

# **THE OPTICAL DESIGN OF REFLECTORS**

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**SECOND EDITION**

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**William B. Elmer**

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A volume in the Wiley Series in Pure and Applied Optics—  
Stanley S. Ballard, Founder; Joseph W. Goodman, Advisory Editor

# The Optical Design of Reflectors

**WILLIAM B. ELMER**

**SECOND EDITION**

*John Wiley & Sons, New York/Chichester/Brisbane/Toronto*

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*Library of Congress Cataloging in Publication Data:*

Elmer, William B

The optical design of reflectors.

(Wiley series in pure and applied optics)

Bibliography: p.

Includes index.

1. Reflectors, Lighting—Design and construction.
2. Reflection (Optics) I. Title.

TH7970.R4E37 1979

621.32'2

79-14206

ISBN 0-471-05310-4

Printed in the United States of America

10 9 8 7 6 5 4 3 2 1

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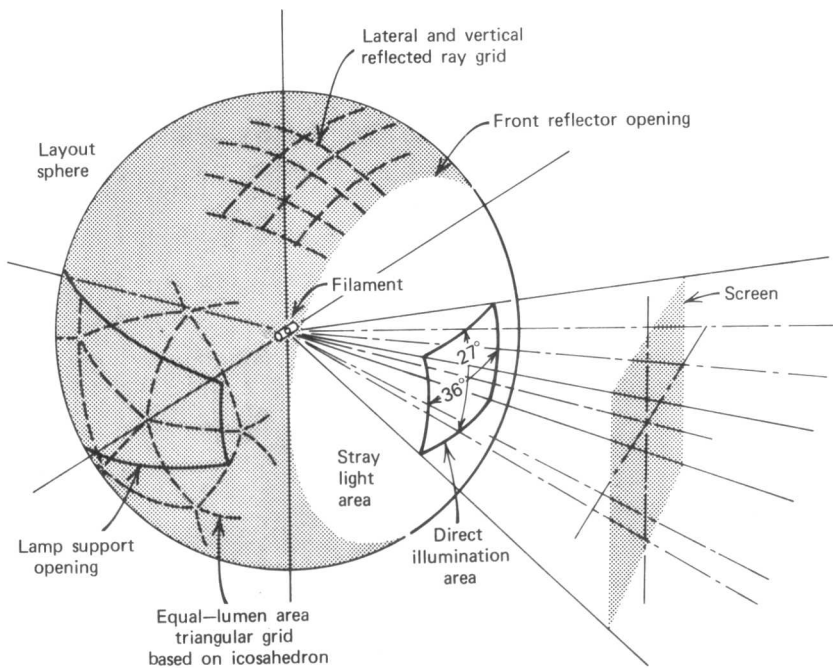
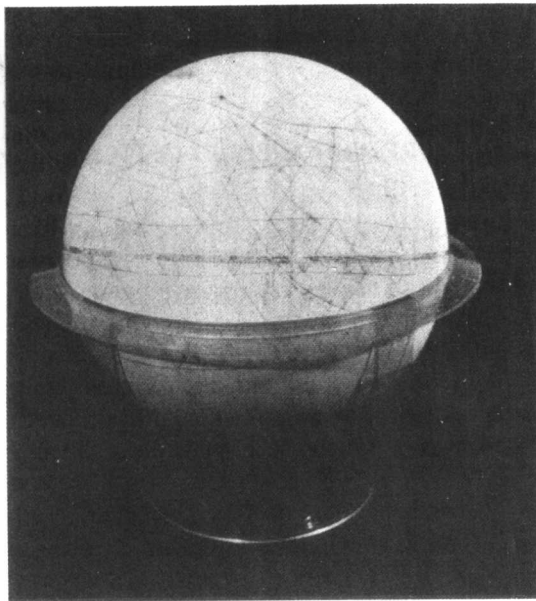
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Spherical drafting board used in design of asymmetric reflectors.

