, Fig. 13; 70, Table 9, surface 13).

15. **Regarding Claim 6**, Baik in view of Tsai et al. discloses as is set forth above and Baik further discloses wherein the third lens element has positive refractive power ('414, Example 5, Fig. 13; 30, Paragraph 0116, line 13).

16. **Regarding Claim 7**, Baik in view of Tsai et al. discloses as is set forth above and Baik further discloses wherein the fourth lens element has positive refractive power ('414, Example 5, Fig. 13; 40, Paragraph 0116, lines 13-14).

17. **Regarding Claim 8**, Baik in view of Tsai et al. discloses as is set forth above and Baik further discloses wherein at least three lens elements have positive refractive

power ('414, Example 5, Fig. 13; 10, 30, 40, 50, Paragraph 0116, lines 11-15) among the first lens element, the second lens element, the third lens element, the fourth lens element, the fifth lens element, the sixth lens element and the seventh lens element, the focal length of the photographing optical lens assembly is  $f$ , a curvature radius of the image-side surface of the seventh lens element is  $R14$ , and the following condition is satisfied:  $0 < R14/f < 0.7$  (Example 5, Paragraph 0116, line 3, Table 9, surface 14,  $R14/f = 1.494/4.522 = 0.33$  and  $0 < 0.33 < 0.7$ , so mathematical condition is satisfied).

18. **Regarding Claim 9**, Baik in view of Tsai et al. discloses as is set forth above and Baik further discloses wherein the focal length of the photographing optical lens assembly is  $f$ , a curvature radius of the image-side surface of the sixth lens element is  $R12$ , and the following condition is satisfied:  $0 < f/R12 < 5.0$  (Example 5, Paragraph 0116, line 3, Table 9, surface 12,  $f/R12 = 4.522/2.965 = 1.53$  and  $0 < 1.53 < 5.0$ , so mathematical condition is satisfied).

19. **Regarding Claim 10**, Baik in view of Tsai et al. discloses as is set forth above and Baik further discloses wherein the seventh lens element has negative refractive power ('414, Example 5, Fig. 13; 70, Paragraph 0116, line 16).

20. **Regarding Claim 11**, Baik in view of Tsai et al. discloses as is set forth above and Baik further discloses wherein a curvature radius of the object-side surface of the seventh lens element is  $R13$ , a curvature radius of the image-side surface of the seventh lens element is  $R14$ , and the following condition is satisfied:  $0 < (R13 - R14)/(R13 + R14) < 1.5$  (Example 5, Table 9, surfaces 13, 14,  $(R13 - R14)/(R13 + R14) =$

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$(2.794-1.494)/(2.794+1.494)=0.3$ , and  $0<0.30<1.5$ , so the mathematical condition is satisfied).

21. **Regarding Claim 12**, Baik in view of Tsai et al. discloses as is set forth above and Baik further discloses wherein a sum of axial distances between any two lens elements adjacent to each other is  $\Sigma AT$ , a maximum image height of the photographing optical lens assembly is  $ImgH$ , and the following condition is satisfied:

$0.20<\Sigma AT/ImgH<0.60$ . (Example 5, Table 9,  $\Sigma AT=1.52$ , Fig. 15,  $ImgH=3.43$ ,  $\Sigma AT/ImgH=1.52/3.43=0.44$ , and  $0.20<0.44<0.60$ , so the mathematical condition is satisfied).

22. **Regarding Claim 13**, Baik in view of Tsai et al. discloses as is set forth above and Baik further discloses wherein both of an object-side surface and an image-side surface of the first lens element are aspheric (Example 5, Paragraph 0117, Lines 4-5, Table 10, Surfaces2 and 3), both of an object-side surface and an image-side surface of the second lens element are aspheric (Example 5, Paragraph 0117, Lines 4-5, Table 10, Surfaces 4 and 5), both of an object-side surface and an image-side surface of the third lens element are aspheric (Example 5, Paragraph 0117, Lines 4-5, Table 10, Surfaces6 and 7), both of an object-side surface and an image-side surface of the fourth lens element are aspheric (Example 5, Paragraph 0117, Lines 4-5, Table 10, Surfaces8 and 9), both of an object-side surface and an image-side surface of the fifth lens element are aspheric (Example 5, Paragraph 0117, Lines 4-5, Table 10, Surfaces 10 and 11), an axial distance between the object-side surface of the first lens element and an image surface is  $TL$ , the focal length of the photographing optical lens assembly is  $f$ ,

and the following condition is satisfied:  $0.80 < TL/f < 1.80$  (Example 5, Table 15,  $TL/f=1.26$ , so the conditional expression is satisfied).

23. **Regarding Claim 15**, Baik in view of Tsai et al. discloses as is set forth above and Baik further discloses wherein an Abbe number of the second lens element is  $V_2$ , and the following condition is satisfied:  $V_2 < 26.0$  ('414, Example 5, Table 9,  $V_2=24.0$ , so the conditional expression is satisfied).

24. **Regarding Claim 17**, Baik in view of Tsai et al. discloses as is set forth above and Baik further discloses wherein the focal length of the photographing optical lens assembly is  $f$ , and the following condition is satisfied:  $3.0[\text{mm}] < f < 6.5[\text{mm}]$  ('414, Example 5, Paragraph 0116, line 3,  $f=4.522$ , so conditional expression is satisfied).

25. **Regarding Claim 18**, Baik in view of Tsai et al. discloses as is set forth above and Baik further discloses wherein further comprising a stop, wherein an axial distance between the stop and the image-side surface of the seventh lens element is  $SD$ , an axial distance between an object-side surface of the first lens element and the image-side surface of the seventh lens element is  $TD$ , and the following condition is satisfied:  $0.75 < SD/TD < 1.1$  ('414, Example 5, Table 9,  $SD/TD=4.7/4.65=1.01$ , so the conditional expression is satisfied).

26. **Regarding Claim 21**, Baik in view of Tsai et al. discloses as is set forth above and Baik further discloses wherein a central thickness of the first lens element is  $CT_1$ , a central thickness of the second lens element is  $CT_2$ , an axial distance between the second lens element and the third lens element is  $T_{23}$ , an axial distance between the third lens element and the fourth lens element is  $T_{34}$ , and the following conditions are

satisfied:  $1.0 < CT1/CT2 < 5.5$ ; and  $0.5 < T23/T34 < 4.5$ , ('414, Example 5, Table 9,  $CT1/CT2 = 0.44/0.22 = 2$ ,  $T23/T34 = 0.05/0.322 = 0.95$ , so the conditional expressions are satisfied).

27. **Regarding Claim 22**, Baik in view of Tsai et al. discloses as is set forth above and Baik further discloses wherein an image capturing unit ('414, Paragraph 0054, lines 8-17), comprising: the photographing optical lens assembly of claim 1; and an image sensor ('414, Example 5, Fig. 13;90, Paragraph 0116, line 5), wherein the image sensor is disposed on the image side of the photographing optical lens assembly ('414, Example 5, Fig. 13;90).

28. **Regarding Claim 23**, Baik in view of Tsai et al. discloses as is set forth above and Baik further discloses wherein an electronic device ('414, Paragraph 0054, lines 8-17), comprising: the image capturing unit of claim 22.

29. **Regarding Claim 24**, Baik discloses a photographing optical lens assembly comprising, in order from an object side to an image side: a first lens (Example 5, Fig. 13; 10) element having positive (Example 5, Paragraph 0116, line 11) refractive power; a second lens (Example 5, Fig. 13; 20) element having refractive power (Example 5, Paragraph 0116, line 12); a third lens (Example 5, Fig. 13; 30) element having refractive power (Example 5, Paragraph 0116, line 13); a fourth lens (Example 5, Fig. 13; 40) element having refractive power (Example 5, Paragraph 0116, line 14); a fifth lens (Example 5, Fig. 13; 50) element having refractive power (Example 5, Paragraph 0116, lines 14-15); a sixth lens (Example 5, Fig. 13; 60) element with refractive power having an image-side surface being concave in a paraxial region thereof (Example 5,

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Paragraph 0116, line 15, Table 9, surface 12), wherein both of an object-side surface and the image-side surface of the sixth lens element are aspheric (Example 5, Paragraph 0117, Lines 4-5, Table 10, Surfaces 12 and 13), and the image-side surface of the sixth lens element has at least one inflection point (Example 5, Fig. 13; image side of 60, Table 10, surface 13); and a seventh lens (Example 5, Fig. 13; 70) element with refractive power (Example 5, Paragraph 0116, line 16) having an image-side surface being concave (Example 5, Table 9, surface 14) in a paraxial region thereof, wherein both of an object-side surface and the image-side surface of the seventh lens element are aspheric (Example 5, Paragraph 0117, Lines 4-5, Table 10, Surfaces 14 and 15), and the image-side surface of the seventh lens element has at least one inflection point (Example 5, Fig. 13; image side of 70, Table 10, surface 15); a focal length of the first lens element is  $f_1$ , a focal length of the second lens element is  $f_2$ , an axial distance

between an object-side surface of the first lens element and an image surface is  $TL$ , a maximum image height of the photographing optical lens assembly is  $ImgH$ , and the following conditions are satisfied:  $|f_1/f_2| < 2.0$  ('414, Example 5, Fig. 13; 10, 20, Paragraph 0116, lines 11-12,  $f_1/f_2 = |4.584/-8.221| = 0.55$ , so the conditional expression is satisfied); and  $TL/ImgH < 2.20$  ('414, Example 5, Fig. 15,  $ImgH = 3.43$ , Table 9,  $TL = 5.453$ ,  $TL/ImgH = 5.453/3.43 = 1.59$ , so the conditional expression is satisfied).

30. Baik does not specifically disclose wherein a vertical distance between a non-axial critical point on the image-side surface of the seventh lens element and an optical

axis is  $Y_{c72}$ , a focal length of the photographing optical lens assembly is  $f$ , and the following condition is satisfied  $0.1 < Y_{c72}/f < 0.9$ .

31. However Tsai et al., in the same field of endeavor, teaches wherein a vertical distance between a non-axial critical point on the image-side surface of the seventh lens element and an optical axis is  $Y_{c72}$ , a focal length of the photographing optical lens assembly is  $f$ , and the following condition is satisfied  $0.1 < Y_{c72}/f < 0.9$  ('495, Col. 2, lines 32-43) for the purpose of providing a compact lens design.

32. Therefore, it would have been obvious to one of ordinary skill in the art before the effective filing date to have the photographing optical lens of Baik with the wherein a vertical distance between a non-axial critical point on the image-side surface of the seventh lens element and an optical axis is  $Y_{c72}$ , a focal length of the photographing optical lens assembly is  $f$ , and the following condition is satisfied  $0.1 < Y_{c72}/f < 0.9$  of Tsai et al. for the purpose of providing a compact lens design.

33. **Regarding Claim 25**, Baik in view of Tsai et al. discloses as is set forth above and Baik further discloses wherein the object-side surface of the first lens element is convex in a paraxial region thereof ('414, Example 5, Fig. 13; 10, Table 9, surface 1), and the second lens element has an image-side surface being concave in a paraxial region thereof ('414, Example 5, Fig. 13; 20, Table 9, surface 4).

34. **Regarding Claim 27**, Baik in view of Tsai et al. discloses as is set forth above and Baik further discloses wherein the third lens element has an object-side surface being convex in a paraxial region thereof ('414, Example 5, Fig. 13; 30, Table 9, surface 5).

35. **Regarding Claim 29**, Baik in view of Tsai et al. discloses as is set forth above and Baik further discloses wherein the fifth lens element has an image-side surface being convex in a paraxial region thereof ('414, Example 5, Fig. 13; 50, Table 9, surface 10).

36. **Regarding Claim 30**, Baik in view of Tsai et al. discloses as is set forth above and Baik further discloses wherein the focal length of the photographing optical lens assembly is  $f$ , a curvature radius of the image-side surface of the sixth lens element is  $R_{12}$ , and the following condition is satisfied:  $0 < f/R_{12} < 3.0$  (Example 5, Paragraph 0116, line 3, Table 9, surface 12,  $f/R_{12} = 4.522/2.965 = 1.53$  and  $0 < 1.53 < 3.0$ , so mathematical condition is satisfied).

37. **Regarding Claim 31**, Baik in view of Tsai et al. discloses as is set forth above and Baik further discloses wherein the focal length of the first lens element is  $f_1$ , the focal length of the second lens element is  $f_2$ , a focal length of the third lens element is  $f_3$ , a focal length of the fourth lens element is  $f_4$ , a focal length of the fifth lens element is  $f_5$ , a focal length of the sixth lens element is  $f_6$ , a focal length of the seventh lens element is  $f_7$ , and the following condition is satisfied:  $|f_1| < |f_i|$ , wherein  $i = 2, 3, 4, 5, 6, 7$ . (Example 5, Paragraph 0116, lines 3-16,  $4.584 < 8.221, 6.410, 73.896, 17.417, 12.539$ , and  $6.829$ , so conditional expression is satisfied).

38. **Regarding Claim 33**, Baik in view of Tsai et al. discloses as is set forth above and Baik further discloses wherein the focal length of the photographing optical lens assembly is  $f$ , the focal length of the first lens element is  $f_1$ , the focal length of the second lens element is  $f_2$ , a focal length of the third lens element is  $f_3$ , a focal length of

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the fourth lens element is  $f_4$ , a focal length of the fifth lens element is  $f_5$ , a focal length of the sixth lens element is  $f_6$ , a focal length of the seventh lens element is  $f_7$ , and the following condition is satisfied:  $|f/f_j|_{\max} < 1.8$ , wherein  $j = 1, 2, 3, 4, 5, 6, 7$ . (Example 5, Paragraph 0116, lines 3-16,  $|f/f_1| = 0.98$ , which is the maximum, since  $0.98 < 1.8$ , then conditional expression is satisfied).

