MD Lenses

Instructions for Servicing

April 1. 1979

General Information about Lenses

Index

Aberration

Because a lens is spherical, it has some inherent factors that affect image formation. Such factors are known as aberrations. The classification worked out by Seidel in 1956 is still used today. It contains five aberrations as follow:

(1) Spherical aberration
(2) Non-point aberration
(3) Comatic aberration
(4) Curvature of field
(5) Distortion aberration

All the above are caused by the spherical surfac of the lens, and are sometimes called spherical aberration in a wide sense of the meaning.
A sheet of glass is not spherical but has a characteristic that diffuses white light into colored light. Therefore, glass has six aberration types when color aberration is added to the above.

o Spherical aberration
Spherical aberration occurs when light from a point on the optical axis passes through the marginal area of the lens and is subsequetly focused nearer the lens than light passing through the center.

o Non-point aberration
Light from a point of the subject outside the optical axis passes through the lens and is not focused at a point thereafter but become a short line extended in a certain direction.

o Comatic aberration
This can be regarded as a spherical aberration outside the axis. Light from a point outside the axis passes through the lens and is not focused at a point thereafter but is accompanied by blur running comatically.

o Curvature of field
The picture of a subject on a plane vertical to the optical axis is to be formed on a plane vertical to the optical axis. However, the image is formed on a curved surface being bent on the lens side (then the marginal area of the image is blurred on the image forming side).

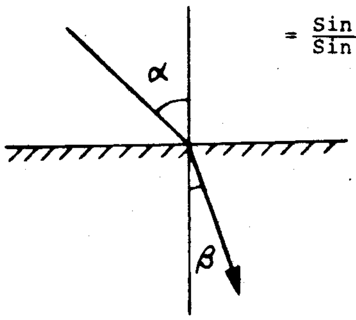
o Distortion aberration
The shape of the subject is not analogous to the shape of the image. It is barrel-like or spindle-like shaped depending on the lens composition.

o Color aberration
The same as a white light is diffused into colored light by prism, also in the case of lens, the focal plane differs with different refractive indexes of the colored light, and the distance to the focal point of purple light of strong refraction is short and that of red light or weak refraction is long, thus causing imge blurring. This is called color aberration on optical axis. Also, the size of image varies due to colored light because the position of principal point varies depending on the refractive indexes. This is called color aberration of magnification.

In order to compensate for these averrations, various combinations of lenses of different refraction and diffusion are emplyoed. However, it is impossible to completely eliminate such aberrations, and those aberrations that cannot be rectified are called residual aberrations.

Amber coating

The purpose of amber coating is to reduce reflected light and adjust the color balance. When the number of reflection surface of glass is m, the transmission factor is 0.95^m (5% reflection per surface). Therefore, the transmitted light will be greatly reduced when many lenses are used. For wave length λ_o it is theoretically possible to achieve zero reflection by coating the surface with a $\lambda_o/4$ thick coating of a substance whose refractive index is $\sqrt{ng}$ when the refractive index of the glass is ng. This is an ideal anti-reflection coating.



Refractive index $= \frac{\sin\alpha}{\sin\beta}$

Eg.) To reduce the yellow light reflection of d ray (587.6mμ) of helium (he) entering the glass (refractive index ng=1.69), can be reduced to zero by coating the surface with a substance whose refractive index of $\sqrt{1.69}=1.3$by d= 587.6/1.3x4=112 mμ thickness. However, it is practically impossible to find a substance whose refractive index is 1.3, and the refractive index of MgF_2 usually used is 1.38 to 1.40, which is not enough to produce zero reflection. Suitable substances are limited by various factors such as film strength, hardness, uniformity, etc.

Ultraviolet ray ⟵ Visible rays ⟶ Infrared ray

Purple   Indigo   Blue   Green   Yellow   Orange   Red

The refractive index of light varies depending on the light color. Therefore, the color must be specified when referring to refractive index. Usually, D ray of naturim (Na) is employed.

Eg.) D ray (Na) 589.3mμ

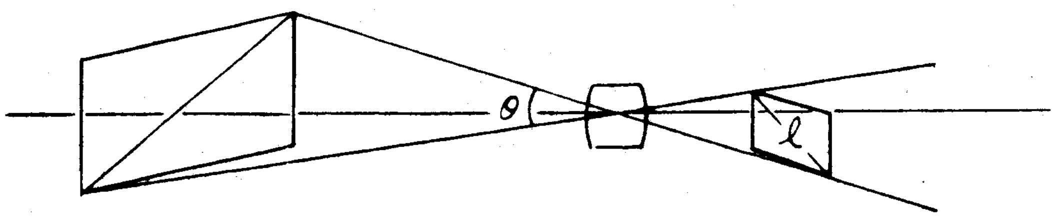
d ray (He) 587.6mμ

Coating and film thickness

Film color	Coating	Film thickness
Amber	Amber	115mμ
Red purple	Purple	126mμ
Blue purple	Magenta	138mμ

Angle of view (picture taking angle)

This is an angle of photographing with lens set at infinity. Generally, it is the angle viewed from the optical center (the 2nd principal point) of lens in the direction of the diagonal line of the picture.
Also, a lens whose focal length is nearly the same as the length of the diagonal line is called a standard lens. (f=43mm, θ=53deg. in 35mm type)



The angle of view is also called a picture taking angle that is different from an inclusive angle. The relations among picture size, focal length and angle of view are shown below.

f (mm)	Angle of view (θ)	f (mm)	Angle of view (θ)
20	94.5	135	18.2
28	75.4	150	16.4
35	63.4	200	12.3
40	56.8	300	8.2
45	51.4	400	6.2
50	46.8	500	5.0
75	32.2	600	4.1
85	28.6	800	3.1
100	24.4	1000	1.6

Calculation formula $\theta = 2\tan^{-1} \ell/2f$

◆ Canada balsam

This pale yellow resin is taken from certain pine trees in Canada and North America. The refraction factor of this resin is nearly the same as that of optical glass and haveing a high adhesive power it is widely used for lenses and filters.

◆ Clearness

This is somrtimes called "sharp cut". Definition of the meaning is difficult because of the problem of subjectivity. It cannot be represented quantitatively. The picture must be clear and sharp as well as being well focused.

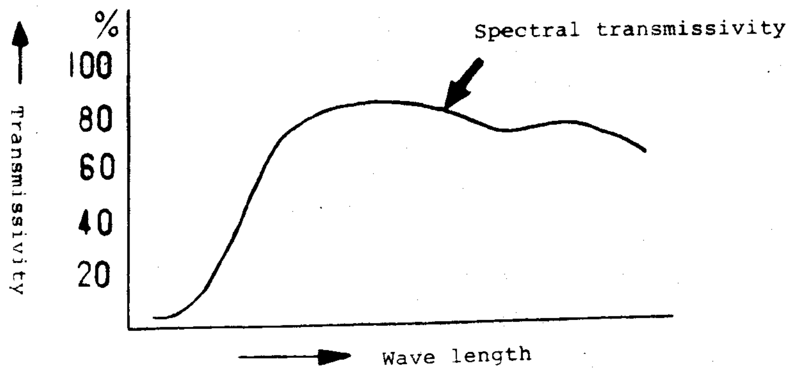
◆ Collimator

This device is used for optical measurements of lenses, and to artificially produce infinite bundles of rays.

◆ Color contribution

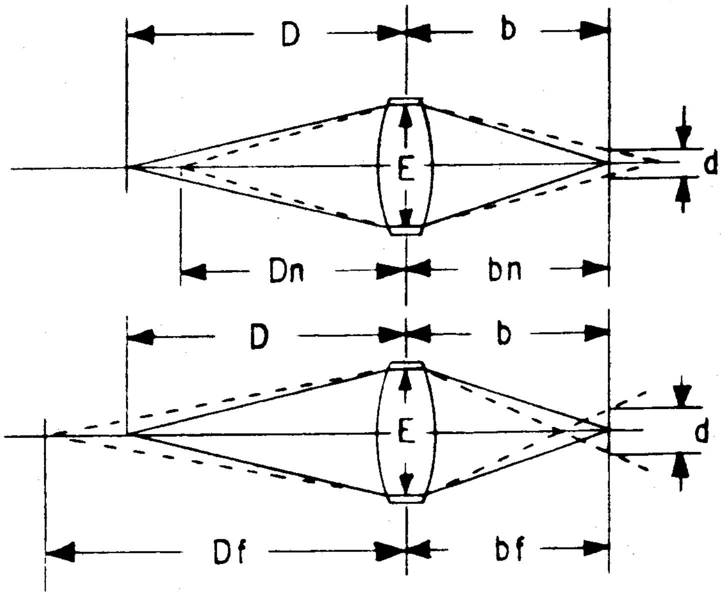
ASA PH3-37-1969 shows the calculation and indication methods for color characteristic of photographic lens for color film.