*To my mother Clarabelle  
that tiny, mad idealist and most  
unwitting coauthor*

*The single most important book ever written is  
Euclid's Geometry, since it taught men to think rationally.*

HUNTINGTON CAIRNS

*Euclid alone has looked on beauty bare.*

EDNA ST. VINCENT MILLAY

# FOREWORD

If Brahms felt he must wait 20 years before releasing his first symphony because he "ever heard the tramp of giants behind him," why should I be apologetic for having waited until my seventies to produce this book? My object is to preserve and transmit what I have learned about designing reflectors during the practice of nearly 40 years, so that others may benefit. Since I am a practitioner rather than an academician, most of the subject here presented had to be evolved as original work in order to satisfy the multitude and variety of demands arising from lighting tasks all the way from the depths of the ocean and the bottoms of coal mines to the surface of the moon. All this substance has been verified in practice. It is not armchair theory and I am not a doctor (anyhow, whoever heard of "Dr." Euclid?).

I have been helped more by men long dead and gone than by my living peers (not to underestimate the magnificent contributors of the latter group!) and I find it profoundly moving and a source of regret that I cannot reach back through the centuries to express my gratitude to those who working during such primitive times were able to leave such a marvellous legacy. I am fortunate to have flourished during this (transient?) crest of human culture, enjoying the use of superb tools, often in luxurious surroundings, to make this task easier. I was surprised to discover that one theorem by Sir Christopher Wren will probably outlast his finest architecture. This gives me hope that some of this work may outlast the millions of lights I have designed or influenced and that are burning usefully throughout the world.

I also hope that these pages will stimulate the further evolution of reflector optics, which, strangely, have stagnated for so long. Kirk Reid and Henry Chanon of NELA Park first aroused my intense admiration for this art. I owe much to my departed friend and patron C.A.B. Halvorson, who once collaborated with Thomas A. Edison himself; also to General Electric's prolific Frank Benford, whom I regret having never met. I owe a debt to the "Ex-Prodigy" Norbert Wiener in whose mathematics

classes I was undistinguished; to many admirable younger contemporaries of whom S. Christopher Peek, Allyn White, and Kenneth White are a few; and many others whose recognition and patronage helped immeasurably to make this labor possible.

WILLIAM B. ELMER

*February 1974*



## PREFACE TO THE SECOND EDITION

Having completed my work on the second edition of this book I am not sure whether I should apologize for delaying its appearance until almost the age of eighty or should feel deserving of congratulations for my persistence in completing it regardless of age. In any event, an old man may perhaps be pardoned for a personal intrusion into the technical scene.

During the nearly five years since the first edition was published I have been vastly cheered and recompensed for my efforts by the reception the book has received. (One English secretary even expressed the hope that I would write an autobiography!) Among the many accolades, perhaps the crowning one was that given by my erstwhile employer of more than 30 years ago, the Westinghouse Company's *Lighting Division*, when its engineering manager W. M. Waldbauer wrote: "Your original design concepts . . . are still cited to new engineers as an outstanding example of creative design which opened up entirely new concepts of *Roadway Lighting*."

I have never been driven by the "publish or perish" threat. The University of Rochester invited me to give a colloquium at its Institute of Optics, and I owe a debt of gratitude to that presiding dean of optics, Professor Rudolph Kingslake, for his valued recognition.

Also to the excellent and mature Franz Euler, who came to me asking for tutelage, I owe much gratitude. His discerning comments resulted in several necessary corrections in the book.

I am indebted to Fred Gronberg of Flash Technology and to the ILC Corporation, whose physicist, Helen Gourley, only recently made clear to me the need for the new theory of the diffuse reflector first published here.

I must add my belief that I owe my bent to those five Yankee village blacksmiths from whom I am sprung, and I say to them that I am one of you; truthfully, I am only a partially educated blacksmith.

And to my Colonial progenitor Edward I say I am sorry that you were killed by an Indian; nevertheless my greatest good fortune of all was your gamble in shipping to this land of opportunity so long ago.

And to *his* grandfather John, who was a doughty Bishop of London, perhaps I owe my monastic devotion to a lifework.

Finally, I am uncommonly fortunate to have been granted these still busy, useful, and fascinating years. My perspective is now exceptionally far-reaching. Memories of a childhood when gas mantles were the latest and best in residential lighting, horsecars still ran, and the airplane had not yet taken off seem unreal in this year 1979. And I remember my astonishment as a tongue-tied adolescent when, during high school graduation, I was given a \$5 gold piece for excellence in mathematics. These and countless other memories intensify my thankfulness for the lifelong panorama that I have been given to witness and for the conviction that I will (all too soon) have left behind something of more than ephemeral value.

During World War II I designed an engine of war that sank ships and drowned men. I often wonder, in the final reckoning, if this black mark has been fully expunged by the many lives my lights have saved.