39. **Regarding Claim 34**, Baik in view of Tsai et al. discloses as is set forth above and Baik further discloses wherein an Abbe number of the first lens element is  $V_1$ , an Abbe number of the second lens element is  $V_2$ , an Abbe number of the third lens element is  $V_3$ , an Abbe number of the fourth lens element is  $V_4$ , an Abbe number of the fifth lens element is  $V_5$ , an Abbe number of the sixth lens element is  $V_6$ , an Abbe number of the seventh lens element is  $V_7$ , and at least three lens elements among the first lens element to the seventh lens element satisfy the following condition:  $V_i < 26.0$ , wherein  $i = 1, 2, 3, 4, 5, 6, 7$ . (Example 5, Table 9,  $V_2 = 24.0$ ,  $V_4 = 24.0$ ,  $V_6 = 24.0$ , so the conditional expression is satisfied).

40. **Regarding Claim 35**, Baik in view of Tsai et al. discloses as is set forth above and Baik further discloses wherein further comprising a stop ('414, Example 5, Table 9, ST), wherein the first lens element, the second lens element, the third lens element, the fourth lens element, the fifth lens element, the sixth lens element and the seventh lens element are all independent and non-cemented lens elements, and the stop is located between an imaged object and the second lens element ('414, Example 5, Fig. 13; 10, 20, 30, 40, 50, 60, 70, Table 9, ST is closer to object than surfaces 3 and 4).

41. **Regarding Claim 38**, Baik in view of Tsai et al. discloses as is set forth above and Baik further discloses wherein further comprising a stop (‘414, Example 5, Table 9, ST), wherein an axial distance between the first lens element and the second lens element is T12, an axial distance between the second lens element and the third lens element is T23, an axial distance between the third lens element and the fourth lens element is T34, an axial distance between the fourth lens element and the fifth lens element is T45, an axial distance between the fifth lens element and the sixth lens element is T56, an axial distance between the sixth lens element and the seventh lens element is T67, and the following condition is satisfied:

$0 < (T12/T23) + (T34/T45) + (T56/T67) < 3.8$ . (Example 5, Table 9,  $(T12/T23) + (T34/T45) + (T56/T67) = (0.102/0.305) + (0.322/0.125) + (0.15/0.516) = 3.2$ , so the conditional expression is satisfied).

42. **Regarding Claim 39**, Baik in view of Tsai et al. discloses as is set forth above and Baik further discloses wherein further comprising a stop (‘414, Example 5, Table 9, ST), wherein further comprising a stop, wherein the stop is located between an object and the first lens element, an axial distance between the second lens element and the third lens element is T23, a central thickness of the second lens element is CT2, the focal length of the photographing optical lens assembly is f, a curvature radius of an image-side surface of the third lens element is R6, and the following conditions are satisfied:  $0.3 < T23/CT2 < 3.0$  (Example 5, Table 9,  $T23/CT2 = 0.305/0.22 = 1.4$ , so the conditional expression is satisfied); and  $-1.0 < f/R6 < 2.5$  (Example 5, Table 9,  $R6 = -$

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18.245, Paragraph 0116, line 3,  $f=4.522$ ,  $f/R6=-0.2$ , so the conditional expression is satisfied).

***Allowable Subject Matter***

43. **Claims 14, 16, 19, 20, 26, 28, 32, 36, and 37 are objected to** as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

44. **Claims 14, 16, 19, 20, 26, 28, 32, 36, and 37** would be allowable if rewritten to overcome the rejection(s) under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), 2nd paragraph, set forth in this Office action and to include all of the limitations of the base claim and any intervening claims.

45. The following is a statement of reasons for the indication of allowable subject matter: with respect to the allowable subject matter, none of the prior art either alone or in combination disclose or teach of the claimed combination of limitations to warrant a rejection under 35 USC 102 or 103.

46. **Specifically, with respect to claim 14**, none of the prior art either alone or in combination disclose or teach of the claimed photographing optical lens assembly specifically including, as the distinguishing feature(s) in combination with the other limitations, wherein a maximum refractive index of one single lens element among the first lens element, the second lens element, the third lens element, the fourth lens element, the fifth lens element, the sixth lens element and the seventh lens element is  $N_{max}$ , and the following condition is satisfied:  $1.640 \leq N_{max} < 1.750$ .

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47. **Specifically, with respect to claim 16**, none of the prior art either alone or in combination disclose or teach of the claimed photographing optical lens assembly specifically including, as the distinguishing feature(s) in combination with the other limitations, wherein a vertical distance between a non-axial critical point on the image-side surface of the sixth lens element and an optical axis is  $Yc62$ , the vertical distance between a non-axial critical point on the image-side surface of the seventh lens element and the optical axis is  $Yc72$ , and the following condition is satisfied:

$$0.5 < Yc62/Yc72 < 1.5.$$

48. **Specifically, with respect to claim 19**, none of the prior art either alone or in combination disclose or teach of the claimed photographing optical lens assembly specifically including, as the distinguishing feature(s) in combination with the other limitations, wherein a curvature radius of an object-side surface of the first lens element is  $R1$ , a curvature radius of an image-side surface of the first lens element is  $R2$ , and the following condition is satisfied:  $-0.2 < R1/R2 < 0.2$ .

49. **Specifically, with respect to claim 20**, none of the prior art either alone or in combination disclose or teach of the claimed photographing optical lens assembly specifically including, as the distinguishing feature(s) in combination with the other limitations, wherein the focal length of the photographing optical lens assembly is  $f$ , an entrance pupil diameter of the photographing optical lens assembly is  $EPD$ , half of a maximal field of view of the photographing optical lens assembly is  $HFOV$ , and the following conditions are satisfied:  $1.2 < f/EPD < 2.6$ ; and  $15[\text{deg.}] < HFOV < 45[\text{deg.}]$ .

50. **Specifically, with respect to claim 26**, none of the prior art either alone or in combination disclose or teach of the claimed photographing optical lens assembly specifically including, as the distinguishing feature(s) in combination with the other limitations, wherein the sixth lens element has positive refractive power.

51. **Specifically, with respect to claim 28**, none of the prior art either alone or in combination disclose or teach of the claimed photographing optical lens assembly specifically including, as the distinguishing feature(s) in combination with the other limitations, wherein the fifth lens element has negative refractive power.

52. **Specifically, with respect to claim 32**, none of the prior art either alone or in combination disclose or teach of the claimed photographing optical lens assembly specifically including, as the distinguishing feature(s) in combination with the other limitations, wherein a curvature radius of the object-side surface of the sixth lens element is  $R11$ , a curvature radius of the image-side surface of the sixth lens element is  $R12$ , and the following condition is satisfied:  $-2.0 < (R11 - R12) / (R11 + R12) < 0.2$ .

53. **Specifically, with respect to claim 36**, none of the prior art either alone or in combination disclose or teach of the claimed photographing optical lens assembly specifically including, as the distinguishing feature(s) in combination with the other limitations, wherein a vertical distance between a non-axial critical point on the object-side surface of the sixth lens element and an optical axis is  $Yc61$ , a vertical distance between a non-axial critical point on the image-side surface of the sixth lens element and an optical axis is  $Yc62$ , and the following condition is satisfied:  
 $0.30 < Yc62 / Yc61 < 1.80$ .

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54. **Specifically, with respect to claim 37**, none of the prior art either alone or in combination disclose or teach of the claimed photographing optical lens assembly specifically including, as the distinguishing feature(s) in combination with the other limitations, wherein the focal length of the photographing optical lens assembly is  $f$ , a focal length of the third lens element is  $f_3$ , and the following condition is satisfied:  
 $-0.5 < f/f_3 < 0.6$ .

### ***Conclusion***

Any inquiry concerning this communication or earlier communications from the examiner should be directed to WILLIAM R. ALEXANDER whose telephone number is (571)270-7656. The examiner can normally be reached on Mondays through Thursdays 7:30 AM through 5:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Bumsuk Won can be reached on 571-272-2713. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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.

/WILLIAM R ALEXANDER/  
Examiner, Art Unit 2872  
October 8, 2015

/BUMSUK WON/  
Supervisory Patent Examiner, Art Unit 2872

|                                   |                                       |  |                                                              |             |
|-----------------------------------|---------------------------------------|--|--------------------------------------------------------------|-------------|
| <b>Notice of References Cited</b> | Application/Control No.<br>14/488,106 |  | Applicant(s)/Patent Under Reexamination<br>HUANG, HSIN-HSUAN |             |
|                                   | Examiner<br>WILLIAM R. ALEXANDER      |  | Art Unit<br>2872                                             | Page 1 of 1 |

#### U.S. PATENT DOCUMENTS

| * |   | Document Number<br>Country Code-Number-Kind Code | Date<br>MM-YYYY | Name            | CPC Classification | US Classification |
|---|---|--------------------------------------------------|-----------------|-----------------|--------------------|-------------------|
| * | A | US-2015/0103414 A1                               | 04-2015         | Baik; Jae Hyun  | G02B9/64           | 359/708           |
| * | B | US-8,599,495 B1                                  | 12-2013         | Tsai; Tsung-Han | G02B13/0045        | 359/708           |
|   | C | US-                                              |                 |                 |                    |                   |
|   | D | US-                                              |                 |                 |                    |                   |
|   | E | US-                                              |                 |                 |                    |                   |
|   | F | US-                                              |                 |                 |                    |                   |
|   | G | US-                                              |                 |                 |                    |                   |
|   | H | US-                                              |                 |                 |                    |                   |
|   | I | US-                                              |                 |                 |                    |                   |
|   | J | US-                                              |                 |                 |                    |                   |
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Doc code: IDS

PTO/SB/08a (01-10)

Doc description: Information Disclosure Statement (IDS) Filed

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| <b>INFORMATION DISCLOSURE<br/>STATEMENT BY APPLICANT</b><br>( Not for submission under 37 CFR 1.99) | Application Number     |                                  |              |  |
|                                                                                                     | Filing Date            |                                  | 2014-09-16   |  |
|                                                                                                     | First Named Inventor   | Hsin-Hsuan HUANG                 |              |  |
|                                                                                                     | Art Unit               |                                  |              |  |
|                                                                                                     | Examiner Name          | /William Alexander/ (10/08/2015) |              |  |
|                                                                                                     | Attorney Docket Number |                                  | 15042-101133 |  |

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| /W.A./            | 1       | 8736979       | B2                     | 2014-05-27 | TSAI et al.                                     |                                                                        |
| /W.A./            | 2       | 8599495       | B1                     | 2013-12-03 | TSAI et al.                                     |                                                                        |

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| /W.A./                              | 1       | 20140139719        | A1                     | 2014-05-22       | FUKAYA                                          |                                                                        |

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| /W.A./                   | 1       | 203595858                            | CN                        | U                      | 2014-05-14       | FUJIFILM CORPORATION                            |                                                                        | <input checked="" type="checkbox"/> |
| /W.A./                   | 2       | 203673137                            | CN                        | U                      | 2014-06-25       | KANTATSU CO., LTD.                              |                                                                        | <input checked="" type="checkbox"/> |

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|                        |                                  |              |
|------------------------|----------------------------------|--------------|
| Application Number     |                                  |              |
| Filing Date            |                                  | 2014-09-16   |
| First Named Inventor   | Hsin-Hsuan HUANG                 |              |
| Art Unit               |                                  |              |
| Examiner Name          | /William Alexander/ (10/08/2015) |              |
| Attorney Docket Number |                                  | 15042-101133 |

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|--------|---|-------------|----|---|------------|--------------------|--|-------------------------------------|
| /W.A./ | 3 | 2012-155223 | JP |   | 2012-08-16 | TAMRON CO LTD      |  | <input checked="" type="checkbox"/> |
| /W.A./ | 4 | 2012173299  | JP | A | 2012-09-10 | SONY CORP          |  | <input checked="" type="checkbox"/> |
| /W.A./ | 5 | 2013-182090 | JP |   | 2013-09-12 | KONICA MINOLTA INC |  | <input checked="" type="checkbox"/> |
| /W.A./ | 6 | 2013-195587 | JP |   | 2013-09-30 | RICOH CO LTD       |  | <input checked="" type="checkbox"/> |
| /W.A./ | 7 | 2013195588  | JP | A | 2013-09-30 | RICOH CO LTD       |  | <input checked="" type="checkbox"/> |
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Doc description: Information Disclosure Statement (IDS) Filed

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| <b>INFORMATION DISCLOSURE<br/>STATEMENT BY APPLICANT</b><br>( Not for submission under 37 CFR 1.99) | Application Number     |                                      | 14488106   |
|                                                                                                     | Filing Date            |                                      | 2014-09-16 |
|                                                                                                     | First Named Inventor   | Hsin-Hsuan Huang                     |            |
|                                                                                                     | Art Unit               | 2827                                 |            |
|                                                                                                     | Examiner Name          | N/A /William Alexander/ (10/08/2015) |            |
|                                                                                                     | Attorney Docket Number | 0115042.10018                        |            |

