KG
11366
150

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AG 11366.150

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12 inch Object Glass

✓ O. 3786 (543) ~~O. 1910 (543)~~ Jena Barytа Leight Flint
(13 ± diam × 1 3/4 ± thick)

✓ O. 1479 (93) Jena Ordinary Silicate Flint
(12 3/4 ± diam × 1 1/4 ± thick)

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Schott & Co.'s Invoice Oct. 28th 1903.

1 disk	Barylin Light Flint 0.1910 320/38-40 m/m	430.00	Marks
1 "	Ordinary Silicate Flint 0.1479 320/40 m/m	430.00	"
	Packing	2.00	"
	Consular Fees	11.45	"
		873.45	"
	less ½ % for prepayment	4.35	"
	Total =	869.10	"

Draft sent Oct 5th (W. W. Jacobs & Co.) $206.35
" " Nov. 11th " 2.75
869.10 Marks = $209.10

- Prisms included -

(1 Mark = 24.05 cents)

Freight & Express Charges	7.29
Clearance papers. H. Holcombe	1.00
Total cost	$217.39

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Glass arrived November 27th 1903.

The Baryta Glass was correct for size but contained many small bubbles and specks

The Flint was so small that only a 12½ in over all lens could be ground from it. It was nearly perfectly clear. Being too small to use it was returned to Schott & Co. Dec. 10th

See letter to Schott & Co. of Dec. 1903

Express Paid to Jena Dec. 10th 1903	$3.60
G. S. Parker. Box for do.	1.04

The Baryta Leight Flint disc was returned Jan. 30th 1904

Express paid to Jena	$3.65
G. S. Parker Box for do.	.99

Both discs of glass now received from Jena April 27th 1905 each about 13in diam.

Freight & Express charges	$6.81
Clearance Paper - H. Holcombe	1.00
Consular Fees - 10.60 M.	2.62
Previous total cost	217.39
Total cost to April 27th 1905 -	$237.10

Nov. 20th 1905 Express to Alvan Clark & Sons To be tested for strains & striae - .90

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Forward $238.00

Feb. 10th 1906 Alvan Clark & Sons
Polishing faces & testing for imperfections $17.80

Aug 29th 1906 Alvan Clark & Sons
Grinding and centering 190.00

June 1st 1907 H. B. Tuttle & Co.
Patterns for cell 10,70

June 5th 1907 I. C. H. & Co.
67½ lbs. Bronze Castings for cell 18.87
Express & Alvan Clark & Sons. 1.00

July 19th 1907 Alvan Clark & Sons
Check C.P.H. on account 300.00

November 7th 1907 Alvan Clark & Sons
Check. I. 2 H & Co. balance for polishing and figuring. 381.95

March 24th 1908 Alvan Clark & Sons 146.00

Dec. 14 1909 Taxicab - Clarks to Depot 3.00

1307.32

17.80
190.
681.95
889.75
146.
1035.75

Box (Parker)

Clark =

17,80
190,00
300,00
381,95
146,00
1035,75

Paid Clark & Sons 1035,75
" for glass 237,10
Patterns & casting for cell &c } 36,47
Express, box, &c
1309,32

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– Mounting –

Patterns – Lerase & Johnson

June 10 to July 30th 1909 –			$ 69.46
Aug 21	Worm Gear, 15.94 Sept 10 1.25		17.19
Oct 7	Arm. 5 patterns		13.39
" 23 & Nov. 4 1909 –	Decl. clamps.		11.61
Dec 14			.56
			$ 112.21

Iron Castings – Taylor & Fenn –

July 13 & Aug 4th		14.48	
Sept 13th	Whel – 115 lbs	5.75	
Oct 9	~~Block~~ Arm 39 lbs	1.95	
" 16 & Nov. 9th		1.50	23.68

Dec 17. Cir weights for eye end, inside, 32 lbs 1.60

Malleable Iron Castings – Vulcan I. Wks.

June 26th	Tube Trunnion 57 lbs @ 8	4.56	
Aug 20th	N.B. Fork &c Castings 47 @ 9	4.23	8.79

Machinery Steel – Ensworth

July 23rd	3½" rd for collar. & cutting off	1.15

Screws, Bolts & Nuts ~~Hfd.~~ Mach. Screws

July 17, Aug 10		3.63	
Oct 5		.89	4.52

Lumber – Edwin Taylor Lumber Co.

Oct 14	5×5, 2×10, 7×7 S. Pine	34.59	
Nov. 17	Sheathing for Top & bottom (ends)	3.38	37.97
			188.32

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Mounting – continued – forward 188.32

L. E. Rhodes –	Aug 11	103.52	
	Sept. 2	80.76	
Incl. Gear Wheel	Oct 14	72.30	
Iron.	Nov. 1	20.46	
Dec'l clamp	" 26	24.74	
& Weights under eye end.	Dec 29	3.33	305.11

Besemon & Bostwick			
Gal Iron Tube, &c	Sept 9	42.72	
" "on Polar Axis	Dec 8	21.54	64.26

Alvan Clark & Sons			
Tail Piece –	Sept. 23		150.00

Incl Cl & Tell &c.
12" Brass bearings – Dbl H & Co 3.12
Patterns, included in items on p. 4. $9.24 July 14.
Express 1.30
Total 163.66

G. S. Parker –			
Woodwork &c	Dec 8		92.80

Foundations –

Am. Bridge Co.	2-6" Channels, Cleats	3.00	
J. L. H. & Co.	2-5/8 rods, Nuts & Channel.	2.90	
"	2-3/4 1½" x 27" anchors	.80	
Dowling	Old piece pipe – 3-5/8" tie Bolts, 8-3/4" Pipes S.P.S.	00	
Richard Johnson Masonry	Dec 20	50.68	57.38

Erecting –	Bill Bros.	Dec 8	11.58
Painting	J. C. Clark	Jan 6	10.66
		Forward to p. 8	880.11

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1904 **Cost of Centering Chuck**

		Patterns (Leitle & Co)		$ 3.80
Dec 31(03)		46-4 Iron Castings	5	2.30
Jan 6th		"Screws" Hfd Mch Screw Co.		.60
" 4 }	27½ hrs	Boardman	@ 27½	7.52
to 9 }	1	Parker	33	.33
			S. E.	3.92
				$ 18.47

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Cost of Setting up Grinding Machine

Dec 11 hrs Boardman

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Mounting – continued – from p. 5

Forward –		880.11
Lead weight – 113 lbs	J.H. Hobbs.	6.50
2 Bronze Ball Bearing Collars.		
5 Steel Collars. abt 3/4" diam	J.H. Hobbs	
3 " Washers.		
Bronze castings	$0.33	
Steel rod ft.	—	
32 Steel balls 3/8"	.15	
Labor + S.E.	36.18	36.66

Tie Rods with Nuts + Washers.

8, 3/8"
8 + 9, 5/8"
4 + 2 9, 1/2"

6.39

929.66

Motor – N. E. Engineering Co Nov 17. 12.75

~~Cost to Jan 1st 1910~~ $942.41.

Object Glass, brought to Hartford Dec 14th 1909 and put in tube Jan. 1st 1910.

Omitted from above. Dec. 17 – 32 lbs cast iron weight 1.60

6 lbs Balls for Decl. Bearing
12 " Eye end – Tail Pier
1 1/4 for Weight – Ob. End } 19 1/4 lbs Bronze castings 5.00

Screws + Washers .65

Express. 3.00

Cost to Jan 1st 1910 $952.66

Dec. 17th 1909 32 lbs 1.60
3 weights – Thin .25
May 20 1910 Tools. Rhodes. 15.15
Oct 1910 3 rolls " 1.80
Jan 30 1911 2 2 " " upper 26.15

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Eye Pieces Lundin

1905	"Airy" low power	lenses 15.00 brass 5.00	$20.00
"	" 1"		10.00
Nov. 15, 1910	Huygheneian	1 3/4"	15.00
"	"	3/4 "	6.00
"	"	1/2 "	6.00
	"	1/3 " (Clark 1878)	
	"Airy"	3/4 . 1/2 and 1/3" Dec. 1915	24.00

Sept 22 1910 Sun diagonal 10.00

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Nov. 1905

Color

Prisms from each kind of glass made by Mr. Leundin
Index of Refraction measured as follow.

	Baryta L. 7.		Silicate Flint	
	0.3786 (543)		0.1479 (93)	
7	1.572231	7894	1.635122	12354
D	1.564337	32354	1.622768	4963
b	1.561102	11129	1.617805	17317

$n'_7 - n'_c$ = .0.17317 = 8.23847

$n_7 - n_c$ = .0.11129 = 8.04646

0.19201

$n_D - 1$ = .56434 = 9.75154

.87811 = 9.94353

$n'_B - 1$ = .62277

0.25534 = 9.40712

B = 3.9163 = 0.59288

0.19201

A = 6.0938 = 0.78489

$\frac{}{n'-n'}$ $\frac{}{n-n}$

.012354 = C × .007894 + J × .000062316
.004963 = C × .003235 + J × .000010466
.012109 = C × .007894 + J × .000025539
.000245 = J × .000036777

J = 6.817

.007894 = 7.8973 × 2 = 5.7946
.003235 = 7.5099 × 2 = 5.0198
0.3874 0.3874

.004963 7.6957 5.4072

8.0831

6.3992
5.5656
J = 6.817 = 0.8336
B = 0.5929
Sn_F^2 = 5.7946
$S\varphi_F$ = .001664 = 7.2211



This indicates an unusually good color correction.

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April 1908 Color - continued

	n Barylite L. F.	n' Silicate Flint
p. 102.	0.3786 (543)	0.1477 (93)
F	1.572246 ✓	1.635116 ✓
	6224 ✓	9792 ✓
5614	1.566022 ✓	1.625324 ✓
	6123 ✓	9327 ✓
B	1.559899 ✓	1.615997 ✓
	.012347 ✓	.019119 ✓

$n_F - n_B = .012347$ ✓ = 8.09156
0.18991 ✓

$n'_F - n'_B = .019119$ ✓ = 8.28147 ✓

$n_{5614} - 1 = .566022$ ✓ = 9.75283 ✓
$.87648$ ✓ = 9.94274 ✓
$n'_{5614} - 1 = .625324$ ✓

$.25116$ ✓ = 9.39995 ✓
$B = 3.9815$ ✓ = 0.60005 ✓
0.18991 ✓

$A = 6.1654$ ✓ = 0.78996 ✓

Finished O. G.
Separation = 0.815
p178 and 186.

$B = 4.2342$

$A = 6.3055$

$n' - n$

.009792 ✓ = C × .006224 ✓ + J × .000038738 ✓
.009327 ✓ = C × .006123 ✓ + J × .000037491 ✓
.009481 ✓ C × .006224 ✓ + J × .000038095 ✓
.000311 ✓ = J × .000000629 ✓

see p104 J = 4.103 J = 4950 ✓ Error

F - 5614 .006224 ✓ = 7.79407 ✓ × 2 = 5.58814 ✓
5614 - B .006123 ✓ = 7.78696 ✓ × 2 = 5.57392 ✓
0.00711 ✓ 0.00711 ✓
.009327 ✓ = 7.96974 ✓ 5.58103 ✓
7.97685 ✓

Error. see p104 → J = 4950 = 6.4927 ✓
3.799 ✓
= 2.6937 ✓
B = 0.600 ✓
δn_F^2 = 5.588 ✓
= 8.881 ✓

(for B 5614 + F)

Finished O. G. $\delta\varphi_F = \frac{0.1345}{180} = 0.000753$

$\delta\varphi_F = .0760$
$\delta\varphi_F = .000650$ just as before. see p 187

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1903phae.proj.11527

Index of Refraction

see p. 102 & 103 Spectrometer p 107

Baryta Light Flint (0.3786)

Ray	n	log n	log (n-1)
B	1.5-5-9893 (959) +66	0.1930948 ✓	9.74810 ✓
C	1.5-61102	0.1934312	
$D_{\frac{1+2}{2}}$	1.5-64337	0.1943302	
5614	1.5-66031 (61) -50	0.1948004	
1st line	1.5-66616	0.1949625 ✓	9.75329 ✓
b_1	1.5-69256	0.195-6938	
F	1.5-72231 (93) -62	0.1965-163	9.75757
calculated	1.573339	0.1968223 ✓	9.75841 ✓
1st line	1.574363	0.1971049	

See p. 212 (204-210) Book for 7= O. 4. Index of Refraction
" " 114 " " " " Ray to combine with B for color correction
" " 107 This book for Spectrometer measures

5-614	o	o	λ
F	.006200	10,60	4 ...
1st line	.008332	14.24	4665-

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Index of Refraction

Silicate Flint (0.1479)

Ray	n	log n	log (n-1)
	P. 107		
B	1.616017 (101) -84	0.2084459 ✓	9.789593 ✓
C	1.617805	0.2089261	
$D_{\frac{1+2}{2}}$	1.622768	0.2102564	
5-614	1.625363 (383) (107) - 19	0.2109504	
1st line	1.626184	0.2111697 ✓	9.79670 ✓
b_1	1.630268	0.2122590	
F	1.635122 (149) -27	0.2135500	9.80286
calculated	1.636 (91) -	0.2140 $\frac{2}{2}$ $\frac{1}{2}$ ✓	9.8040 $\frac{7}{2}$ $\frac{3}{4}$ $\frac{1}{2}$ ✓
1st line	1.638516	0.2144508	

B

$n' = \log 0.2084459$

$n = \quad 0.1930948$

$1.035980 = 0.0153511 = N$

$0.035980 = 8.53606 = N-1$

Nov. 25 1911

C line

25 - 96° 1' 7"

96 1 7

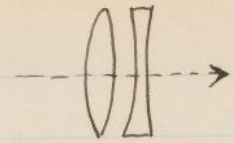
96 1 23

Ave 96 1 12

$n = 1.617830$

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Baryta in Front 

By a preliminary calculation (see p. 123 Book for 7÷ O.G.) both color and spherical aberration would be correct if -

$r_1 = r_2 = 57.096$ $\quad t_1 = 1.07$

$D = 0.500$

$r_3 = 53.494$ concave

$r_4 = 192.362$ concave $\quad t_2 = 0.33$

$f_4 = 178.80 \quad = 180,000$ Eq. 7.

Compare p. 179 the curves finally used.

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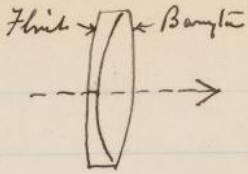
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III

"Flint" in Front



By a preliminary calculation (see page 236 Book for 7 in A. G.) the approximates curves are: B + F united

$r_1 = 216.553$

$r_2 = r_3 = 37.282$ $\quad t_1 = 0.33$

$r_4 = 132.265$ $\quad t_2 = 1.07$

$f_4 = 179.30 = 180.000$ Eq. 7.

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Color

B

F' (calculated sup 22)

I.

