International Standard 4854

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION•МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ•ORGANISATION INTERNATIONALE DE NORMALISATION

Personal eye-protectors — Optical test methods

Protecteurs individuels de l'œil — Méthodes d'essai optiques

First edition — 1981-05-15

UDC 614.893 **Ref. No. ISO 4854-1981 (E)**

Descriptors : accident prevention, eyes, eyeglasses, safety devices, tests, optical tests.

Price based on 17 pages

ISO 4854-1981 (E)

Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 4854 was developed by Technical Committee ISO/TC 94, *Personal safety — Protective clothing and equipment*, and was circulated to the member bodies in July 1978.

It has been approved by the member bodies of the following countries :

Australia	Iran	Poland
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The member body of the following country expressed disapproval of the document on technical grounds :

United Kingdom

Printed in Switzerland

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Personal eye-protectors — Optical test methods

1 Scope and field of application

This International Standard specifies the optical test methods for eye-protectors the requirements for which are given in ISO 4849 to ISO 4853.[1]

The test methods other than optical test methods are given in ISO 4855.

2 References

ISO 4849, *Personal eye-protectors — Specifications.*

ISO 4850, *Personal eye-protectors for welding and related techniques — Filters — Utilisation and transmittance requirements.*

ISO 4851, *Personal eye-protectors — Ultraviolet filters — Utilisation and transmittance requirements.*

ISO 4852, *Personal eye-protectors — Infrared filters — Utilisation and transmittance requirements.*

3 Test for refractive, astigmatic and prismatic powers

Any method of examining the required area with an accuracy of ± 0,015 m^{-1} may be used. However, the methods described below are given as reference methods for use in cases of dispute.

3.1 Testing unmounted oculars

3.1.1 Apparatus

3.1.1.1 Telescope, with a magnification of between 7,5 and 20 (recommended magnification 15) with an aperture of 15 to 20 mm and an adjustable eye-piece fitted with a graticule, for example a theodolite which is adjustable both vertically and laterally.

In the event that the telescope, a large-aperture instrument, shows a doubling of the image or other aberration, the ocular to be tested shall be examined with a 5 mm aperture instrument to locate and quantify the area or areas of aberration in the total area of 20 mm diameter. A focometer may be used for this operation.

3.1.1.2 Adjustable light source, with condenser.

3.1.1.3 Target, consisting of a black plate with the cut-out pattern shown in figure 1. The bars are 2,0 mm wide. The larger annulus depicted inside the bars has a diameter of 23 mm with an annular aperture of 0,6 mm, and the smaller has a diameter of 11 mm. The diameter of the central aperture is 0,6 mm. The target is mounted on a glass plate.

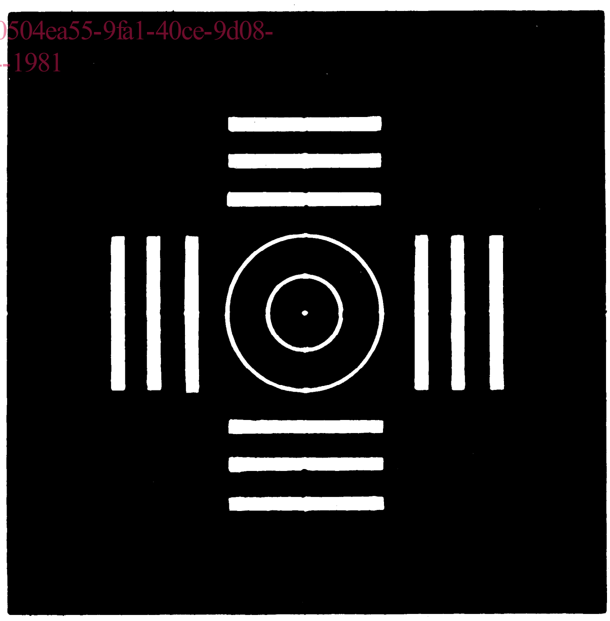

Figure 1 — Target

3.1.1.4 Interference filter, with λ max. = 555 ± 10 nm and a half-band width of approximately 50 nm.

1) In preparation : ISO 4853, *Personal eye-protectors — Daylight filters, utilisation and transmittance requirements.*

3.1.1.5 Standard lenses, with refractive powers of $\pm$ 0,06 m^{-1}, $\pm$ 0,12 m^{-1} and $\pm$ 0,25 m^{-1} (tolerance $\pm$ 0,01 m^{-1}). Any other method of calibration may be used.