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| /W.A./                              | 1       | 20140376105        | A1                     | 2014-12-25       | SEKINE                                          |                                                                        |
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|                        |                                                |            |
|------------------------|------------------------------------------------|------------|
| Application Number     |                                                | 14488106   |
| Filing Date            |                                                | 2014-09-16 |
| First Named Inventor   | Hsin-Hsuan Huang                               |            |
| Art Unit               | 2827                                           |            |
| Examiner Name          | <del>WA</del> /William Alexander/ (10/08/2015) |            |
| Attorney Docket Number | 0115042.10018                                  |            |

|        |   |             |    |            |                  |  |
|--------|---|-------------|----|------------|------------------|--|
| /W.A./ | 6 | 20150198791 | A1 | 2015-07-16 | KUBOTA et al.    |  |
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| /W.A./            | 1       | 204188865                            | CN                        | U                      | 2015-03-04       | Optical Logic Corporation et al.                |                                                                          | <input checked="" type="checkbox"/> |
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|------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|-------------------------------------------------------------------------|
| <b><i>Index of Claims</i></b><br><br> | <b>Application/Control No.</b><br><br>14488106 | <b>Applicant(s)/Patent Under Reexamination</b><br><br>HUANG, HSIN-HSUAN |
|                                                                                                                        | <b>Examiner</b><br><br>WILLIAM R ALEXANDER     | <b>Art Unit</b><br><br>2872                                             |

|   |                 |   |                   |   |                     |   |                 |
|---|-----------------|---|-------------------|---|---------------------|---|-----------------|
| ✓ | <b>Rejected</b> | - | <b>Cancelled</b>  | N | <b>Non-Elected</b>  | A | <b>Appeal</b>   |
| = | <b>Allowed</b>  | ÷ | <b>Restricted</b> | I | <b>Interference</b> | O | <b>Objected</b> |

| <input 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 |  |  |  |
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| CLAIM                                                                                  |          | DATE                         |  |                               |  |                                 |  |  |  |
| Final                                                                                  | Original | 10/08/2015                   |  |                               |  |                                 |  |  |  |
|                                                                                        | 1        | ✓                            |  |                               |  |                                 |  |  |  |
|                                                                                        | 2        | ✓                            |  |                               |  |                                 |  |  |  |
|                                                                                        | 3        | ✓                            |  |                               |  |                                 |  |  |  |
|                                                                                        | 4        | ✓                            |  |                               |  |                                 |  |  |  |
|                                                                                        | 5        | ✓                            |  |                               |  |                                 |  |  |  |
|                                                                                        | 6        | ✓                            |  |                               |  |                                 |  |  |  |
|                                                                                        | 7        | ✓                            |  |                               |  |                                 |  |  |  |
|                                                                                        | 8        | ✓                            |  |                               |  |                                 |  |  |  |
|                                                                                        | 9        | ✓                            |  |                               |  |                                 |  |  |  |
|                                                                                        | 10       | ✓                            |  |                               |  |                                 |  |  |  |
|                                                                                        | 11       | ✓                            |  |                               |  |                                 |  |  |  |
|                                                                                        | 12       | ✓                            |  |                               |  |                                 |  |  |  |
|                                                                                        | 13       | ✓                            |  |                               |  |                                 |  |  |  |
|                                                                                        | 14       | ✓                            |  |                               |  |                                 |  |  |  |
|                                                                                        | 15       | ✓                            |  |                               |  |                                 |  |  |  |
|                                                                                        | 16       | ✓                            |  |                               |  |                                 |  |  |  |
|                                                                                        | 17       | ✓                            |  |                               |  |                                 |  |  |  |
|                                                                                        | 18       | ✓                            |  |                               |  |                                 |  |  |  |
|                                                                                        | 19       | ✓                            |  |                               |  |                                 |  |  |  |
|                                                                                        | 20       | ✓                            |  |                               |  |                                 |  |  |  |
|                                                                                        | 21       | ✓                            |  |                               |  |                                 |  |  |  |
|                                                                                        | 22       | ✓                            |  |                               |  |                                 |  |  |  |
|                                                                                        | 23       | ✓                            |  |                               |  |                                 |  |  |  |
|                                                                                        | 24       | ✓                            |  |                               |  |                                 |  |  |  |
|                                                                                        | 25       | ✓                            |  |                               |  |                                 |  |  |  |
|                                                                                        | 26       | ✓                            |  |                               |  |                                 |  |  |  |
|                                                                                        | 27       | ✓                            |  |                               |  |                                 |  |  |  |
|                                                                                        | 28       | ✓                            |  |                               |  |                                 |  |  |  |
|                                                                                        | 29       | ✓                            |  |                               |  |                                 |  |  |  |
|                                                                                        | 30       | ✓                            |  |                               |  |                                 |  |  |  |
|                                                                                        | 31       | ✓                            |  |                               |  |                                 |  |  |  |
|                                                                                        | 32       | ✓                            |  |                               |  |                                 |  |  |  |
|                                                                                        | 33       | ✓                            |  |                               |  |                                 |  |  |  |
|                                                                                        | 34       | ✓                            |  |                               |  |                                 |  |  |  |
|                                                                                        | 35       | ✓                            |  |                               |  |                                 |  |  |  |
|                                                                                        | 36       | ✓                            |  |                               |  |                                 |  |  |  |

|                                                                                                                                       |                                            |                                                                     |
|---------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|---------------------------------------------------------------------|
| <p align="center"><b><i>Index of Claims</i></b></p>  | <b>Application/Control No.</b><br>14488106 | <b>Applicant(s)/Patent Under Reexamination</b><br>HUANG, HSIN-HSUAN |
|                                                                                                                                       | <b>Examiner</b><br>WILLIAM R ALEXANDER     | <b>Art Unit</b><br>2872                                             |

|   |                 |   |                   |   |                     |   |                 |
|---|-----------------|---|-------------------|---|---------------------|---|-----------------|
| ✓ | <b>Rejected</b> | - | <b>Cancelled</b>  | N | <b>Non-Elected</b>  | A | <b>Appeal</b>   |
| = | <b>Allowed</b>  | ÷ | <b>Restricted</b> | I | <b>Interference</b> | O | <b>Objected</b> |

| <input 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 | 10/08/2015                   |  |                               |  |                                 |  |  |  |
|                                                                                        | 37       | ✓                            |  |                               |  |                                 |  |  |  |
|                                                                                        | 38       | ✓                            |  |                               |  |                                 |  |  |  |
|                                                                                        | 39       | ✓                            |  |                               |  |                                 |  |  |  |

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| <b>INFORMATION DISCLOSURE<br/>STATEMENT BY APPLICANT</b><br>( Not for submission under 37 CFR 1.99) | Application Number     |                                      | 14488106   |
|                                                                                                     | Filing Date            |                                      | 2014-09-16 |
|                                                                                                     | First Named Inventor   | Hsin-Hsuan Huang                     |            |
|                                                                                                     | Art Unit               | 2872                                 |            |
|                                                                                                     | Examiner Name          | TDB /William Alexander/ (10/08/2015) |            |
|                                                                                                     | Attorney Docket Number | 15042-101133                         |            |

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| W.A./                    | 1       | 203941337                            | CN                          | U                      | 2014-11-12       | FUJIFILM CORPORATION                            |                                                                        | <input checked="" type="checkbox"/> |
| W.A./                    | 2       | 203965708                            | CN                          | U                      | 2014-11-26       | KANTATSU CO. LTD.                               |                                                                        | <input checked="" type="checkbox"/> |
| W.A./                    | 3       | M490015                              | TW                          | U                      | 2014-11-11       | FUJIFILM CORPORATION                            |                                                                        | <input checked="" type="checkbox"/> |

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

|                        |                                      |
|------------------------|--------------------------------------|
| Application Number     | 14488106                             |
| Filing Date            | 2014-09-16                           |
| First Named Inventor   | Hsin-Hsuan Huang                     |
| Art Unit               | 2872                                 |
| Examiner Name          | TBD /William Alexander/ (10/08/2015) |
| Attorney Docket Number | 15042-101133                         |

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<sup>1</sup> See Kind Codes of USPTO Patent Documents at [www.USPTO.GOV](http://www.USPTO.GOV) or MPEP 901.04. <sup>2</sup> Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). <sup>3</sup> For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. <sup>4</sup> Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. <sup>5</sup> Applicant is to place a check mark here if English language translation is attached.



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## BIB DATA SHEET

CONFIRMATION NO. 2225

|                                                                                                                                                                                                                                                                                                                   |                                                                                                                   |                                   |                                                                                                                                                                                                                                                                           |                                             |                                |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|--------------------------------|
| <b>SERIAL NUMBER</b><br>14/488,106                                                                                                                                                                                                                                                                                | <b>FILING or 371(c) DATE</b><br>09/16/2014<br><b>RULE</b>                                                         | <b>CLASS</b><br>359               | <b>GROUP ART UNIT</b><br>2872                                                                                                                                                                                                                                             | <b>ATTORNEY DOCKET NO.</b><br>0115042.10018 |                                |
| <b>APPLICANTS</b><br>LARGAN Precision Co., Ltd., Taichung, TAIWAN;<br><b>INVENTORS</b><br>Hsin-Hsuan HUANG, Taichung, TAIWAN;<br><b>** CONTINUING DATA *****</b><br><b>** FOREIGN APPLICATIONS *****</b><br>TAIWAN 103126480 08/01/2014<br><b>** IF REQUIRED, FOREIGN FILING LICENSE GRANTED **</b><br>09/22/2014 |                                                                                                                   |                                   |                                                                                                                                                                                                                                                                           |                                             |                                |
| Foreign Priority claimed <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No<br>35 USC 119(a-d) conditions met <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No<br>Verified and /WILLIAM R ALEXANDER/<br>Acknowledged Examiner's Signature                                     | <input type="checkbox"/> Met after Allowance<br>Initials                                                          | <b>STATE OR COUNTRY</b><br>TAIWAN | <b>SHEETS DRAWINGS</b><br>29                                                                                                                                                                                                                                              | <b>TOTAL CLAIMS</b><br>39                   | <b>INDEPENDENT CLAIMS</b><br>2 |
| <b>ADDRESS</b><br>Locke Lord LLP<br>P.O. BOX 55874<br>BOSTON, MA 02205<br>UNITED STATES                                                                                                                                                                                                                           |                                                                                                                   |                                   |                                                                                                                                                                                                                                                                           |                                             |                                |
| <b>TITLE</b><br>PHOTOGRAPHING OPTICAL LENS ASSEMBLY, IMAGE CAPTURING UNIT AND ELECTRONIC DEVICE                                                                                                                                                                                                                   |                                                                                                                   |                                   |                                                                                                                                                                                                                                                                           |                                             |                                |
| <b>FILING FEE RECEIVED</b><br>3120                                                                                                                                                                                                                                                                                | FEES: Authority has been given in Paper<br>No. _____ to charge/credit DEPOSIT ACCOUNT<br>No. _____ for following: |                                   | <input type="checkbox"/> All Fees<br><input type="checkbox"/> 1.16 Fees (Filing)<br><input type="checkbox"/> 1.17 Fees (Processing Ext. of time)<br><input type="checkbox"/> 1.18 Fees (Issue)<br><input type="checkbox"/> Other _____<br><input type="checkbox"/> Credit |                                             |                                |

|                                                                                                              |                                                |                                                                         |
|--------------------------------------------------------------------------------------------------------------|------------------------------------------------|-------------------------------------------------------------------------|
| <b>Search Notes</b><br><br> | <b>Application/Control No.</b><br><br>14488106 | <b>Applicant(s)/Patent Under Reexamination</b><br><br>HUANG, HSIN-HSUAN |
|                                                                                                              | <b>Examiner</b><br><br>WILLIAM R ALEXANDER     | <b>Art Unit</b><br><br>2872                                             |

| CPC- SEARCHED    |           |          |
|------------------|-----------|----------|
| Symbol           | Date      | Examiner |
| G02B13/002, 0045 | 10/8/2015 | WA       |
| G02B9/00, 64     | 10/8/2015 | WA       |

| CPC COMBINATION SETS - SEARCHED |      |          |
|---------------------------------|------|----------|
| Symbol                          | Date | Examiner |
|                                 |      |          |

| US CLASSIFICATION SEARCHED |                         |           |          |
|----------------------------|-------------------------|-----------|----------|
| Class                      | Subclass                | Date      | Examiner |
| 359                        | 682, 708, 713, 754, 755 | 10/8/2015 | WA       |

| SEARCH NOTES                                                                                                                         |           |          |
|--------------------------------------------------------------------------------------------------------------------------------------|-----------|----------|
| Search Notes                                                                                                                         | Date      | Examiner |
| CPC: G02B13/002, 0045, G02B9/00, 64, USPC: 359/682, 708, 713, 754, 755. Classification and Text Search. See Search history printout. | 10/8/2015 | WA       |
| East Search-Text Search. See Search History Printout.                                                                                | 10/8/2015 | WA       |
| Inventor Search-See Search History Printout.                                                                                         | 10/8/2015 | WA       |
| Consulted with Zach Wilkes regarding search and rejections.                                                                          | 10/8/2015 | WA       |

| INTERFERENCE SEARCH     |                         |      |          |
|-------------------------|-------------------------|------|----------|
| US Class/<br>CPC Symbol | US Subclass / CPC Group | Date | Examiner |
|                         |                         |      |          |

|                                                 |  |
|-------------------------------------------------|--|
| /WILLIAM R ALEXANDER/<br>Examiner.Art Unit 2872 |  |
|-------------------------------------------------|--|

