

A SYSTEM OF OPTICAL DESIGN

*The Basics of Image Assessment and of
Design Techniques with
A Survey of Current Lens Types*

Arthur Cox



THE FOCAL PRESS
LONDON *and* NEW YORK

© 1964 FOCAL PRESS LIMITED

*No part of this book may be reproduced in any
form without written permission of the publishers*

Library of Congress Catalog Number 65-15348

Part I, pages 1-556, printed in Hungary
Part II, pages 557-668, printed in Great Britain
Jackets printed in Great Britain
Bound in Great Britain

PERFORMANCE DIAGRAMS

There is considerable value in having an approximate idea of the performance of an optical system, for which constructional data has been published. It enables a judgment to be made as to whether further work should be carried on, using these data as a starting point.

For this reason the performance diagrams are given in the following pages. In order to enable a rapid scan to be accomplished, a sketch of each design has been included with the performance curves. In this way it is a comparatively simple matter to pick out possible candidates, in terms of complexity, within each group.

With one exception, to be noted below, the constructional diagrams have been drawn with the long conjugate of the lens on the left hand side, so that in standard use the light can be taken as going through the lens from left to right. The one exception is for the section on eyepieces. In this case the long conjugate is on the right hand side of the lens, and the "front" of the eyepiece is the surface at the right hand of the diagram. This conforms to the usual way in which an eyepiece is shown in the layout of an optical system.

The performance is indicated in approximate terms by the following graphs:

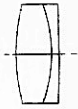
- (a) *Spherical aberration, measured by the longitudinal aberration δs . When the spherical aberration is under-correct then δs is negative;*
- (b) *Offense against the Sine Condition, which indicates the presence or absence of coma in near central regions of the field;*
- (c) *Sagittal astigmatism, measured by the longitudinal aberration δs . When the sagittal focus lies closer to the lens than the paraxial focal plane then δs is negative;*
- (d) *Tangential astigmatism, measured by the longitudinal aberration δt . The sign convention is the same as in (c);*
- (e) *The radial distortion, measured in per cent deviation of the radial distance of the image from the centre of the field. When the deviation is positive the actual image is at a greater distance from the centre of the field than the ideal image.*

All calculations are based on a nominal focal length of 1.000 inches.

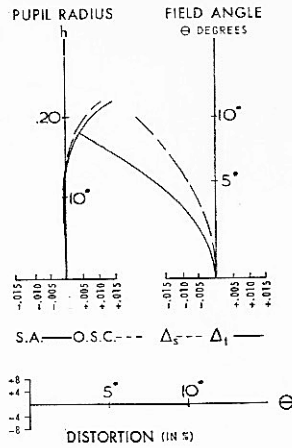
For completeness the Petzval Sum is also given, as well as the back focus of the lens and its overall length.

These values have been calculated at the Bell & Howell Company. When no field or aperture values are specified in the patent literature the computers have been programmed to stop whenever the numerical value of δs or δt exceeds 0.015.

TYPE I



E.F.L. 1.000
 B.F.L. .925
 OVERALL LENGTH .135
 PETZVAL SUM .671

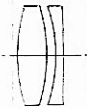


Design Example Number: 1-01

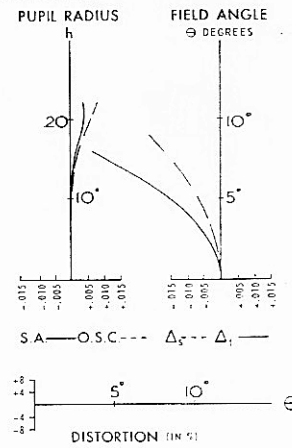
| | ρ | τ | μ | V |
|----|---------|--------|-------|------|
| 1. | 1.5400 | .110 | 1.617 | 55.0 |
| 2. | -2.2300 | .025 | 1.720 | 29.3 |
| 3. | -.2975 | | | |

Stop Position: On ρ_1

TYPE I



E.F.L. 1.000
 B.F.L. .872
 OVERALL LENGTH .142
 PETZVAL SUM .614

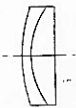


Design Example Number: 1-02

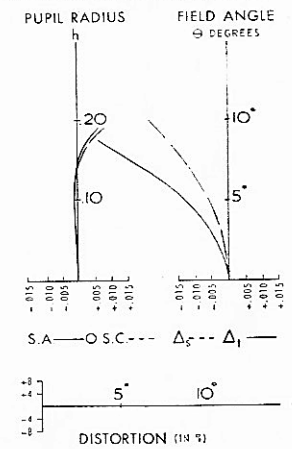
| | ρ | τ | μ | V |
|----|---------|--------|-------|------|
| 1. | 1.7900 | .090 | 1.620 | 60.3 |
| 2. | -1.5050 | .027 | | |
| 3. | -1.7900 | .025 | 1.720 | 29.3 |
| 4. | -.2466 | | | |

Stop Position: On ρ_1

TYPE I



E.F.L. 1.000
 B.F.L. .928
 OVERALL LENGTH .102
 PETZVAL SUM .659

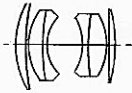


Design Example Number: 1-03

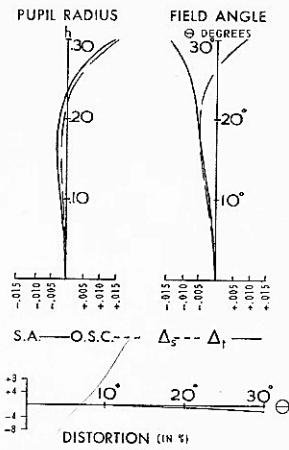
| | ρ | τ | μ | V |
|----|--------|--------|-------|------|
| 1. | 2.0100 | .027 | 1.720 | 29.3 |
| 2. | 3.8600 | .075 | 1.617 | 55.0 |
| 3. | .1024 | | | |

Stop Position: On ρ_1

TYPE 12



E.F.L. 1000
 B.F.L. .724
 OVERALL LENGTH .622
 PETZVAL SUM .193
 PATENT No. 2,831,396 Table A
 DESIGNER G.KLENT
 M



Design Example Number: 12-04
 Patent No. U.S.P.: 2,831,396, Table A

| | ρ | t | μ | V |
|-----|---------|-------|--------|------|
| 1. | 1.8238 | .0671 | 1.6700 | 47.2 |
| 2. | .6400 | .0127 | | |
| 3. | 2.5208 | .0893 | 1.6935 | 53.5 |
| 4. | .5941 | .0352 | 1.6645 | 35.9 |
| 5. | 3.8625 | .2121 | | |
| 6. | -3.3113 | .0317 | 1.6398 | 34.6 |
| 7. | 1.1089 | .1188 | 1.6584 | 50.8 |
| 8. | -2.3883 | .0021 | | |
| 9. | .0424 | .0525 | 1.7447 | 44.7 |
| 10. | -1.2947 | | | |

Stop Position: .10 Forward of p_6