3.1.2 Procedure

The target shall be trans-illuminated by means of a parallel beam of monochromatic light of adjustable intensity. The telescope and the optical system of the target shall be on the same axis.

The interference filter is used to reduce chromatic aberration.

The focusing adjustment of the telescope shall be calibrated so that a power of 0,01 m^{-1} can be measured.

The distance between the telescope and the target shall be 4,6 $\pm$ 0,1 m. Focus the graticule and the target and align the telescope to obtain a clear image of the target. This setting shall be regarded as the zero point of the scale of the telescope.

Calibrate the equipment using standard lenses of known refractive powers or any other equivalent method.

Position the ocular normal to the telescope axis. Make measurements at the test points defined in sub-clause 7.1.2.1.1 of ISO 4849.

To determine the refractive power, adjust the telescope until the image of the target is perfectly resolved. Then read the refractive power of the eye-protector from the scale of the telescope.

The astigmatism of the ocular is the maximum refractive power difference between two perpendicular meridians observed during rotation of the ocular axis. Record this maximum difference obtained in resolving the horizontal and vertical bars during rotation as the astigmatism.

To determine the prismatic power, position the ocular to be tested in front of the telescope and, if the point of intersection of the lines of the graticule falls outside the image of the bigger annulus, the prismatic power exceeds 0,25 cm/m. If the permitted limit is 0,12 cm/m, the point of intersection of the lines of the graticule shall fall inside the image of the smaller annulus of the target.

The values obtained for the refractive, astigmatic and prismatic powers shall be within the limits defined in table 2, sub-clause 7.1.2.1.1, of ISO 4849.

Oculars may be also tested with a device using a laser beam. This optional method, allowing the measurement of small refractive and astigmatic powers, is described in annex A.

3.2 Control methods for mounted oculars

3.2.1 Apparatus

3.2.1.1 Standard support for spectacles, constructed in metal or other rigid material according to figure 2, to reproduce the position of the spectacles in front of the eyes of the wearer. Protectors without side pieces shall be positioned on the support as they are normally placed before the eyes when worn.

3.2.1.2 Two telescopes, similar to the one described in 3.1.1.1, fitted with 6 mm diameter circular diaphragms and fixed with 2 axes 66 mm apart and parallel to within 1′.

A single telescope may also be used which can be displaced, its axis remaining parallel to within 1′ of its original direction; alternatively, the protector may be displaced relative to the single telescope and target, these remaining fixed. The distance between ocular and telescope shall be reduced to a minimum.

In the event that the telescope, a large-aperture instrument, shows a doubling of the image or other aberration, the ocular to be tested shall be examined with a 5 mm aperture instrument to locate and quantify the area or areas of aberration in the total area of 20 mm diameter. A focometer may be used for this operation.

3.2.1.3 Double target, conforming to the design shown in figure 3, or **single target,** as the case may be, on which the reading is made. The target is brightly illuminated and placed 4,6 $\pm$ 0,1 m from the telescope(s).

3.2.2 Procedure

Place the protector to be tested on the support (3.2.1.1). Using both telescopes, one for each ocular in the case of spectacles (the arms of those must be horizontal) and two-piece goggles, or at each visual centre in the case of face-shields and one-piece goggles, measure the horizontal and vertical prismatic powers by counting the number of circles across which the vertical and horizontal cross-wires of the graticule are displaced and by interpolating between two circles if necessary. Since each circle represents 0,05 cm/m, the reading may be made to the nearest $\pm$ 0,025 cm/m.

Deviations measured for each ocular or each visual centre are added when they are in opposite directions and subtracted when they are in the same direction.

Measure the refractive power for each ocular or each visual centre by opening the telescope diaphragm to 20 mm. Determine the astigmatism by the difference of refractive powers measured by resolving 2 circular arcs on the target. Spherical effect is the average of refractive powers measured by resolving 2 circular arcs on the target.