The B-G-R ratio is calcuted and numerically indicated by multiplying the spectral transmission factor of photographic lens by the weight based on the photosensitivity of color film. In Minolta, the standard ratio is 9-0-1 for kodak film. With large E values, the color is yellowish, and with small values, blueish.



Depth of subject sphere

When the lens is focused on a subject, the focusing is maintained in a certain range even if the subject is shifted back and forth. This range is called the depth of subject sphere.



Front subject sphere depth formula
$Dn = Df^2/f^2 + DdF$

Rear subject shere depth formula
$Df = Df^2/f^2 - DdF$

(a) Subject sphere depth is less with greater F value.
(b) Subject sphere depth is less with larger f value.
(c) Subject sphere depth is less at shorter distance.
(d) Subject sphere depth is less on front (camera side) and greater on the rear as viewed from the focused point.

Diffraction of light

This is a turbulence phenomenon occuring when light passes over the edge of the obstruction in the light passage. This phenomenon is common to all types of waves (sound, water and light waves). If a wave meets an obstruction it will pass over and swirl around at the back. This is a diffractive effect.

The diffraction of light occurs when the light passes through a very narrow space. When a spot light passes through a small hole, the projected image is bright at the center and surrounded by a ring pattern.
The apertures of wide angle lenes are provided with F value up to 16 or so to avoid the influence of light diffraction.

EV

Initials of Exposure Value
EV is a combonation of aperture and shutter, and EV value in the degree of exposure control represented in the from of index, but it is not the unit of brightness.
According to the APEX (Additive system of Photographic Exposure), the relationship between aperture and shutter speed is as follows:

TV: (Time Value) : represents the effective exposure time of shutter Formula $2^{TV}=1/T$ corresponds to conventional shutter exposure time (T).

AV (Aperture Value) : represents F number. Formula $2^{AV}=A^2$ corresponds to conventional F number (A).

EV (Exposure Value) : represents the degree of exposure. The relation between TV and AV is as follows:
$2^{EV}=A^2/T$ EV=TV+AV

F number

F number represent the luminosity stages of lenes. The luminosity is shown by value (f/D), attained by dividing focal distance (f) by effective diameter(D). It is usually shown by aperture ratio (ratio of effective diameter and focal distance). F number value is a geometric progression where $\sqrt{2}$ is common ratio.
$(\sqrt{2})^0=1$, $(\sqrt{2})^1=1.4$, $(\sqrt{2})^2=2$, $(\sqrt{2})^3=2.8$, $(\sqrt{2})^4=4$.....

(T number)

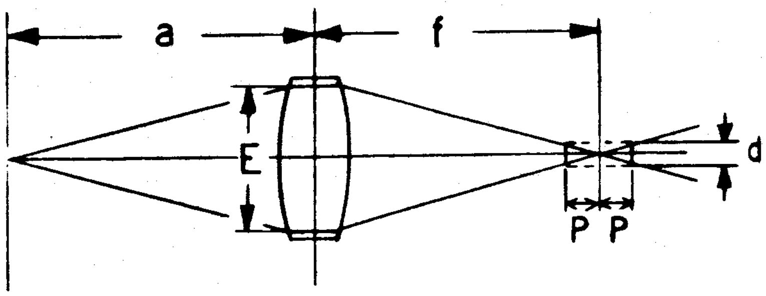
F numbers are also dependent on the transmission factor of the lens. For example, when many lenses are used, as for zoom lenses, the F number indication differs from the actual luminosity. The real luminosity (effective F number) of the lens is obatined by subtracting the amount of light reduced due to reflection from the F number, that is T number.

f'F (Flange back)

Flange back is the distance from the flange of lens to the focal surface. It is necessary to rebulate this diatance sine a single reflex camera measures the distance by forming the image on the recicle, using a reflection mirror. Therefore focusing with the finder does not produce focusing on the film unless VB (finder back) is matched with f'F (these are not always matched with each other because of aberration).

Focal depth

When the lens is focused on a subjct at a certain distance, there is a range in which the image can be regarded as being clear and sharp when the subject is caught on the focal plane. This range is called focal depth. The permissable range varies depending on how the allowable turbulence circle is used, and the method varies depending on the size of image and the magnification. Usually, it ranges from d/1000 to d/1500, and the standard point in Minolta is d/1300. (d: length of diagonal line on image)



P: focal depth
The focal depth is 2P as illustrated. P can be obtained fromula of dF. Therefore, P is proportional to F number with d determined.

(a) Focal depth is equal on both front and rear of the focal surface.
(b) Focal depth has no relation to the focal length.
(c) Focal depth is proportional to F number, and increases as the aperture is reduced.

Ghost

When an extremely strong light enters the lens, it reaches the image through internal reflection. This phenomenon is called "ghost". This can be considered as a kind of flare, but sometimes occurs in the form of spot or small mark. It can be considerably reduced by coating but cannot be completely eliminated. Reflection occurs not only on the lens surface but on the periphery, internal surfaces of metal parts, diaphragm, etc. Accordingly, a picture of a pure balck subject is not always completely black and a red subject may sometimes include a slight blue fog. Optical flare (halo) due to residual aberration is completely different from this phenomenon. The user must be careful not to confuse the two. Recently, with the increase in color photography it is desirable that the balance of B-G R be maintained for flare light as well. Flare facror is the quantity of flare represented by %. Theoretically, it is the illuminance ratio between a black body whose luminance is zero and an object whose luminance is In.

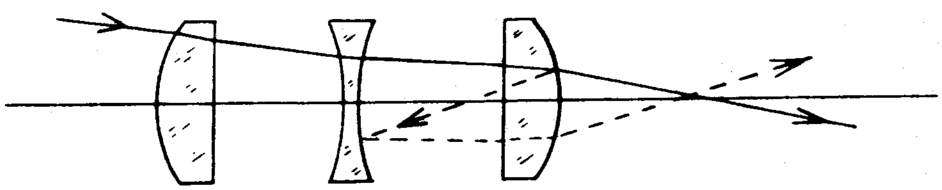


Image point movement

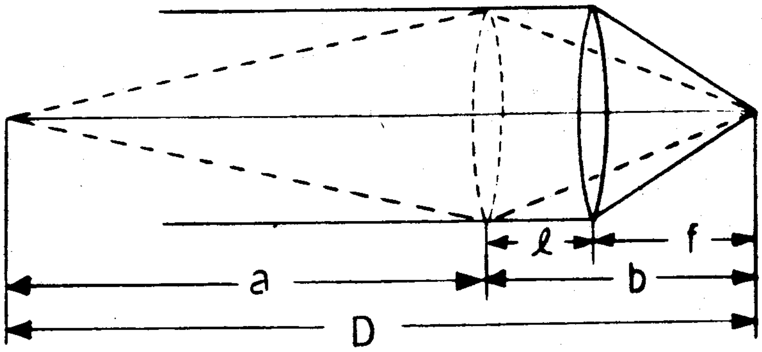
Ideally speaking, the image foeming point of the lens should be constant irrespective of diaphragm or the focal lengthof zoom lenes. Actually, however, the best image point may sometimes be deflected due to the residual aberration. Such movement is called image point movement due to aperture charges or zooming. Single reflex using open photometering or enlarging lenses are liable to be affected by image point movement.