EAST Search History

EAST Search History (Prior Art)

| Ref # | Hits   | Search Query                                                                                             | DBs                                                                  | Default Operator | Plurals | Time Stamp          |
|-------|--------|----------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------|------------------|---------|---------------------|
| L1    | 972553 | huang.in.                                                                                                | US-PGPUB; USPAT;<br>USOCR; FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | OR               | ON      | 2015/10/08<br>07:31 |
| L2    | 602    | Lens and (first near10 positive)<br>and (seventh same concave)<br>and aspheric and (focal adj<br>length) | US-PGPUB; USPAT;<br>USOCR; FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | OR               | ON      | 2015/10/08<br>07:31 |
| L3    | 40     | huang.in. and L2                                                                                         | US-PGPUB; USPAT;<br>USOCR; FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | OR               | ON      | 2015/10/08<br>07:31 |
| L4    | 6      | huang.in. and L2 and (critical<br>adj point)                                                             | US-PGPUB; USPAT;<br>USOCR; FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | OR               | ON      | 2015/10/08<br>07:31 |
| L5    | 6      | huang.in. and L2 and (critical<br>adj point)                                                             | US-PGPUB; USPAT;<br>USOCR; FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | OR               | ON      | 2015/10/08<br>07:32 |
| L6    | 6      | huang.in. and L2 and (critical<br>adj point) and "yc72"                                                  | US-PGPUB; USPAT;<br>USOCR; FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | OR               | ON      | 2015/10/08<br>07:32 |
| L7    | 0      | huang.in. and L2 and (critical<br>adj point) and "yc72" and<br>"yc62"                                    | US-PGPUB; USPAT;<br>USOCR; FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | OR               | ON      | 2015/10/08<br>07:33 |
| L8    | 6      | huang.in. and L2 and (critical<br>adj point) and "yc72"                                                  | US-PGPUB; USPAT;<br>USOCR; FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | OR               | ON      | 2015/10/08<br>07:33 |
| L9    | 6      | ("7869142"   "8000030").PN.<br>OR ("8599495").URPN.                                                      | US-PGPUB; USPAT;<br>USOCR                                            | OR               | ON      | 2015/10/08<br>07:34 |
| L10   | 1      | "20150103414"                                                                                            | US-PGPUB; USPAT;<br>USOCR                                            | OR               | ON      | 2015/10/08<br>07:34 |
| L11   | 0      | ("2015/0103414").URPN.                                                                                   | USPAT                                                                | OR               | ON      | 2015/10/08<br>07:35 |
| S1    | 0      | "14488106"                                                                                               | US-PGPUB; USPAT                                                      | OR               | ON      | 2015/10/01<br>13:58 |
|       |        |                                                                                                          |                                                                      |                  |         |                     |

|     |      |                                                                                                          |                                                                      |    |     |                     |
|-----|------|----------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------|----|-----|---------------------|
| S2  | 1013 | (359/708).OCLS.                                                                                          | US-PGPUB; USPAT                                                      | OR | OFF | 2015/10/01<br>14:15 |
| S3  | 311  | (359/713).OCLS.                                                                                          | US-PGPUB; USPAT                                                      | OR | OFF | 2015/10/01<br>14:18 |
| S4  | 504  | (359/682).OCLS.                                                                                          | US-PGPUB; USPAT                                                      | OR | OFF | 2015/10/01<br>14:20 |
| S5  | 544  | (359/754).OCLS.                                                                                          | US-PGPUB; USPAT                                                      | OR | OFF | 2015/10/01<br>14:20 |
| S6  | 146  | (359/755).OCLS.                                                                                          | US-PGPUB; USPAT                                                      | OR | OFF | 2015/10/01<br>14:21 |
| S7  | 1199 | G02B13/0045.cpc.                                                                                         | US-PGPUB; USPAT                                                      | OR | ON  | 2015/10/01<br>14:23 |
| S8  | 87   | G02B13/002.cpc.                                                                                          | US-PGPUB; USPAT                                                      | OR | ON  | 2015/10/01<br>14:23 |
| S9  | 1199 | G02B13/0045.cpc.                                                                                         | US-PGPUB; USPAT                                                      | OR | ON  | 2015/10/01<br>14:26 |
| S10 | 216  | G02B9/64.cpc.                                                                                            | US-PGPUB; USPAT                                                      | OR | ON  | 2015/10/01<br>14:26 |
| S11 | 28   | G02B9/00.cpc.                                                                                            | US-PGPUB; USPAT                                                      | OR | ON  | 2015/10/01<br>14:27 |
| S12 | 3442 | S2 S3 S4 S5 S6 S7 S8 S9 S10<br>S11                                                                       | US-PGPUB; USPAT                                                      | OR | ON  | 2015/10/01<br>14:28 |
| S13 | 648  | Lens and (first near10 positive)<br>and (seventh same concave)<br>and aspheric                           | US-PGPUB; USPAT                                                      | OR | ON  | 2015/10/01<br>14:30 |
| S14 | 663  | Lens and (first near10 positive)<br>and (seventh same concave)<br>and aspheric                           | US-PGPUB; USPAT;<br>USOCR; FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | OR | ON  | 2015/10/01<br>14:30 |
| S15 | 602  | Lens and (first near10 positive)<br>and (seventh same concave)<br>and aspheric and (focal adj<br>length) | US-PGPUB; USPAT;<br>USOCR; FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | OR | ON  | 2015/10/01<br>14:31 |
| S16 | 155  | S12 and S15                                                                                              | US-PGPUB; USPAT;<br>USOCR; FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | OR | ON  | 2015/10/01<br>14:32 |
| S17 | 3    | "20150198787"                                                                                            | US-PGPUB; USPAT;<br>USOCR; FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | OR | ON  | 2015/10/02<br>09:44 |
| S18 | 1013 | (359/708).OCLS.                                                                                          | US-PGPUB; USPAT                                                      | OR | OFF | 2015/10/06<br>11:51 |
| S19 | 311  | (359/713).OCLS.                                                                                          | US-PGPUB; USPAT                                                      | OR | OFF | 2015/10/06<br>11:51 |
| S20 | 504  | (359/682).OCLS.                                                                                          | US-PGPUB; USPAT                                                      | OR | OFF | 2015/10/06<br>11:51 |
| S21 | 544  | (359/754).OCLS.                                                                                          | US-PGPUB; USPAT                                                      | OR | OFF | 2015/10/06<br>11:51 |
| S22 | 146  | (359/755).OCLS.                                                                                          | US-PGPUB; USPAT                                                      | OR | OFF | 2015/10/06<br>11:51 |
| S23 | 1200 | G02B13/0045.cpc.                                                                                         | US-PGPUB; USPAT                                                      | OR | ON  | 2015/10/06          |

|     |      |                                                                                                          |                                                                      |    |    |                     |
|-----|------|----------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------|----|----|---------------------|
|     |      |                                                                                                          |                                                                      |    |    | 11:51               |
| S24 | 87   | G02B13/002.cpc.                                                                                          | US-PGPUB; USPAT                                                      | OR | ON | 2015/10/06<br>11:51 |
| S25 | 1200 | G02B13/0045.cpc.                                                                                         | US-PGPUB; USPAT                                                      | OR | ON | 2015/10/06<br>11:51 |
| S26 | 217  | G02B9/64.cpc.                                                                                            | US-PGPUB; USPAT                                                      | OR | ON | 2015/10/06<br>11:51 |
| S27 | 29   | G02B9/00.cpc.                                                                                            | US-PGPUB; USPAT                                                      | OR | ON | 2015/10/06<br>11:51 |
| S28 | 3444 | S18 S19 S20 S21 S22 S23 S24<br>S25 S26 S27                                                               | US-PGPUB; USPAT                                                      | OR | ON | 2015/10/06<br>11:51 |
| S29 | 602  | Lens and (first near10 positive)<br>and (seventh same concave)<br>and aspheric and (focal adj<br>length) | US-PGPUB; USPAT;<br>USOCR; FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | OR | ON | 2015/10/06<br>11:51 |
| S30 | 155  | S28 and S29                                                                                              | US-PGPUB; USPAT;<br>USOCR; FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | OR | ON | 2015/10/06<br>11:51 |
| S31 | 6    | S30 and ((critical adj point)<br>same seventh)                                                           | US-PGPUB; USPAT;<br>USOCR; FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | OR | ON | 2015/10/06<br>11:51 |
| S32 | 2    | "20150103414"                                                                                            | US-PGPUB; USPAT;<br>USOCR; FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | OR | ON | 2015/10/06<br>16:24 |

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S/N 14/488,106

PATENT  
Confirmation No. 2225

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

|              |                                                                                    |                 |                     |
|--------------|------------------------------------------------------------------------------------|-----------------|---------------------|
| Inventor(s): | Hsin-Hsuan Huang                                                                   | Examiner:       | William R Alexander |
| Serial No.:  | 14/488,106                                                                         | Group Art Unit: | 2872                |
| Filed:       | September 16, 2014                                                                 | Docket No.:     | 0115042.10018       |
| Title:       | PHOTOGRAPHING OPTICAL LENS ASSEMBLY, IMAGE CAPTURING<br>UNIT AND ELECTRONIC DEVICE |                 |                     |

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**AMENDMENT**

Mail Stop: Amendment  
Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

January 15, 2016

**CUSTOMER NO. 21874**

Dear Sir/Madam:

In response to the Office Action mailed October 22, 2015, please amend the above-identified application as follows and consider the following Remarks/Arguments:

**Amendments to the Claims** are reflected in the listing of claims that begins on page **2** of this paper.

**Remarks/Arguments** begin on page **12** of this paper.

### AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions and listings of claims in the application:

#### Listing of Claims

1. (Currently amended) A photographing optical lens assembly comprising, in order from an object side to an image side:
  - a first lens element having positive refractive power;
  - a second lens element having negative refractive power;
  - a third lens element ~~having refractive power~~;
  - a fourth lens element having positive refractive power;
  - a fifth lens element ~~having~~ with negative refractive power having an object-side surface being concave in a paraxial region thereof and an image-side surface being convex in a paraxial region thereof;
  - a sixth lens element ~~with refractive power~~ having an image-side surface being concave in a paraxial region thereof, wherein both of an object-side surface and the image-side surface of the sixth lens element are aspheric, and the image-side surface of the sixth lens element has at least one inflection point; and
  - a seventh lens element ~~with refractive power~~ having an image-side surface being concave in a paraxial region thereof, wherein both of an object-side surface and the image-side surface of the seventh lens element are aspheric, and the image-side surface of the seventh lens element has at least one inflection point;wherein the photographing optical lens assembly has a total of seven lens elements, there is a non-axial critical point on the image-side surface of the sixth lens element at which a tangent to the image-side surface of the sixth lens element is perpendicular to an optical axis, there is a non-axial critical point on the image-side surface of the seventh lens element at which a tangent to the image-side surface of the

seventh lens element is perpendicular to the optical axis, a vertical distance between the non-axial critical point on the image-side surface of the sixth lens element and the optical axis is Yc62, a vertical distance between ~~[[a]]~~the non-axial critical point on the image-side surface of the seventh lens element and ~~[[an]]~~the optical axis is Yc72, a focal length of the photographing optical lens assembly is f, a focal length of the first lens element is f1, a focal length of the seventh lens element is f7, and the following conditions are satisfied:

$$\underline{0.5 < Yc62/Yc72 < 1.5};$$

$$0.1 < Yc72/f < 0.9; \text{ and}$$

$$|f1/f7| < 3.0.$$

2. (Original) The photographing optical lens assembly of claim 1, wherein the object-side surface of the sixth lens element is convex in a paraxial region thereof.
3. (Canceled)
4. (Canceled)
5. (Original) The photographing optical lens assembly of claim 1, wherein the object-side surface of the seventh lens element is convex in a paraxial region thereof.
6. (Original) The photographing optical lens assembly of claim 1, wherein the third lens element has positive refractive power.
7. (Canceled)
8. (Original) The photographing optical lens assembly of claim 1, wherein at least three lens elements have positive refractive power among the first lens element, the second lens

element, the third lens element, the fourth lens element, the fifth lens element, the sixth lens element and the seventh lens element, the focal length of the photographing optical lens assembly is  $f$ , a curvature radius of the image-side surface of the seventh lens element is  $R14$ , and the following condition is satisfied:

$$0 < R14/f < 0.7.$$

9. (Original) The photographing optical lens assembly of claim 1, wherein the focal length of the photographing optical lens assembly is  $f$ , a curvature radius of the image-side surface of the sixth lens element is  $R12$ , and the following condition is satisfied:

$$0 < f/R12 < 5.0.$$

10. (Original) The photographing optical lens assembly of claim 1, wherein the seventh lens element has negative refractive power.