In this way a value for the horizontal prismatic power and a value for the vertical prismatic power are obtained, as well as values for the spherical effect and astigmatism. These values shall be within the limits defined in table 3 of sub-clause 7.1.2.1.2 of ISO 4849.

Two other optional methods for prismatic power measurement are presented in annexes B and C.

Dimensions in millimetres

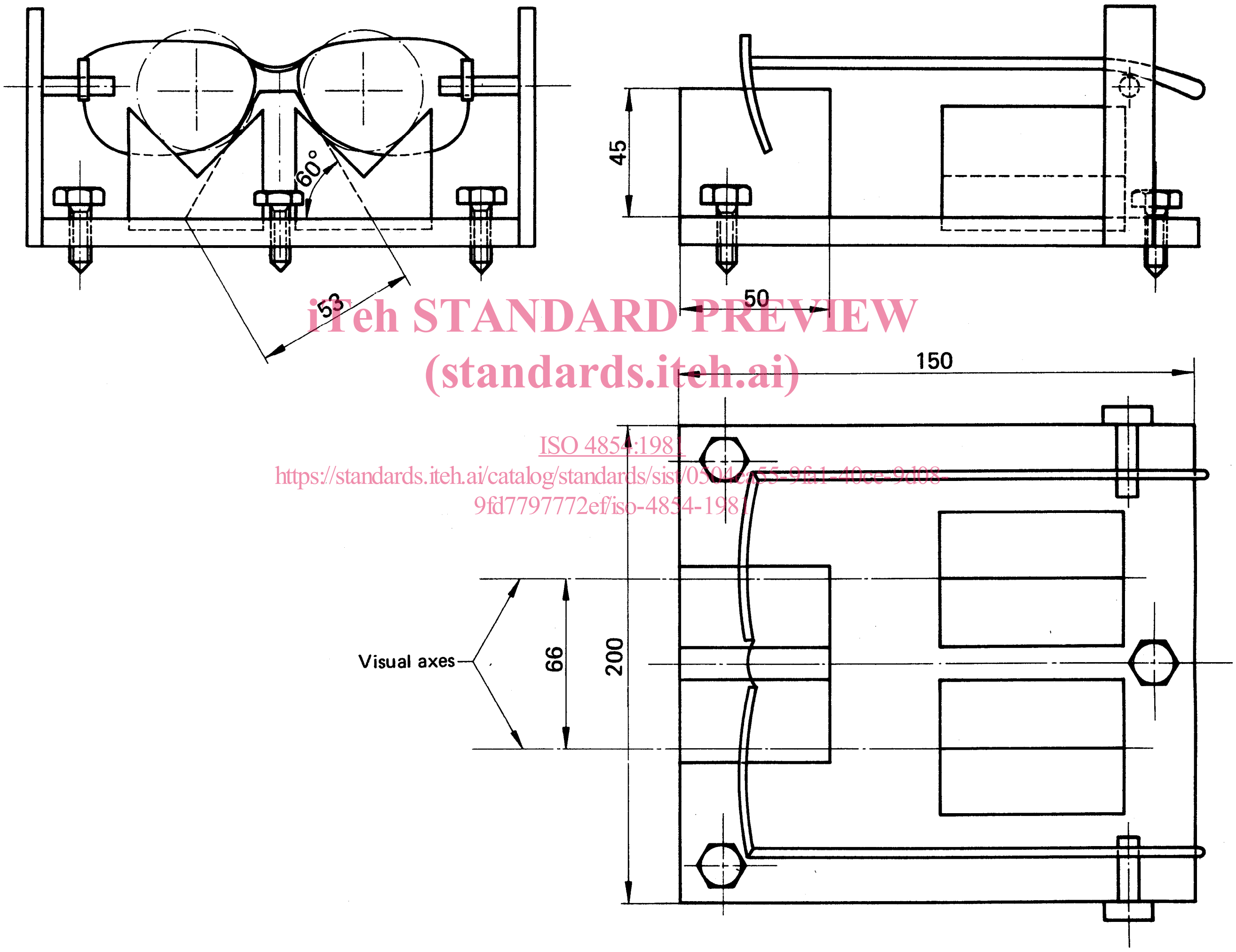