K = 6 = 0.778157

r_1 = 216.553 = 2.335356½

i = 1° 35' 15".65 Sin = 8.442588½ i = 1° 35' 15".65 i = sin 8.442588½

n = 0.208447½ n = 0.214007½

λ = 0 5h 56.60 = sin 8.23414 λ = 0 5h 11.61 = sin 8.22858

v' = 0 36 19.05 r_1 = 2.335356½ 0 37 4.04 r_1 = 2.335356½

0.567707½ 0.564147½

sin 8.023837½ sin 8.032717

351.455 = 2.54587 339.966 = 2.531437½

216.553 216.553

f_1 = 568.008 f_1 = 556.519

.330 .330

d_2 = 567.678 d_2 = 556.189

r_2 = 37.282 37.282

530.396 = 2.72460 518.907 = 2.715109

IV. sin v = 8.023837½ sin v = 8.032717

0.748437½ 0.747807

r_2 = 1.557150 r_2 = 1.557150

i = 8° 38' 37".8 = sin 9.176937½ i = 8° 37' 52.0 = sin 9.176307

N = 0.015357 N = 0.017187¼

= sin 9.192287½ = sin 9.193487¼

λ = 8 5h 26.3 r_2 = 1.557150 λ = 8 5h 56.1 1.557150

0 1h 48.5 0.763787½ 0 2 4.1 0.764987¼

v = 0 36 19.05 0 37 4.04

v' = 0 17 30.55 = sin 7.706997 v' = 0 15 59.94 = sin 7.667813¼

1139.71 = 3.056797½ 1250.73 = 3.097167½

r_2 = 37.282 f_2 = 1176.99 37.282 f_2 = 1288.012 f_2 = 1288.012

f_2 = 1176.997 d_4 = 1175.92 f_2 = 1288.012 1.07 d_4 = 1286.94

r_4 = 132.265 132.261

II. d_4+r_4 = 1308.18 = 3.117027½ 1420.28 = 3.152387½

sin v = 7.706997 1.07 7.667813¼

0.824017½ d_4+r_4 = 1419.21 0.820197¼

r_4 = 2.121447½ 2.121447½

i = 2° 53' 23".50 = sin 8.702577 i = 2° 51' 52.25 = sin 8.698747¾

n = 0.193097½ 0.196827¼

λ = 4 30 38.24 = sin 8.895667½ λ = 4 30 34.68 = sin 8.895577

1 37 14.74 r = 2.121447½ 1 38 42.43 2.121447½

v^x = 0 17 30.55 0.017117 0 15 59.94 1.017017½

v' = 1 54 44.29 = sin 8.523417¾ 1 54 42.37 = sin 8.523237¼

311.668 = 2.493697¼ 311.733 = 2.493787¼

r_4 = 132.265 132.261

f_4 = 179.403 f_4 = 179.468

.403

.065

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III

B

d_4 = 1175.92 ✓
r_4 = 132.265 ✓
1308.185 ✓ = 3.11667 ✓
v = sin 7.70699 ✓
0.82366 ✓
r_4 = 2.12144 ½ ✓
2° 53′ 15.00″ ✓ = sin 8.70221 ½ ✓
n = 0.19309 ½ ✓
4 30 24.94 ✓ = sin 8.89531 ✓
1 37 9.94 ✓ 2.12144 ½ ✓
0 17 30.85 ✓ 1.01675 ½ ✓
1 54 40.49 ✓ = sin 8.52311 ½ ✓
311.630 ✓ = 2.49364 ✓
132.265 ✓
f_4 = 179.365 ✓

F′

d_4 = 1286.942 ✓
132.265 ✓
1419.207 ✓ = 3.15204 ½ ✓
v = sin 7.66781 ¾ ✓
0.81986 ¼ ✓
2.12144 ½ ✓
2° 51′ 44.41″ ✓ = sin 8.69841 ¾ ✓
n = 0.19682 ¼ ✓
4 30 22.32 ✓ = sin 8.89524 ✓
1 38 37.91 ✓ 2.12144 ½ ✓
0 15 59.94 ✓ 1.01668 ½ ✓
1 54 37.85 ✓ = sin 8.52294 ¾ ✓
311.700 ✓ = 2.49373 ¾ ✓
132.265 ✓
f_4 = 179.435 ✓

.365
.070 Baryta weak.

Try r_4 = 130.00
d_4 = 1175.92
1305.92 = 3.11591 ¾
v = sin 7.70699
0.82290 ¾
r_4 = 2.11394 ¼
2° 55′ 57.95″ = sin 8.70896 ½
n = 0.19309 ½
4 34 39.61 = sin 8.90206
1 38 41.66 2.11394 ¼
0 17 30.85 1.01600 ¼
1 56 12.21 = sin 8.52886 ¼
307.001 = 2.48714
130.000
177.001

r_4 = 130.00
d_4 = 1286.942
1416.942 = 3.15135 ¼
7.66781 ¾
0.81917
2.11394 ¼
2° 54′ 27.40″ = sin 8.70522 ¾
0.19682 ¼
4 34 39.20 = sin 8.90205
1 40 11.80 2.11394 ¼
0 15 59.94 1.01599 ¼
1 56 11.74 = sin 8.52883 ¼
307.015 = 2.48716
130.000
177.015

.001
.014 Baryta Weak

2.265 : .056 :: x : .014
$\frac{2.265 \times .014}{.056} = .5663$

0.35851
8.1461
8.50012
8.7482
9.75530

r_4 = 130.000
.566
129.434

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1903phae.proj.1152P

B

try $r_4 = 129.434$

$d_4 = \frac{1175.920}{1305.354} = 3.115723\frac{3}{4}$

$\delta = \sin 7.70699$

$0.82271\frac{3}{4}$

$r_4 = 2.11204\frac{3}{4}$

$2^\circ\ 56'\ 39.53 = \sin 8.71067$

$n = 0.19309\frac{1}{2}$

$4\ 35\ 44.59 = \sin 8.90376\frac{1}{2}$

$2.11204\frac{3}{4}$

$1\ 39\ 5.07$

$0\ 17\ 30.53$

$1.01581\frac{1}{4}$

$1\ 56\ 35.62 = \sin 8.53031\frac{3}{4}$

$2.48549\frac{1}{2}$

305.840

129.434

$f_4 = 176.406$

F'

$r_4 = 129.434$

$\frac{1286.942}{1416.376} = 3.15117\frac{3}{4}$

$7.66781\frac{3}{4}$

$0.81899\frac{1}{2}$

$r_4 = 2.11204\frac{3}{4}$

$2^\circ\ 53'\ 9.00 = \sin 8.70694\frac{3}{4}$

$n = 0.19682\frac{1}{4}$

$4\ 35\ 44.78 = \sin 8.90377$

$2.11204\frac{3}{4}$

$1\ 40\ 35.78$

$0\ 15\ 59.94$

$1.01581\frac{3}{4}$

$1\ 56\ 35.72 = \sin 8.53032\frac{1}{2}$

305.849

$= 2.48549\frac{1}{4}$

129.434

$f_4 = 176.405$

leslie correct

To find i_2 and i_3

p. 27

$\sin i = 9.17693\frac{1}{2}$

$n = 0.20844\frac{1}{2}$

$\sin 9.38538$

$i_2 = 14^\circ\ 3'\ 22.3''$

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III

Central

B.

I

$\frac{nr}{n-1}$

$n = 0.20844\frac{1}{2}$ ✓

$r_1 = 2.33536\frac{1}{2}$ ✓

2.54401 ✓

$n-1 = 9.78959\frac{1}{4}$ ✓

$f_1 = 568.090$ ✓ $= 2.75441\frac{3}{4}$ ✓

1.33 ✓

$d_2 = 567.760$ ✓ $= 2.75416\frac{1}{2}$ ✓

$r_2 = 1.57150$ ✓

$4.32566\frac{1}{2}$ ✓

IV

$N = 0.01535$ ✓

$r_2 = 1.57150$ ✓

$1.58685 = 38.6234$ ✓

$d_2 = 2.75416\frac{1}{2}$ ✓

$N-1 = 8.53606$ ✓

$1.31022\frac{1}{2} = 20.4280$ ✓

$18.1954 = 1.25996\frac{1}{4}$ ✓

$f_2 = 1163.33$ ✓ $= 3.06570\frac{1}{4}$ ✓

1.07

$d_4 = 1162.26$ ✓ $= 3.06530\frac{1}{4}$ ✓

$r_4 = 129.43$ ✓ $= 2.11204\frac{3}{4}$ ✓

5.17735 ✓

$n = 0.19309\frac{1}{2}$ ✓

$r = 2.11204\frac{3}{4}$ ✓

$2.30514\frac{1}{4} = 201.903$ ✓

$d = 3.06530\frac{1}{4}$ ✓

$n-1 = 9.74810$ ✓

$2.81340\frac{1}{4} = 650.733$ ✓

$852.636 = 2.93076\frac{1}{4}$ ✓

$f_4 = 176.436$ ✓ $= 2.24658\frac{3}{4}$ ✓

Marginal B = $\frac{176.406}{.030}$

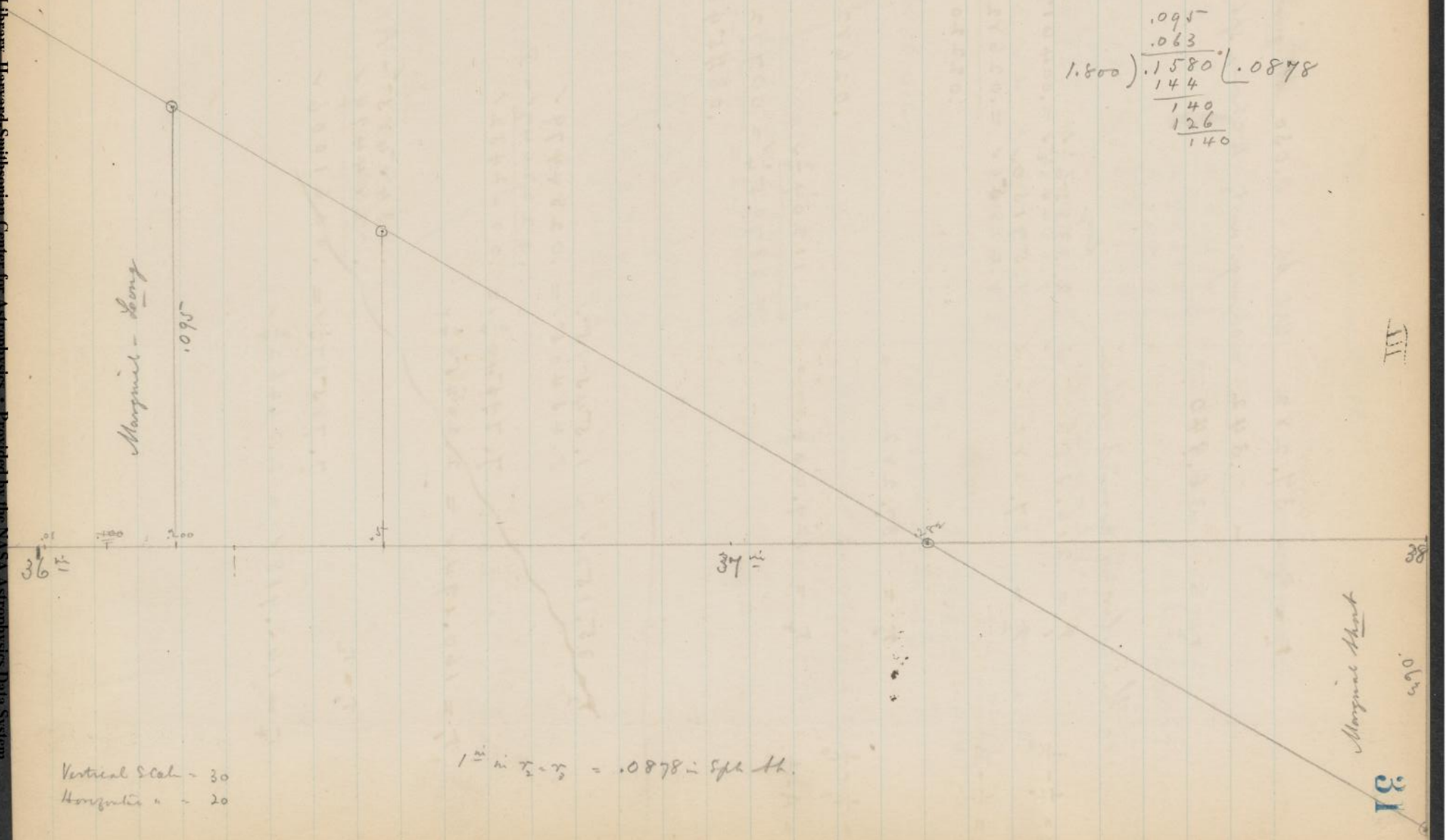
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From pages 224 & 235 Book for 7th Obs.

$f_4 = 179.27$ about

.095
.063
1.800).1580 (.0878
144
140
126
140



Vertical Scale - 30
Horizontal " - 20

$1^m = r_2 - r_3 = .0878 = 5pt$ 11.

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$r_2 = r_3 = 37.282$ Sph. Ab. = 0.030 Marginal short

$- \underline{.342}$ = change in r_2 to change sph ab. 0.030

$r_2 = 36.940$

The color is correct when

$-B = \frac{1}{r_1} - \frac{1}{r_2}$

$\frac{1}{r_1} = \frac{1}{r_2} - B$

		log
$r_1 = 216.5\bar{5}3$	=	$2.335\bar{3}6\frac{1}{2}$ ✓
		$7.664431\frac{1}{2}$ ✓ $= .00461780$ ✓
$r_2 = 37.282$	=	$1.5\bar{7}150$ ✓
		$8.428\bar{4}0$ ✓ $= .0268225\bar{}$ ✓
		$.0222047$ ✓ $= B$

$A = \frac{1}{r_3} + \frac{1}{r_4}$

$\frac{1}{r_4} = A - \frac{1}{r_3}$

$r_3 = 37.282$	=	
		$.0268225\bar{}$ ✓
$r_4 = 129.434$	=	$2.11204\frac{3}{4}$ ✓
		$7.88795\bar{}\frac{1}{4}$ ✓ $= .0077260$ ✓
		$.0345485\bar{}$ ✓ $= A$

$r_2 = 35.\bar{1}52$ ✓ = $1.\bar{5}45\bar{9}5\bar{}$ ✓

$8.\bar{4}5406\bar{}$ ✓ $= .0284479$ ✓

$.0222047$ ✓ $= B$

$7.795\bar{4}0\frac{3}{4}$ ✓ $= .0062432$ ✓

$r_1 = 160.174$ ✓ = $2.20459\frac{1}{4}$ ✓

$.0345\bar{4}85\bar{}$ ✓ $= A$

$.0284479$ ✓

$r_3 = r_2$

$7.785\bar{3}7\frac{1}{4}$ ✓ $= .0061006$ ✓

$r_4 = 163.918$ ✓ = $2.21462\frac{3}{4}$ ✓

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~~B — Spherical Ab.~~

~~Secondary~~

II. $n = 0.208441\frac{1}{2}$

$160.174 = r_1 = 2.204591\frac{1}{4}$

$2.413033\frac{3}{4}$

$n-1 = 9.789591\frac{1}{4}$

$f_1 = 420.190 = 2.623441\frac{1}{2}$

.33

$d_2 = 419.860 = 2.623101\frac{1}{2}$

IV. $r_2 = 35.152 = 1.545495$

$4.169051\frac{1}{2}$

$N = 0.015535$

$r_2 = 1.545495 / 1.56130 = 36.4167$

$d_2 = 2.623101\frac{1}{2}$

$N-1 = 8.53606 / 1.179161\frac{1}{2} = 15.1065 / 21.3102 = 1.328578\frac{3}{4}$

$f_2 = 692.576 = 2.840463\frac{3}{4}$

1.07

$d_4 = 691.506 = 2.839791\frac{1}{2}$

$r_4 = 163.918 = 2.214623\frac{3}{4}$

$5.054421\frac{1}{4}$

$n = 0.193091\frac{1}{2}$

$r = 2.214623\frac{3}{4}$

$2.407721\frac{1}{4} = 255.695$

$d = 2.839791\frac{1}{2}$

$n-1 = 9.74810 / 2.58989\frac{1}{2} = 387.164 / 642.859 = 2.808111\frac{1}{2}$

$f_4 = 176.322 = 2.246303\frac{3}{4}$

~~Marginal~~

$r_2 = 36.940 = 1.567493\frac{3}{4}$

$8.432507\frac{1}{4} = .0270709$

.0222047 = B

$r_1 = 7.68719 = .0048662$

$205.499 = 2.312811$

.0345485 = A

$\frac{1}{r_3} = .0270709$

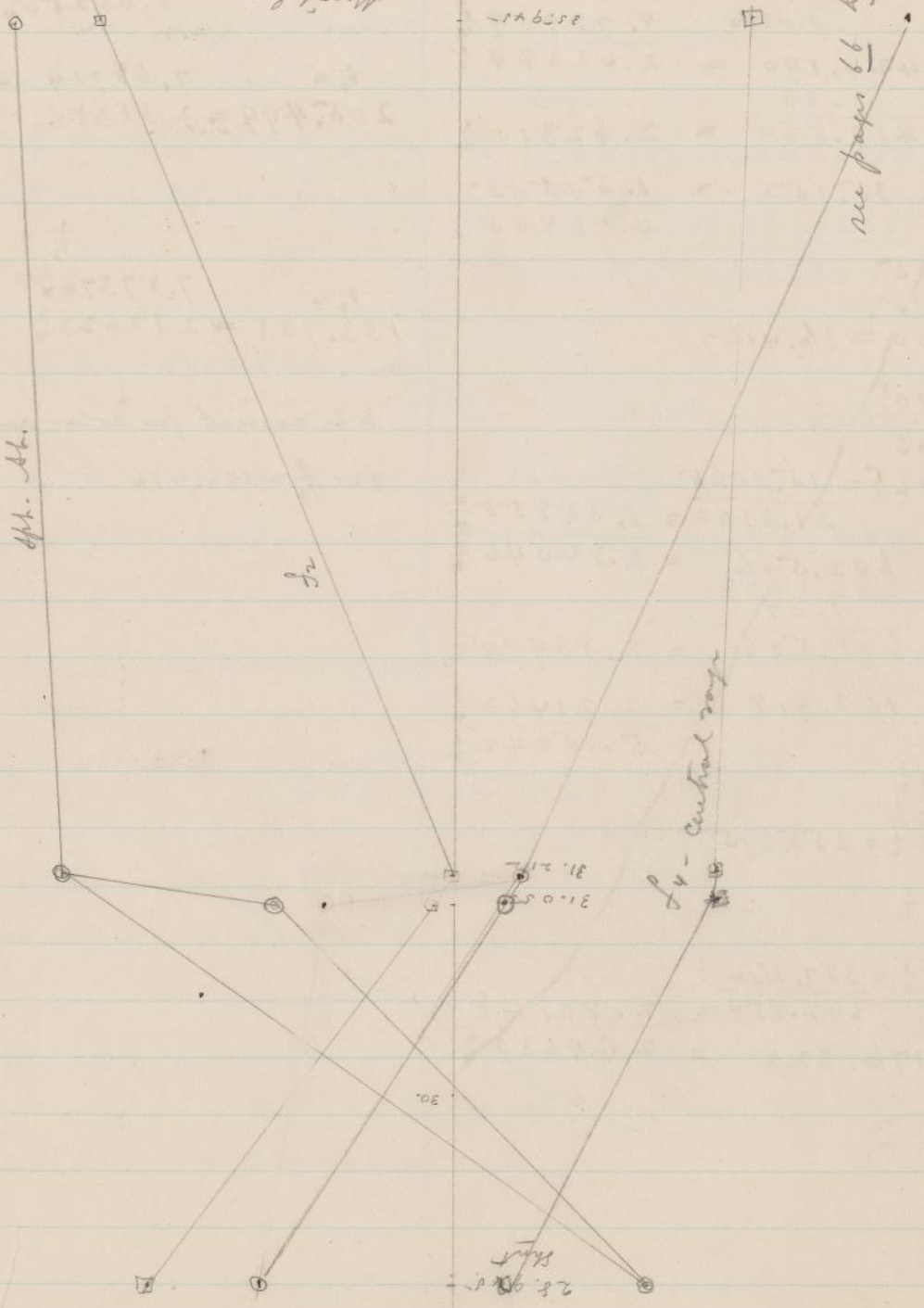
$7.873761\frac{1}{4} = .0074776$

$r_4 = 133.733 = 2.126233\frac{3}{4}$

to be correct for color and Sph. ab. for $f_4 = 176.436$.