11. (Original) The photographing optical lens assembly of claim 1, wherein a curvature radius of the object-side surface of the seventh lens element is  $R13$ , a curvature radius of the image-side surface of the seventh lens element is  $R14$ , and the following condition is satisfied:

$$0 < (R13-R14)/(R13+R14) < 1.5.$$

12. (Original) The photographing optical lens assembly of claim 1, wherein a sum of axial distances between any two lens elements adjacent to each other is  $\Sigma AT$ , a maximum image height of the photographing optical lens assembly is  $ImgH$ , and the following condition is satisfied:

$$0.20 < \Sigma AT/ImgH < 0.60.$$

13. (Original) The photographing optical lens assembly of claim 1, wherein both of an object-side surface and an image-side surface of the first lens element are aspheric, both

of an object-side surface and an image-side surface of the second lens element are aspheric, both of an object-side surface and an image-side surface of the third lens element are aspheric, both of an object-side surface and an image-side surface of the fourth lens element are aspheric, both of an object-side surface and an image-side surface of the fifth lens element are aspheric, an axial distance between the object-side surface of the first lens element and an image surface is TL, the focal length of the photographing optical lens assembly is f, and the following condition is satisfied:

$$0.80 < TL/f < 1.80.$$

14. (Original) The photographing optical lens assembly of claim 1, wherein a maximum refractive index of one single lens element among the first lens element, the second lens element, the third lens element, the fourth lens element, the fifth lens element, the sixth lens element and the seventh lens element is Nmax, and the following condition is satisfied:

$$1.640 \leq N_{\max} < 1.750.$$

15. (Original) The photographing optical lens assembly of claim 1, wherein an Abbe number of the second lens element is V2, and the following condition is satisfied:

$$V2 < 26.0.$$

16. (Canceled)

17. (Original) The photographing optical lens assembly of claim 1, wherein the focal length of the photographing optical lens assembly is f, and the following condition is satisfied:

$$3.0[\text{mm}] < f < 6.5[\text{mm}].$$

18. (Currently amended) The photographing optical lens assembly of claim 1, further comprising [[a]]an aperture stop, wherein an axial distance between the aperture stop and

the image-side surface of the seventh lens element is SD, an axial distance between an object-side surface of the first lens element and the image-side surface of the seventh lens element is TD, and the following condition is satisfied:

$$0.75 < SD/TD < 1.1.$$

19. (Original) The photographing optical lens assembly of claim 1, wherein a curvature radius of an object-side surface of the first lens element is R1, a curvature radius of an image-side surface of the first lens element is R2, and the following condition is satisfied:

$$-0.2 < R1/R2 < 0.2.$$

20. (Original) The photographing optical lens assembly of claim 1, wherein the focal length of the photographing optical lens assembly is f, an entrance pupil diameter of the photographing optical lens assembly is EPD, half of a maximal field of view of the photographing optical lens assembly is HFOV, and the following conditions are satisfied:

$$1.2 < f/EPD < 2.6; \text{ and}$$

$$15[\text{deg.}] < \text{HFOV} < 45[\text{deg.}].$$

21. (Original) The photographing optical lens assembly of claim 1, wherein a central thickness of the first lens element is CT1, a central thickness of the second lens element is CT2, an axial distance between the second lens element and the third lens element is T23, an axial distance between the third lens element and the fourth lens element is T34, and the following conditions are satisfied:

$$1.0 < CT1/CT2 < 5.5; \text{ and}$$

$$0.5 < T23/T34 < 4.5.$$

22. (Original) An image capturing unit, comprising:  
the photographing optical lens assembly of claim 1; and  
an image sensor, wherein the image sensor is disposed on the image side of the

photographing optical lens assembly.

23. (Original) An electronic device, comprising:  
the image capturing unit of claim 22.
24. (Currently amended) A photographing optical lens assembly comprising, in order from an object side to an image side:  
a first lens element having positive refractive power;  
a second lens element ~~having refractive power~~;  
a third lens element having positive refractive power;  
a fourth lens element having positive refractive power;  
a fifth lens element ~~having refractive power~~;  
a sixth lens element with positive refractive power having an image-side surface being concave in a paraxial region thereof, wherein both of an object-side surface and the image-side surface of the sixth lens element are aspheric, and the image-side surface of the sixth lens element has at least one inflection point; and  
a seventh lens element ~~with refractive power~~ having an image-side surface being concave in a paraxial region thereof, wherein both of an object-side surface and the image-side surface of the seventh lens element are aspheric, and the image-side surface of the seventh lens element has at least one inflection point;  
wherein the photographing optical lens assembly has a total of seven lens elements, there is a non-axial critical point on the image-side surface of the seventh lens element at which a tangent to the image-side surface of the seventh lens element is perpendicular to an optical axis, a focal length of the photographing optical lens assembly is  $f$ , a vertical distance between ~~[[a]]~~the non-axial critical point on the image-side surface of the seventh lens element and ~~[[an]]~~the optical axis is  $Y_{c72}$ , a focal length of the first lens element is  $f_1$ , a focal length of the second lens element is  $f_2$ , an axial distance between an object-side surface of the first lens element and an image surface is  $TL$ , a

maximum image height of the photographing optical lens assembly is  $ImgH$ , and the following conditions are satisfied:

$$0.1 < Y_{c72}/f < 0.9;$$

$$|f1/f2| < 2.0; \text{ and}$$

$$TL/ImgH < 2.20.$$

25. (Original) The photographing optical lens assembly of claim 24, wherein the object-side surface of the first lens element is convex in a paraxial region thereof, and the second lens element has an image-side surface being concave in a paraxial region thereof.
26. (Canceled)
27. (Original) The photographing optical lens assembly of claim 24, wherein the third lens element has an object-side surface being convex in a paraxial region thereof.
28. (Original) The photographing optical lens assembly of claim 24, wherein the fifth lens element has negative refractive power.
29. (Original) The photographing optical lens assembly of claim 24, wherein the fifth lens element has an image-side surface being convex in a paraxial region thereof.
30. (Original) The photographing optical lens assembly of claim 24, wherein the focal length of the photographing optical lens assembly is  $f$ , a curvature radius of the image-side surface of the sixth lens element is  $R12$ , and the following condition is satisfied:
$$0 < f/R12 < 3.0.$$
31. (Original) The photographing optical lens assembly of claim 24, wherein the focal length of the first lens element is  $f1$ , the focal length of the second lens element is  $f2$ , a focal

length of the third lens element is  $f_3$ , a focal length of the fourth lens element is  $f_4$ , a focal length of the fifth lens element is  $f_5$ , a focal length of the sixth lens element is  $f_6$ , a focal length of the seventh lens element is  $f_7$ , and the following condition is satisfied:

$$|f_1| < |f_i|, \text{ wherein } i = 2, 3, 4, 5, 6, 7.$$

32. (Original) The photographing optical lens assembly of claim 24, wherein a curvature radius of the object-side surface of the sixth lens element is  $R_{11}$ , a curvature radius of the image-side surface of the sixth lens element is  $R_{12}$ , and the following condition is satisfied:

$$-2.0 < (R_{11}-R_{12})/(R_{11}+R_{12}) < 0.2.$$

33. (Original) The photographing optical lens assembly of claim 24, wherein the focal length of the photographing optical lens assembly is  $f$ , the focal length of the first lens element is  $f_1$ , the focal length of the second lens element is  $f_2$ , a focal length of the third lens element is  $f_3$ , a focal length of the fourth lens element is  $f_4$ , a focal length of the fifth lens element is  $f_5$ , a focal length of the sixth lens element is  $f_6$ , a focal length of the seventh lens element is  $f_7$ , and the following condition is satisfied:

$$|f/f_j| \max < 1.8, \text{ wherein } j = 1, 2, 3, 4, 5, 6, 7.$$

34. (Original) The photographing optical lens assembly of claim 24, wherein an Abbe number of the first lens element is  $V_1$ , an Abbe number of the second lens element is  $V_2$ , an Abbe number of the third lens element is  $V_3$ , an Abbe number of the fourth lens element is  $V_4$ , an Abbe number of the fifth lens element is  $V_5$ , an Abbe number of the sixth lens element is  $V_6$ , an Abbe number of the seventh lens element is  $V_7$ , and at least three lens elements among the first lens element to the seventh lens element satisfy the following condition:

$$V_i < 26.0, \text{ wherein } i=1, 2, 3, 4, 5, 6, 7.$$

35. (Currently amended) The photographing optical lens assembly of claim 24, further comprising ~~[[a]]an aperture~~ stop, wherein the first lens element, the second lens element, the third lens element, the fourth lens element, the fifth lens element, the sixth lens element and the seventh lens element are all ~~independent and~~ non-cemented lens elements, and the aperture stop is located between an imaged object and the second lens element.
36. (Currently amended) The photographing optical lens assembly of claim 24, wherein there is a non-axial critical point on the object-side surface of the sixth lens element at which a tangent to the object-side surface of the sixth lens element is perpendicular to the optical axis, there is a non-axial critical point on the image-side surface of the sixth lens element at which a tangent to the image-side surface of the sixth lens element is perpendicular to the optical axis, a vertical distance between ~~[[a]]the~~ non-axial critical point on the object-side surface of the sixth lens element and ~~[[an]]the~~ optical axis is Yc61, a vertical distance between ~~[[a]]the~~ non-axial critical point on the image-side surface of the sixth lens element and ~~[[an]]the~~ optical axis is Yc62, and the following condition is satisfied:  
$$0.30 < Yc62/Yc61 < 1.80.$$
37. (Original) The photographing optical lens assembly of claim 24, wherein the focal length of the photographing optical lens assembly is f, a focal length of the third lens element is f3, and the following condition is satisfied:  
$$-0.5 < f/f3 < 0.6.$$
38. (Original) The photographing optical lens assembly of claim 24, wherein an axial distance between the first lens element and the second lens element is T12, an axial distance between the second lens element and the third lens element is T23, an axial distance between the third lens element and the fourth lens element is T34, an axial distance between the fourth lens element and the fifth lens element is T45, an axial

distance between the fifth lens element and the sixth lens element is T56, an axial distance between the sixth lens element and the seventh lens element is T67, and the following condition is satisfied:

$$0 < (T12/T23) + (T34/T45) + (T56/T67) < 3.8.$$

39. (Currently amended) The photographing optical lens assembly of claim 24, further comprising [[a]]aperture stop, wherein the aperture stop is located between an imaged object and the first lens element, an axial distance between the second lens element and the third lens element is T23, a central thickness of the second lens element is CT2, the focal length of the photographing optical lens assembly is f, a curvature radius of an image-side surface of the third lens element is R6, and the following conditions are satisfied:

$$0.3 < T23/CT2 < 3.0; \text{ and}$$

$$-1.0 < f/R6 < 2.5.$$

### **REMARKS/ARGUMENTS**

Claims 1-39 were pending in the present application before this amendment as set forth above. By the amendment, claims 1, 18, 24, 35, 36 and 39 are amended, and claims 3, 4, 7, 16, and 26 are canceled. The amendment is made for specifying the invention.

In the October 22, 2015 Office Action, claims 1-29 were rejected under 35 U.S.C. §112(b) or 35 U.S.C. §112(pre-AIA), second paragraph. Claims 1-13, 15, 17, 18, 21-25, 27, 29-31, 33-35, 38, and 39 were rejected under 35 U.S.C. §103 as being unpatentable over Baik (U.S. Patent Application Publication No. 2015/0103414, hereinafter “Baik”) in view of Tsai et al. (U.S. Patent No. 8,599,495, hereinafter “Tsai”).

However, the Examiner indicated that claims 14, 16, 19, 20, 26, 28, 32, 36, and 37 were objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims and to overcome the rejections under 35 U.S.C. §112.

Applicant appreciates the Examiner’s careful review of the application, and allowability of claims 14, 16, 19, 20, 26, 28, 32, 36, and 37. Applicant further submits that the rejection in this Office Action is respectfully traversed and the amendment is made for further specifying the claimed invention to facilitate the examination procedure.

In response, as set forth above, Applicant has amended claims 1, 24, and 36 to overcome the rejections under 35 U.S.C. §112(b) or 35 U.S.C. §112(pre-AIA), second paragraph.

Further, Applicant has amended independent claim 1 to incorporate allowable subject matter of claim 16 and the limitations of claims 3, 4, 7, 28, 29, and amended independent claim 24 to incorporate allowable subject matter of claim 26 and the limitations of claims 6 and 7, which makes claims 1 and 24 allowable now. Claims 3, 4, 7, 16, and 26 have been canceled,

Any amendments to the claims not specifically referred to herein as being included for the purpose of distinguishing the claims from cited references are included for the purpose of clarification, consistence and/or grammatical correction only. No new matter is added.

Accordingly, claims 2, 5, 6, 8-15, 17-23, 25, 27-39, which depend from now allowable independent claims 1 and 24, respectively, are patentable as well.

Serial No.: 14/488,106  
Amdt. Dated January 15, 2016  
Reply to Office Action of October 22, 2015

It is now believed that the application is in condition for allowance and such allowance is respectfully requested.

### **CONCLUSION**

Applicant respectfully submits that the foregoing Response place this application in condition for allowance. If the Examiner believes that there are any issues that can be resolved by a telephone conference, or that there are any informalities that can be corrected by an Examiner's amendment, please call the undersigned at 404-870-4698.

It is believed that no fee is due. However, the Commissioner is hereby authorized to charge any deficiency of fees that may be required, and credit of any overpayments to Deposit Account No. 121781.