Minimum turbulence circle and allowable turbulence circle

When spherical aberration occurs in the lens, light from certain points of the subject is not correctly formed on the focal place and is accompanied with circular blur. Shifting the image in the direction of the optical axis change the size of the blur. The point where the blur is minimal is called a minimum turbulence circle. Actually, a small blur equivalent to such a minimum turbulence circle appears as a spot can be considered as the image point. Apart from this, the particular size at which the turbulence circle can be regqrded as a spot is called an allowable turbulence circle, which is required to obtain depth, etc. but it should not be confused with the minimum turbulence circle.

Movement of lens

When a lens it set at infinity this is the degree of movement required to shift the lens forwards in order to focus on a subject near the camera. The longer the focal length, the greater the amount of movement. For taking pictures of subjects very near the camera, a bellows and close contact ring are to be used.



$$\frac{1}{a} + \frac{1}{b} = \frac{1}{f} \longrightarrow b = \frac{af}{a-f} \text{ --- } (1)$$

The movement of lens is $\frac{f2}{a-f}$ putting $\ell = b-f$ into formula (1).

ND filter

There are five types of filter:

- Sharp cut filter
- Color temperature conversion filter
- Color correction filter
- ND filter
- Polarized filter

1) Sharp cut filter
This is used to cut rays below a certain wave length to contrast or stree the image. For example, a Y48 filter is used to cut wave lengths of 480 mμ or less.

2) Color temperature conversion filter (Light balancing filter)
This is used to adjust color temperature by absorbing part of the wave length to change the color temperature. (Color temperature is discussed later.)

3) Color compensating filter

For example, fluorescent light includes luminance rays that neigher human eyes nor photometers can detect, and color temperature compensation is not enougn to prevent photo taken in fluorescent light from turning out greenish because of this ray. This filter is used to compensate for this effect.

4) Neutral density filter
This filter is used to reduce the amount of light uniformly. This is usually used for light interusity control of high sensitive film and EE camera or for the light internsity adjustment of reflex telephoto lens.

5) Polarized filter
When a tennis ball is thrown against a wall, it flattens on impact. A similar phenomenon takes place when light is reflect on an object surface. This is called polarization. A polarized filter is intended to cut the polarization of the light. This type of filter is used for taking pictures of fish in water or objects in show windows at an angle.

(Color temperature)
°K indicates color temperature. For example, if an entirely black body of 100% light absorption factor is heated, the color gradually turns from red to yellow and finally blue. When the temperature reaches 2,800 degrees, the color becomes the same as a tungsten light. When the temperature is about 7,000 degrees, the color quality becomes almost equaly to that of light under a cloudy sky. Therefore, the color temperature under a cloudy sky is 7,000 C. Film is designed so that optimum color balance is possible at any color temperature (usually 5,800 K for day light, 2,850°K for tungsten), but because color temperature constantly very, a light balancing filter is required.

(Note)
Since °K is an absolute temperature,color temperature 6,000°K is equivalent to the illumination of a black body at 5,727 C.

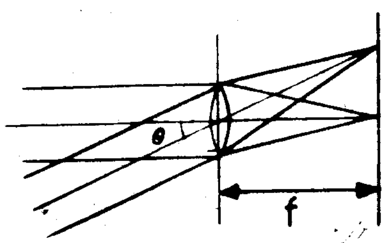
Non-spherical lens

It is common knowledge that a lens is spherical. Because it is spherical, its curvature is the same at both the center and at the edges, giving rise to the problem of unrectifiable aberrations. If it is possible to make the curvature at the marginal area more moderate, the characteristics of lens will be greatly improved. A lens whose curvature at the center is different from that at the marginal area is called a non-spherical lens. This type of lens can be designed but is not suited for massproduction and still very expensive. Therefore, it is not widely employed today.

Opening efficiency

This value represents the lens characteristic that indicates the deficiency rate of marginal light intensity. Parallel rays entering the lens at an angle are smaller in sectional area, vertical to the optical axis, than reys entering the lens in parallel with the optical axis. This area ratio, represented by perventage, is Opening efficiency.

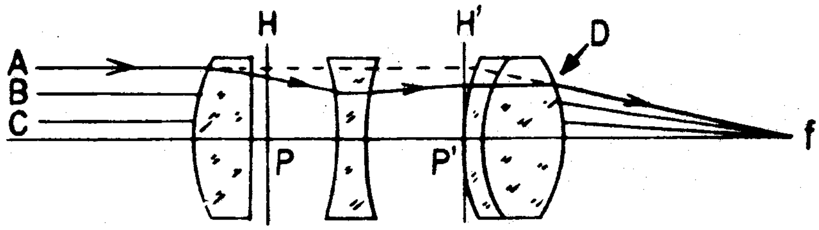
(Cosine 4th power rule)



1) Light entering at angle θ is cos θ times less than the light on the optical axis as explained above.
2) Distance from the lens to the film is reciprocally cos 0 times longer than length f (f x 1/cos θ). Brightness is $\cos^2\theta$ less because it is in reverse proportion to squared distance.

3) Since the light meets the film at an angle the light internsity per unit area is reduced cos θ times. Also, it is reduced by $\cos^4\theta$ times in brightness. This is called the cosine fourth power rule.

Principal point and focal length



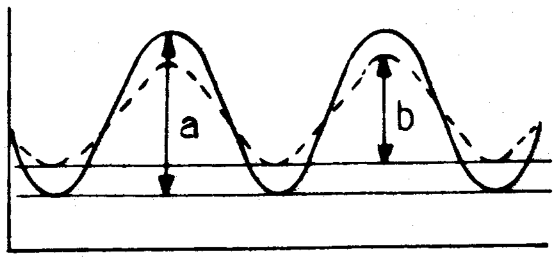
The light entering the lens in parallel to the optical axis is refracted many times and finally focused when passing from lens surface D to f. The intersection between extentions of fD and A is H'. Then it can be considered that line A is refracted at point H' and goes to f. Drop a perpendicular from H8 to the optical axis and suppose its intersection with the optical axis is P'. In this case you may assume that B and C as well as A are refreacted on line H'P' and then forward to f. Contrarily, the same holds true, even when the light comes from the image side. In this case, they may seem to be refracted on line HP. P ¡s the first principal point, and P' the second principal point. HP is the first principal surface and H' the second principal surface. Focal length is the distance from the second principal surface to f. In cidentally, principal surfaces do not always exist within the lens system.

Resolving power

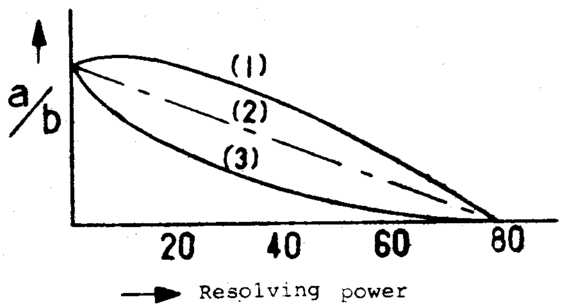
This is a representative value to indicate the portraying power of a photographic lens, that is, the ability of lens in terms of fineness of picture. When a 1mm wide chart carrying 30 stripes of white and black lines is photographed with one magnification by using a lens, and if the 30 line are clearly observed in the picture, the projection resolving power of the lens is at least 30 lines. This is shown by euation R=1/mP. (R=resolving power, m=magnification, P=pitch of stripes). Available methods of resolving power measurement include the photographing method, projection method, aerial method, etc. Comparison cannot be made using only the announced values of resolution. Also, it is impractical to use a resolving power as the representative value to indicate the protrying characteristic of a lens, thus the so-called response funciton, that takes the luminance distribution of the subject into consideration, has been adopted.

(Response function)

Sometimes the sharpest subjects look soft when viewed through a lens. This phenomenon is called response. Mathematically, when a varies depending on b, a is the funciton of b. That is, response function is a means to represent the state of change of a reproducing reaction. The figure below illustrates such a change using a chart which includes the change of concentration in the form of sine waves.