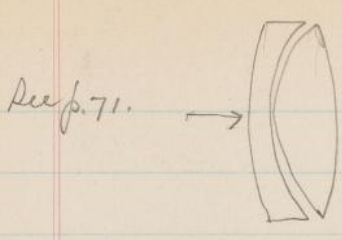
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III

$\tau_1 = 205.499$
$\tau_2 = 36.940$
$\tau_3 = 36.940$
$\tau_4 = 133.733$

$f_4 = 176.436$

For $f_4 = 179.20$ ——— log 2.25358

$\tau_1 = 208.835$ } $t = 0.33$
$\tau_2 = 37.5740$ }

$\tau_3 = 37.5740$ } $t = 1.07$
$\tau_4 = 135.903$ }

176.436 = 2.246583/4
0.00699 1/4
τ_1 = 2.31281
$\tau_1 = 208.835$ = 2.31980 1/4

0.00699 1/4
$\tau_2 = \tau_3$ = 1.57749 3/4
$\tau_2 = 37.5396$ = 1.57449

0.00699 1/4
τ_4 = 2.12623 3/4
$\tau_4 = 135.903$ 2.13323

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Finished A. 4. —

Nov. 11 1908

$r_1 = r_2 = 57.0923$ ✓
$t_1 = 1.0508$ ✓
$r_3 = 54.4901$ ✓ Concave p. 179
$t_2 = 0.3241$ ✓
$r_4 = 193,3632$ ✓ Concave

B

$k = 6 = 0.7781513$ ✓

$r_1 = 57.0923 = 1.7565779$ ✓ $D = 0.815$ ✓ p 186

6° 1′ 57″.080 ✓ = sin 9.0215734 ✓ — 0102 — $n = 0.1930965$ ✓

3 51 46.926 ✓ = sin 8.8284769 ✓

2 10 10.154 ✓ $r_1 = 1.7565779$ ✓

0.5850548 ✓

= sin 8.5781307 ✓

101.6071 ✓ = 2.0069241 ✓

57.0923 ✓

$f_1 =$ 158.6994 ✓

1.0508 ✓

$d_2 =$ 157.6486 ✓

$r_2 =$ 57.0923 ✓

214.7409 ✓ = 2.3319147 ✓

sin 8.5781307 ✓

0.9100454 ✓

$r_2 = r_1 =$ 1.7565779 ✓

8° 11′ 9″.411 ✓ = sin 9.1534675 ✓

$n = 0.1930965$ ✓

12 49 58.325 ✓ sin 9.3465640 ✓

4 38 48.914 ✓ $r =$ 1.7565779 ✓

2 10 10.154 ✓ 1.1031419 ✓

6 48 59.068 ✓ = sin 9.0744078 ✓

106.8400 ✓ = 2.0287341 ✓

57.0923 ✓

$f_2 =$ 49.7477 ✓

F

6° 1′ 57″.080 ✓ = sin 9.0215734 ✓

$n =$ 0.1965204 ✓

3 49 57.552 ✓ = sin 8.8250530 ✓

2 11 59.528 ✓ 1.7565779 ✓

0.5816309 ✓

sin 8.5841674 ✓

99.4176 ✓ = 1.9974635 ✓

57.0923 ✓

$f_1 =$ 156.0995 ✓

1.0508 ✓

155.4591 ✓

$r_2 =$ 57.0923 ✓

212.5514 ✓ = 2.3274641 ✓

sin 8.5841674 ✓

0.9116315 ✓

1.7565779 ✓

8° 12′ 57″.945 ✓ = sin 9.1550536 ✓

$n = 0.1965204$ ✓

12 59 3.661 ✓ = sin 9.3515740 ✓

4 46 5.716 ✓ 1.7565779 ✓

2 11 59.528 ✓ 1.1081519 ✓

6 58 5.244 ✓ = sin 9.0839219 ✓

105.7377 ✓ = 2.0242300 ✓

57.0923 ✓

$f_2 =$ 48.6454 ✓

B F

BF

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Finished D. 9.

B

$f_2 = 49.7477$ ✓
0.8150 ✓
$d_3 = 48.9327$ ✓
$r_3 = 54.4901$ ✓
103.4228 ✓ = 2.0146163 ✓

sin 9.0744078 ✓
1.0890241 ✓
r_3 = 1.7363176 ✓
13° 1′ 7.″868 ✓ = sin 9.3527065 ✓
n = 0.2084406 ✓
8 0 47.453 ✓ = sin 9.1442659 ✓
5 0 20.415 ✓ 1.7363176 ✓
6 48 59.068 ✓ 0.8805835 ✓
1 48 38.653 ✓ sin 8.4996604 ✓
240.3937 ✓ = 2.3809231 ✓

54.4901 ✓
f_3 = 185.9036 ✓
.3241 ✓
d_4 = 185.5795 ✓
r_4 = 193.3632 ✓
7.7837 ✓ = 0.8911861 ✓

sin 8.4996604 ✓
9.3908465 ✓
r_4 = 2.2863747 ✓
7.1044718 ✓
0° 4′ 22.″3601 ✓ = sin n = 0.2084406 ✓
0° 7′ 3.″97268 ✓ sin 7.3129124 ✓
2.2863747 ✓
0° 2′ 41.″6126 ✓ 9.5992871 ✓
1 48 38.653 ✓
1 51 20.266 ✓ sin 8.5102927 ✓
1.0899944 ✓
12.27423 ✓
r_4 = 193.3632 ✓
f_4 = 181.0890 ✓

181.0111 central
.0779

F

$f_2 = 48.6454$ ✓
0.8150 ✓
$d_3 = 47.8304$ ✓
$r_3 = 54.4901$ ✓
102.3205 ✓ = 2.0099626 ✓✓
9.0839219 ✓✓
1.0938845 ✓✓
r_3 = 1.7363176 ✓✓
13° 10′ 4.″766 ✓ = sin 9.3575669 ✓✓
n = 0.2135485 ✓✓
8 0 30.927 ✓ = sin 9.1440184 ✓✓
5 9 33.839 ✓ 1.7363176 ✓✓
6 58 8.244 ✓ 0.8803360 ✓✓
1 48 31.405 ✓ = sin 8.4991774 ✓
240.5241 ✓ = 2.3811586

54.4901
f_3 = 186.0340 ✓✓
.3241 ✓
185.7099 ✓✓
193.3632 ✓✓
7.6533 ✓✓ = 0.8838487 ✓✓
8.4991774 ✓✓
9.3830261 ✓✓

r_4 = 2.2863747 ✓✓
0° 4′ 17.″6780 ✓✓ sin 7.0966514 ✓✓
n = 0.2135485 ✓✓
0 7 1.″3331 ✓✓ = sin 7.3101999 ✓✓
0 2 43.″6551 ✓✓ 2.2863747 ✓✓
1 48 31.405 ✓✓ 9.5965746 ✓✓
1 51 15.″0601 ✓✓ = sin 8.5099572 ✓✓
12.2073 ✓✓ = 1.0866204 ✓✓
193.3632 ✓✓
f_4 = 181.1559 ✓✓
181.0183 central
.1376

181.0890 ✓
.0669 ✓ 7 beyond B
.0072
.0597
.0298

Plotted on p. 187.

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p. 187 Minimum focal length at $n = 1.565150$ ✓ to find corresponding value of n' $n = \log 0.1945360$ ✓

p. 104 $n' = \alpha + \beta n + \gamma n^2$

$= 9.263604^{\checkmark} - 17.691396^{\checkmark} + 10.051766^{\checkmark}$

$n' = 1.623974^{\checkmark} = \log 0.2105791^{\checkmark}$

	9.263604 ✓
	19.315370 ✓
	17.691396 ✓
	1.623974 ✓

p. 187 Ray combined with B $n = 1.570450$ ✓ $= \log 0.1960241$ ✓

$n' = 9.263604^{\checkmark} - 17.751302^{\checkmark} + 10.119956^{\checkmark}$

$n' = 1.632258^{\checkmark} = \log 0.2127888$ ✓

	9.263604 ✓
	19.383560 ✓
	17.751302 ✓
	1.632258 ✓

As finished p. 38 continued

Central

B

$n = 0.1930965$ ✓
$r = 1.756779$ ✓
1.9496744 ✓
$n-1 = 9.7481096$ ✓

$f_1 = 159.0614$ ✓ $= 2.2015648$ ✓
1.0508 ✓
$d_2 = 158.0106$ ✓ $= 2.1986862$ ✓
$r_2 = 1.756779$ ✓
3.9552641 ✓

$n = 0.1930965$ ✓
$r = 1.756779$ ✓
1.9496744 ✓ $= 89.05831$ ✓

$d = 2.1986862$ ✓
$n-1 = 9.7481096$ ✓
1.946795 ✓ $= 88.46996$ ✓
177.52827 ✓
2.2492676 ✓

$f_2 = 50.81534$ ✓ $= 1.7059965$ ✓

D

$n = 0.1965204$ ✓
$r = 1.756779$ ✓
1.9530983 ✓
$n-1 = 9.7573825$ ✓

$f_1 = 156.8613$ ✓ $= 2.1955158$ ✓
1.0508 ✓
$d_2 = 155.8105$ ✓ $= 2.1925967$ ✓
$r_2 = 1.756779$ ✓
3.9491746 ✓

$n = 0.1965204$ ✓
$r = 1.756779$ ✓
1.9530983 ✓ $= 89.76318$ ✓

2.1925967 ✓
$n-1 = 9.7573825$ ✓
1.950179 ✓ $= 89.16188$ ✓
178.92506 ✓
2.2526712 ✓

$f_2 = 49.71683$ ✓ $= 1.6965034$ ✓

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Finished A. G. Central

B

$f_2 = 50.81534$ ✓
$.8150$ ✓
$d_3 = 50.00054$ ✓ $= 1.6989747$ ✓
$n = 0.2084406$ ✓
$\tau_3 = 1.7363176$ ✓
3.6437329 ✓

$d = 1.6989747$ ✓
$n-1 = 9.7895787$ ✓ 54.4901 ✓
1.4885534 ✓ $= 30.800019$ ✓
23.689911 ✓ $=$

1.3745634 ✓
$f_3 = 185.85306$ ✓ 2.2691695 ✓
$.3246$ ✓
$d_4 = 185.5289$ ✓ $= 2.2684115$ ✓
$\tau_4 = 2.2863747$ ✓
4.5547862 ✓

$n = 0.2084406$ ✓
$\tau_4 = 2.2863747$ ✓
2.4948153 ✓ $= 312.4730$ ✓

$d = 2.2684115$ ✓
$n-1 = 9.7895787$ ✓
2.0579902 ✓ $= 114.2853$ ✓
198.1897 ✓ $=$

2.2970810 ✓
$f_4 = 181.0111$ ✓ $= 2.2577052$ ✓

~~181.0183~~
~~.0072~~

F

$f_2 = 49.71683$ ✓
$.8150$ ✓
$d_3 = 48.90183$ ✓ $= 1.6893250$ ✓
$n = 0.2135485$ ✓
$\tau_3 = 1.7363176$ ✓
3.6391911 ✓

$d = 1.6893250$ ✓
$n-1 = 9.8028529$ ✓ 54.4901 ✓
1.4921779 ✓ $= 31.058311$ ✓
23.431791 ✓ $=$

1.3698055 ✓
$f_3 = 185.94555$ ✓ $= 2.2693856$ ✓
$.3241$ ✓
$d_4 = 185.6214$ ✓ $= 2.2686281$ ✓
$\tau_4 = 2.2863747$ ✓
4.5550028 ✓

$n = 0.2135485$ ✓
$\tau_4 = 2.2863747$ ✓
2.4999232 ✓ $= 316.1718$ ✓

$d = 2.2686281$ ✓
$n-1 = 9.8028529$ ✓
2.0714810 ✓ $= 117.8911$ ✓
198.2807 ✓ $=$

2.2972804 ✓
$f_4 = 181.0183$ ✓ $= 2.2577224$ ✓

181.0111
$.0072$

Flint Strong
7 beyond B

181.0111
180.8963
$181.5)\ .1148$
$.0006325$

$.1148$
$.1220$
$2)\ .2368$
$181.5)\ .1184$
$.0006523$

181.0147
180.8963
$181.5)\ .1184$
$.0006522$

$181.5)\ .11840\ (.00065$
10890
9500

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~~Finished O. C.~~

"Brightest"

Iserom $n = 1.565150 \checkmark = \log 0.1945560 \checkmark$

$n-1 = 0.565150 \checkmark = \;\; " \;\; 9.7521637 \checkmark$

Flint $n' = 1.623974 \checkmark = \log 0.2105791 \checkmark$

$n-1 = 0.623974 \checkmark = \quad 9.7951665 \checkmark$

$n = 1.1945560 \checkmark$

$\tau_1 = \underline{1.756779 \checkmark}$

$2.9511339 \checkmark$

$n-1 = \underline{9.7521637 \checkmark}$

$= 3.1989702$

Finished O. C. 5614

$n = 0.1947979 \checkmark$ p102

$\tau_1 = \underline{1.756779 \checkmark\checkmark}$

$1.9513758 \checkmark$

$n-1 = \underline{9.7528333 \checkmark}$

$= 2.1985425 \checkmark$

$f_1 = 157.9583 \checkmark$

$\underline{1.0508 \checkmark}$

$d_2 = 156.9075 \checkmark = 2.1956437 \checkmark$

$\tau_2 = \underline{1.756779 \checkmark}$

$3.9522216 \checkmark$

$n = 0.1947979 \checkmark$

$\tau = \underline{1.756779 \checkmark}$

$1.9513758 \checkmark = 89.40790 \checkmark$

$d = 2.1956437 \checkmark$

$n-1 = \underline{9.7528333 \checkmark}$

$1.9484770 \checkmark = \underline{88.81310 \checkmark}$

$178.22100 \checkmark = \underline{2.2509588 \checkmark}$

$f_2 = 50.26467 \checkmark = 1.7012628 \checkmark$

$\underline{.8150 \checkmark}$

$d_2 = 49.44967 \checkmark$

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5614

$\alpha_3 = 49.44967 \checkmark$ = 1.6941634 ✓

$n' =$ 0.2109398 ✓

$\tau_3 =$ 1.7363176 ✓

3.6414208 ✓

$\alpha =$ 1.6941634 ✓

$n-1 =$ 9.7961047 ✓ 54.4901 ✓

1.4902681 ✓ = 30.92204 ✓

23.56806 ✓ = 1.3723238 ✓

= 2.2690970 ✓

$f_3 = 185.8219 \checkmark$

.3241 ✓

$\alpha_4 = 185.4978 \checkmark$ = 2.2683388 ✓

$\tau_4 =$ 2.2863747 ✓

4.5547135 ✓

$n = 0.2109398 \checkmark$

$\tau_4 =$ 2.2863747 ✓

2.4973145 ✓ = 314.2784 ✓

$\alpha = 2.2683388 \checkmark$

$n-1 =$ 9.7961047 ✓

2.0644435 ✓ = 115.9962 ✓

198.2822 ✓ = 2.2972837 ✓

$f_4 =$ 180.8963 ✓ = 2.2574298 ✓

Central Rays

f_4 181.0111 – B

181.0183 – F

294

B+7 = 181.0147 Ave

5614 180.8963

181.5) .1184 (.000065

1090

950

1.05

.815

325

2.190

1.09

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44 Finished - Index of refraction by "Hastings" spectrometer p. 107 -