January 15, 2016

Respectfully submitted,  
Locke Lord LLP



---

Tim Tingkang Xia  
Attorney for Applicant on the Record  
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## Electronic Acknowledgement Receipt

|                                             |                                                                                 |
|---------------------------------------------|---------------------------------------------------------------------------------|
| <b>EFS ID:</b>                              | 24634036                                                                        |
| <b>Application Number:</b>                  | 14488106                                                                        |
| <b>International Application Number:</b>    |                                                                                 |
| <b>Confirmation Number:</b>                 | 2225                                                                            |
| <b>Title of Invention:</b>                  | PHOTOGRAPHING OPTICAL LENS ASSEMBLY, IMAGE CAPTURING UNIT AND ELECTRONIC DEVICE |
| <b>First Named Inventor/Applicant Name:</b> | Hsin-Hsuan HUANG                                                                |
| <b>Customer Number:</b>                     | 21874                                                                           |
| <b>Filer:</b>                               | Tim Tingkang Xia/Debby Yew                                                      |
| <b>Filer Authorized By:</b>                 | Tim Tingkang Xia                                                                |
| <b>Attorney Docket Number:</b>              | 0115042.018US2                                                                  |
| <b>Receipt Date:</b>                        | 15-JAN-2016                                                                     |
| <b>Filing Date:</b>                         | 16-SEP-2014                                                                     |
| <b>Time Stamp:</b>                          | 12:11:02                                                                        |
| <b>Application Type:</b>                    | Utility under 35 USC 111(a)                                                     |

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### File Listing:

| Document Number | Document Description                                  | File Name                  | File Size(Bytes)/ Message Digest                   | Multi Part /.zip | Pages (if appl.) |
|-----------------|-------------------------------------------------------|----------------------------|----------------------------------------------------|------------------|------------------|
| 1               | Amendment/Req. Reconsideration-After Non-Final Reject | 011504210018ResponseOA.pdf | 148919<br>4ce052cdd3c88dd2fca4cc7146466bcb0a3a7b42 | no               | 13               |

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| <b>PATENT APPLICATION FEE DETERMINATION RECORD</b><br>Substitute for Form PTO-875 | Application or Docket Number<br><b>14/488,106</b> | Filing Date<br><b>09/16/2014</b> | <input type="checkbox"/> To be Mailed |
|-----------------------------------------------------------------------------------|---------------------------------------------------|----------------------------------|---------------------------------------|

ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO**APPLICATION AS FILED – PART I**

(Column 1)

(Column 2)

| FOR                                                                        | NUMBER FILED                                                                                                                                                                                                                  | NUMBER EXTRA | RATE (\$) | FEE (\$) |
|----------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-----------|----------|
| <input type="checkbox"/> BASIC FEE<br>(37 CFR 1.16(a), (b), or (c))        | N/A                                                                                                                                                                                                                           | N/A          | N/A       |          |
| <input type="checkbox"/> SEARCH FEE<br>(37 CFR 1.16(k), (i), or (m))       | N/A                                                                                                                                                                                                                           | N/A          | N/A       |          |
| <input type="checkbox"/> EXAMINATION FEE<br>(37 CFR 1.16(o), (p), or (q))  | N/A                                                                                                                                                                                                                           | N/A          | N/A       |          |
| TOTAL CLAIMS<br>(37 CFR 1.16(i))                                           | minus 20 =                                                                                                                                                                                                                    | *            | X \$ =    |          |
| INDEPENDENT CLAIMS<br>(37 CFR 1.16(h))                                     | minus 3 =                                                                                                                                                                                                                     | *            | X \$ =    |          |
| <input type="checkbox"/> APPLICATION SIZE FEE<br>(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). |              |           |          |
| <input type="checkbox"/> MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j)) |                                                                                                                                                                                                                               |              |           |          |
| * If the difference in column 1 is less than zero, enter "0" in column 2.  |                                                                                                                                                                                                                               |              | TOTAL     |          |

**APPLICATION AS AMENDED – PART II**

(Column 1)

(Column 2)

(Column 3)

| AMENDMENT       | 01/15/2016                                                                               | CLAIMS REMAINING AFTER AMENDMENT | Minus | HIGHEST NUMBER PREVIOUSLY PAID FOR | PRESENT EXTRA | RATE (\$) | ADDITIONAL FEE (\$) |
|-----------------|------------------------------------------------------------------------------------------|----------------------------------|-------|------------------------------------|---------------|-----------|---------------------|
|                 | Total (37 CFR 1.16(i))                                                                   | * 34                             | Minus | ** 39                              | = 0           | X \$80 =  | 0                   |
|                 | Independent (37 CFR 1.16(h))                                                             | * 2                              | Minus | ***3                               | = 0           | X \$420 = | 0                   |
|                 | <input type="checkbox"/> Application Size Fee (37 CFR 1.16(s))                           |                                  |       |                                    |               |           |                     |
|                 | <input type="checkbox"/> FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j)) |                                  |       |                                    |               |           |                     |
| TOTAL ADD'L FEE |                                                                                          |                                  |       |                                    |               | <b>0</b>  |                     |

(Column 1)

(Column 2)

(Column 3)

| AMENDMENT       | CLAIMS REMAINING AFTER AMENDMENT                                                         | Minus | HIGHEST NUMBER PREVIOUSLY PAID FOR | PRESENT EXTRA | RATE (\$) | ADDITIONAL FEE (\$) |
|-----------------|------------------------------------------------------------------------------------------|-------|------------------------------------|---------------|-----------|---------------------|
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|                 | Independent (37 CFR 1.16(h))                                                             | *     | Minus                              | ***           | =         | X \$ =              |
|                 | <input type="checkbox"/> Application Size Fee (37 CFR 1.16(s))                           |       |                                    |               |           |                     |
|                 | <input type="checkbox"/> FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j)) |       |                                    |               |           |                     |
| 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 number found in the appropriate box in column 1.

LIE  
/ANGELA s. WHITE/

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| APPLICATION NUMBER | FILING OR 371(C) DATE | FIRST NAMED APPLICANT | ATTY. DOCKET NO./TITLE |
|--------------------|-----------------------|-----------------------|------------------------|
| 14/488,106         | 09/16/2014            | Hsin-Hsuan HUANG      | 0115042.018US2         |

**CONFIRMATION NO. 2225**

## PUBLICATION NOTICE



\*OC000000080336659\*

21874  
Locke Lord LLP  
P.O. BOX 55874  
BOSTON, MA 02205

**Title:**PHOTOGRAPHING OPTICAL LENS ASSEMBLY, IMAGE CAPTURING UNIT AND ELECTRONIC DEVICE

**Publication No.**US-2016-0033742-A1

**Publication Date:**02/04/2016

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21874 7590 02/16/2016  
Locke Lord LLP  
P.O. BOX 55874  
BOSTON, MA 02205

EXAMINER

ALEXANDER, WILLIAM R

ART UNIT

PAPER NUMBER

2872

DATE MAILED: 02/16/2016

| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|-----------------|-------------|----------------------|---------------------|------------------|
|-----------------|-------------|----------------------|---------------------|------------------|

14/488,106

09/16/2014

Hsin-Hsuan HUANG

0115042.018US2

2225

TITLE OF INVENTION: PHOTOGRAPHING OPTICAL LENS ASSEMBLY, IMAGE CAPTURING UNIT AND ELECTRONIC DEVICE

| 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            | 05/16/2016 |

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21874 7590 02/16/2016  
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**P.O. BOX 55874**  
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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|-----------------|-------------|----------------------|---------------------|------------------|
| 14/488,106      | 09/16/2014  | Hsin-Hsuan HUANG     | 0115042.018US2      | 2225             |

TITLE OF INVENTION: PHOTOGRAPHING OPTICAL LENS ASSEMBLY, IMAGE CAPTURING UNIT AND ELECTRONIC DEVICE

| 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            | 05/16/2016 |

| EXAMINER             | ART UNIT | CLASS-SUBCLASS |
|----------------------|----------|----------------|
| ALEXANDER, WILLIAM R | 2872     | 359-708000     |

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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. |
|------------------------------------------------------|-------------|----------------------|----------------------|------------------|
| 14/488,106                                           | 09/16/2014  | Hsin-Hsuan HUANG     | 0115042.018US2       | 2225             |
| 21874                                                | 7590        | 02/16/2016           | EXAMINER             |                  |
| Locke Lord LLP<br>P.O. BOX 55874<br>BOSTON, MA 02205 |             |                      | ALEXANDER, WILLIAM R |                  |
|                                                      |             |                      | ART UNIT             | PAPER NUMBER     |
|                                                      |             |                      | 2872                 |                  |
| DATE MAILED: 02/16/2016                              |             |                      |                      |                  |

## 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 law or regulation.

|                               |                                         |                                          |                                                   |
|-------------------------------|-----------------------------------------|------------------------------------------|---------------------------------------------------|
| <b>Notice of Allowability</b> | <b>Application No.</b><br>14/488,106    | <b>Applicant(s)</b><br>HUANG, HSIN-HSUAN |                                                   |
|                               | <b>Examiner</b><br>WILLIAM R. ALEXANDER | <b>Art Unit</b><br>2872                  | <b>AIA (First Inventor to File) Status</b><br>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 1/15/2016.  
☐ 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, 2, 5, 6, 8-15, 17-25, and 27-39. 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](http://www.uspto.gov/patents/init_events/pph/index.jsp) or send an inquiry to [PPHfeedback@uspto.gov](mailto: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 type="checkbox"/> Information Disclosure Statements (PTO/SB/08),<br>Paper No./Mail Date _____    | 6. <input checked="" type="checkbox"/> Examiner's Statement of Reasons for Allowance |
| 3. <input type="checkbox"/> Examiner's Comment Regarding Requirement for Deposit<br>of Biological Material | 7. <input type="checkbox"/> Other _____                                              |
| 4. <input type="checkbox"/> Interview Summary (PTO-413),<br>Paper No./Mail Date _____                      |                                                                                      |

/WILLIAM R ALEXANDER/  
Examiner, Art Unit 2872

The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

## **DETAILED ACTION**

### ***Claim Rejections - 35 USC § 112***

Examiner acknowledges amended claims 1, 24, and 36, as well as canceled claim 16, and accordingly withdraws the associated 35 USC § 112 claim rejection as detailed in the office action dated 10/22/2015.

### ***Reasons for Allowance/Examiner's Comments***

Claims 1, 2, 5, 6, 8-15, 17-25, and 27-39 are allowed.

The following is a statement of reasons for the indication of allowable subject matter: with respect to the allowable subject matter, none of the prior art either alone or in combination disclose or teach of the claimed combination of limitations to warrant a rejection under 35 USC 102 or 103.

The following is the examiner's statement of reasons for allowance: Claims 1 and 24 are considered allowable for reasons set forth in arguments provided by applicant on 1/15/2016 (Page numbered 12, lines 20-28).

Specifically regarding the allowability of Claim 1, amended Claim 1 now contains "wherein a vertical distance between a non-axial critical point on the image-side surface of the sixth lens element and an optical axis is  $Y_{c62}$ , the vertical distance between a non-axial critical point on the image-side surface of the seventh lens element and the optical axis is  $Y_{c72}$ , and the following condition is satisfied:  $0.5 < Y_{c62}/Y_{c72} < 1.5$ , and wherein the fifth lens element has negative refractive power" which contains the

contents of claims 16 and 28, which were identified as being allowable subject matter in the office action dated 10/22/2015.

Specifically regarding the allowability of Claim 24, amended Claim 24 contains the original contents of claim 26, namely, "wherein the sixth lens element has positive refractive power" which was identified as being allowable subject matter in the office action dated 10/22/2015.

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."

### ***Conclusion***

Any inquiry concerning this communication or earlier communications from the examiner should be directed to WILLIAM R. ALEXANDER whose telephone number is (571)270-7656. The examiner can normally be reached on Mondays through Thursdays 7:30 AM through 5:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Bumsuk Won can be reached on 571-272-2713. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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.

/WILLIAM R ALEXANDER/  
Examiner, Art Unit 2872

/BUMSUK WON/  
Supervisory Patent Examiner, Art Unit 2872

## EAST Search History

## EAST Search History (Prior Art)

| Ref # | Hits | Search Query                                                                                    | DBs                                                      | Default Operator | Plurals | Time Stamp       |
|-------|------|-------------------------------------------------------------------------------------------------|----------------------------------------------------------|------------------|---------|------------------|
| L1    | 1022 | (359/708).OCLS.                                                                                 | US-PGPUB; USPAT                                          | OR               | OFF     | 2016/02/02 12:49 |
| L2    | 347  | (359/713).OCLS.                                                                                 | US-PGPUB; USPAT                                          | OR               | OFF     | 2016/02/02 12:49 |
| L3    | 507  | (359/682).OCLS.                                                                                 | US-PGPUB; USPAT                                          | OR               | OFF     | 2016/02/02 12:49 |
| L4    | 554  | (359/754).OCLS.                                                                                 | US-PGPUB; USPAT                                          | OR               | OFF     | 2016/02/02 12:49 |
| L5    | 148  | (359/755).OCLS.                                                                                 | US-PGPUB; USPAT                                          | OR               | OFF     | 2016/02/02 12:49 |
| L6    | 1388 | G02B13/0045.cpc.                                                                                | US-PGPUB; USPAT                                          | OR               | ON      | 2016/02/02 12:49 |
| L7    | 112  | G02B13/002.cpc.                                                                                 | US-PGPUB; USPAT                                          | OR               | ON      | 2016/02/02 12:49 |
| L8    | 1388 | G02B13/0045.cpc.                                                                                | US-PGPUB; USPAT                                          | OR               | ON      | 2016/02/02 12:49 |
| L9    | 247  | G02B9/64.cpc.                                                                                   | US-PGPUB; USPAT                                          | OR               | ON      | 2016/02/02 12:49 |
| L10   | 38   | G02B9/00.cpc.                                                                                   | US-PGPUB; USPAT                                          | OR               | ON      | 2016/02/02 12:49 |
| L11   | 3668 | L1 L2 L3 L4 L5 L6 L7 L8 L9 L10                                                                  | US-PGPUB; USPAT                                          | OR               | ON      | 2016/02/02 12:49 |
| L12   | 625  | Lens and (first near10 positive) and (seventh same concave) and aspheric and (focal adj length) | US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB | OR               | ON      | 2016/02/02 12:49 |
| L13   | 172  | L11 and L12                                                                                     | US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB | OR               | ON      | 2016/02/02 12:49 |
| L14   | 8    | L13 and ((critical adj point) same seventh)                                                     | US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB | OR               | ON      | 2016/02/02 12:49 |
| L15   | 3    | L14 and @pd<"20140801"                                                                          | US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB | OR               | ON      | 2016/02/02 12:50 |
| L25   | 0    | "14488106"                                                                                      | US-PGPUB; USPAT                                          | OR               | ON      | 2016/02/02 16:09 |
| S1    | 0    | "14488106"                                                                                      | US-PGPUB; USPAT                                          | OR               | ON      | 2015/10/01 13:58 |