When a chart, with a concentration difference as shown by the solid line,is reproduced through a lens, shown by the dotted line, the contrast of the image is reduced to b/a although the resolving power remains unchanged. Next, as the chart pitch gradually narrows, the difference between the maximum and minimum concentratins of the image becomes zero, and finally the whole image becomes gray. In this way, the b/a for each frequency can be graphed as follows.



b/a becomes 0 at the same point, but the behavior of intermediate frequencies is different:
(1) is contrast tyep
(3) is resoltuion type

Tilt

This is generally called one-sided blur. At a certain image height (e.g.y'=18mm), turn the lens until the image is totally out of focus. Tilt is the difference between this point and that 180 degrees opposite. The amount of allowable tilt is closely related with the allowable turbulence circle. In a lens of F1.4 calss, the desirable amount is about 0.1mm or less.

SLR Lens Projection Resolving Power Inspections

Index

1 Purpose of projecting resolving power inspection

The projection resolving power inspections based upon the values of projection resolving power that the Service Department regards necessary, are intended to check that the optical performances of repair lenses meet the users' requirements. Accordingly, the values of projection resolving power classified by the grop of products mentioned on page 10 are the standard values to be used for the checks during servicing.

2 Model subjected to projection resolving power inspections

The models for inspection are shown in the table on page 10 (paragraph of subject models). Also, the necessity of projection inspection is specified in the lens parts list of subject medels. Thlephoto lenses whose focal distance f=85mm or over are omitted bacause of the small photography angles and their minimal influence on resolving power.

* Lens parts list

This has been prepared as an additional parts list because opticla parts have only been included in the repair parts group since the start of full servicing for MD lens.

3 Projection resolving power inspection procedure

Instruments required

- Darkroom: If a darkroom is not available, use as dark a room as possible.
- Screen: Art paper (788x1091mm)
- Tape measure: 5m measure (for projection distance measuring)
- Plane mirror: Use a mirror for single reflex camera.
- Single reflex body back gauge: Back gauge usually used for SR body.

Preparations

1. Set the projector mount (flange position) 43.60±0.05mm (recommended) from the chart.

   (1) Turn the mount moving ring until it stops. (Then the distance from mount position to chart position is 43.50mm.)

   (2) Rotate the mount moving ring to protrude the mount by 1/10 turn. (The mount then protrudes 0.1mm as the ring thread pitch is 1mm.)

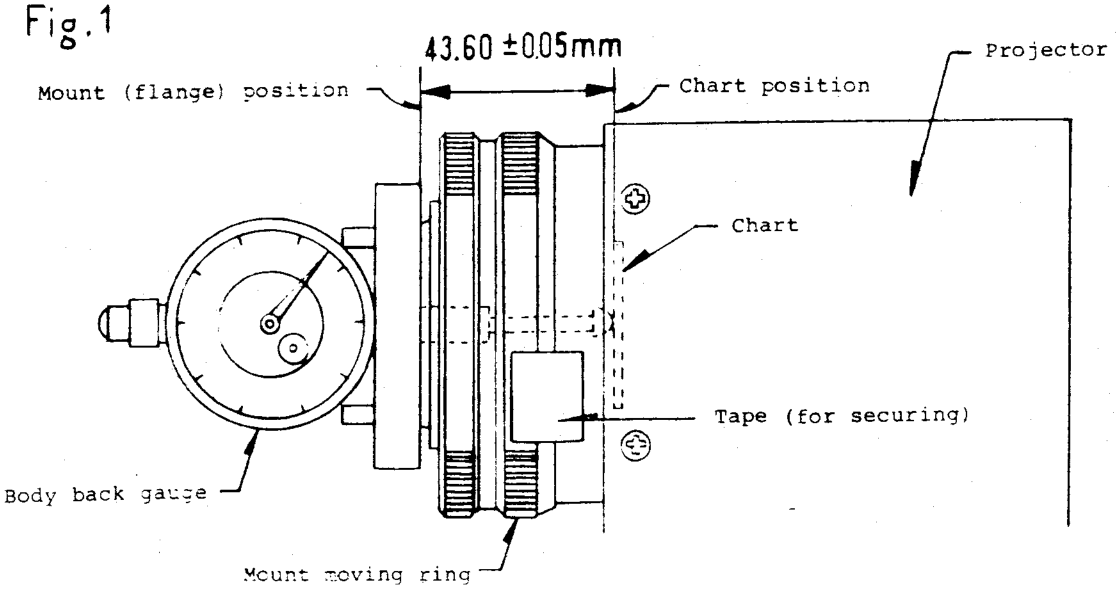
   (3) Measure the distance from the mount (flange position) to the chart position with a single reflex body back gauge as shown in Fig.1. (Caution) Do not move the gauge during the measurement. Otherwise the chart glass surface may be scratched. Avoid measuring on the resolving power chart.

   (4) Calculate the difference between the measured value and 43.60mm. Measured value minus 43.60mm is the amount of adjustment. If the amount is plus, turn the mount moving ring to decrease the said distance, and if it is minus, turn the ring to protrude the mount.

   (5) Repeat the operations in (3) and (4) until the distance between the mount (flange) position and the chart position is 43.60±0.05mm.

   (6) After the adjustment, secure the mount moving ring by using tape as shown in Fig.1.

Fig.1

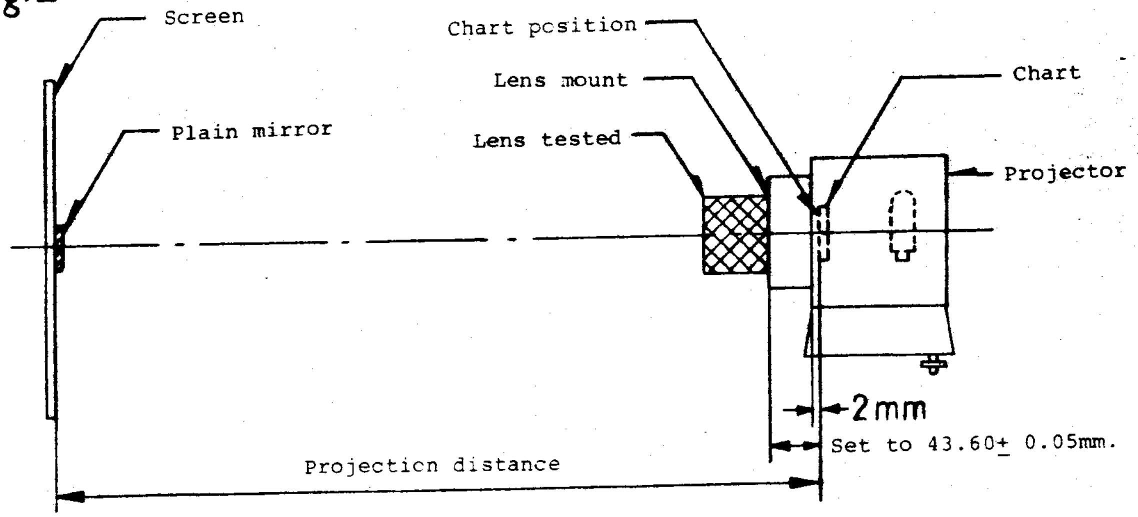


Reference

Securing the mount protruding ring is not necessary for projection chart observation of the whole unit protruding lens, but will be for floating, zoomm VFC, VARISOFT, internal focusing lenses, etc. In this paper, the distance from the mount to the chart has been set at 43.60±0.05mm (recommended) alterable with the mount protruding ring. It is, however, preferable to observe the projection chart image by making the distance equal to the flange back value of the lens to be inspected. (This method is employed at the plant.) However, there is almost no difference between the flange back value of the lens and 43.60±0.05mm (recommended) during projection of the lens to be tested. Therefore, securing the mount protruding ring is recommend at the Service Department to prevent any error. It is possible to use the factory method, but beware of possible errors.

2. Set the screen and the projector as illustrated below.

Fig.2



3. Insert the AC cord to the AC connector. The cooling fan will rotate.
4. Turn the lamp switch ON. The lamp lights up.
5. Attach the lens to the projector and set it to the open aperture value. The flange back and lens interval of the lens tested (floating, zoom, VFC, VARISOFT, internal focusing lenses) should be within the specification.
6. Set the projector to the projection distance mentioned in the projection resolving power standard values classified by the group of products (page 10). (The projection distance is the distance from the screen to the chart inside the projector.)

7. Set the optical axis of the lens vertical to the screen. (The chart in the projector should be parallel with the screen.)