Figure 2 — Standard support for spectacles

Dimensions in millimetres

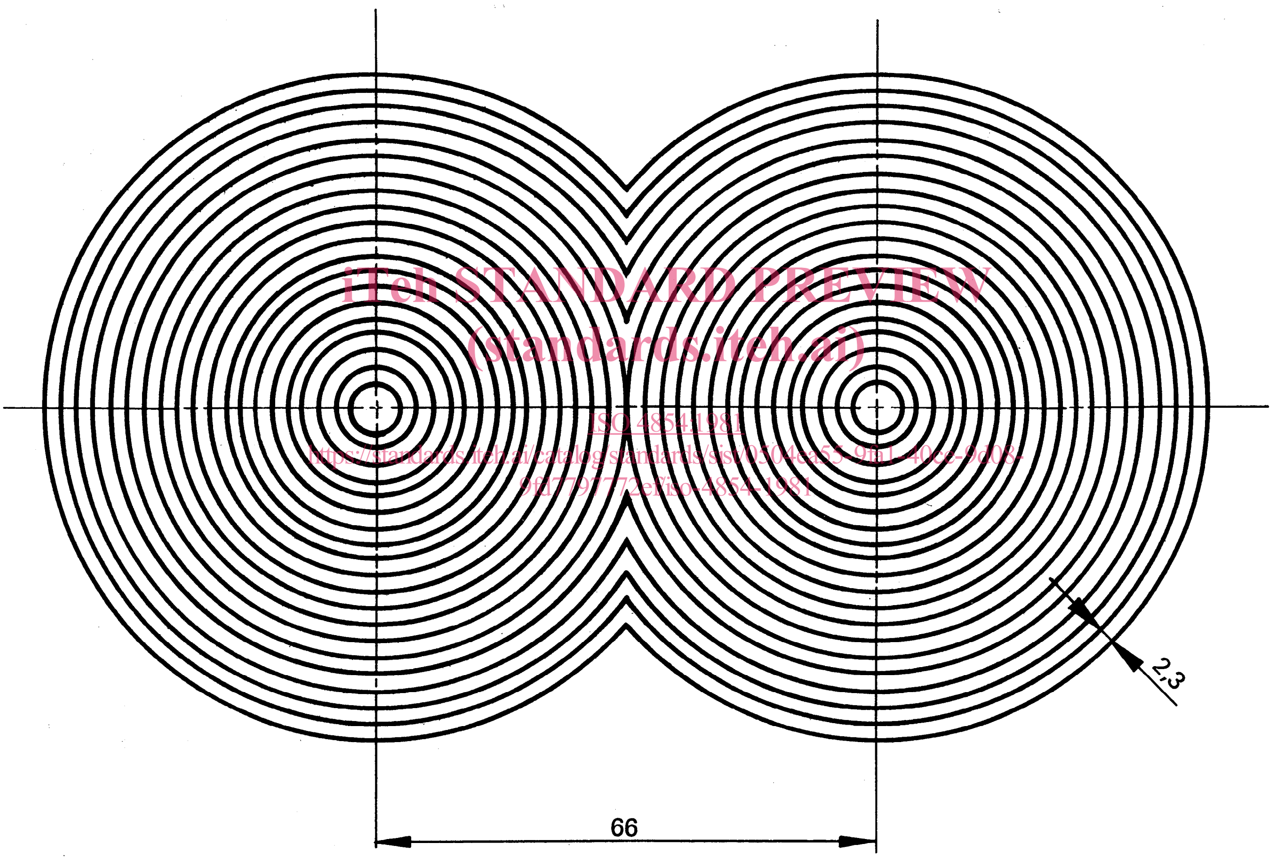

Figure 3 — Double target

4 Diffusion test

The test method described in 4.3 is given as a reference method. Alternative methods for filters having a transmittance value (τ_v) in excess of 10 % may be used, as for example a hazemeter or visual inspection, provided that correlation has been established for the material under test.