|     |      |                                                                                                          |                                                                      |    |     |                     |
|-----|------|----------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------|----|-----|---------------------|
| S2  | 1013 | (359/708).OCLS.                                                                                          | US-PGPUB; USPAT                                                      | OR | OFF | 2015/10/01<br>14:15 |
| S3  | 311  | (359/713).OCLS.                                                                                          | US-PGPUB; USPAT                                                      | OR | OFF | 2015/10/01<br>14:18 |
| S4  | 504  | (359/682).OCLS.                                                                                          | US-PGPUB; USPAT                                                      | OR | OFF | 2015/10/01<br>14:20 |
| S5  | 544  | (359/754).OCLS.                                                                                          | US-PGPUB; USPAT                                                      | OR | OFF | 2015/10/01<br>14:20 |
| S6  | 146  | (359/755).OCLS.                                                                                          | US-PGPUB; USPAT                                                      | OR | OFF | 2015/10/01<br>14:21 |
| S7  | 1199 | G02B13/0045.cpc.                                                                                         | US-PGPUB; USPAT                                                      | OR | ON  | 2015/10/01<br>14:23 |
| S8  | 87   | G02B13/002.cpc.                                                                                          | US-PGPUB; USPAT                                                      | OR | ON  | 2015/10/01<br>14:23 |
| S9  | 1199 | G02B13/0045.cpc.                                                                                         | US-PGPUB; USPAT                                                      | OR | ON  | 2015/10/01<br>14:26 |
| S10 | 216  | G02B9/64.cpc.                                                                                            | US-PGPUB; USPAT                                                      | OR | ON  | 2015/10/01<br>14:26 |
| S11 | 28   | G02B9/00.cpc.                                                                                            | US-PGPUB; USPAT                                                      | OR | ON  | 2015/10/01<br>14:27 |
| S12 | 3442 | S2 S3 S4 S5 S6 S7 S8 S9 S10<br>S11                                                                       | US-PGPUB; USPAT                                                      | OR | ON  | 2015/10/01<br>14:28 |
| S13 | 648  | Lens and (first near10 positive)<br>and (seventh same concave)<br>and aspheric                           | US-PGPUB; USPAT                                                      | OR | ON  | 2015/10/01<br>14:30 |
| S14 | 663  | Lens and (first near10 positive)<br>and (seventh same concave)<br>and aspheric                           | US-PGPUB; USPAT;<br>USOCR; FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | OR | ON  | 2015/10/01<br>14:30 |
| S15 | 602  | Lens and (first near10 positive)<br>and (seventh same concave)<br>and aspheric and (focal adj<br>length) | US-PGPUB; USPAT;<br>USOCR; FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | OR | ON  | 2015/10/01<br>14:31 |
| S16 | 155  | S12 and S15                                                                                              | US-PGPUB; USPAT;<br>USOCR; FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | OR | ON  | 2015/10/01<br>14:32 |
| S17 | 3    | "20150198787"                                                                                            | US-PGPUB; USPAT;<br>USOCR; FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | OR | ON  | 2015/10/02<br>09:44 |
| S18 | 1013 | (359/708).OCLS.                                                                                          | US-PGPUB; USPAT                                                      | OR | OFF | 2015/10/06<br>11:51 |
| S19 | 311  | (359/713).OCLS.                                                                                          | US-PGPUB; USPAT                                                      | OR | OFF | 2015/10/06<br>11:51 |
| S20 | 504  | (359/682).OCLS.                                                                                          | US-PGPUB; USPAT                                                      | OR | OFF | 2015/10/06<br>11:51 |
| S21 | 544  | (359/754).OCLS.                                                                                          | US-PGPUB; USPAT                                                      | OR | OFF | 2015/10/06<br>11:51 |
| S22 | 146  | (359/755).OCLS.                                                                                          | US-PGPUB; USPAT                                                      | OR | OFF | 2015/10/06<br>11:51 |
| S23 | 1200 | G02B13/0045.cpc.                                                                                         | US-PGPUB; USPAT                                                      | OR | ON  | 2015/10/06          |

|     |        |                                                                                                          |                                                                      |    |    |                     |
|-----|--------|----------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------|----|----|---------------------|
|     |        |                                                                                                          |                                                                      |    |    | 11:51               |
| S24 | 87     | G02B13/002.cpc.                                                                                          | US-PGPUB; USPAT                                                      | OR | ON | 2015/10/06<br>11:51 |
| S25 | 1200   | G02B13/0045.cpc.                                                                                         | US-PGPUB; USPAT                                                      | OR | ON | 2015/10/06<br>11:51 |
| S26 | 217    | G02B9/64.cpc.                                                                                            | US-PGPUB; USPAT                                                      | OR | ON | 2015/10/06<br>11:51 |
| S27 | 29     | G02B9/00.cpc.                                                                                            | US-PGPUB; USPAT                                                      | OR | ON | 2015/10/06<br>11:51 |
| S28 | 3444   | S18 S19 S20 S21 S22 S23 S24<br>S25 S26 S27                                                               | US-PGPUB; USPAT                                                      | OR | ON | 2015/10/06<br>11:51 |
| S29 | 602    | Lens and (first near10 positive)<br>and (seventh same concave)<br>and aspheric and (focal adj<br>length) | US-PGPUB; USPAT;<br>USOCR; FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | OR | ON | 2015/10/06<br>11:51 |
| S30 | 155    | S28 and S29                                                                                              | US-PGPUB; USPAT;<br>USOCR; FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | OR | ON | 2015/10/06<br>11:51 |
| S31 | 6      | S30 and ((critical adj point)<br>same seventh)                                                           | US-PGPUB; USPAT;<br>USOCR; FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | OR | ON | 2015/10/06<br>11:51 |
| S32 | 2      | "20150103414"                                                                                            | US-PGPUB; USPAT;<br>USOCR; FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | OR | ON | 2015/10/06<br>16:24 |
| S33 | 972553 | huang.in.                                                                                                | US-PGPUB; USPAT;<br>USOCR; FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | OR | ON | 2015/10/08<br>07:31 |
| S34 | 602    | Lens and (first near10 positive)<br>and (seventh same concave)<br>and aspheric and (focal adj<br>length) | US-PGPUB; USPAT;<br>USOCR; FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | OR | ON | 2015/10/08<br>07:31 |
| S35 | 40     | huang.in. and S34                                                                                        | US-PGPUB; USPAT;<br>USOCR; FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | OR | ON | 2015/10/08<br>07:31 |
| S36 | 6      | huang.in. and S34 and (critical<br>adj point)                                                            | US-PGPUB; USPAT;<br>USOCR; FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | OR | ON | 2015/10/08<br>07:31 |
| S37 | 6      | huang.in. and S34 and (critical<br>adj point)                                                            | US-PGPUB; USPAT;<br>USOCR; FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | OR | ON | 2015/10/08<br>07:32 |
| S38 | 6      | huang.in. and S34 and (critical<br>adj point) and "yc72"                                                 | US-PGPUB; USPAT;<br>USOCR; FPRS;                                     | OR | ON | 2015/10/08<br>07:32 |

|     |   |                                                                  |                                                                      |    |    |                     |
|-----|---|------------------------------------------------------------------|----------------------------------------------------------------------|----|----|---------------------|
|     |   |                                                                  | EPO; JPO;<br>DERWENT;<br>IBM_TDB                                     |    |    |                     |
| S39 | 0 | huang.in. and S34 and (critical adj point) and "yc72" and "yc62" | US-PGPUB; USPAT;<br>USOCR; FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | OR | ON | 2015/10/08<br>07:33 |
| S40 | 6 | huang.in. and S34 and (critical adj point) and "yc72"            | US-PGPUB; USPAT;<br>USOCR; FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | OR | ON | 2015/10/08<br>07:33 |
| S41 | 6 | ("7869142"   "8000030").PN.<br>OR ("8599495").URPN.              | US-PGPUB; USPAT;<br>USOCR                                            | OR | ON | 2015/10/08<br>07:34 |
| S42 | 1 | "20150103414"                                                    | US-PGPUB; USPAT;<br>USOCR                                            | OR | ON | 2015/10/08<br>07:34 |
| S43 | 0 | ("2015/0103414").URPN.                                           | USPAT                                                                | OR | ON | 2015/10/08<br>07:35 |

EAST Search History (Interference)

| Ref # | Hits | Search Query                                                                                           | DBs                | Default Operator | Plurals | Time Stamp          |
|-------|------|--------------------------------------------------------------------------------------------------------|--------------------|------------------|---------|---------------------|
| L16   | 51   | (Lens and (first near10 positive) and (seventh same concave) and aspheric and (focal adj length)).clm. | US-PGPUB;<br>USPAT | OR               | ON      | 2016/02/02<br>12:51 |
| L17   | 9    | ((critical adj point) same seventh).clm.                                                               | US-PGPUB;<br>USPAT | OR               | ON      | 2016/02/02<br>12:52 |
| L18   | 7    | l16 and l17                                                                                            | US-PGPUB;<br>USPAT | OR               | ON      | 2016/02/02<br>12:52 |
| L19   | 10   | ((seventh near7 aspheric) and (seventh near10 inflection)).clm.                                        | US-PGPUB;<br>USPAT | OR               | ON      | 2016/02/02<br>12:54 |
| L23   | 8870 | (vertical adj distance).clm.                                                                           | US-PGPUB;<br>USPAT | OR               | ON      | 2016/02/02<br>12:56 |
| L24   | 5    | l16 and l17 and l19 and l23                                                                            | US-PGPUB;<br>USPAT | OR               | ON      | 2016/02/02<br>12:57 |

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|                                                                                                                 |                                            |                                                                     |  |
|-----------------------------------------------------------------------------------------------------------------|--------------------------------------------|---------------------------------------------------------------------|--|
| <b>Issue Classification</b><br> | <b>Application/Control No.</b><br>14488106 | <b>Applicant(s)/Patent Under Reexamination</b><br>HUANG, HSIN-HSUAN |  |
|                                                                                                                 | <b>Examiner</b><br>WILLIAM R ALEXANDER     | <b>Art Unit</b><br>2872                                             |  |

| CPC    |  |    |   |      |      |            |
|--------|--|----|---|------|------|------------|
| Symbol |  |    |   |      | Type | Version    |
| G02B   |  | 13 | / | 0045 | F    | 2013-01-01 |
| G02B   |  | 9  | / | 64   | I    | 2013-01-01 |
| G02B   |  | 13 | / | 002  | I    | 2013-01-01 |
| G02B   |  | 9  | / | 00   | I    | 2013-01-01 |
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| CPC Combination Sets |      |     |         |         |
|----------------------|------|-----|---------|---------|
| Symbol               | Type | Set | Ranking | Version |
|                      |      |     |         |         |
|                      |      |     |         |         |

|                                                                                     |                          |                                        |                            |
|-------------------------------------------------------------------------------------|--------------------------|----------------------------------------|----------------------------|
| /WILLIAM R ALEXANDER/<br>Examiner.Art Unit 2872<br><br>(Assistant Examiner)         | 02/02/2016<br><br>(Date) | <b>Total Claims Allowed:</b><br><br>34 |                            |
| /BUMSUK WON/<br>Supervisory Patent Examiner.Art Unit 2872<br><br>(Primary Examiner) | 02/09/2016<br><br>(Date) | O.G. Print Claim(s)<br><br>1           | O.G. Print Figure<br><br>1 |



|                                                                                                                 |                                            |                                                                     |
|-----------------------------------------------------------------------------------------------------------------|--------------------------------------------|---------------------------------------------------------------------|
| <b>Issue Classification</b><br> | <b>Application/Control No.</b><br>14488106 | <b>Applicant(s)/Patent Under Reexamination</b><br>HUANG, HSIN-HSUAN |
|                                                                                                                 | <b>Examiner</b><br>WILLIAM R ALEXANDER     | <b>Art Unit</b><br>2872                                             |

| <input 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 |
| 1                                                                                      | 1        | 13    | 17       | 28    | 33       |       |          |       |          |       |          |       |          |       |          |
| 2                                                                                      | 2        | 14    | 18       | 29    | 34       |       |          |       |          |       |          |       |          |       |          |
|                                                                                        | 3        | 15    | 19       | 30    | 35       |       |          |       |          |       |          |       |          |       |          |
|                                                                                        | 4        | 16    | 20       | 31    | 36       |       |          |       |          |       |          |       |          |       |          |
| 3                                                                                      | 5        | 17    | 21       | 32    | 37       |       |          |       |          |       |          |       |          |       |          |
| 4                                                                                      | 6        | 18    | 22       | 33    | 38       |       |          |       |          |       |          |       |          |       |          |
|                                                                                        | 7        | 19    | 23       | 34    | 39       |       |          |       |          |       |          |       |          |       |          |
| 5                                                                                      | 8        | 20    | 24       |       |          |       |          |       |          |       |          |       |          |       |          |
| 6                                                                                      | 9        | 21    | 25       |       |          |       |          |       |          |       |          |       |          |       |          |
| 7                                                                                      | 10       |       | 26       |       |          |       |          |       |          |       |          |       |          |       |          |
| 8                                                                                      | 11       | 22    | 27       |       |          |       |          |       |          |       |          |       |          |       |          |
| 9                                                                                      | 12       | 23    | 28       |       |          |       |          |       |          |       |          |       |          |       |          |
| 10                                                                                     | 13       | 24    | 29       |       |          |       |          |       |          |       |          |       |          |       |          |
| 11                                                                                     | 14       | 25    | 30       |       |          |       |          |       |          |       |          |       |          |       |          |
| 12                                                                                     | 15       | 26    | 31       |       |          |       |          |       |          |       |          |       |          |       |          |
|                                                                                        | 16       | 27    | 32       |       |          |       |          |       |          |       |          |       |          |       |          |

|                                                           |            |                                    |                   |
|-----------------------------------------------------------|------------|------------------------------------|-------------------|
| /WILLIAM R ALEXANDER/<br>Examiner.Art Unit 2872           | 02/02/2016 | <b>Total Claims Allowed:</b><br>34 |                   |
| (Assistant Examiner)                                      | (Date)     |                                    |                   |
| /BUMSUK WON/<br>Supervisory Patent Examiner.Art Unit 2872 | 02/09/2016 | O.G. Print Claim(s)                | O.G. Print Figure |
| (Primary Examiner)                                        | (Date)     | 1                                  | 1                 |