   (1) Set up the projector vertical to the screen. (Fig. 3)

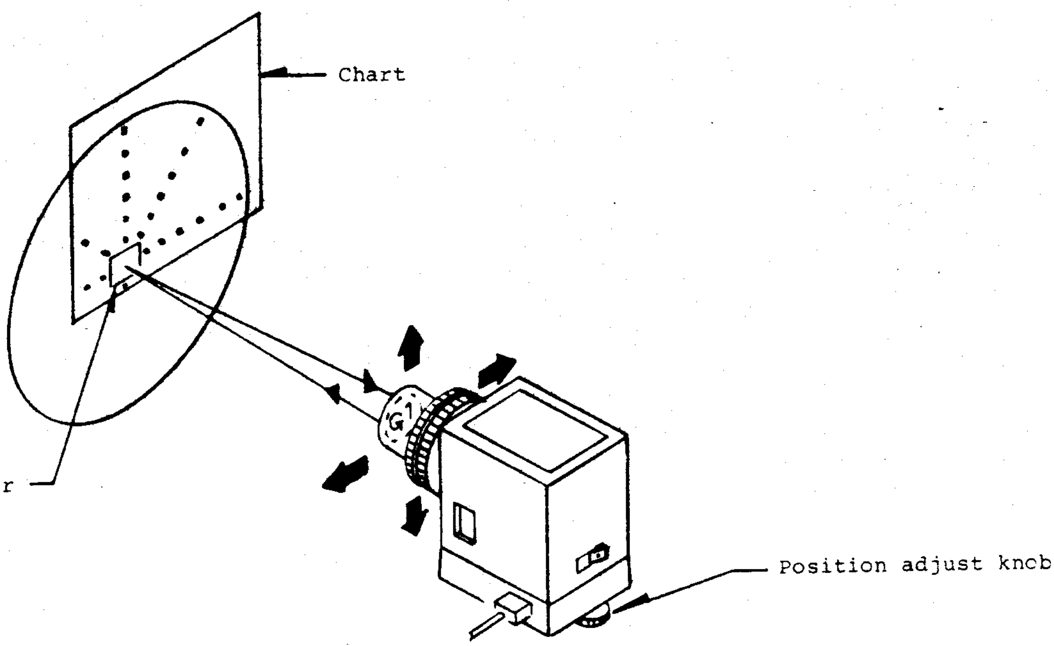
   (2) Pressing the plane mirror against the projected image on the screen, slide it on the screen and hold it when the center of the reflection from the mirror is reflected into the lens to be tested (Gl area in Fig. 3).

   (3) Change the angle of the projector to the screen so that the center of the projected image is aligned to the plane mirror being held. (Do not change the projection distance.)

   (4) Press the plane mirror against the center of the projected image on the screen and ensure that the reflected light enters the lens (Gl area). (This is the opposite of (3) .) If the reflected light does not enter the lens, slide the mirror slightly up and down or right and left. Then checked the reflected light around the lens in the same direction as the mirror sliding direction.

   (5) If the reflected light is deflected, repeat the operations in (2), (3) and (4). When the above steps are complete, the optical axis of the lens will be nearly vertical to the screen.

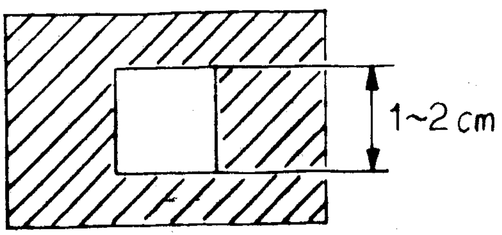
Fig.3



Reference

Use a plane mirror of about 1 or 2 cm sq. In the case of a mirror for single reflex camera, cover the area as shown in Fig.4 with black tape or black ink.

Fig.4



Measurement

Take great care when measuring resolving power since reading errors often occur.

1. Turn the distance ring of the lens so that the projefted center image (y'=0) on the screen reaches the maximum resolving power point (125 lines/mm or 100 lines/mm is clearly visible).
2. Rotate the mount turing board of the projector and read the minimu resolving power where y'=0. Read both sagittal and meridional images.

Judgement

When the lens of the measured projection resolving power (y'=0, y'=15mm S image, y'=15mm M image)are more than the standard value of projection resolving power classified by the grop of products, the lens is satisfactory. When the lines are less than the standard value, the performance of the lens may be poor (or the lens may be defective), therefore, refer to the defective lens repairing procedure in paragraph 5 (page 8,9)

4 Description

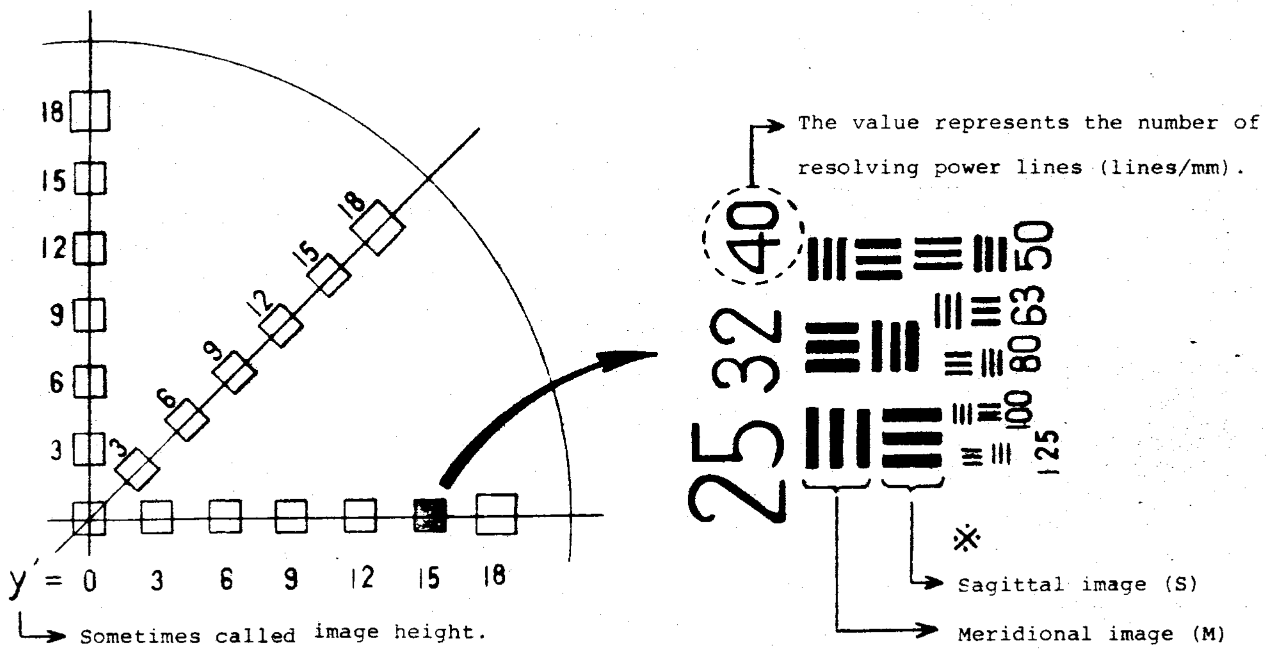
Projector

(1) Chart (There are two different chart images that appear on the screen depending on the types of projectors.)