4.1 Basic notions

4.1.1 Reduced luminance factor

The degree of diffusion of light produced by a filter is proportional to the illuminance E. Luminance is a measure of the diffusion of light by the filter, and the value L_s is proportional to the illuminance E of the filter. The proportionality factor is the luminance factor $l = L_s/E$, which is expressed in candelas per lux per square metre [cd · m^{-2} · lx^{-1}]. To obtain a factor l^* which does not depend upon the transparency of the filter, the luminance factor is divided by τ, thus producing :

$$l^* = \frac{l}{\tau} = \frac{L_s}{E\tau}$$

This quantity is known as the reduced luminance factor and is expressed in the same units as luminance factor.

NOTE — Variation of diffusion with observation direction : Most oculars have diffusion properties which are symmetrical about the optical axis. For these oculars, the mean value of the reduced luminance factor is constant within an angle limited by the two cones shown in figure 4. This mean value depends upon values α and $\Delta\alpha$.

4.1.2 Fluorescence

The luminance factor also includes fluorescent light caused by any ultraviolet radiation; therefore, the spectral distribution of the source used during measurement shall be similar to that of the source to which the filter is exposed in practice.

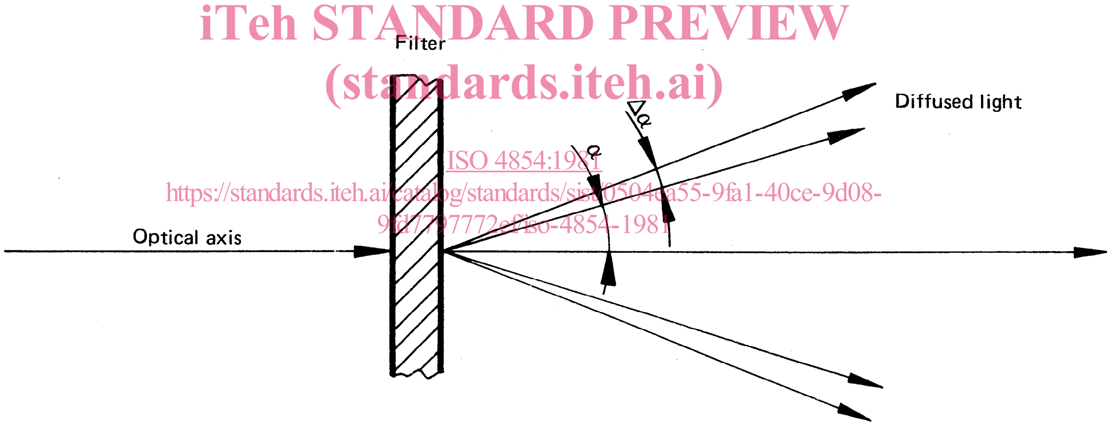

Figure 4 — Variation of diffusion with observation direction

4.2 Apparatus

Figure 5 illustrates the assembly of the apparatus.