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## BIB DATA SHEET

CONFIRMATION NO. 2225

|                                                                                                                                                                                                                                                                                                                   |                                                                                                                   |                                   |                                                                                                                                                                                                                                                                           |                                              |                                |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|--------------------------------|
| <b>SERIAL NUMBER</b><br>14/488,106                                                                                                                                                                                                                                                                                | <b>FILING or 371(c) DATE</b><br>09/16/2014<br><b>RULE</b>                                                         | <b>CLASS</b><br>359               | <b>GROUP ART UNIT</b><br>2872                                                                                                                                                                                                                                             | <b>ATTORNEY DOCKET NO.</b><br>0115042.018US2 |                                |
| <b>APPLICANTS</b><br>LARGAN Precision Co., Ltd., Taichung, TAIWAN;<br><b>INVENTORS</b><br>Hsin-Hsuan HUANG, Taichung, TAIWAN;<br><b>** CONTINUING DATA *****</b><br><b>** FOREIGN APPLICATIONS *****</b><br>TAIWAN 103126480 08/01/2014<br><b>** IF REQUIRED, FOREIGN FILING LICENSE GRANTED **</b><br>09/22/2014 |                                                                                                                   |                                   |                                                                                                                                                                                                                                                                           |                                              |                                |
| Foreign Priority claimed <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No<br>35 USC 119(a-d) conditions met <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No<br>Verified and /WILLIAM R<br>ALEXANDER/<br>Acknowledged Examiner's Signature                                  | <input type="checkbox"/> Met after Allowance<br>Initials                                                          | <b>STATE OR COUNTRY</b><br>TAIWAN | <b>SHEETS DRAWINGS</b><br>29                                                                                                                                                                                                                                              | <b>TOTAL CLAIMS</b><br>33 34                 | <b>INDEPENDENT CLAIMS</b><br>2 |
| <b>ADDRESS</b><br>Locke Lord LLP<br>P.O. BOX 55874<br>BOSTON, MA 02205<br>UNITED STATES                                                                                                                                                                                                                           |                                                                                                                   |                                   |                                                                                                                                                                                                                                                                           |                                              |                                |
| <b>TITLE</b><br>PHOTOGRAPHING OPTICAL LENS ASSEMBLY, IMAGE CAPTURING UNIT AND ELECTRONIC DEVICE                                                                                                                                                                                                                   |                                                                                                                   |                                   |                                                                                                                                                                                                                                                                           |                                              |                                |
| <b>FILING FEE RECEIVED</b><br>3120                                                                                                                                                                                                                                                                                | FEES: Authority has been given in Paper<br>No. _____ to charge/credit DEPOSIT ACCOUNT<br>No. _____ for following: |                                   | <input type="checkbox"/> All Fees<br><input type="checkbox"/> 1.16 Fees (Filing)<br><input type="checkbox"/> 1.17 Fees (Processing Ext. of time)<br><input type="checkbox"/> 1.18 Fees (Issue)<br><input type="checkbox"/> Other _____<br><input type="checkbox"/> Credit |                                              |                                |

|                                                                                                              |                                                |                                                                         |
|--------------------------------------------------------------------------------------------------------------|------------------------------------------------|-------------------------------------------------------------------------|
| <b>Search Notes</b><br><br> | <b>Application/Control No.</b><br><br>14488106 | <b>Applicant(s)/Patent Under Reexamination</b><br><br>HUANG, HSIN-HSUAN |
|                                                                                                              | <b>Examiner</b><br><br>WILLIAM R ALEXANDER     | <b>Art Unit</b><br><br>2872                                             |

| CPC- SEARCHED    |           |          |
|------------------|-----------|----------|
| Symbol           | Date      | Examiner |
| G02B13/002, 0045 | 10/8/2015 | WA       |
| G02B9/00, 64     | 10/8/2015 | WA       |
| Updated          | 2/2/2016  | WA       |

| CPC COMBINATION SETS - SEARCHED |      |          |
|---------------------------------|------|----------|
| Symbol                          | Date | Examiner |
|                                 |      |          |

| US CLASSIFICATION SEARCHED |                         |           |          |
|----------------------------|-------------------------|-----------|----------|
| Class                      | Subclass                | Date      | Examiner |
| 359                        | 682, 708, 713, 754, 755 | 10/8/2015 | WA       |
|                            | Updated                 | 2/2/2016  | WA       |

| SEARCH NOTES                                                                                                                         |           |          |
|--------------------------------------------------------------------------------------------------------------------------------------|-----------|----------|
| Search Notes                                                                                                                         | Date      | Examiner |
| CPC: G02B13/002, 0045, G02B9/00, 64, USPC: 359/682, 708, 713, 754, 755. Classification and Text Search. See Search history printout. | 10/8/2015 | WA       |
| East Search-Text Search. See Search History Printout.                                                                                | 10/8/2015 | WA       |
| Inventor Search-See Search History Printout.                                                                                         | 10/8/2015 | WA       |
| Consulted with Zach Wilkes regarding search and rejections.                                                                          | 10/8/2015 | WA       |
| Updated                                                                                                                              | 2/2/2016  | WA       |

| INTERFERENCE SEARCH     |                                                                      |          |          |
|-------------------------|----------------------------------------------------------------------|----------|----------|
| US Class/<br>CPC Symbol | US Subclass / CPC Group                                              | Date     | Examiner |
|                         | PGPub/USPAT text search. 2/2/2016, see interference search printout. | 2/2/2016 | WA       |

|                                                 |  |
|-------------------------------------------------|--|
| /WILLIAM R ALEXANDER/<br>Examiner.Art Unit 2872 |  |
|-------------------------------------------------|--|

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21874 7590 02/16/2016  
**Locke Lord LLP**  
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| (Depositor's name) |
| (Signature)        |
| (Date)             |

| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|-----------------|-------------|----------------------|---------------------|------------------|
| 14/488,106      | 09/16/2014  | Hsin-Hsuan HUANG     | 0115042.018US2      | 2225             |

TITLE OF INVENTION: PHOTOGRAPHING OPTICAL LENS ASSEMBLY, IMAGE CAPTURING UNIT AND ELECTRONIC DEVICE

| 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            | 05/16/2016 |

| EXAMINER             | ART UNIT | CLASS-SUBCLASS |
|----------------------|----------|----------------|
| ALEXANDER, WILLIAM R | 2872     | 359-708000     |

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

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2. For printing on the patent front page, list

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1 Locke Lord LLP

2 Tim Tingkang Xia, Esq.

3 \_\_\_\_\_

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.

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(B) RESIDENCE: (CITY and STATE OR COUNTRY)

**LARGAN PRECISION CO., LTD.**

**TAICHUNG, TAIWAN**

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☒ Corporation or other private group entity ☐ Government

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- ☐ Applicant changing to regular undiscounted fee status.

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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 Tingkang Xia/

Typed or printed name Tim Tingkang Xia

Date May 13, 2016

Registration No. 45242

## Electronic Patent Application Fee Transmittal

|                                                    |                                                                                 |                 |               |                             |
|----------------------------------------------------|---------------------------------------------------------------------------------|-----------------|---------------|-----------------------------|
| <b>Application Number:</b>                         | 14488106                                                                        |                 |               |                             |
| <b>Filing Date:</b>                                | 16-Sep-2014                                                                     |                 |               |                             |
| <b>Title of Invention:</b>                         | PHOTOGRAPHING OPTICAL LENS ASSEMBLY, IMAGE CAPTURING UNIT AND ELECTRONIC DEVICE |                 |               |                             |
| <b>First Named Inventor/Applicant Name:</b>        | Hsin-Hsuan HUANG                                                                |                 |               |                             |
| <b>Filer:</b>                                      | Tim Tingkang Xia/Debby Yew                                                      |                 |               |                             |
| <b>Attorney Docket Number:</b>                     | 0115042.018US2                                                                  |                 |               |                             |
| Filed as Large Entity                              |                                                                                 |                 |               |                             |
| <b>Filing Fees for Utility under 35 USC 111(a)</b> |                                                                                 |                 |               |                             |
| <b>Description</b>                                 | <b>Fee Code</b>                                                                 | <b>Quantity</b> | <b>Amount</b> | <b>Sub-Total in USD(\$)</b> |
| <b>Basic Filing:</b>                               |                                                                                 |                 |               |                             |
| <b>Pages:</b>                                      |                                                                                 |                 |               |                             |
| <b>Claims:</b>                                     |                                                                                 |                 |               |                             |
| <b>Miscellaneous-Filing:</b>                       |                                                                                 |                 |               |                             |
| Publ. Fee- Early, Voluntary, or Normal             | 1504                                                                            | 1               | 0             | 0                           |
| <b>Petition:</b>                                   |                                                                                 |                 |               |                             |
| <b>Patent-Appeals-and-Interference:</b>            |                                                                                 |                 |               |                             |
| <b>Post-Allowance-and-Post-Issuance:</b>           |                                                                                 |                 |               |                             |

| Description            | Fee Code | Quantity | Amount | Sub-Total in USD(\$) |
|------------------------|----------|----------|--------|----------------------|
| Utility Appl Issue Fee | 1501     | 1        | 960    | 960                  |
| Extension-of-Time:     |          |          |        |                      |
| Miscellaneous:         |          |          |        |                      |
| Total in USD (\$)      |          |          |        | 960                  |

## Electronic Acknowledgement Receipt

|                                             |                                                                                 |
|---------------------------------------------|---------------------------------------------------------------------------------|
| <b>EFS ID:</b>                              | 25769939                                                                        |
| <b>Application Number:</b>                  | 14488106                                                                        |
| <b>International Application Number:</b>    |                                                                                 |
| <b>Confirmation Number:</b>                 | 2225                                                                            |
| <b>Title of Invention:</b>                  | PHOTOGRAPHING OPTICAL LENS ASSEMBLY, IMAGE CAPTURING UNIT AND ELECTRONIC DEVICE |
| <b>First Named Inventor/Applicant Name:</b> | Hsin-Hsuan HUANG                                                                |
| <b>Customer Number:</b>                     | 21874                                                                           |
| <b>Filer:</b>                               | Tim Tingkang Xia/Debby Yew                                                      |
| <b>Filer Authorized By:</b>                 | Tim Tingkang Xia                                                                |
| <b>Attorney Docket Number:</b>              | 0115042.018US2                                                                  |
| <b>Receipt Date:</b>                        | 13-MAY-2016                                                                     |
| <b>Filing Date:</b>                         | 16-SEP-2014                                                                     |
| <b>Time Stamp:</b>                          | 11:22:48                                                                        |
| <b>Application Type:</b>                    | Utility under 35 USC 111(a)                                                     |

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|                                          |                 |
|------------------------------------------|-----------------|
| Submitted with Payment                   | yes             |
| Payment Type                             | Deposit Account |
| Payment was successfully received in RAM | \$960           |
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|-----------------|-----------------------------|-------------------------|----------------------------------------------|------------------|------------------|
| 1               | Issue Fee Payment (PTO-85B) | 011504210018IFTrans.pdf | 134399                                       | no               | 1                |
|                 |                             |                         | b332bdd176a9a5687ab2653a4ad2d38bbb<br>cfe323 |                  |                  |

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### Information:

|   |                      |              |                                              |    |   |
|---|----------------------|--------------|----------------------------------------------|----|---|
| 2 | Fee Worksheet (SB06) | fee-info.pdf | 32619                                        | no | 2 |
|   |                      |              | c3067c1f51df275eaa401c5133895ef0f9d35<br>738 |    |   |

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### 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.**



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| APPLICATION NO. | ISSUE DATE | PATENT NO. | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|-----------------|------------|------------|---------------------|------------------|
| 14/488,106      | 06/14/2016 | 9366845    | 0115042.018US2      | 2225             |

21874 7590 05/25/2016  
Locke Lord LLP  
P.O. BOX 55874  
BOSTON, MA 02205

## 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):

Hsin-Hsuan HUANG, Taichung, TAIWAN;  
LARGAN Precision Co., Ltd., Taichung, TAIWAN;

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