1924

p. 40

p. 38

Central

B

p. 107 - $n = 0.193113$ ✓

$\tau_1 = 1.756578$ ✓

1.949691 ✓

$n-1 = 9.748156$ ✓

$f_1 = 159.0505$ ✓ $= 2.201535$ ✓

1.0508 ✓

$d_2 = 157.9997$ ✓ $= 2.198656$ ✓

$\tau_2 = 1.756578$ ✓

3.955234 ✓

$n = 0.193113$ ✓

$\tau_2 = 1.756578$ ✓

1.949691 ✓ $= 89.0617$ ✓

$d_2 = 2.198656$ ✓

$n-1 = 9.748156$ ✓

1.946812 ✓ $= 88.4732$ ✓

$177.5349 =$ ✓

2.249284 ✓

$f_2 = 50.8101$ ✓ $= 1.705950$ ✓

$.8150$ ✓

$d_3 = 49.9951$ ✓ $= 1.698927\frac{1}{2}$ ✓

$n' = 0.208468\frac{1}{2}$ ✓

$\tau_3 = 1.736317\frac{1}{2}$ ✓

$3.643713\frac{1}{2}$ ✓

$d_3 = 1.698927\frac{1}{2}$ ✓

$n-1 = 9.789652$ ✓ 54.4901 ✓

$1.488579\frac{1}{2} = 30.80204$ ✓

23.68806 ✓ $=$

$1.374529\frac{1}{2}$ ✓

$f_3 = 185.8592$ ✓ $= 2.269184$ ✓

$.3241$

$d_4 = 185.5351$ ✓ $= 2.268426$ ✓

$\tau_4 = 2.286375$ ✓

4.554801 ✓

$n = 0.208468\frac{1}{2}$ ✓

$\tau_4 = 2.286375$ ✓

$2.494843\frac{1}{2}$ ✓ $= 312.4953$ ✓

$d = 2.268426$ ✓

$n-1 = 9.789652$ ✓

2.058078 ✓ $= 114.3084$ ✓

198.1869 ✓ $=$

2.297075 ✓

$f_4 = 181.0172$ ✓ $= 2.257726$ ✓

$.8715$

$.1457$

180.9877

$.0295$

Barylite Light Flint

F

$n = 0.196533\frac{1}{2}$ ✓

$\tau_1 = 1.756578$ ✓

$1.953111\frac{1}{2}$ ✓

$n-1 = 9.757618\frac{1}{2}$ ✓

$f_1 = 156.8530$ ✓ 2.195493 ✓

1.0508 ✓

$d_2 = 155.8022$ ✓ $= 2.192574$ ✓

1.756578 ✓

3.949152 ✓

$n = 0.196533\frac{1}{2}$ ✓

$\tau_2 = 1.756578$ ✓

$1.953111\frac{1}{2}$ ✓ $= 89.7660$ ✓

$d_2 = 2.192574$ ✓

$n-1 = 9.757618\frac{1}{2}$ ✓

$1.950192\frac{1}{2}$ ✓ $= 89.1646$ ✓

$178.9306 =$ ✓

$2.252684\frac{1}{2}$ ✓

$f_2 = 49.71272$ ✓ $= 1.696467\frac{1}{2}$ ✓

$.8150$ ✓

$d_3 = 48.89772$ ✓ $= 1.689288\frac{1}{2}$ ✓

$n' = 0.213557\frac{1}{2}$ ✓

$\tau_3 = 1.736317\frac{1}{2}$ ✓

$3.639163\frac{1}{2}$ ✓

$d_3 = 1.689288\frac{1}{2}$ ✓

$n'-1 = 9.802876$ ✓ 54.4901 ✓

$1.492164\frac{1}{2} = 31.05735$ ✓

23.43275 ✓ $=$

$1.369823\frac{1}{4}$ ✓

$f_3 = 185.9260$ ✓ $= 2.269340$ ✓

$.3241$ ✓

$d_4 = 185.6019$ ✓ $= 2.268582\frac{1}{2}$ ✓

$\tau_4 = 2.286375$ ✓

$4.555749\frac{1}{2}$ ✓

$n = 0.213557\frac{1}{2}$ ✓

$\tau_4 = 2.286375$ ✓

$2.499932\frac{1}{2}$ ✓ $= 316.1786$ ✓

$d = 2.268582\frac{1}{2}$ ✓

$n-1 = 9.802876$ ✓

$2.071458\frac{1}{2}$ ✓ $= 117.8850$ ✓

198.2936 ✓ $=$

$2.297308\frac{1}{2}$ ✓

$f_4 = 180.9877$ ✓ $= 2.257649$ ✓

$.8715$

$.1162$

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(1924)

Central

56 Cyg

$n = 0.194814\frac{1}{2}$ ✓

$r_1 = 1.756578$

$1.951392\frac{1}{2}$

$n-1 = 9.752879$ ✓

$f_1 = 157.94778$

1.0508

$d_2 = 156.89698$

$= 2.198513\frac{1}{2}$

$= 2.195614\frac{1}{2}$

$r_2 = 1.756578$

$3.952192\frac{1}{2}$

$n = 0.194814\frac{1}{2}$

$r_2 = 1.756578$

$1.951392\frac{1}{2} = 89.4113$

$d_2 = 2.195614\frac{1}{2}$

$n-1 = 9.752879$

$1.948493\frac{1}{2} = 88.8165$

$178.2278 =$

$2.250975\frac{1}{2}$

$= 1.701217$

$f_2 = 50.2594$

$.8150$

$d_3 = 49.4444$ ✓

$= 1.694117$ ✓

$n' = 0.210956$ ✓

$r_3 = 1.736317\frac{1}{2}$ ✓

$3.641390\frac{1}{2}$ ✓

$d_3 = 1.694117$ ✓

$n'-1 = 9.796146\frac{1}{2}$ ✓

$1.490263\frac{1}{2}$ ✓ $= 34.4901$ ✓

30.92171 ✓

23.56839 ✓ $=$

1.372330 ✓

$f_3 = 185.8063$ ✓ $= 2.269060\frac{1}{2}$ ✓

$.3241$ ✓

$d_4 = 185.4822$ ✓

$= 2.268302$ ✓

$r_4 = 2.286375$ ✓

4.554677 ✓

$n = 0.210956$ ✓

$r_4 = 2.286375$ ✓

2.497331 ✓ $= 314.2903$ ✓

$d = 2.268302$ ✓

$n-1 = 9.796146\frac{1}{2}$ ✓

$2.064448\frac{1}{2}$ ✓ $= 115.9975$ ✓

$198.2928 =$

2.297307 ✓

$f_4 = 180.8715$ ✓ $= 2.257370$

181.0172 | 181.0172

180.9877 | 180.9877

.0295 | 2 | 2.0049

181.0024

180.8715

182) .1309 (.00072

1274

350

1.05

.81

.32

2 | 2.28

1.14

180.87

182.01

182) .0295 (.000162

182

1130

1092

380

F = about 182in

182) .1457 (.00080

1456

182) .1162 (.00064

1092

700

180.87

1.10

181.97

1.054

.815

.324

2 | 2.190

1.095

.00072

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(1924)

Less separation between lenses to give better color correction

p. 38 Make $D = .7150$

p. 44

B

$f_2 = 50.8101$
$.7150$
$d_3 = 50.0951 = 1.699795$
$n' = 0.208468\frac{1}{2}$
$r_3 = 1.736317\frac{1}{2}$
3.644581

$d_3 = 1.699795$
$n-1 = 9.789652 \quad 54.4901$
$1.489447 = 30.86363$
$23.62647 =$
1.373399
$= 2.271182$

$f_3 = 186.7162$
$.3241$
$d_4 = 186.3921 = 2.270427\frac{1}{2}$
$r_4 = 2.286375$
$4.556802\frac{1}{2}$

$n = 0.208468\frac{1}{2}$
$r_4 = 2.286375$
$2.494843\frac{1}{2} = 312.4953$

$d_4 = 2.270427\frac{1}{2}$
$n-1 = 9.789652$
$2.060079\frac{1}{2} = 114.8364$
$197.6589 =$
$2.295916\frac{1}{2}$
$f_4 = 182.3417 = 2.260886$

F

$f_2 = 49.71272$
$.7150$
$d_3 = 48.99772 = 1.690176$
$n' = 0.213557\frac{1}{2}$
$r_3 = 1.736317\frac{1}{2}$
3.640051

$d_3 = 1.690176$
$n-1 = 9.802876 \quad 54.4901$
$1.493052 = 31.12090$
$23.3692 =$
1.368644
$= 2.271407$

186.8130
$.3241$
$d_4 = 186.4889 = 2.270653$
2.286375
4.557028

$n r_4 = 316.1786$

$d_4 = 2.270653$
$n-1 = 9.802876$
$2.073529 = 118.4484$
$197.7302 =$
2.296073
$f_4 = 182.3707 = 2.260955$

$.3417$
$+ .0290$
$- .6295$ before
$.0588$ = change by moving lenses $\frac{1}{10}$ in. nearer together

This makes the color about right

May 4 '24 Separation should be .7092

$.8150$
$.7092$
$.1058$

$.7150$
$.0058$
$.7092$

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(1924)

Color corrections of 6m 7m & 12m A.G.'s
compared

	Reduced to $F_o = 100$		Actual
	$\frac{1}{2}(F_B + F_F) - F_{5614}$	$F_F - F_B$	$F_F - F_B$
6m	+ .00058	+.000112	+ .0103
7m	+ .00~~133~~	+.000~~320~~	+ .~~0360~~
12m	+ .00072	−.000162	−.0295 Should be +.0324 p. 84

p224 last bk

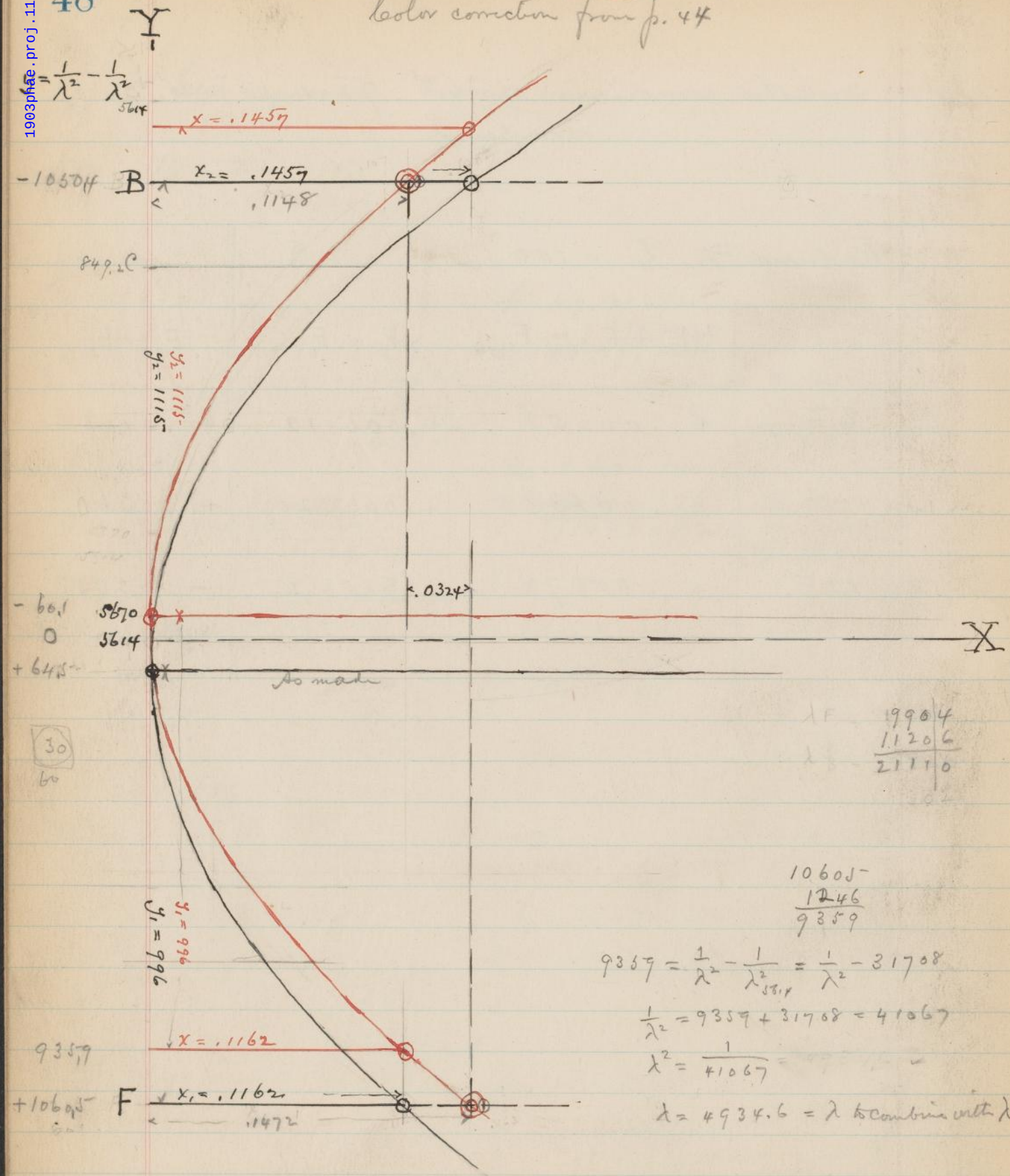
May 4'24

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12h = (1924)

Color correction from p. 44



	19964
	11206
	21110

10605
1246
9359

$9359 = \frac{1}{\lambda^2} - \frac{1}{\lambda^2_{5614}} = \frac{1}{\lambda^2} - 31708$

$\frac{1}{\lambda^2} = 9359 + 31708 = 41067$

$\lambda^2 = \frac{1}{41067}$

$\lambda = 4934.6 = \lambda$ to combine with λ_B

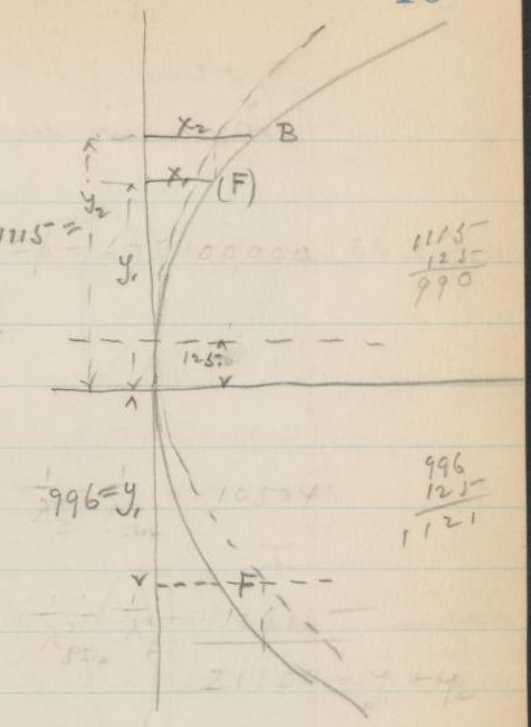
$\lambda = 5061 = \lambda$ to combine with λ_C

See p 139

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$y^2 = 2px$ $\qquad \frac{y_1^2}{y_2^2} = \frac{2px_1}{2px_2} = \frac{x_1}{x_2}$



$x_1 = .1162$ ✓
$x_2 = .1457$ ✓
$y_1 + y_2 = 2111$ ✓
} To find y_1 and y_2

$\frac{y_1^2}{y_2^2} = \frac{x_1}{x_2} = \frac{.1162}{.1457} = .7975$ ✓

$\frac{y_1}{y_2} = \sqrt{.7975} = .8929$ ✓

$y_1 = .8929\, y_2$
$y_1 + y_2 = 2111$ }

$1.8929\, y_2 = 2111$ ✓
$y_2 = 1115$ ✓
$y_1 = 996$ ✓

$\frac{1}{\lambda_B^2} - \frac{1}{\lambda_{5514}^2} = 1050^+$ ✓ $\qquad \lambda_B = 1060^-$ ✓
$y_2 = 1115$ ✓ $\qquad y_1 = 996$ ✓
$64\frac{1}{2}$ ✓ $\qquad 64\frac{1}{2}$ ✓

$\frac{1}{\lambda_B^2} - \frac{1}{\lambda_{5514}^2} = 1050 = y_1$

$\frac{1}{\lambda_{5514}^2} - \frac{1}{\lambda_F^2} = \frac{1060^-}{2110} = y_2$
$y_1 + y_2 = 2110$

λ_B

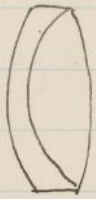
continued on p. 84

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To obtain inner surfaces of different curvatures

From p. 33



$r_1 = 205.499$

$r_2 = 36.940$

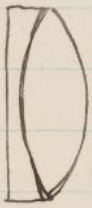
$r_3 = 36.940$

$r_4 = 133.733$

$f = 176.436$

I

Diagram p. 31



$r_2 = r_3$ greater than above

Marginal short Crown too strong for Sph. Ab.