Type A...The whole chart image is circular. (Model LP-2101. Appearance: specified by Minolta)

Type B...The whole chart image is 35mm, the same size as the camera film frame. (Sakai Plant make. Appearance: Black)

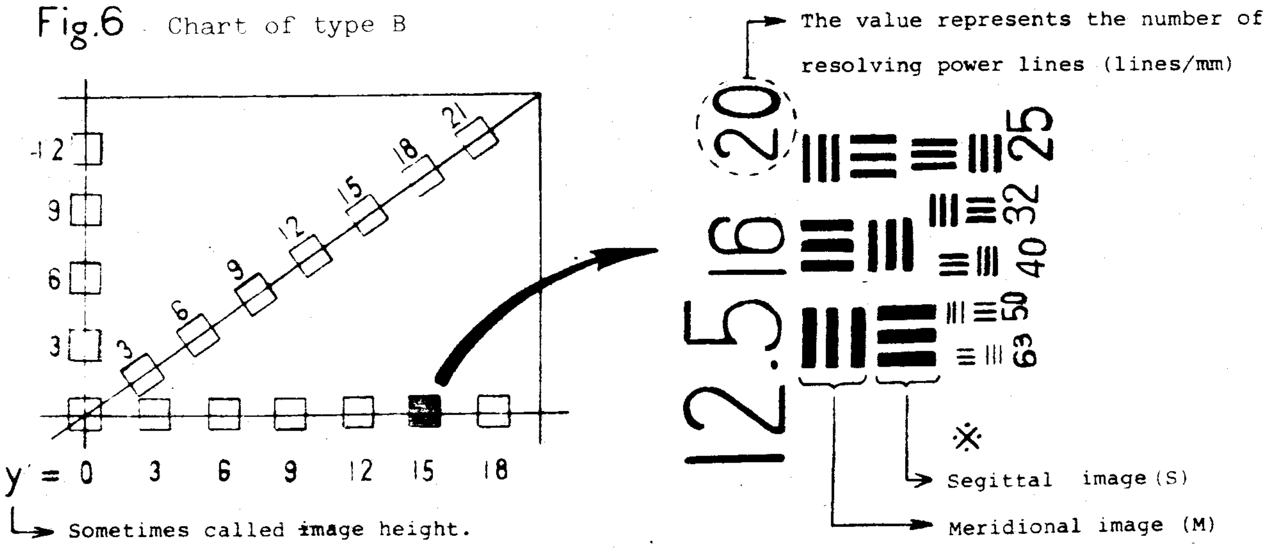
Fig.5 Chart of type A



※ Sagittal image(s)---Lines at night angles to the optical axis of lens

Meridional image(H)---Lines around the optical axis of lens

Fig.6 Chart of type B



(2) How to read the resolving power value (lines/mm)

∘ Type A --- y' = 0 3 6 9 12 15 | 18

Readable from 25 - 125 lines/mm. ← | → Readable from 16 - 80 lines/mm.

∘ Type B --- y' = 0 | 3 6 9 12 15 18 21

Readable from 25 - 125 lines/mm. ← | → Readable from 12.5 - 63 lines/mm.

■ Description of words

(1) y' (image height) mm
Distance from char center is shown in mm. Eg:...y'=15mm indicates a distance of 15mm from chart center.

(2) Resolving power
A quantity to represent the performance of a lens or photosensitive material. Black and white lines whose contrast can be observed.

(3) Limit of resolution
Minimum interval between two optical spots or two lines that can be resolved.

(4) Number of projection resolving power lines
Concerns the light and darkness of an image projected by a lens and this is tested by using a chart consisting of equally bright lines. The minimum line of which the light and darkness can be observed is the limit of resolution, and the value corresponding to this limit is the number of projection resolving power lines represented by lines/mm.

(5) False resolution
A phenomenon in which fine black and white lines exceed-ing the resolving power appear as fully resolved lines. This occurs when three black and white lines are reversed and lock as if they are two or four lines, and this is called false resolution. Be careful not to mistake this for the limit of resolution. (Refer to Fig. 7.)

Fig.7

Normal | Flase resolution (Black and white are reversed) | Flase resolution (Looking as if there are 2 or 4 lines.)

(6) One-sided fading
Since it is difficult to represent one-sided fading by the number of projection resolving power lines in the projector used (although the discrimination of the size of one-side fading is possible), the inspection and judge, at the Service Department are made by checking the minimum marginal resolving power lines with the center set at the best point. Because of different lens characteristics, some lenses of small one-sided fading are essentially low in marginal resolving power, and some lenses of large one-sided fading are high in marginal resolving power. Accordingly, the Service Department employs the measuring method on page 5 to read the marginal resolving power values and compares them with the standard projection resolving power values.

5 Checks for defective lense (poor resolving power) and repair procedure

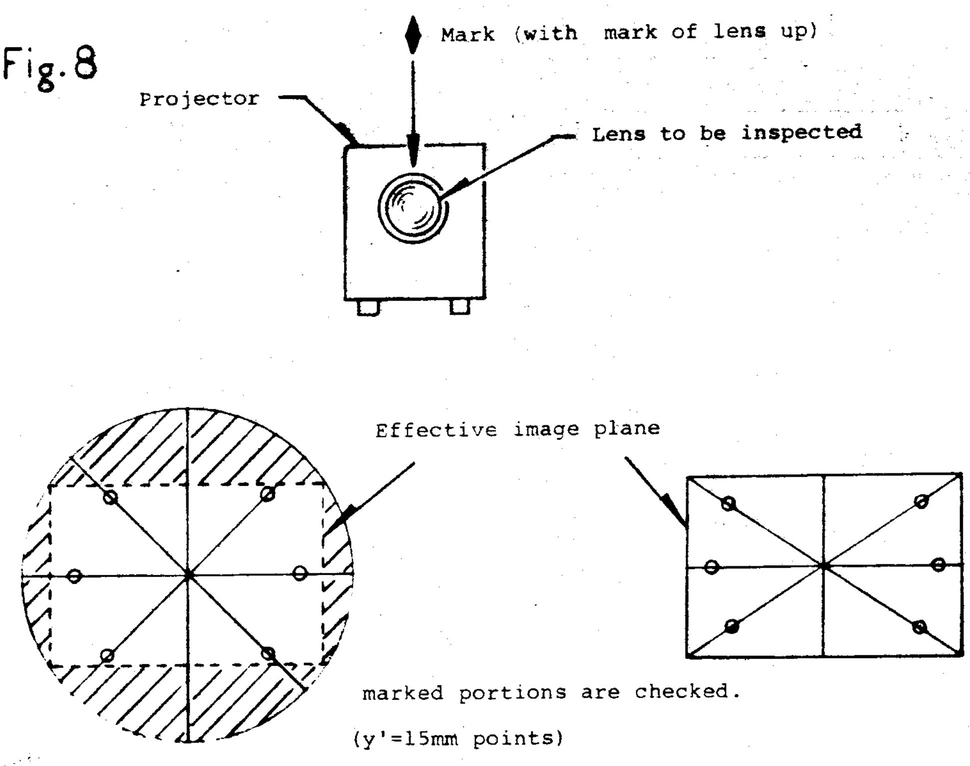
Ragarding defective resolving power, first check the following items 1 and 2.

Check of resolving power

1. Since the lens has an optical characteristic wherein the marginal resolution may very in 1 or 2 stages depending on the method of central focusing, check it again during projection inspection. Tentatively, make the central focus setting where the resolving power is over 80 lines, and then check the sagittal image (y'=0, y'=15mm) and merdional image (y'=15mm). (Some lenses improve in marginal resolution when the centeral resolve-power is reduced.) If the results are smaller than the standard resolving power values, make the following checks.

2. Check the projection resolving power within effective image plane. In paragraph 4-3 of the projection resolving power inspection procedure, the performance of the lens is inspected by watching one of the marginal points on the chart and turning the rotary board. In this paragraph, however, the results are judged by checking the chart at six marginal points (y'=15mm points) within the effective image plane, without rotating the lens.

Fig.8



The lens is acceptable even when the result is defective in the shaded //// area. If the six checking points shown above do not come within the screen (788x1091mm) mentioned in paragraph 3,place white art paper (100x100mm) or the like on the checking portion.

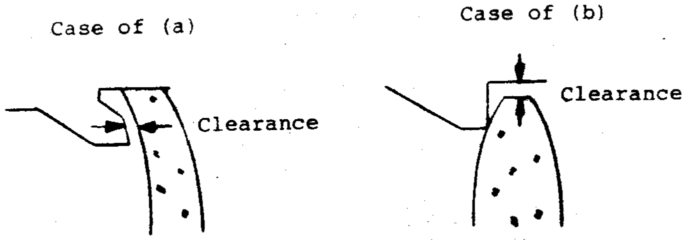
3. If the lens doesn't pass the above tests, check the flange back and lens interval(floating, zoom, VFC, VARISOFT, internal focusing). If the requirements are not satisfied, adjust and conduct another projection inspection once again.