I can think of no finer occupation than mine. The Carpenter's occupation was noble. But his Father's was more sublime. The most magnificent, beautiful, dramatic, theatrical, and moving passage in the English language, little read today, culminates in the sixteenth verse of Genesis 1: "And God made two great lights. . . ."

WILLIAM B. ELMER

*Andover, Massachusetts*  
*April 1979*

# CONTENTS

Figures, xvi  
Tables, xix  
Theorems, xx

## **Introduction** **1**

### **PART 1 REFLECTOR OPTICS**

## **Chapter 1 General Reflector Characteristics** **9**

- 1.1 Dual Nature of Luminaire Optics, 9
- 1.2 General Reflector Phenomena, 10
- 1.3 "Brightness" versus "Flux" Engineering, 19
- 1.4 Congruent Reflectors, 20

## **Chapter 2 Reflecting Materials** **22**

- 2.1 Specular Surfaces, 25
- 2.2 Diffuse Surfaces, 26
- 2.3 Spreading Surfaces, 27
- 2.4 Combination Surfaces, 30
- 2.5 Absorption and Regradation, 34
- 2.6 Selective Reflection—Dichroics and Transflectors, 35

## **Chapter 3 Geometric Foundations of Reflector Design** **37**

- 3.1 Geometry of Curved Surfaces "In the Small," 37
- 3.2 Classical Hyperbolic (Conic) Sections, 42
- 3.3 Rationale of Focal Curves, 48

**Chapter 4 Curve Generation** **54**

- 4.1 Curves for Remote Tasks, 54
- 4.2 Curves for Proximate Tasks, 55
- 4.3 Curves by Ray Tracing, 55
  - 4.3.1 *Geometric Basis for Ray Tracing*, 56
  - 4.3.2 *Curve for Remote Task—Compact Source*, 65
  - 4.3.3 *Curve for Proximate Task—Compact Source*, 67
  - 4.3.4 *Curves for Large Sources*, 68
  - 4.3.5 *Phantom Light Center*, 69
  - 4.3.6 *Extinction Curve*, 71
- 4.4 Curves by Calculation, 72

**PART 2 DESIGNING THE REFLECTOR**

**Chapter 5 The Specification** **79**

- 5.1 Types of Specifications, 79
- 5.2 Some Attributes of the Eye, 81
- 5.3 Some Visibility Factors Influencing Luminaire Design, 82

**Chapter 6 Specular Reflectors for Remote Tasks** **85**

- 6.1 Determining the Angle Function, 85
- 6.2 Specular Focal Reflectors, 88
  - 6.2.1 *Concentrating Beams—The Paraboloid*, 88
  - 6.2.2 *Concentrating Beams—The Ellipsoid*, 89
  - 6.2.3 *Hyperbolic Beams*, 91
  - 6.2.4 *Revolved Parabolic Beams*, 92
  - 6.2.5 *Extinction Reflectors for Sharp Cutoff*, 92
- 6.3 Regular Nonfocal Specular Reflectors—Compact Source for Remote Tasks, 95
  - 6.3.1 *Circular Reflectors for Round Beams—Compact Source*, 95
  - 6.3.2 *Use of Zonal Constants*, 98
  - 6.3.3 *Long Trough Reflectors for Rectangular Beams—Compact Source*, 105
  - 6.3.4 *Symmetrical Beams from Large (Macroscopic) Sources*, 111
- 6.4 Specular Bowl Reflectors for Asymmetric Beams—Compact Source, 111



**PART 3 OPTICAL CONSIDERATIONS IN LUMINAIRE  
MECHANICAL DESIGN AND PRODUCTION**

**Chapter 11 Luminaire Mechanical Design Details Affecting Optics 189**

- 11.1 Edges, Holes, Joints, and Fasteners, 189
- 11.2 Reflector Housings, 190
- 11.3 Supports, 191
- 11.4 Lampholders, 191