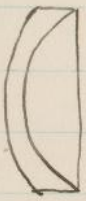


Crown weakened for Sph. Ab.

see p 57

II

Diagram p. 31



$r_2 = r_3$ less than above

Marginal long Crown too weak for Sph. Ab.



Crown strengthened for Sph. Ab.

See p. 80

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Case I



1st surface of Flint – Flat

$\frac{1}{r_2} = \frac{1}{r_1} + B = \frac{1}{\infty} + B = B = .0222047$ ✓ $= 8.34644\frac{1}{2}$ ✓ p. 32

$r_2 = 45.0355$ ✓ $= 1.65355\frac{1}{2}$ ✓

Try $r_3 = 43.0355 = 1.633824$

$= 8.36617\frac{1}{4}$ $\quad .0345485 = A$

$\quad .0232366$

$\frac{1}{r_4} = A - \frac{1}{r_3}$ $\quad 8.05353\frac{1}{2} = .0113119$

$r_4 = 88.403 = 1.94646\frac{1}{2}$

Try $r_3 = r_4$

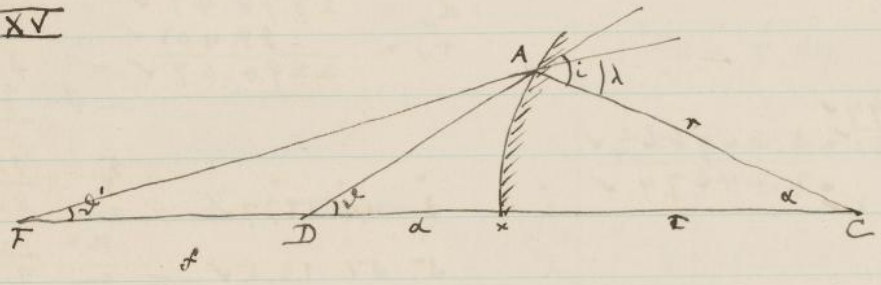
$\frac{1}{r_3} = \frac{1}{r_4} = \frac{A}{2}$

$A = .0345485$

$\frac{A}{2} = .0172742\frac{1}{2} = 8.23740$

$r_3 = r_4 = 57.889\frac{1}{2} = 1.76260$

XV



ADC. $\frac{\sin i}{\sin v} = \frac{d+r}{r}$ $\quad \sin i = \frac{(d+r)\sin v}{r}$

$v' = v - (i - \lambda)$

central rays

AFC $\frac{\sin v'}{\sin \lambda} = \frac{r}{f+r}$ $\quad f + r = \frac{r \sin \lambda}{\sin v'}$

$f = \frac{r \sin \lambda}{\sin v'} - r$

$f = \frac{n dr}{r - d(n-1)}$

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II. Case I Continued r_1 = Inf.

Central		Field		Marginal	
VII	B	$k = 6$			VII
$r_2 =$	1.65 355 $\frac{1}{2}$ ✓	$r_2 = 45.035\frac{1}{2}$ ✓		=	0.77815 ✓
$x-1 =$	9.78959 $\frac{1}{4}$ ✓	$i = 7° 39' 22".2$ ✓		=	1.65355 $\frac{1}{2}$ ✓
$f_2 =$	73.1076 ✓ = 1.86396 $\frac{1}{4}$ ✓	$\lambda = 12\ 25\ 58.9$ ✓		sin =	9.12459 $\frac{1}{2}$ ✓
		$\lambda' = 4\ 46\ 36.7$ ✓		n =	0.20844 $\frac{1}{2}$ ✓
				= sin	9.33304 ✓
				r =	1.65355 $\frac{1}{2}$ ✓
				sin	0.98659 $\frac{1}{2}$ ✓
				sin	8.92051 $\frac{3}{4}$ ✓
		116.433 ✓		=	2.06607 $\frac{3}{4}$ ✓
		45.035 $\frac{1}{2}$ ✓			
		$f_2 =$ 71.397 $\frac{1}{2}$ ✓			

Crown

	(P. 51)	$f_2 = 71.397\frac{1}{2}$	XV	
		.00		
$n =$	0.19309 $\frac{1}{2}$ ✓	$d_3 = 71.397\frac{1}{2}$ ✓	Sup 51	
$d =$	1.86396 $\frac{1}{4}$ ✓	$r_3 = 43.035\frac{1}{2}$ ✓		
$r_3 =$	1.63382 $\frac{3}{4}$ ✓	114.433 ✓ =		2.05853 ✓
	3.69088 $\frac{3}{4}$ ✓		sin d =	8.92051 $\frac{3}{4}$ ✓
		43.035 $\frac{1}{2}$ =	r_3 =	0.97906 $\frac{3}{4}$ ✓
$d = 1.86396\frac{1}{4}$ ✓				1.63382 $\frac{3}{4}$ ✓
$x-1 = 9.74810$ ✓	43.035 $\frac{1}{2}$ ✓	$i = 12° 47' 35".3$ ✓	= sin	9.34524 ✓
1.61206 $\frac{1}{4}$ ✓	= 40.9322 ✓		n =	0.19309 $\frac{1}{2}$ ✓
2.1033 ✓	= 0.32290 ✓	$\lambda = 8\ 9\ 39.2$ ✓	= sin	9.15214 $\frac{1}{2}$ ✓
$f_3 =$ 2333.39 ✓	= 3.36798 $\frac{3}{4}$ ✓	$4\ 37\ 56.1$ ✓	r =	1.63382 $\frac{3}{4}$ ✓
1.07 ✓		$d = 4\ 46\ 36.7$ ✓		~~7.51831 $\frac{3}{4}$~~
$d_4 =$ 2334.46 ✓	= 3.36818 $\frac{3}{4}$ ✓	$d' = 0\ 8\ 40.6$ ✓	sin	0.78597 $\frac{1}{4}$ ✓
$r_4 =$	1.94646 $\frac{1}{2}$ ✓		sin	7.40207 $\frac{3}{4}$ ✓
	5.31465 $\frac{1}{4}$ ✓	2420.44 ✓	=	3.38389 $\frac{1}{2}$ ✓
		$r_3 =$ 43.04 ✓		
$d = 3.36818\frac{3}{4}$ ✓		$f_3 =$ 2377.40 ✓		
$x-1 = 9.74810$ ✓		1.07 ✓		
3.11628 $\frac{3}{4}$ ✓	= 1307.03 ✓	$d_4 =$ 2378.47 ✓	VIII	
		$r_4 =$ 88.403 ✓		
$x = 0.19309\frac{1}{2}$ ✓		2290.07 ✓ =		3.35984 $\frac{3}{4}$ ✓
$r = 1.94646\frac{1}{2}$ ✓			sin d =	7.40207 $\frac{3}{4}$ ✓
2.13956 ✓	137.899 ✓			0.76192 $\frac{1}{2}$ ✓
1169.131 ✓	= 3.06786 $\frac{1}{4}$ ✓		r_4 =	1.94646 $\frac{1}{2}$ ✓
$f_4 =$	176.518 ✓ = 2.24679 ✓	i 3° 44' 53".7 ✓	= sin	8.81546 ✓
			n =	0.19309 $\frac{1}{2}$ ✓
		λ 5° 51 13.5 ✓	= sin	9.00855 $\frac{1}{2}$ ✓
175.168 ✓ marginal		2 6 17.8 ✓	r =	1.94646 $\frac{1}{2}$ ✓
1.350 ✓ spherical Al.		$d' = 0\ 8\ 40.6$ ✓		0.95502 ✓
Crown too strong		$d' = 1\ 57\ 37.2$ ✓	= sin	8.53412 $\frac{1}{4}$ ✓
		263.571 ✓		= 2.42089 $\frac{3}{4}$ ✓
		88.403 ✓		
		$f_4 =$ 175.168 ✓		

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by $r_3 = 41.0353''$ = 1.61316 .0345485 = A
8.38684 = .0243691
8.00772¼ = .0101794

$r_4 = 98.237\frac{1}{2}$ = 1.99227¾

Central B

$n = 0.19309\frac{1}{2}$
$d = 1.86396\frac{1}{2}$
$r_3 = 1.61316$
3.67022

$d = 1.86396\frac{1}{2}$
$n-1$ 41.0353''
40.9322
0.1033 = 9.01410
= 4.65612

$f_3 = 45302.3$
1.07
$d_4 = 45301.2$ = 4.65611
$r_4 = 1.99227\frac{3}{4}$
6.64838¾

$d = 4.65611$
$n-1 = 9.74810$
4.40421 = 25363.6

$n = 0.19309\frac{1}{2}$
$r_4 = 1.99227\frac{3}{4}$
2.18537¼ = 153.24
25210.36 = 4.40158
$f_4 = 176.526$ = 2.24680¾

174.856 Marginal
1.670 Sph. Ab.
Crown two strong

Marginal B

$d_3 = 71.397\frac{1}{2}$
$r_3 = 41.0353''$
112.433 = 2.05089½
sin d = 8.92051¾
0.97141¼
r_3 = 1.61316
i = 13° 11' 21".0 = sin 9.35825¼
n = 0.19309½
= sin 9.16515¾
λ = 8 24 39.1 1.61316
$i-\lambda$ = 4 46 41.9 XI 0.77831¾
v = 4 46 36.7 least
v' = 0 0 5.2 = sin 5.40157¾
= 5.37674

238090.
+ 41.
f_3 = 238131
1.07
d_4 = 238132.
r_4 = 98.
238034. = 5.37664
5.40157¾
0.77821¾
r_4 = 1.99227¾
i = 3° 30' 7".69 = sin 8.78594
n = 0.19309½
λ = 5° 28 4.26 = sin 8.97903½
1 57 56.57 r = 1.99227¾
v = 0 0 5.2 0.97130¼
v' = 1 57 51.37 = sin 8.53499¼
= 2.43631

273.093
98.237½
f_4 = 174.856½

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II.

When r_3 = 43.0353⁻ Sph Ab = 1.350

" " = 41.0353⁻ " " = 1.670

r_3 changes 2.0000 Sph. Ab changes .320

.320 : 1.350 :: 2. : x

2 = 0.30103
1.350 = 0.13033
0.43136
43.0353⁻ .320 = 9.50515⁻
8.4374 = 0.92628
Try r_3 = 51.473

---

r_3 = 51.634 = 1.71293½✓ .0345485⁻✓ = A
8.28706½✓ = .0193671✓
8.18131¼✓ = .0151814✓
r_4 = 65.870✓ = 1.81868¾✓

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Central B

XV

$n = 0.19309\frac{1}{2}$ ✓
$d = 1.86396\frac{1}{2}$ ✓
$51.634 = r_3 = 1.71293\frac{1}{2}$ ✓
$3.76999\frac{1}{2}$ ✓

51.634 ✓
40.9322 ✓
10.7018 ✓ = $1.02945\frac{3}{4}$ ✓
$f_3 = 530.22$ ✓ = $2.74053\frac{3}{4}$ ✓
1.07 ✓

VIII $d_4 = 551.29$ ✓ = 2.74138 ✓
$r_4 = 1.81868\frac{3}{4}$ ✓
$4.56006\frac{3}{4}$ ✓

$d = 2.74138$ ✓
$n-1 = 9.74810$ ✓
24.8948 ✓ = 308.660 ✓

$n = 0.19309\frac{1}{2}$ ✓
$r = 1.81868\frac{3}{4}$ ✓
$2.01178\frac{1}{4}$ ✓ = 102.750 ✓
205.910 ✓ = $2.31367\frac{3}{4}$ ✓

$f_4 = 176.356$ ✓ = 2.24639 ✓

Marginal B

$d_3 = 71.397\frac{1}{2}$ ✓
$r_3 = 51.634$ ✓
$123.031\frac{1}{2}$ ✓

$i = 11^\circ\ 26'\ 41.6$ ✓
$\lambda = 7\ 18\ 29.1$ ✓
$4\ 8\ 12.5$ ✓
$4\ 46\ 36.7$ ✓
$\nu' = 0\ 38\ 24.2$ ✓

587.967 ✓
r_3 − 51.634 ✓
$f_3 = 536.333$ ✓
1.07 ✓
$d_4 = 537.403$ ✓
$r_4 = -65.870$ ✓
471.533 ✓

$i = 4^\circ\ 35'\ 12.00$ ✓
$\lambda = 7\ 9\ 56.6$ ✓
$2\ 34\ 44.6$ ✓
$\nu = 0\ 38\ 24.2$ ✓
$\nu' = 1\ 56\ 20.4$ ✓

242.840
65.870 ✓
176.970 ✓

XV

$= 2.09001\frac{1}{2}$ ✓
$\sin \nu = 8.92051\frac{3}{4}$ ✓
$1.01053\frac{1}{4}$ ✓
$r_3 = 1.71293\frac{1}{2}$ ✓
$= \sin 9.29759\frac{3}{4}$ ✓
$n = 0.19309\frac{1}{2}$ ✓
$= \sin 9.10450\frac{1}{4}$ ✓
$r = 1.71293\frac{1}{2}$ ✓
$0.81743\frac{3}{4}$ ✓
$\sin 8.04808\frac{1}{2}$ ✓
$= 2.76935\frac{1}{4}$ ✓

VIII

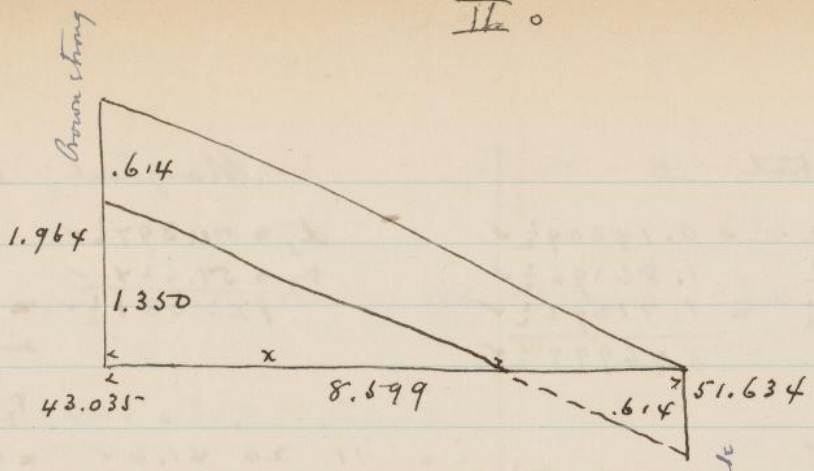
$= 2.67351\frac{1}{4}$ ✓
$\sin \nu = 8.04808\frac{1}{2}$ ✓
$0.72159\frac{3}{4}$ ✓
$r_4 = 1.81868\frac{3}{4}$ ✓
$= \sin 8.90291\frac{1}{4}$ ✓
$n = 0.19309\frac{1}{2}$ ✓
$= \sin 9.09600\frac{1}{2}$ ✓
$r = 1.81868\frac{3}{4}$ ✓
$0.91469\frac{1}{4}$ ✓
$\sin 8.52937\frac{1}{4}$
$= 2.38532$

176.356 central
.614 Sph. Ab.
Corona too weak

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II.