After completing checks 1, 2 and 3, carry out the following checks of lenses with defective projection resolving power.

Checks of lens with defective resolving power

1. Check the fitting between the lens and the lens frame.
   (a) If the clearance between the lens and the lens frame is insufficient, the lens may have been fitted incorrectly.
   (b) If the clearance between the lens and the lens frame is excessive, the lens may be one-sided.

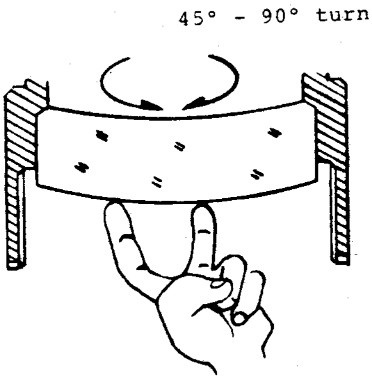
Fig.9



Types of lenes for which checks are required are specified in the lens parts list. Lenses marked with ① (the number indicates the order of influence level caused to the lens performance) should be checked in particular.

2. Change the position of the lens. (① marked lens only) Release the lens retaining washer and change the lens position by 45° to 90° while holding the lens in place with the finger, and then tighten the washer. (The lens should be cleaned after this operation.)

Fig.10



If hte ① marked lenses are of multiple type, check one by one using the projection inspection method outlined above.

3. Change the lens frame.
   If the lens is defective after procedure 1 and 2, change the lens frame of the ① marked.

4. Change the lens block.
   If the lenses are provided in blocks, change the combinations of the front and rear lens groups.

If the lens is still defective after the above procedure, it should be returned to the factory.

6 Stand projection resolving power values classified by product groups

■ Stand value of projection resolving power

For the instpection of projection resolving power at the factory, reference lenses (acceptable and unacceptable limit samples) are prepared for every individual model taking errors due to instrumetns and inspecting personnel into consideration. However, it is almost impossible for the Service Department to conduct the projection inspection in the same way as at the factory. Therefore, the standard values of resolving power classified by the group of products are given here for the Service Department. Errors in projectors being installed at the Service Department will not seriously affect projection inspection, although all the projectors may not have been checked.

MD.....MD lens

MC.....MC lens

	Focal distance	Projection distance	Projection resolving power (lines/mm or over)	Subject model (f/F, type)	Remarks
STANDARD	f=50mm	0.9m	y'=0----80 lines	524(50/2,MD,MC)	
				588(45/2,MD)	
				589(50/1.2,MD)	
				2520(50/1.7,MD)	
				2521(50/1.4,MD)	
			y'=15mm--S 32 lines, M 32 lines		
MACRO	f=50mm	0.9m	y'=0----80 lines	630(50/4.5,MC)	
				635(50/3.5,MD,MC)	
				654(100/3.5,MD,MC)	
	f=100	2.5m	y'=15mm--S 40 lines, M 32 lines		
ZOOM	f=24mm	0.8m	y'=0----100 lines	637(75-200)/4.5,MD)	Only in 676, the meridional image of marginal resolution (y'=15mm) is controlled by 25 lines.
	f=35mm	1.2m		675(35-70/3.5,MD)	
	f=50mm	1.7m		676(24-50/4,MD)	
	f=70mm	2m		677(50-135/3.5,MD)	
	f=100mm	2.5m	y'=15mm--S 32 lines, M 32 lines	669(80-200/4.5,MC,MD)	
	f=135mm	4m		679(100-200/5.6,MC,MD)	
	f=200mm	5m			

	Focal distance	Projection distance	Projection resolving power (lines/mm or over)	Subject model (f/F, type)	Remarks
WIDE	f=17mm	0.6m	y'=0----80 lines y'=15mm--S 32 lines M 32 lines	611(17/4,MD,MC)	
WIDE	f=20mm ∫ f=24mm	0.7m	y'=0----80 lines y'=15mm--S 32 lines M 25 lines	515(20/2.8,MD) 610(28/2.8,MD,MC) 615(28/2.8,MD,MC) 684(24/2.8,MD)	
WIDE	f=28mm ∫ f=35mm	0.8m	y'=0----80 lines y'=15mm--S 32 lines M 25 lines	505(28/2.8,MD,MC) 590(28/2.8,MD) 591(28/3.5,MD) 592(35/2.8,MD) 605(35/1.8,MD) 614(35/2.8,MD,MC) 616(28/3.5,MD,MC) 504(28/2,MD,MC)	Only in 605, the projection distance is set to 1.3m.
TELE	f=85mm	2m	y'=0----80 lines y'=15mm--S 40 lines M 32 lines	647(85/1.7,MD,MC) 685(85/2,MD) 653(85/2.8,MD)	In 647 (MD,MC), the projection distance is set to 3m.

IM - 1030

Dec., 1978

INSTRUCTION MANUAL
OF
APERTURE ERROR RECEPTOR
FOR EE TESTER
MODEL 8034-760

MINOLTA CAMERA CO., LTD.

1. Outline

. This receptor is used in measurement of aperture error of the complete lens assembly (SLR lens) of a single-lens reflex camera.

. This receptor can be used in conjunction with EE-Tester Model EE-2101 or EE-2111, but unavailable for other types of EE testers.

. Due to the small full-open aperture error of the lens, the aperture error is determined by measuring the diaphragming steps from full-open aperture according to the change of light intensity projected on a film centered on optical axis.

[Note] Even though the Model EE-2101 and EE-2111 have aperture error measuring capability, no precise measurement is attainable with optional lenses other than the standard lens due to disadvantage mentioned below.

1. The nominal indicating level of the Model EE-2101 and EE-2111 are set for the 35mm standard lens (50mm, F 1.4) of the EE tester calibration instrument. Thereby, if the transmission ratio of the lens tested were to differ from that of 35mm standard lens (50mm, F 1.4), that difference results in error.

2. Because photo sensing window of the photo cell used for the 35mm receptor of the EE Tester is so large as to ϕ16mm, relation between the aperture diameter and illumination on the film comes to deviate due to vignetting of the lens, when focus distance of the lens tested comes to differ.

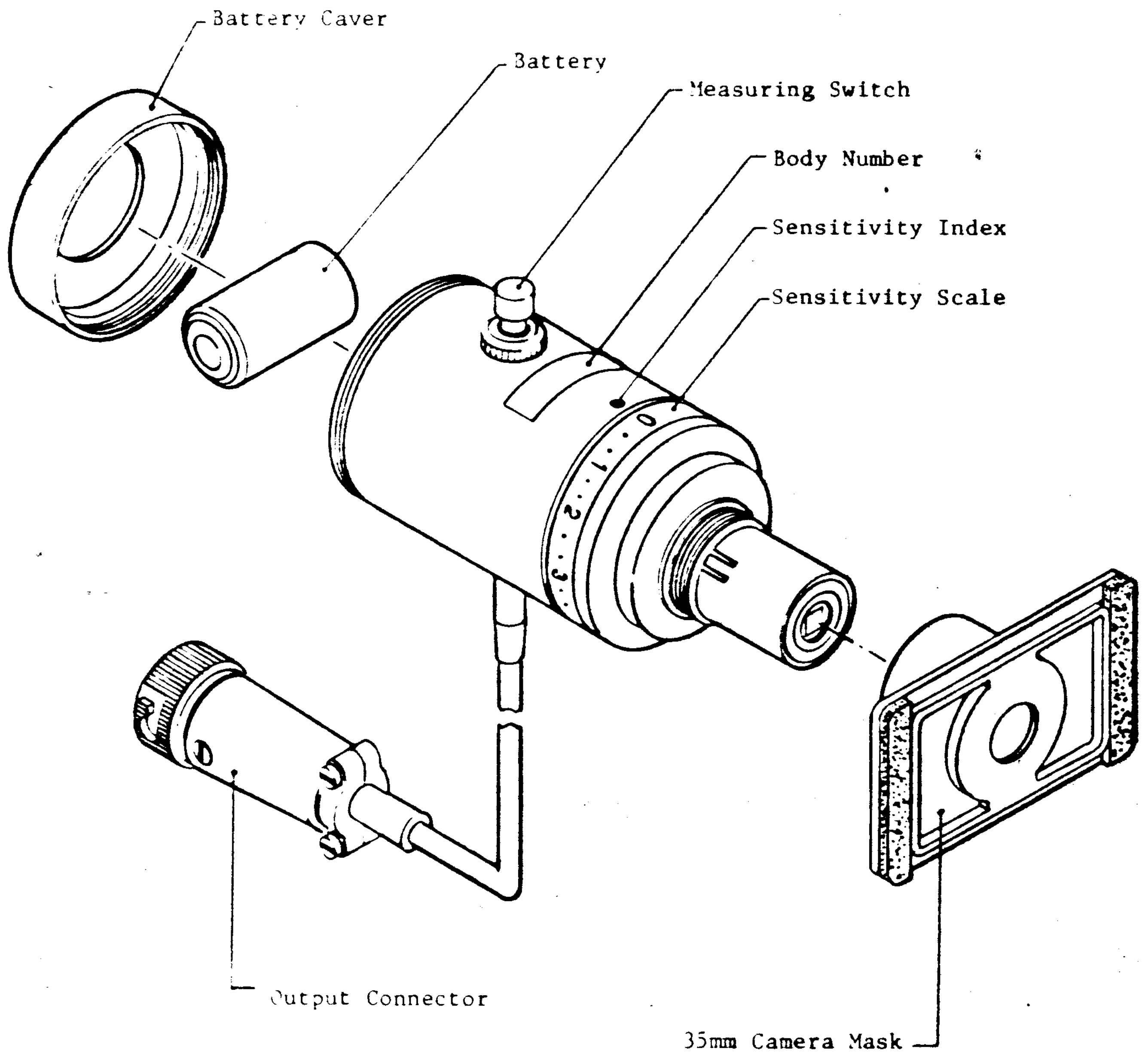
In order to solve above problems, the following procedures are taken.