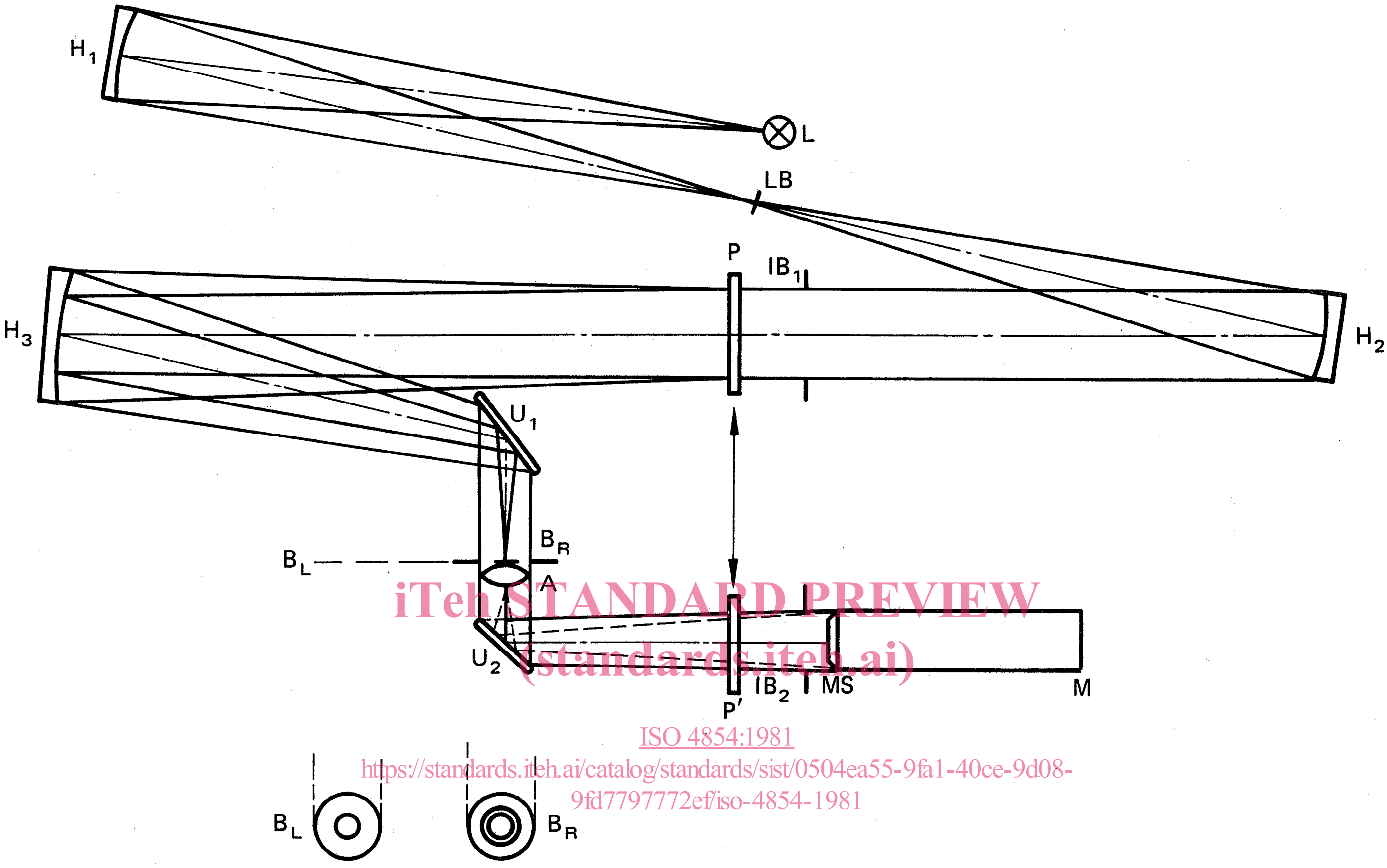

Figure 5 — Assembly of apparatus for diffusion test

L	Very pure silica-glass high-pressure xenon lamp (for example XBO 150 W — 4 or CS X 150 W — 4)
H_1	Spherical concave mirror : focal length 150 mm; diameter 40 mm
H_2	Spherical concave mirror : focal length 300 mm; diameter 40 mm
H_3	Spherical concave mirror : focal length 300 mm; diameter 70 mm
A	Achromatic lens : focal length 200 mm; diameter 30 mm
U_1, U_2	Flat mirrors
B_R	Annular diaphragm : diameter of outer circle 21,00 mm; diameter of inner circle 15,75 mm
B_L	Circular diaphragm : diameter of aperture 7,5 mm
M	Photomultiplier corrected according to curve V (λ) with diffusing screen MS
IB_1	Iris-diaphragm to adjust diameter of field of observation
IB_2	Iris-diaphragm to eliminate edge effects from IB_1
LB	Circular diaphragm, diameter of aperture 0,4 mm
P, P'	Positions of test sample

Spherical mirror H_1 forms an image of light source L at diaphragm LB of the same dimensions as L. The concave mirror H_3 forms an image of diaphragm LB in the plane of diaphragms B_L and B_R. The achromatic lens A is positioned immediately behind the diaphragm so that a reduced image of the test sample in position P appears on diffusing screen MS. The image of iris-diaphragm IB_1 is simultaneously formed on IB_2.

