Use of Aspherical Surfaces in the Design of Magnifiers for Binocular Vision

DURING recent years, renewed and increasing interest has been shown in the use of aspherical surfaces as a means of improving the performance of optical instruments, and one notable application has been to low-power singlet lenses for industrial inspection purposes. Nevertheless, to the best of our knowledge, no serious attempt has hitherto been made to correct these lenses for binocular vision, and as a result of extensive experiments in this connexion it is now clear that a major contribution to the comfort of the user of such lenses over prolonged periods can be made by designing primarily for binocular viewing. It is proposed to publish a more detailed account of this investigation elsewhere; but in the meantime some notes on the more important features of the design may be of interest.

Most designers stress the necessity for freedom from distortion as being the most desirable property of a low-power magnifier. This is at first sight true; but there is, in fact, a defect of much greater significance, not immediately apparent to the user, but which produces to a greater or lesser degree headache, eye-strain and double vision. Take the case of a 6-in. focus lens of $4\frac{1}{2}$ -in. aperture and having spherical surfaces of radii $7\frac{1}{2}$ in. and 5 in. Such a lens is shown in Fig. 1, the section being so chosen as to include the axis of the lens and both eyes, this being the simplest case to discuss as it avoids the use of skew rays. This particular 'bending' of the lens is chosen for various reasons which need not be considered here. An eye relief of 5 in. is also selected for certain reasons, and it will then be found that for most observers a working distance of about 3 in. from the lens will automatically be assumed, because the virtual image will be formed at about 14 in. from the eyes, that is, at a rather greater distance than the least distance of distinct vision. We now consider the images of the section of a plane object as seen by each eye separately and by both eyes taken binocularly.

Fig. 1

These may be determined either trigonometrically or by direct measurement, and are also shown in Fig. 1. A more thorough investigation in which the entire object surface is considered indicates that the section chosen is, in general, that which exhibits the greatest amount of aberration and therefore it provides an adequate basis for further computations.

From an examination of the curves shown in Fig. 1 it will be apparent in particular that, as the edge of

the field is approached, a rapidly increasing separation exists between the two monocular fields, and it will thus be clear that the normal relation between accommodation and convergence must be upset seriously.

Another point to observe is that, due to vignetting, the monocular fields extend considerably beyond the binocular field. In Fig. 1 it will be seen that a sharp discontinuity of viewing conditions will occur at the edge of the binocular field, thereby adding to the discomfort experienced by the user.

By aspherizing one or both surfaces suitably, much can be done to remedy these defects as well as to correct distortion and other optical aberrations, and the curves of Fig. 2 are self-explanatory.

Fig. 2

This result has been achieved by using a conic to generate the surface remote from the eyes, its equation in Cartesian co-ordinates being $y^2 = x(-15 + 10x)$ using the usual sign conventions.

Needless to say, the best results cannot be achieved by restricting the design to conics, and details of lenses employing higher-degree curves will be given elsewhere.

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Life-time for Pair Emission by Spherically Symmetrical Excited State of the O^{16} Nucleus

IN a previous note¹, we reported measurements of the relative probability of emission of electron-positron pairs from the excited state of O^{16} at 5.9 MeV. as a function of the angle between directions of emission of positron and electron. The results of these measurements are, at least approximately, in agreement with the assumption that the transition occurs between two states of the O^{16} nucleus with zero angular momentum and even parity, and is essentially electromagnetic in nature. The absolute probability (that is, the life-time) of such a transition depends on more detailed properties of the two nuclear states involved, although the indication that the process is of an electromagnetic type suggests a value more closely comparable with the short life-times for γ -radiative transitions, rather than the longer times typical of β -decay processes.

We have made measurements of the life-time which confirm this expectation. In a first series of experi-