**Chapter 12 Reflector Production as It Affects Optical Performance 192**

- 12.1 Tolerances, 192
- 12.2 Fabrication Miscellany, 193

**Chapter 13 Optical Accessories for Reflectors 196**

- 13.1 Visors, Shields, and Louvers, 196
- 13.2 Screens, 198
- 13.3 Guards, 198

**PART 4 PREDICTING AND VERIFYING LUMINAIRE  
OPTICAL PERFORMANCE**

**Chapter 14 Predicting Specular Reflector Beams 201**

- 14.1 Calculating the Performance of Specular Reflectors, 202
  - 14.1.1 *Red-Green Diagram*, 202
  - 14.1.2 *Calculating Reflector Beams*, 203
  - 14.1.3 *Reflector Beams from Luminous Areas*, 208
  - 14.1.4 *Parabolic Beams*, 211
- 14.2 Symmetrical Noncircular Beams, 211
- 14.3 Asymmetric Beams, 214

**Chapter 15 Predicting Diffuse Reflector Beams 215**

- 15.1 Estimating the Reflected Beam Shape, 215
- 15.2 Estimating the Complete Beam, 217

Chapter 16 Verifying Luminaire Optical Performance 218

# FIGURES

FIG.  
NO.

- 1 Polar diagram of direct and reflected beams, with expanded zero, 10
- 2 Mirror action, Experiment 1, 11
- 3 Mirror action, Experiment 3, 12
- 4 Mirror action, Experiment 4, 13
- 5 How lamp position in reflector governs image size, 16
- 6 Some varieties of beams, 18
- 7 Lamp characteristics—brightness, efficacy, spectral, and spatial, 20
- 8 Reflection diagram, 24
- 9 Varieties of reflector characteristics, 29
- 10 Percent of light reflected from specular surfaces of some transparent media in air, 33
- 11 Curvature, 39
- 12 Focal curves, 40
- 13 Proof of hyperbolic ("conic") sections, 45
- 14 Focal curves of different elongations with common focal length, 47
- 15 Focal curves in planes cutting hyperbolic surfaces illustrating Theorem 1, 52
- 16 Slope of a tangent to a curve in terms of incident and reflected ray angles, 55
- 17 Angles between any pair of focal lines, bisected by tangents to points on a focal curve, 56
- 18 Proof of Theorem 3, 58
- 19 Tangents intersecting on bisectors of focal angles of ellipse, 59
- 20 Tangents intersecting on bisectors of focal angles of hyperbola, 60
- 21 Focal curves at any angle through a random point located with respect to a common focal point on the major axis, 62
- 22 Curve guide shown with normals to curve, 63
- 23 Errors caused by improper curve drawing, 64
- 24 Joining tangents to ray traced curves, 66



FIG.  
NO.

- 25 Section of ray-traced proximate trough reflector, 67
- 26 Phantom light center, 70
- 27 Ray-traced extinction curve, 72
- 28 General reflector equation, 73
- 29 Brilliance and illumination ranges, 81
- 30 Angle relationships in asymmetric beam, 86
- 31 Parabola drawn with string and T-square, 89
- 32 Constructing parabola, 89
- 33 Ellipse drawn with string over pins, 90
- 34 Elongation  $E$  of spheroidal reflectors, 91
- 35 Hyperbola drawn with string and pivoted rule, 92
- 36 Revolved (gyrated) parabolas, 93
- 37 Extinction curves, 95
- 38 Integrating light flux mathematically, 96
- 39 Use of zonal constants, 98
- 40 Isoradiant spheroid, 101
- 41 Isoradiant hyperboloid, 104
- 42 Section of infinite length trough reflector, 106
- 43 Trough reflector curves, 108
- 44 Calculating tangent angle to reflector curve in  $XY$  plane. General case: incident and reflected rays outside  $XY$  plane, 113
- 45 (a) Reflection from rotating mirror: (b) light rays in two cones, 115
- 46 Finding tangent to reflector curve when reflected ray is outside plane of curve, 116
- 47 Finding tangent to reflector curve when incident ray is outside plane of curve, 118
- 48 Finding tangent to reflector curve when neither incident nor reflected ray is in plane of curve, 119
- 49 Reverse protractor, 121
- 50 Ray tracing for proximate circular task, 125
- 51 Deep diffuse reflector, 132
- 52 Shallow diffuse reflector, 132
- 53 Other diffuse reflectors, 133
- 54 Diffuse reflector of uniform surface brightness, 140
- 55 Large lamp in small reflector, 147
- 56 Divided convergent reflector for large lamp, 148
- 57 Classical reflector ray arrangements, 149
- 58 Spill locus, 156
- 59 Lamp interference boundary, 157
- 60 Hybrid bowl reflector for rectangular beam, 162