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A General Colour Indicator Meter "MOBAR"

The Meter "MOBAR" has been developed in compliance with the colour testing method recommended by the International Commission on Illumination (CIE) in the year 1965 and next in 1971. This method enables to determine the properties of colour reproduction of an arbitrary visible radiation, for instance, that generated by discharge sources with line spectrum components [1].

The meter measures uniformly the trichromatic CIE coordinates proposed by Mac Adam. The radiation examined is measured as well as the reference radiation both being filtered by a set of optical colour filters equivalent to the recommended colour tests. The resulting values of the trichromatic coordinates are used to the colour deviation estimation of the testing colours (of the radiation examined with respect to the reference radiation) and next to the evaluation of the general colour indicator.

Description of the Device

The "MOBAR 70" meter consists of three separate units: a colorimeter, a compensator and a sample. The prior application of the meter is to the measurements requiring a frequent change of position and therefore all the units are linked loosely. The pattern block is an attachable element used for calibration measurements and may be kept separately. The colorimeter is placed on a photographic tripod and may be arbitrarily displaced and directed.

Compensator being loosely joined with the colorimeter by means of a long bundle of conductors is placed on a light portable measuring stage and may be located far from the colorimeter. The compensator itself is an Ulbricht sphere covered from inside with the barium sulphate with a 1% addition of the polyvinyl alcohol used as a binder. The upper hemisphere is equipped with an entrance hole and the receptors *u*, *v* and *w* located symmetrically and directed to the inside [2]. The receptors are dr B. Lange selenium cells corrected with the help of filter sets made of Schott glass. They are irradiated by the light diffused inside the Ulbricht sphere rather than by the falling beam. Above the entrance hole a turn-table with one empty hole and eight other holes, each being supplied with a set of filters equivalent to those recommended for the Munsell testing colours, is mounted. The shading of the entrance hole is realized by rotating the turn-table. The construction takes care of the rotational symmetry of the photometric holes. The correction filters made in the form of sphere zone sets have been installed, which simultaneously simplifies the construction and improves the sensibility of the colorimeter. The said symmetry of the filter sets results in independence of the transmittance response on sphere radius. This property is particularly advantageous, when constructing the devices with point light sources and light channels. This solution has been adopted to the MOBAR. The pattern block is a convectionally cooled housing equipped with an iodine projection lamp 12 V, 50 VA produced by the Narva and a shiftable Schott BG 34 filter rising the distribution temperature, the whole being attachable to the colorimeter. The change in the temperature of the standard reference radiation has been achieved by the supply power regulation and shilding the lamp with the BG 34 filter, while the compensation of the irradiation changes has been realized by the corresponding regulation of the lamp position with respect to the Ulbricht sphere entrance hole.

Calibrating measurements may be carried out in advance and tabulated for different distribution temperatures. The errors due to matching deviations of the receptors may be decreased by taking account of the experimental reference data.

The compensator of the photoelectric current (Fig. 1) is a light, small instrument supplied with a R6 battery (15 V) used as a source of a compensating current and a precise Helipot potentiometer replacing a more expensive and heavier three-decade resistor, applied as a comparing element; the other elements being low-power radio components. Be-

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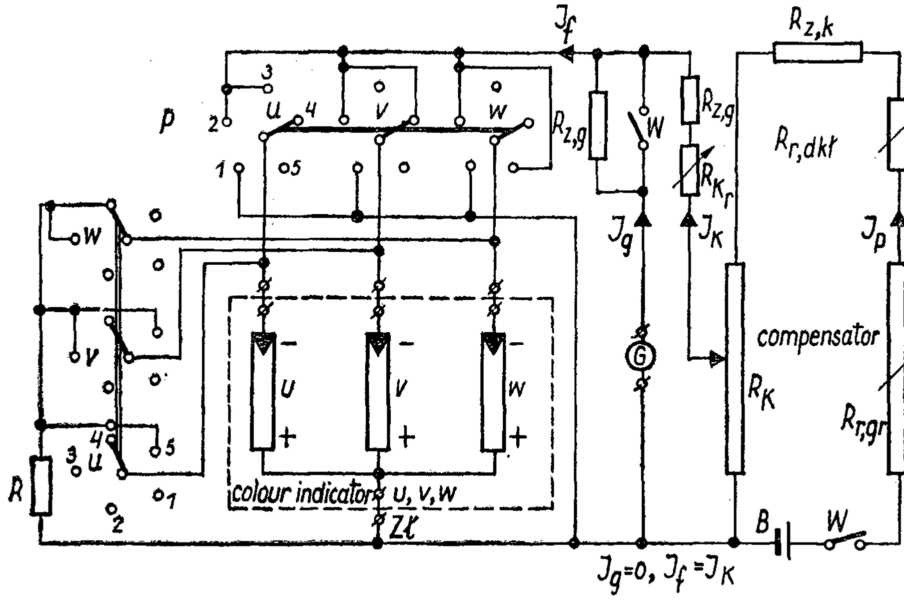