$\tau_3 = 43.035^-$

$8.599 : 1.964 :: x : 1.350$

$$x = \frac{8.599 \times 1.350}{1.964} = 5^-.9107$$

0.93445^-
0.13033
1.06478
0.29314
$= 0.77164$

$\tau_3 = \frac{43.0356^-}{5^-.9107} = \frac{}{48.9462} = 1.68972^\checkmark$

$8.31028^\checkmark = .0204305^-\checkmark$

$8.14977\frac{1}{4}\checkmark = .0141180\checkmark$

$.0345485^- \checkmark = \Delta$

$\tau_4 = 70.8317^\checkmark = 1.8502\,2\frac{3}{4}\checkmark$

P. 57.

$f_3 = 696.5^-14$
1.07
$d_4 = 697.584 = 2.84359\frac{3}{4}$
$\tau = 1.85022\frac{3}{4}$
$4.69382\frac{1}{2}$

$d = 2.84359\frac{3}{4}$
$n-1 = 9.74810$
$2.59169\frac{3}{4} = 390.569$
110.490
$280.079 = 2.44728$
$176.419 = 2.24654\frac{1}{2}$

P. 57

$f_3 = 680.860$
1.07
$d_4 = 681.930 = \cancel{2.83374}$
$\tau_4 = 70.832$
$611.098 = 2.78611$

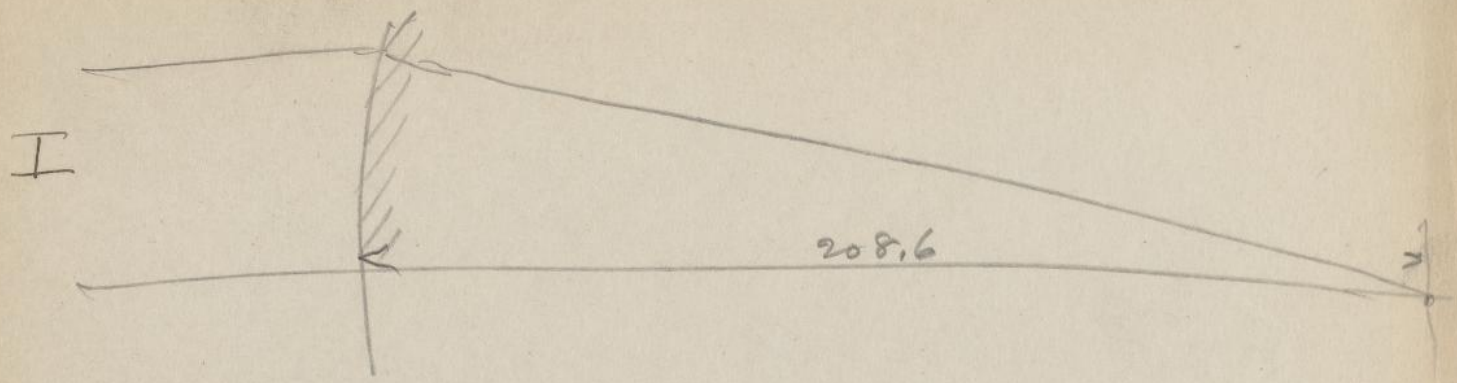
$\sin d = 7.94463\frac{3}{4}$
$0.73074\frac{3}{4}$
$\tau_4 = 1.85022\frac{3}{4}$

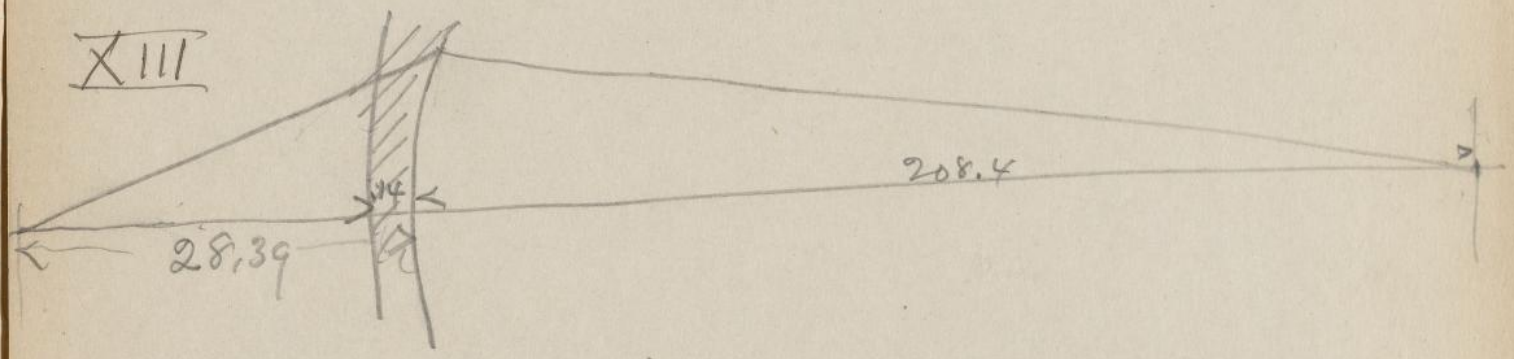
$4\ 21\ 20.63 = \sin 8.8805^-2$
$0.19309\frac{1}{2}$

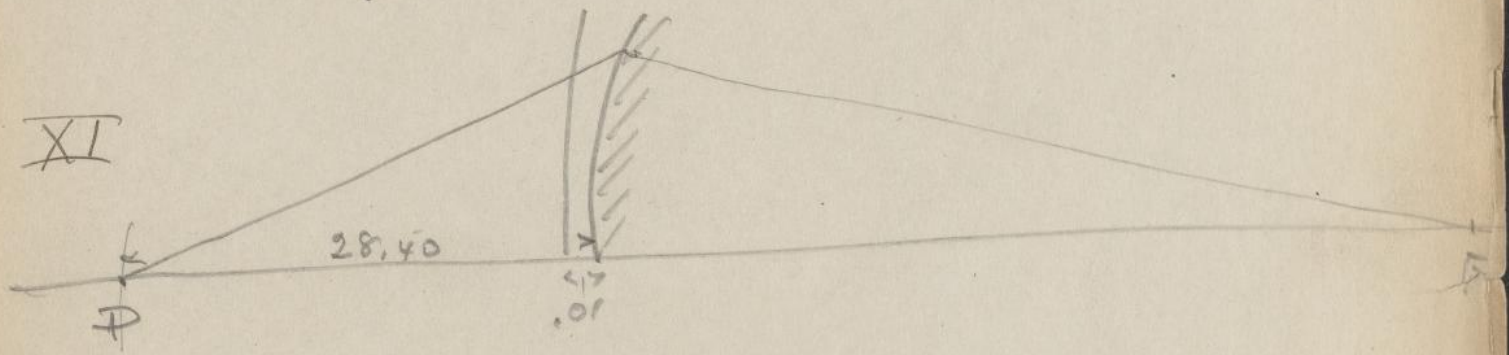
$6\ 48\ 14.10 = \sin 9.07361\frac{1}{2}$
$2\ 26\ 53.47$
$1.85022\frac{3}{4}$
$0\ 30\ 15.8$
$0.92384\frac{1}{4}$
$1\ 56\ 37.67 = \sin 8.5^-3044\frac{1}{2}$
$247.399 = 2.39339\frac{3}{4}$
70.832
176.567
$.419$
$.148$ sph. ab.

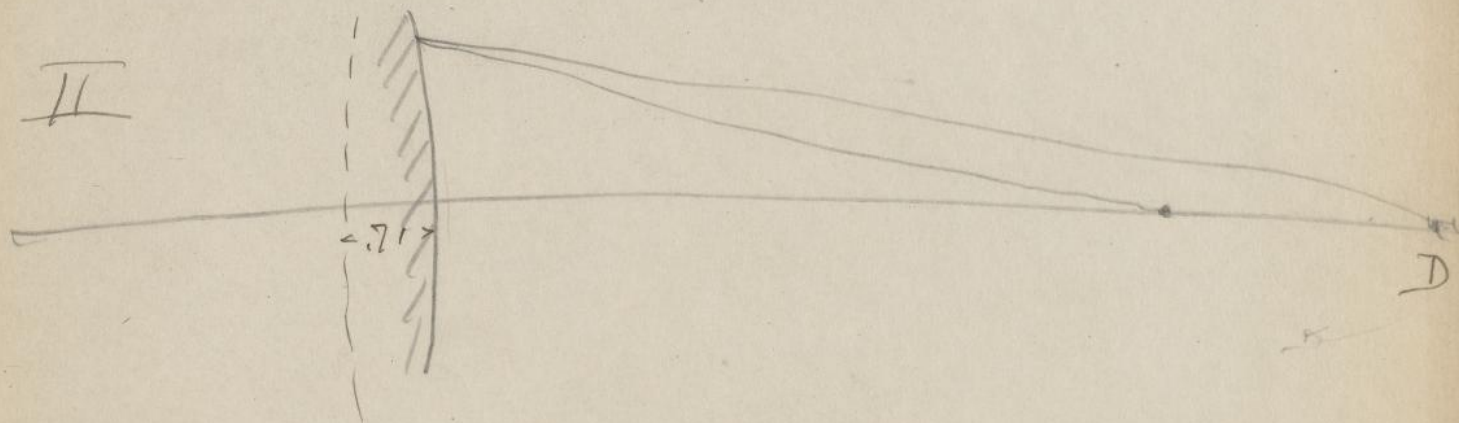
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.6 ≈

	f_4 central	(F=93)	F=1
B	91.7447	.0486	.000522
5614	91.6961	0	
F	91.7550	.0589	.000633

$\frac{y_F}{y_B^2} = \frac{x_F}{x_B} = \frac{633}{522} =$ 2.801 / 2 | 2.718 / 0.083 / 0.0415

$\frac{y_F}{y_B} = 1.10$

$y_F + y_B = 21125$

$1.10 y_B + y_B = 21125$

$2.104 y_B = 21125$

4.32480 − 0.3222 = 4.0026

	f_4 Marginal		$\frac{y_F}{y_B} = \sqrt{\frac{x_F}{x_B}} = \sqrt{\frac{884}{285}} = 1.761$
B	91.6562	.0265	$y_F + y_B = 21125$
5614	91.6297	0	$1.761 y_B + y_B = 21125$
F	91.7119	.0822	$21.761 y_B = 21125$

$y_B = 765.1$

$y_F = 13474$

$y_B = 10060$

$y_F = 11065$

$\frac{1}{\lambda_F^2} = 423.12$

$y_F = \frac{110.65}{312.47} = 2.49481$ / 2 | 7.505119 = 3.752560

$\lambda = 5657$

	Sph. Ht=0	(F=93)	F=1
B	91.7226	.0265	.000285
5614	91.6961	0	0
F	91.7783	.0822	.000884

$\frac{1}{\lambda_F^2} = 423.12$

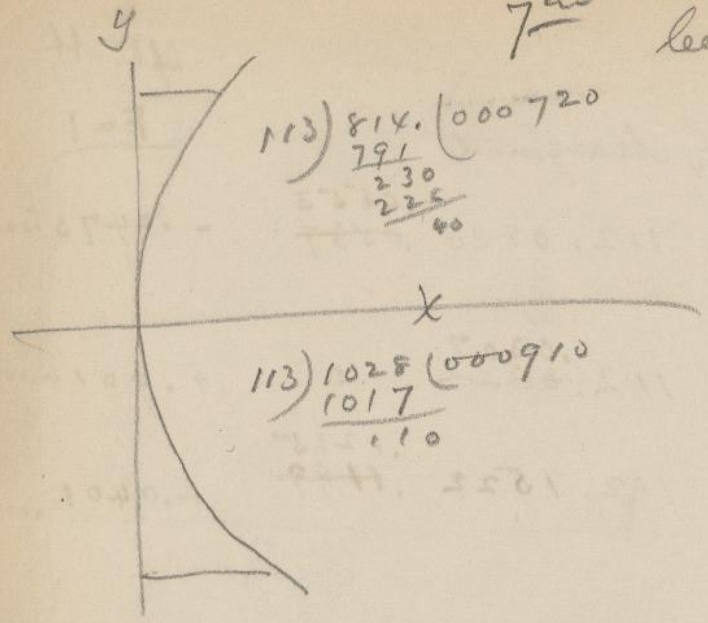
$y_F = \frac{134.74}{288.38} = 2.45996$ / 2 | 7.540004 = 3.770002

$\lambda = 5889$

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7th Central Rays

113) 814. (000720
791
230
225
40

113) 1028 (000910
1017
.10

$\frac{y_F^2}{y_B^2} = \frac{x_F}{x_B} = \frac{F=1\ 720}{814} \quad \frac{814}{1028}\ \boxed{910}\ F=1$

$\frac{y_F}{y_B} = .8898$

$y_F + y_B = 21125^-$

$1.8898\, y_B = 21125^-$

$y_B = 11179$

$y_F = 9946$

$\frac{y_F}{y_B} = \sqrt{\frac{814}{1028}} = .8898$

814 = 2.9106
1028 = 3.0120
2 | 9.8986
= 9.9493

$21125^- = 4.32480$
$1.8898 = 0.27641$
$11179. = 4.04839$

$\frac{1}{\lambda_F^2} = 423.12 \quad 9946$
$\frac{1}{\lambda_x^2} = 323.66$
$= 2.5^-1009$
2 | 7.48991
$= 3.7449^5$

$\lambda = 5338.4$

Marginal Rays

$\frac{y_F^2}{y_B^2} = \frac{x_F}{x_B} = \frac{.00\boxed{1061} = F=1}{1199} \quad \frac{1199}{537}\ \boxed{.00047\,5^-}$

$\frac{y_F}{y_B} = 1.494$

$y_F + y_B = 21125^-$

$2.494\, y_B = 21125^-$

$y_B = 8470$
$y_F = 12655^-$

1199 = 3.0788
537 = 2.7300
2 | 0.3488
= 0.1744

$21125^- = 4.32480$
$2.494 = 0.39690$
$y_B = \frac{21125^-}{8470.3} = 3.92790$
$y_F = 12655^-$

$\frac{1}{\lambda_F^2} = 423.12 \quad 12655^-$
$\frac{1}{\lambda_F^2} = 296.5^-7 = 2.47213$
2 | 7.52787
$\lambda_F = 5^-806.7 = 3.76393$

113) 1199 (001061
113
690
678
120

113) 537 (475^-
452
850
791
590

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Front lens reversed, flint to front, p. 210 7.in

No Sph. Ab.

		f_4 Central	f_4 Marginal	Sph. Ab. F=1
$r_1 = 22.7725^-$	B	112.1335^- .1012 ~~.1028~~ ✓	112.0860 .0553 ~~.0537~~ ✓	$-.0475^-$ .000420
$r_2 = 22.6407$	5614	$112.$ .0323 ~~.0307~~ 0	$112.$ .0307 ~~.0323~~ 0	$+.0016$ .000014
(1) $r_3 = 21.8518$	F	112.1121 .0798 ~~.0814~~ ✓	112.1522 .1215⁻ ~~.1199~~ ✓	$+.0401^-$ .000355
$r_4 = 47.0497$				

$t_1 = .895^-$ $D = .212$ $t_2 = .215^-$

	Sph Ab
B	− 000434
5614	0
F	− 000341

~~radii~~ As measured by Spherometer -

		f_4 Central	f_4 Marginal	Sph Ab Flint-two strong
$r_1 = 22.6407$	B	112.0879 1021	112.2710 .0512	.1831
$r_2 = 22.7725^-$	5614	111.9858 0	112.2198 0	− 0569 F=1 .000450 .2340 0
(2) $r_3 = 21.814$	F	112.0609 .0751	112.3436 .1238	.2827
$r_4 = 47.226$				+ .0487 F=1.000422

$t_1 = .895^-$ $D = .212$ $t_2 = .215^-$

~~radii~~ as measured by Spherometer, p224

	B	112.2977 .0990
	5614	112.1987 0
	F	112.2847 .0860

Same as (2) ✓ $t_1 = .900$ $D = .2034$ $t_2 = .2200$

$t_1 = .900$ $D = .2034$ $t_2 = .2200$

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Central B

XV

$n = 0.19309\frac{1}{2}$ ✓
$d = 1.86396\frac{1}{4}$ ✓
$r_3 = 1.68972$ ✓
3.74678 ✓

$r_3 = 48.9462$ ✓
$d(n-1) = 40.9322$ ✓
8.0140 ✓ = 0.90385 ✓
$f_3 = 696.514$ ✓ = 2.84293 ✓
... + 1.07
VIII
error → $d_4 = 695.444$ ✓ = $2.84226\frac{1}{4}$ ✓
$r_4 = 1.85022\frac{3}{4}$ ✓
4.69249 ✓

$d = 2.84226\frac{1}{4}$ ✓
$n-1 = 9.74810$ ✓
$2.59036\frac{1}{4}$ ✓ = 389.870 ✓

$n = 0.19309\frac{1}{2}$ ✓
$r = 1.85022\frac{3}{4}$ ✓
$2.04332\frac{1}{4}$ = 110.490 ✓
278.880 ✓ = $2.44541\frac{3}{4}$ ✓
f_4 = 176.633 ✓ = $2.24707\frac{1}{4}$ ✓

← see p. 56

$d_3 = 71.397\frac{1}{2}$ ✓
$r_3 = 48.9462$ ✓
120.3437 ✓ =

XV

$i = 11° 48' 53.1$ ✓ = sin $2.08042\frac{1}{4}$ ✓
sin d = $8.92051\frac{3}{4}$ ✓
1.00094 ✓
r_3 = 1.68972 ✓
= sin 9.31122 ✓
n = $0.19309\frac{1}{2}$ ✓
= sin $9.11812\frac{1}{2}$ ✓
1.68972 ✓
$0.80784\frac{1}{2}$ ✓
$\lambda = 7\ 32\ 32.2$ ✓ = sin $7.94463\frac{3}{4}$ ✓
$4\ 16\ 20.9$ ✓ = $2.86320\frac{3}{4}$ ✓
$4\ 46\ 36.7$ ✓
$d' = 0\ 30\ 15.8$ ✓ = sin

729.806 ✓
48.946 ✓
f_3 = 680.860 ✓
+1.07
Error
d_4 = 679.790 ✓
r_4 = 70.832 ✓
608.958 ✓ =

VIII

$2.78468\frac{3}{4}$ ✓
sin d = $7.94463\frac{3}{4}$ ✓
$0.72922\frac{1}{2}$ ✓
r_4 = $1.85022\frac{3}{4}$ ✓
$8.87899\frac{3}{4}$ ✓
n = $0.19309\frac{1}{2}$ ✓
= sin $9.07209\frac{1}{4}$ ✓
$1.85022\frac{3}{4}$ ✓
0.92232 ✓
$4° 20' 25.64$ ✓ = sin 8.52851 ✓
$6\ 46\ 48.00$ ✓ = 2.39381 ✓
$2\ 26\ 22.36$ ✓
$0\ 30\ 15.1$ ✓
$1\ 56\ 6.56$ ✓ = sin

f 247.634 ✓
70.832 ✓
f_4 = 176.802 ✓
176.633 ✓
.169 ✓ Sph Sh.

lessons neat

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II.