With respect to the Item-1:	Measurement is carried out after compensating the transmission ratio of the lens at full-open aperture position.
With respect to the Item-2:	Illumination over 2 x 2mm area of the optical axis at film surface is measured.

2. Specifications

(1) Measuring system	: Based on full-open aperture.
(2) Measuring range	: F 1.2∼22 (incombined state with the EE Tester)
(3) Photo cell	: Silicon photo cell, 2x2mm area to be measured
(4) Sensitivity scale	: 0∼8, with 1/3 step markings
(5) Input power supply	: D.C. 6V, with silver-oxide battery x 1 pcs. (JIS: 4G-13, Eveready: 544, Mallory: PX28 etc.)
(6) Physical dimensions	: 85(L)x44(W)(mm), excluding the connector section.
(7) Weight	: 160g (with battery)

3. Name of parts



4. Cautions

(1) No precise measurement is attainable with this unit if error in full-open F No. of the tested lens were to be too large, since this unit is operated on the basis of full-open aperture.
Especially, when there is any diaphragm were to remain under full-open aperture, that portion results in error. Therefore, it must be confirmed that no diaphragm is remaining.

(2) Be sure to adjust the unit so that the offset lamp should come to actuate before going into measurement as displacement of the offset of the EE tester bring error to occur at near the full-close aperture.

(3) Be sure to set the distance ring of the tested lens to the infinitive (∞).

(4) As the full-open F No. on the short focus side of the zoom lenses, 675 (35 ~70mm, F 3.5) and 676 (24 ~50mm, F 4), is determined on the basis of the diaphragm, calibration of the full-open F No. should be carried out after setting to long focus side (675: 70mm and 676: 50mm). Measurement shall be carried out at both long-focus and short-focus points.

(5) In case the 653 (VARISOFT 85mm, F2.8) is to be measured, be sure to set the soft scale to "0".

(6) In case a variable field curvature lens such as the 615 (VFC 24mm, F2.8) is to be measured, set the VFC ring to [◆] mark on the middle.

(7) In case a soft lens such as the 613 (SHIF VFC 28mm, F3.5) is to be measured, set the shift ring to the middle of the shift scale (where no shift is applicable).

(8) In case any lens which is fabricated with internal filters, select [1A] or [UV] filter and set it on the lens.

5. Items Required

(1) The EE Tester, Model EE-2101, EE-2111

(2) Luminescence box, Model L-2101, L-222, L-223

(3) Single-lens reflex camera body: Any model will do.

(4) Cable shutter release : To be used for maintaining "Bulb" condition.

6. Measuring Method

6-1 Preparation

(1) Install the battery after removing the battery cover. Do not mistake battery polarity.

(2) The photo cell is attached with the 35mm mask.

(3) The output connector must be connected with the input connector STILL of the EE Tester.

(4) Set the luminescence box to EV11 (ASA 100). In case no EV11 setting is available, set it near that setting.

(5) Set the EE TEster to the following settings.

FUNCTION	....	35
ASA dial	....	F
"K" value dial	....	The same setting as in the luminescence box.
MEAS-CAL SW	....	CAL.

(6) Apply light to the photo cell by depressing the measuring switch, and confirm that indicator arm of the EE Tester is swung. If the indicator arm does not swing, it needs replacement of the battery.

(7) Now, offset adjustment is carried out.

Turn the offset dial until the offset lamp (green lamp) comes to light after setting the F-value dial of the EE Tester to F22.

[Note] As poor offset adjustment causes error near at the full-close aperture, be sure to conduct offset adjustment before going into the measurement.

(8) Fit the tested lens to the single-lens reflex camera and keep the camera under "Bulb" condition.

(9) Set it over luminous plane.

6-2 Calibration of full-open F-No.

(1) Set the tested lens to the following settings.

Aperture ring	......	Full-open F-No.
Distance ring	......	Infinitive (∞)
Zoom ring	......	On long focus side, (This, however, is only applicable for zoom lenses).

[Note] For such as the soft scale, VFC ring, shift ring, and internal filters, please refer to the section-4 "PRECAUTIONS".

(2) Set the F-value dial of the EE Tester to the full-open F No. of the tested lens. In case the full-open F No. of the tested lens can not meet with the F-value dial (F1.4 ∿ 22, by each 1Ev step), please refer and set in accordance with Table-1.

(3) Adjust by turning the sensitivity scale so that the indication arm of the EE Tester at the time of depressing the measuring switch should indicate the value shown in Table-1.

[Note] Be careful that the sensitivity scale should not move during measurement.
The full-open F No. should be calibrated by each lens and measurement.

Table 1.

Full-open F No. of the tested lens	F-value dial of the EE Tester	Indication on the EE Tester
F 1.2	F 1.4	+ 0.2 Ev
F 1.4	F 1.4	- 0.2 Ev
F 1.7	F 2	+ 0.3 Ev
F 1.8	F 2	+ 0.15Ev
F 2	F 2	- 0.1 Ev
F 2.5	F 2.8	+ 0.25Ev
F 2.8	F 2.8	- 0.1 Ev
F 3.5	F 4	+ 0.3 Ev
F 4	F 4	- 0.1 Ev
F 4.5	F 4	- 0.4 Ev
F 5.6	F 5.6	- 0.1 Ev
F 6.3	F 5.6	- 0.35Ev

6-3 Measurement of apperture error

(1) Set the aperture ring of the tested lens and the F-value dial of the EE Tester to the desired F-value after calibrating the full-open F-No.

Setting on the EE Tester:

Function	....	35
ASA dial	....	F
K-value dial	....	The same K-value as in the luminescence box.
MEAS-CAL SW	....	CAL
F-value dial	....	The same F-value as in the tested lens.

(2) Read the mean indication value on the EE Tester by releasing the camera a few times after setting the camera to "bulb" condition while depressing the measuring switch.. Then, aperture error is obtained.
In case non-standard item is to be tested, refer to the related service manual prepared for the particular item before proceeding to adjust.

[Note] The reason why the camera is released under "bulb" condition is to take deviation of the preset lever into consideration.

7. Standards

Test Standard:

Nominal F-No.	Allowance	Remarks
F 5.6 and below	±0.35 Ev	
F 5.6 and over	±0.5 Ev	
F22 of a lens whose f = 16~35mm	±0.6 Ev	
F16 and F22 of a lens whose f = 7.5 mm	±0.6 Ev	only MD lens can be measured