Fig. 1. Scheme of the colour reproduction meter MOBAR. Notations: u, v and w — photoelectric cells, Zl — five-contact joint, P — triple switch, G — galwanometer $1 \div 3\ 10^{-9}$ A/mm, R_{zg} — safety resistor 24 kΩ, R_{cr} — critical resistor 50 kΩ, R_k — compensatory potentiometer 500 kΩ, $R_{z,k}$ — safety resistor 2 kΩ, $R_{r,dkl}$ — regulation resistor 10 kΩ, $R_{r,gr}$ — regulation resistor 50 kΩ, W — unipolar cut-out, B — battery R6 1.5 V, I_f, I_g, I_k and I_p, currents: photoelectric, in galvanometer, compensating and auxiliary, 1; 2; 3; 4; and 5 switch positions, 1 — short-circuit of battery, 2 — joint battery, 3 — chosen u, short-circuit of u and v, 4 — chosen v short-circuit of u and w, 5 — chosen w, short-circuit of u and v

sides, all the elements necessary for absolute measurements have been eliminated and the achieved design simplicity resulted in a reliable instrument, which can meet all the requirements usually posed for the portable arrangements. The measurement of the uniform trichromatic coordinates consists in measuring the compensating currents from the photoelectric compensators. By application of a simple analog system the measurements of the relative current contribution of a given receptor (measured in promilles) to the total current produced by all the three detectors is realized, the total current being experimentally regulated to be equal to 1000. The measurement is now reduced to the determination of the voltage drop ratio, i.e. a ratio of the part of the resistance branch in the compensating potentiometer to the total resistance (for $R_{cr} \rangle\rangle R_c$) and is performed with a precision scale of 10 000 divisions coupled with the potentiometer drive. As a zero compensation indicator a GL1D galvanometer of the sensitivity equal to (1—3) 10^{-9} A/mm, the internal resistance 4 kΩ and the critical resistance 50 kΩ. Among the precursors of the colorimeter system Barnes and Somkuti should be named [3].

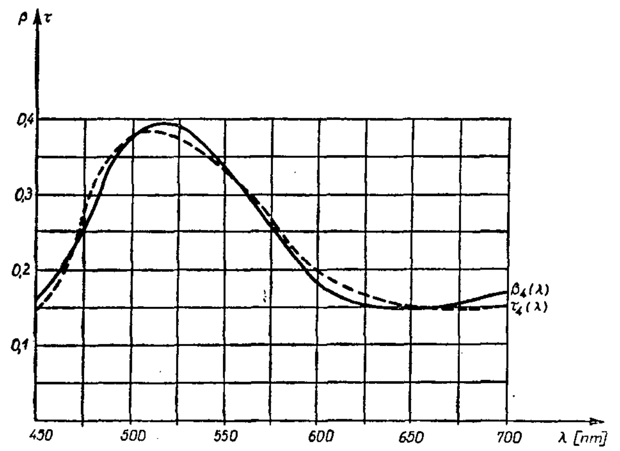

Fig. 2. Comparison of the spectral luminance coefficient $B_4(\lambda)$ of a Munssell colour sample 2.5 G 6/6 and the spectral transmittance factor $T_4(\lambda)$ of a matched mosaic filter set

Type of the mosaic filter	Zone I Zone range, filter symbol, thickness	Zone II Zone range, filter symbol, thickness
Receptor used in Lange cells	277°15′ BG 12 ≠ 2 BG 28 ≠ 2	82°45′ BG 18 ≠ 1 VG 4 ≠ 2
Colour 2.5 G 6/6	86°05′ empty	273°55′ GG6 ≠ 2 VG6 ≠ 2

For the sake of examplification the technical parameters of a Schott filter set used for correcting a Lange selenium cell in order to adjust it to the trichromatic spectral component $\overline{w}(\lambda)$ of the uniform system as well as those for a set equivalent to the colour testing sample 2.5 G 6/6 given in the Munsell atlas have been given in the table. The spectral characteristics of the colour are shown in Fig. 2.

A detailed technical description of the MOBAR 70 meter has been published in the Institute of Electrical Engineering Reports [4].

Deviations of the indicator values for the fluorescent tube radiation were equal to about 10 per cent for the prototype, but it is expected that, when applying the new correction methods (see [5] [6]) the accuracy may be improved.

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Refraction of Light at a Moving Boundary

The refraction of light at a moving boundary between two homogeneous optically different media is investigated in this paper. In accordance with the Einstein's principle of relativity a relativistic generalization of the Snellius-Descartes formula has been obtained. In particular formulae which determine the optical properties of slowly moving refractive boundary have been derived.

Introduction

The Fermat principle is the fundamental postulate of geometrical optics. The practically applicable geometrical properties of light (rectilinear propagation in optically homogeneous medium, reversibility of light ray, the Snellius-Descartes law) result directly from the Fermat variation principle. This principle is thus of obvious theoretical importance and investigations in this field are much justified.

In particular the problem of relativistic invariance of the Fermat principle deserves attention. The use of the Minkowski space is natural and the most effective in this case. The Fermat formulation can be properly generalized [1]. Its relativistic invariance is then apparent.

For the instrumental optics the Snellius-Descartes laws are of fundamental importance. The purpose of this work is to obtain a relativistic generalization of the refraction law. The boundary of two homogeneous optically different media is moving. We are concerned with the dependence of the refraction angle (reflection angle) on the incidence angle as seen by an observer moving in relation to the boundary.

The relativistic corrections may prove to be important in certain conditions; using the general formulae will then become necessary. The light aberration may be regarded as an experimental confirmation of the obtained results. The movement of reference frame plays an important role here.

The Variational Principle

In the four-dimensional formulation the Fermat principle is expressed by a propagation four-vector [1]. In our opinion this quantity is worthy of special

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