(10) (30)

$f_4 = 176.356$ ↘ crown mark

57.634 — 0.614 — crown mark

(Scale 30)

Spherical Abberation



— no separation —

$t_1 = .900$ $D = .2034$ $t_2 = .2200$

(176.419) → +4 — 48.946 — .148

— 48.240

+1 — 48.035

.044

f_4 centre

Aph. Ab.

47

46

$f_3 = \infty$

$\frac{.946}{.1320} \cdot \frac{.1911}{.1920} \cdot \frac{.211}{.0969} \cdot \frac{.0969}{.0722}$

crown mark

+1 176.518 — 1.350 — 43.035

40 Scale

crown strong

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$r_3 = 48.035^{-} = 1.68155\frac{3}{4}$ $\quad .0345485^{-} = A$

$8.318844\frac{1}{4} = .0208182$

$8.13768 = .0137303$

$r_4 = 72.8316 = 1.86232$

XV

$n = 0.19309\frac{1}{2}$

$d = 1.86396\frac{1}{4}$

$r_3 = 1.68155\frac{3}{4}$

$3.73861\frac{1}{2}$

48.035

$d(n-1) = 1.61206\frac{1}{4} = 40.9320$

$7.103 = 0.85144\frac{1}{4}$

$f_3 = 771.210 = 2.88717\frac{1}{4}$

+1.07

VIII

~~Error ~ $d_4 = 770.140 = 2.88657$~~

$r_4 = 1.86232$

4.74889

~~$d = 2.86232$~~

~~2.88657~~

$n-1 = 9.74810$

$2.63467 = 431.191$

$n = 0.19309\frac{1}{2}$

$r = 1.86232$

$2.05541\frac{1}{2} = 113.610$

$317.801 = 2.50185\frac{1}{2}$

$f_4 = 176.618 = 2.24703\frac{1}{2}$

176.590

.028 4th Sh.

Lemon string

Central $f_4 = 176.443$

Marginal $= \frac{.399}{.044}$

~~$r_3 = 48.165^{-}$~~

$d =$ XV

$d = 71.397\frac{1}{2}$

$r_3 = 48.035^{-}$

$119.432\frac{1}{2} =$ $2.07712\frac{1}{4}$

$\sin d = 8.92051\frac{3}{4}$

0.99764

$r_3 = 1.68155\frac{3}{4}$

$i = 11^{\circ}\ 56'\ 59.1''$ $= \sin 9.31608\frac{1}{4}$

$n = 0.19309\frac{1}{2}$

$7\ 37\ 39.75$ $= \sin 9.12298\frac{3}{4}$

$r_3 = 1.68155\frac{3}{4}$

$4\ 19\ 19.35^{-}$ $\quad 0.80454\frac{1}{2}$

$4\ 46\ 36.7$

$0\ 27\ 17.35^{-} = \sin 7.89971\frac{1}{4}$

$803.216 = 2.90483\frac{1}{4}$

48.035

$f_3 = 755.181$

+1.07 ← Error

$d_4 = 754.111$

$r_4 = 72.832$

$681.279 = 2.83332\frac{1}{2}$

$\sin d = 7.89971\frac{1}{4}$

$0.73303\frac{3}{4}$

$r_4 = 1.86232$

$i = 4^{\circ}\ 15'\ 30.00$ $= \sin 8.87071\frac{3}{4}$

$n = 0.19309\frac{1}{2}$

$\lambda = 6\ 39\ 4.92$ $= \sin 9.06381\frac{1}{4}$

$r = 1.86232$

$2\ 23\ 34.92$ $\quad 0.92613\frac{1}{4}$

$0\ 27\ 17.35^{-}$

$1\ 56\ 17.57 = \sin 8.52919\frac{2}{4}$

$249.422 = 2.39693\frac{1}{2}$

72.832

176.590

$f_4 = 176.399$ calculate on Separate Sheet

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II.

$\tau_1 = \text{Inf.}$

$\tau_2 = 45.035$

$\tau_3 = 48.165$ (240) $= 1.682732$ $.0345485$

$8.317268 = .0207620$

$8.139457 = .0137865$

$\tau_4 = 72.5347 = 1.860546$

$f = 176.620$

For $f_4 = 179.30$ ---------- $= \log$ 2.253585

$f_4 = 176.620 =$ 2.24704

0.00654

$(\tau_2 = 45.035) =$ $1.653555\frac{1}{2}$

$\tau_2 = 45.7188 =$ $1.660092\frac{1}{2}$

$\tau_1 = \text{Inf.}$
$\tau_2 = 45.719$ conjecture
$\Big\}\ t = 0.33$

$\tau_3 = 48.896$
$\tau_4 = 73.635$
$\Big\}\ t = 1.07$

0.00654

$(\tau_3 = 48.165) =$ 1.682734

$\tau_3 = 48.896 =$ 1.689274

0.00654

$(\tau_4 = 72.535) =$ $1.860544\frac{1}{2}$

$\tau_4 = 73.635$ $1.867082\frac{1}{2}$

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check on Color -

no space between

B

VII

$k = 6 =$ 0.77815 ✓

$r_2 = 45.719 =$ 1.66009 $\frac{1}{2}$ ✓✓

$i = 7° 32' 27.8$ ✓ $= \sin$ 9.11805 $\frac{1}{2}$ ✓

$n =$ 0.20844 $\frac{1}{2}$ ✓✓

$\lambda = 12\ 14\ 39.5$ ✓✓ $= \sin$ 9.32650 ✓

1.66009 $\frac{1}{2}$ ✓

$\lambda' = 4\ 42\ 11.7$ ✓✓ $\sin$ 0.98659 $\frac{1}{2}$ ✓

$\sin$ 8.91378 $\frac{3}{4}$ ✓

118.252 ✓ $= 2.07280$ $\frac{3}{4}$ ✓

45.719 ✓

$f_2 = 72.533$ ✓

$f_2 =$ 0.

XV

$d_3 = 72.533$

$r_3 = 48.896$

$121.429 =$ 2.08432 $\frac{1}{4}$

$\sin$ 8.91378 $\frac{3}{4}$

0.99811

$r_3 =$ 1.68927 $\frac{1}{4}$

$11° 44' 57.1 = \sin$ 9.30883 $\frac{3}{4}$

$n =$ 0.19309 $\frac{1}{2}$

$7\ 30\ 2.8 =$ 9.11574 $\frac{1}{4}$

$4\ 14\ 54.3$ 1.68927 $\frac{1}{4}$

$4\ 42\ 11.7$ 0.80501 $\frac{1}{2}$

$\lambda' = 0\ 27\ 17.4 = \sin$ 7.89972 $\frac{1}{2}$

$804.063 = 2.90529$

48.896

$f_3 = 755.167$

$+1.07$ ← Error

VIII

$d_4 = 754.097$

$f_4 = 680.462$ and 2.83280 $\frac{1}{2}$

7.89972 $\frac{1}{2}$

0.73253

$r_4 =$ 1.86708 $\frac{1}{2}$

$4° 12' 24.69 = \sin$ 8.86544 $\frac{1}{2}$

$n =$ 0.19309 $\frac{1}{2}$

$6\ 34\ 14.15 =$ 9.05854

$2\ 21\ 49.46$ 1.86708 $\frac{1}{2}$

$0\ 27\ 17.4$ 0.92562 $\frac{1}{2}$

$1\ 54\ 32.06 = \sin$ 8.52258 $\frac{1}{4}$

$252.955 = 2.40304$ $\frac{1}{4}$

73.635

$f_4 = 179.320$

F'

$k = b =$ 0.77815

$i = 7° 32' 27.8$ ✓ $= \sin$ 9.11805 $\frac{1}{2}$ ✓

$n =$ 0.21400 $\frac{1}{2}$ ✓

$\lambda = 12\ 24\ 16.3$ ✓✓ $= \sin$ 9.33206 ✓

$\lambda' = 4\ 51\ 48.5$ ✓✓ 1.66009 $\frac{1}{2}$ ✓

0.99215 $\frac{1}{2}$ ✓

$\sin$ 8.92830 $\frac{1}{4}$ ✓

$= 2.06385$ $\frac{1}{4}$ ✓

115.838 ✓

45.719 ✓

$f_2 = 70.119$ ✓

$d_3 = 70.119$

48.896

$119.015 =$ 2.07560 $\frac{1}{4}$

$\sin$ 8.92830 $\frac{1}{4}$

1.00390 $\frac{1}{2}$

1.68927 $\frac{1}{4}$

$11° 54' 33.5 = \sin$ 9.31463 $\frac{1}{4}$

$n =$ 0.19682 $\frac{1}{4}$

$7\ 32\ 12.4 =$ 9.11781

$4\ 22\ 21.1$ 1.68927 $\frac{1}{4}$

$4\ 51\ 48.5$ 0.80708 $\frac{1}{4}$

$\lambda' = 0\ 29\ 27.4 = \sin$ 7.93290 $\frac{1}{2}$

$748.475 = 2.87417$ $\frac{3}{4}$

48.896

$f_4 = 699.579$

$+1.07$ ← Error

$d_4 = 698.509$ ✓

73.635

$624.874 =$ 2.79579 $\frac{1}{4}$

7.93290 $\frac{1}{2}$

0.72869 $\frac{3}{4}$

1.86708 $\frac{1}{2}$

$4° 10' 11.40 = \sin$ 8.86161 $\frac{1}{4}$

$n =$ 0.19682 $\frac{1}{4}$

$6\ 34\ 8.96 = \sin$ 9.05843 $\frac{1}{2}$

$2\ 23\ 57.56$ 1.86708 $\frac{1}{2}$

$0\ 29\ 27.4$ 0.92552

$1\ 54\ 30.16$ 8.52246 $\frac{1}{4}$

$252.963 = 2.40305$ $\frac{3}{4}$

73.635

$f_4 = 179.328$

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II.

Check of Spherical Aberration

— central —

B

VII

45.719 = n−1

r_2 = 1.66009 ½ ✓
= 9.78959 ¼ ✓
= 1.87050 ¼ ✓

$d_3 = f_2$ = 74.217 ✓

n = 0.19309 ½
r_3 = 1.68927 ¼
3.75287

d = 1.87050 ¼

XV

n−1 = 9.74810 | 48.896
1.61860 ¼ = 41.533
7.343 = 0.86587 ¼

f_3 = 770.900 = 2.88699 ¾
+1.07

d_4 = 769.830 = 2.88639 ½

r_4 = 1.86708 ½
4.75348

d = 2.88639 ½

VIII

n−1 = 9.74810
2.63449 ½ = 431.018

n = 0.19309 ½
r = 1.86708 ½
2.06018 = 114.863
316.155 = 2.49990

f_4 = 179.300 = 2.25358

E′

r_2 = 1.66009 ½ ✓
n−1 = 9.80402 ½ ✓
= 1.85607 ✓

$d_3 = f_2$ = 71.791 ✓

0.19682 ¼
1.68927 ¼
3.74216 ½

d = 1.85607

n−1 = 9.75841 | 48.8960
1.61448 = 41.1604
7.7356 = 0.88849 ½

f_3 = 713.994 = 2.85367
+1.07

d_4 = 712.884 = 2.85302

1.86708 ½
4.72010 ½

d = 2.85302

n−1 = 9.75841
2.61143 = 40.8724

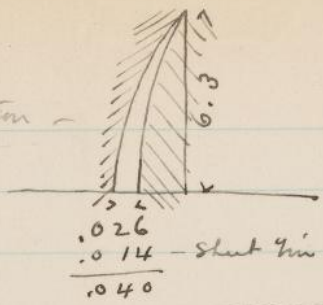
n = 0.19682 ¼
r = 1.86708 ½
2.06390 ¾ = 115.853
292.871 = 2.46667 ¾

f_4 = 179.237 = 2.25342 ¾

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Distance between Lenses



$r_2 = 48.719$

~~$r_3 = 48.896$~~

Color B

0.61. $f_2 = 72.533$ ✓✓
$+.040$ ✓✓
$d_3 = 72.573$ ✓✓
$r_3 = 48.764$ ✓✓
121.337 ✓✓ $=$ $2.08399\frac{1}{4}$ ✓✓

XV

$\sin i = 8.91378\frac{3}{4}$ ✓✓
0.99778 ✓✓
48.764 $r_3 =$ $1.68809\frac{3}{4}$ ✓✓
$11^\circ\ 46'\ 20.7$ ✓✓ $= \sin$ $9.30968\frac{1}{4}$ ✓✓
$n =$ $0.19309\frac{1}{2}$ ✓✓
$i - \lambda = 7\ 30\ 55.7$ ✓✓ $= \sin$ $9.11658\frac{3}{4}$ ✓✓
$\lambda = 4\ 15\ 25.0$ ✓✓ $1.68809\frac{3}{4}$ ✓✓
$4\ 42\ 11.7$ ✓✓ $0.80468\frac{1}{2}$ ✓✓
$0\ 22\ 46.7$ ✓✓ $= \sin$ $7.82124\frac{1}{2}$ ✓✓
Error ↗ 962.587 ✓✓ $= 2.98344$ ✓✓
48.764 ✓✓
$f_3 = 913.823$ ✓✓
$+1.09$ ✓
$d_4 = 914.893$ ✓✓
$r_4 = 73.635$ ✓
841.258 ✓ $=$ $2.92382\frac{1}{4}$ ✓

VIII

$\sin i = 7.82124\frac{1}{2}$ ✓
$0.74806\frac{3}{4}$ ✓
$r_4 = 1.86708\frac{1}{2}$ ✓
$4^\circ\ 19'\ 49.10$ ✓ $= \sin$ $8.87798\frac{1}{4}$ ✓
$n = 0.19309\frac{1}{2}$ ✓
$6\ 45\ 50.73$ ✓ $= \sin$ $9.07107\frac{3}{4}$ ✓
$2\ 26\ 1.63$ ✓ $1.86708\frac{1}{2}$ ✓
$0\ 22\ 46.70$ ✓ $0.93816\frac{1}{4}$ ✓
$2\ 3\ 14.93$ ✓ $= \sin$ $8.85441\frac{1}{2}$ ✓
241.962 ✓ $= 2.38374\frac{3}{4}$ ✓
73.635 ✓
168.327 ✓

$0\ 26\ 46.7$ =

zero p 92

Color F′

$f_2 = 70.119$ ✓✓ Error .159
$+.040$ ✓
$d_3 = 70.150$ ✓✓
$r_3 = 48.764$ ✓✓
118.914 ✓✓ $=$ $2.07523\frac{1}{4}$ ✓

$\sin i = 8.92830\frac{1}{4}$ ✓
$1.00353\frac{1}{2}$ ✓
$r_3 = 1.68809\frac{3}{4}$ ✓
$i = 11^\circ\ 53'\ 54.2$ ✓✓ $= \sin$ $9.31543\frac{3}{4}$ ✓
$n = 0.19682\frac{1}{4}$ ✓
$\lambda = 7\ 33\ 3.0$ ✓✓ $= \sin$ $9.11861\frac{1}{2}$ ✓
$4\ 22\ 51.2$ ✓✓ $r_3 = 1.68809\frac{3}{4}$ ✓
$4\ 51\ 48.8$ ✓✓ $0.80671\frac{1}{4}$ ✓
$0\ 28\ 57.3$ ✓✓ $= \sin$ $7.92544\frac{1}{2}$ ✓
760.795 ✓✓ $= 2.88126\frac{3}{4}$ ✓
48.764 ✓✓
$f_3 = 712.031$ ✓✓
~~$+1.09$ ✓~~
~~710.961 ✓✓~~
$d_4 =$ ~~73.635 ✓~~
637.326 ✓ $=$ $2.80436\frac{1}{4}$ ✓

$7.92544\frac{1}{2}$ ✓
$0.72980\frac{3}{4}$ ✓
$1.86708\frac{1}{2}$ ✓
$4^\circ\ 10'\ 49.88$ ✓ $= \sin$ $8.86272\frac{1}{4}$ ✓
$0.14682\frac{1}{4}$ ✓
$6\ 35\ 9.77$ ✓ $= \sin$ $9.05954\frac{1}{2}$ ✓
$2\ 24\ 19.89$ ✓ $1.86708\frac{1}{2}$ ✓
$0\ 28\ 57.30$ ✓ 0.92663 ✓
$1\ 55\ 22.59$ ✓ $= \sin$ $8.85276\frac{1}{4}$ ✓
251.691 ✓ $= 2.40086\frac{3}{4}$ ✓
73.635 ✓
178.056 ✓
168.327
9.729

continued on page 90.