This assembly collects all the light originating from the filter between angles $\alpha = 1{,}5°$ and $\alpha + \Delta\alpha = 2°$ in relation to the optical axis. The angular area is important in the case of welding, where a point in the immediate proximity of the weld spot has to be observed. It is, however, possible to measure scattered light in other angular areas if use is made of an annular diaphragm with suitably modified dimensions.

4.3 Procedure

Test oculars shall meet the optical requirements of sub-clause 7.1.2.1 of ISO 4849.

Position the test sample in the beam parallel to position P, then set diaphragm B_L in place. The flux Φ_{1L} falling onto the photomultiplier corresponds to the undiffused light transmitted by the sample and is in proportion to $E\tau$. Then replace diaphragm B_L by annular diaphragm B_R; flux Φ_{1R} falling onto the photomultiplier corresponds to the total diffused light originating from the filter and from the apparatus. Then arrange the test sample at position P'. Flux Φ_{2R} falling onto the photomultiplier corresponds to the diffused light coming from the apparatus only.

Difference $\Phi_{1R} - \Phi_{2R}$ is a measure of the light diffused by the filter, and is proportional to ωL_s. The proportionality factor is the same in both cases. The reduced mean luminance factor l^*_m for the solid angle ω is calculated from the preceding fluxes by means of the formula :

$$l^*_m = \frac{1}{\omega} \times \frac{\Phi_{1R} - \Phi_{2R}}{\Phi_{1L}}$$

where

Φ_{1R}, Φ_{2R} are the luminous fluxes with the annular diaphragm;

Φ_{1L} is the luminous flux with the circular diaphragm;

ω is the solid angle defined by the annular diaphragm.

5 Test for quality of material and surface

The apparatus (recommended means of examination) used for this test is shown in figure 6.

The brightness of the lamp shall be related to the optical density of the filter. This subjective examination requires experience and is made at the limit "clear-dark" and without optical magnifying means.

Dimensions in millimetres

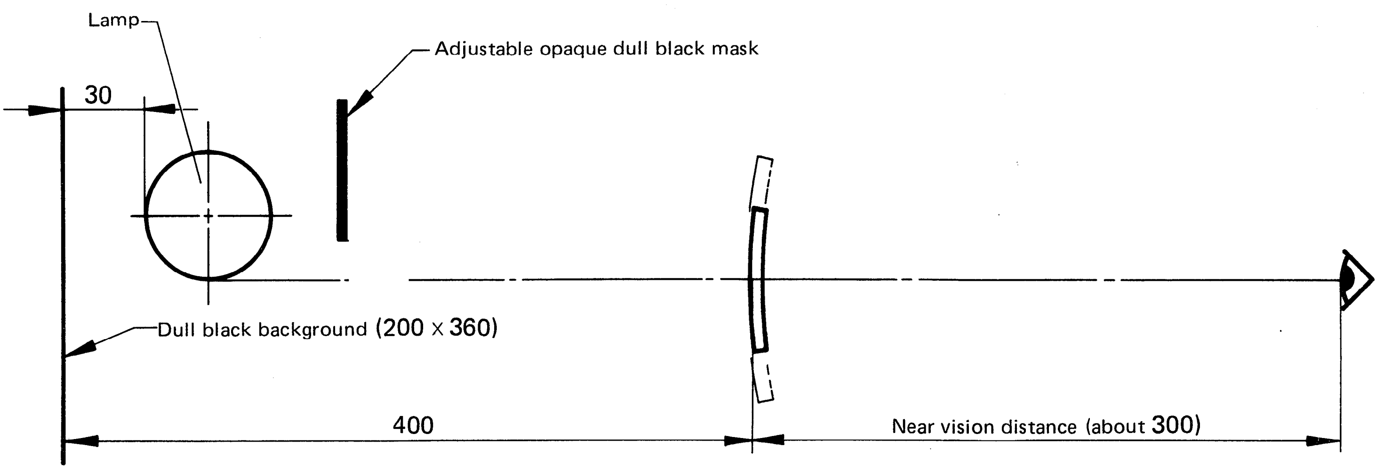

Figure 6 — Apparatus for test for quality of material and surface