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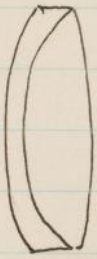
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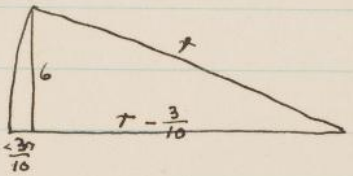
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V

Case II p. 80.





$r^2 = 36 + r^2 - \frac{6}{10}r + \frac{9}{100}$

$\frac{6}{10}r = 36.09$

$r = \frac{360.9}{6} = 60.15$

$r^2 = 36 + r^2 - \frac{6.0}{10}r + \frac{6.25}{100}$

$\frac{1}{2}r = 36.0625$

$r = 72.125$

16) 80.(.31
48
20

2.5
2.5
125
80
.06.25

2 × .25

$\frac{1}{r_2} = \frac{1}{r_1} + B$ $\qquad$ $\frac{1}{r_4} = A - \frac{1}{r_3}$

$r_1 = 80.000 = 1.90309$

$8.09691 = .0125000$

$.0222047 = B$ p. 32

$8.540383/4 = .0347047$

$r_2 = 28.8146 = 1.45961\ 1/4$

by $r_3 = 26.8146 = 1.42837\ 1/4$ $\quad .0345485 = A$ p. 32

$8.57162\ 3/4 = .0372930$

$.0027445$

r_4 concave.

$r_1 = 98.903 = 1.99521$

$8.00479 = .0101109$

$.0222047 = B$

$8.50941\ 1/4 = .0323156$

$r_2 = 30.9448 = 1.49058\ 3/4$

$r_3 = 28.9448 = 1.46157$

$8.53843 = .0345485 = A$

$.0345485$

$.0000000$

$r_4 = \text{Inf.}$

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1903phae.proj.1152P

Central B.

Marginal B. I

$k = 6$ = 0.77815 ✓

80.000 = r_1 = 1.99309 ✓

i = 4 18 4.35 ✓ = sin 8.87506 ✓

n = 0.20844½ ✓

λ = 2 39 36.26 ✓ = sin 8.66661½ ✓

λ' = 1 38 28.09 ✓ r = 1.90309 ✓

0.56970½ ✓

sin = 8.45696¼ ✓

= 2.11274¼ ✓

129.641 ✓

r_1 = 80.000 ✓

f_1' = 209.641 ✓

.330 ✓

d_2 = 209.311 ✓

r_2 = 28.815 ✓

180.496 ✓

XIII

= 2.25646¾ ✓

sin 8.45696¼ ✓

0.71348 ✓

r_2 =

Flint continued on p 74

I

$k = 6$ = 0.77815 ✓

$r_1 = 98.903$ = 1.99521 ✓

= sin 8.78294 ✓

n = 0.20844½ ✓

3 28 40.79 ✓ = sin 8.57449½ ✓

2 9 5.00 ✓ r = 1.99521 ✓

λ' = 1 19 35.79 ✓ 0.56970½ ✓

sin 8.36458¼ ✓

2.20512¼ ✓

160.370 ✓ =

r_1 = 98.903 ✓

f_1 = 259.273 ✓

.330 ✓

d_2 = 258.943 ✓

r_2 = 30.945 ✓

227.998 ✓

XIII

= 2.35793 ✓

sin 8.36458¼ ✓

0.72251¼ ✓

r_2 = 1.49058¾ ✓

i = 9 49 17.3 ✓ = sin 9.23192½ ✓

n = 0.20844½ ✓

λ = 16 0 4.4 ✓ = sin 9.44037 ✓

6 10 47.1 ✓ r_2 = 1.49058¾ ✓

λ' = 1 19 35.8 ✓ 0.93095¾ ✓

λ' = 4 51 11.3 ✓ sin 8.92738 ✓

= 2.00357¾ ✓

100.827 ✓

r_2 = 30.9448 ✓

f_2 = 69.882 ✓

n = 0.20844½ ✓

r_1 = 1.99521 ✓

2.20365½ ✓

$n-1$ = 9.78959¼ ✓

f_1 = 259.455 ✓ = 2.41406¼ ✓

.33 ✓

d_2 = 259.125 ✓ = 2.41351 ✓

r_2 = 1.49058¾ ✓

3.90409¾ ✓

d = 2.41351 ✓

$n-1$ = 9.78959¼ ✓

2.20310¼ ✓ = 159.626 ✓

n = 0.20844½ ✓

r = 1.49058¾ ✓

1.69903¼ ✓ = 50.0072 ✓

109.6188 = 2.03988½ ✓

f_2 = ~~73.1497~~ ✓ = 1.86421¼ ✓

f_2 = 73.1497 ✓

69.8822

3.2675

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1903phae.proj.1152P

VI

lenses

Central B

$f_2 = 73.1497$ ✓

$d_3 = 73.1497$ ✓ $= 1.86421\frac{1}{4}$ ✓

$n = 0.19309\frac{1}{2}$ ✓

$\alpha = 1.46157$ ✓

$3.51887\frac{3}{4}$ ✓

$d = 1.86421\frac{1}{4}$ ✓

$n-1 = 0.74810$ ✓

$1.61231\frac{1}{4} = 40.9555$ ✓

$r_3 = 28.9448$ ✓

12.0107 ✓ $= 1.07956\frac{3}{4}$ ✓

$f_3 = 274.986$ ✓ $= 2.43931$ ✓

1.07

$d_4 = 273.916$ ✓ $= 2.43761\frac{3}{4}$ ✓

$n = 0.19309\frac{1}{2}$ ✓

$f_4 = 175.599$ ✓ $= 2.24452\frac{1}{4}$ ✓

173.461 ✓ Marginal

2.138 ✓ Sph. Ab.

lenses too strong

Marginal B

$f_2 = 69.882$ ✓

$d_3 = 69.882$ ✓

$r_3 = 28.9448$ ✓

98.8268 ✓ $=$ $1.99487\frac{1}{2}$ ✓ XI

$\sin\vartheta =$ 8.92738 ✓

$0.92225\frac{1}{2}$ ✓

$r_3 =$ 1.46157 ✓

$i = 16^\circ\ 47'\ 22''.6$ ✓ $= \sin$ $9.46068\frac{1}{2}$ ✓

$n =$ $0.19309\frac{1}{2}$ ✓

$\lambda = 10\ 40\ 17.5$ ✓ $= \sin$ 9.26759 ✓ $r =$ 1.46157 ✓

$\vartheta = 4\ 57\ 11.3$ ✓ 0.72916 ✓

$\vartheta' = 1\ 15\ 53.8$ ✓ $= \sin$ $8.34391\frac{1}{4}$ ✓

242.800 ✓ $=$ $2.38524\frac{3}{4}$ ✓

$r_3 = 28.945$ ✓

$f_3 = 271.745$ ✓

1.07 ✓

$d_4 = 270.675$ ✓ V

$r_4 =$

$i = \vartheta' = 1^\circ\ 15'\ 53''.8$ ✓ $= \sin$ $8.34391\frac{1}{4}$ ✓

$n =$ $0.19309\frac{1}{2}$ ✓

$\lambda = 1\ 58\ 24.25$ ✓ $= \sin$ $9.53700\frac{3}{4}$ ✓

$\vartheta' = \lambda$

$d_4 = 270.675$ ✓ $=$ $2.43244\frac{3}{4}$ ✓

$i = 1^\circ\ 15^\circ\ 53''.8$ ✓ $= \tan$ 8.34402 ✓

$0.77646\frac{3}{4}$ ✓

$\lambda = 1\ 58\ 24.25$ ✓ $= \tan$ $8.53726\frac{1}{2}$ ✓

$f_4 = 173.461$ ✓ $=$ $2.23920\frac{1}{4}$

Diagram on page 56. shows that a change of 8.599 in r_3 (=43) produces a change in the sph. ab. of 1.964

Try change of 7.000 in r_3

28.9448

35.9448

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by $\tau_3 = 35.9448$ ✓ = 1.555563½ ✓ .0345485 ✓ = A
8.444361½ ✓ = .0278205 ✓
7.827881½ ✓ = .0067280 ✓

$\tau_4 = 148.633$ ✓ = 2.172111½ ✓

Central B

$n = 0.19309\frac{1}{2}$ ✓
$d = 1.86421\frac{1}{4}$ ✓
$\tau = 1.55563\frac{1}{2}$ ✓
$3.61294\frac{1}{4}$ ✓

$d = 1.86421\frac{1}{4}$ ✓
$n-1 = 9.74810$ ✓
$1.61231\frac{1}{4}$ ✓ = 40.955 ✓
$\tau_3 = 35.9448$ ✓
5.0107 = 0.69989¾ ✓

$f_3 = 818.550$ ✓ = 2.91304½ ✓
1.07 ✓
$d_4 = 817.480$ ✓ = 2.91247¾ ✓
~~0.00056¾~~
$\tau_4 = 2.172111\frac{1}{2}$ ✓
5.08459¼ ✓

$n = 0.19309\frac{1}{2}$ ✓
$\tau = 2.172111\frac{1}{2}$ ✓
2.36521 = 231.851 ✓

$d = 2.91247\frac{3}{4}$ ✓
$n-1 = 9.74810$ ✓
$2.66057\frac{3}{4}$ ✓ = 457.696 ✓
689.547 ✓ = 2.83856¼ ✓
$f_4 = 176.210$ ✓ = 2.24603 ✓

Lesson

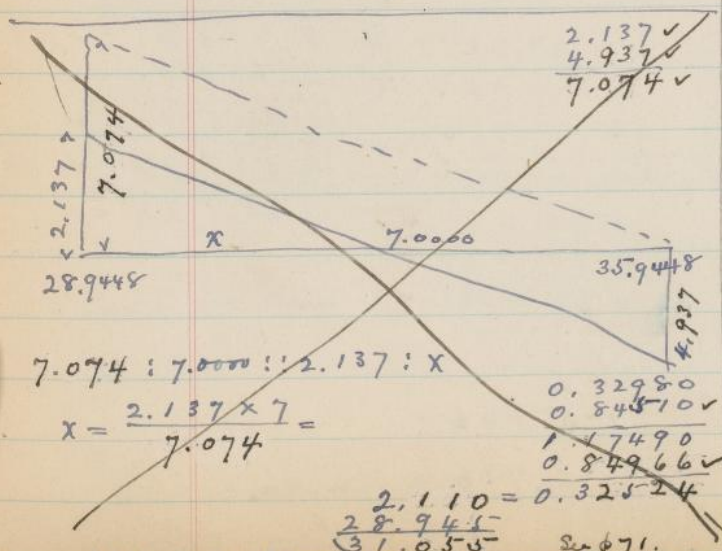
Marginal B

$d_3 = 69.882$ ✓
$\tau_3 = 35.945$ ✓
105.827 ✓ = 2.024559¾ ✓
sin d = 8.92738 ✓
0.95197¾ ✓
$\tau_3 = 1.555563\frac{1}{2}$ ✓
$i = 14^\circ\ 25'\ 23.5''$ ✓ = sin 9.396341¼ ✓
$n = 0.19309\frac{1}{2}$ ✓
$\lambda = 9\ 11\ 17.7$ ✓ = sin 9.203244¾ ✓
$\tau = 1.555563\frac{1}{2}$ ✓
$5\ 14\ 5.8$ ✓
$4\ 51\ 11.3$ ✓
$d' = 0\ 22\ 54.5$ ✓ = sin 7.823716¾ ✓
861.320 ✓ = 2.935161½ ✓

$\tau_3 = 35.945$ ✓
$f_3 = 897.265$ ✓
1.07
$d_4 = 896.195$ ✓
$\tau_4 = 148.633$ ✓
1044.828 ✓ = 3.019041½ ✓
sin d = 7.823716¾ ✓
0.84276¼ ✓
$\tau_4 = 2.172111\frac{1}{2}$ ✓
$i = 2^\circ\ 41'\ 5.66''$ ✓ = sin 8.670643¼ ✓
$n = 0.19309\frac{1}{2}$ ✓
$\lambda = 4\ 11\ 25.33$ ✓ = sin 8.863744¾ ✓
$1\ 30\ 19.67$ ✓ $\tau = 2.172111\frac{1}{2}$ ✓
$d = 0\ 22\ 54.5$ ✓ 1.035855¾ ✓
$1\ 53\ 14.17$ ✓ = sin 8.517634¼ ✓
329.780 ✓ = 2.518221½ ✓
$\tau_4 = 148.633$ ✓
$f_4 = 181.147$ ✓
176.210 ✓ central
4.937 ✓ = sph th
lesson too weak

XI

II



7.074 : 7.0000 :: 2.137 : x
$x = \frac{2.137 \times 7}{7.074} =$

0.32980
0.84510 ✓
1.17490
0.84966 ✓
2.110 = 0.32524
28.945
31.055

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By $r_3 = 31.212 = 1.494\,32\frac{1}{4}$ ✓

$8.505\,67\frac{3}{4}$ ✓ $= .0345485$ ✓ $= A$

$7.399\,60\frac{1}{2}$ ✓ $= .0320389$ ✓

$r_4 = 398.470$ ✓ $= 2.600\,39\frac{1}{2}$ ✓ $.0025096$ ✓

Central B

$n = 0.193\,09\frac{1}{2}$ ✓

$d_3 = 1.864\,21\frac{1}{4}$ ✓

$r_3 = 1.494\,32\frac{1}{4}$ ✓

$3.5\bar{5}163$ ✓

$d = 1.864\,21\frac{1}{4}$

$\sin i =$ 40.9533 ✓

$r_3 = 31.212$ ✓

$9.743\bar{5} = 0.988\,71\frac{1}{2}$ ✓

$f_3 = 365.8\bar{2}3$ ✓ $= 2.\bar{5}629\,1\frac{1}{2}$ ✓

1.07 ✓

$d_4 = 364.4\bar{5}3$ ✓ $= 2.561\,64\frac{1}{4}$ ✓

$r_4 = 2.600\,39\frac{1}{2}$ ✓

$5.162\,03\frac{3}{4}$ ✓

$n = 0.193\,09\frac{1}{2}$ ✓

$r = 2.600\,39\frac{1}{2}$ ✓

$2.793\,49 = 621.5\bar{7}$ ✓

$d = 2.561\,64\frac{1}{4}$ ✓

$\sin i = 9.748\,10$ ✓ $204.0\bar{5}3$ ✓

$2.309\,74\frac{1}{4}$ ✓ 825.623 ✓ $= 2.916\,78\frac{1}{4}$ ✓

$f_4 = 175.896$ ✓ $= 2.245\,2.5\bar{5}\frac{1}{2}$ ✓

~~something wrong here~~

No error in the formulae used.

Marginal B

$d_3 = 69.882$ ✓

$r_3 = 31.212$ ✓

101.094 ✓ $=$ XI $2.004\,72\frac{1}{2}$ ✓

$\sin i =$ $8.927\,38$ ✓

$0.932\,10\frac{1}{2}$ ✓

$r_3 = 1.494\,32\frac{1}{4}$ ✓

$i = 15^\circ\ 5\bar{4}'\ 13.1''$ ✓ $= \sin$ $9.437\,78\frac{1}{4}$ ✓

$n = 0.193\,09\frac{1}{2}$ ✓

$\lambda = 10\ 7\ 2.7$ ✓ $= \sin$ $9.244\,68\frac{3}{4}$ ✓

$5^\circ\ 44'\ 10.4''$ ✓ $r = 1.494\,32\frac{1}{4}$ ✓

$\beta = 4\ 5\bar{1}\ 11.3$ ✓ $0.739\,01$ ✓

$\beta' = 0\ 5\bar{5}\ 59.1$ ✓ $\sin$ $8.211\,77\frac{3}{4}$ ✓

336.692 ✓ $= 2.527\,23\frac{1}{4}$ ✓

$r_3 = 31.212$ ✓

$f_3 = 367.904$ ✓

1.07

$d_4 = 366.834$ ✓

$r_4 = 398.470$ ✓

765.304 ✓ $=$ II $2.883\,83\frac{1}{2}$ ✓

$\sin i =$ $8.211\,77\frac{3}{4}$ ✓

$1.095\,61\frac{1}{4}$ ✓

$r_4 = 2.600\,39\frac{1}{2}$ ✓

$i = 1^\circ\ 47'\ 32.28''$ ✓ $= \sin$ $8.495\bar{2}1\frac{3}{4}$ ✓

$n = 0.193\,09\frac{1}{2}$ ✓

$\lambda = 2\ 47\ 47.23$ ✓ $= \sin$ $8.688\,31\frac{1}{4}$ ✓

$1\ 0\ 14.9\bar{5}$ ✓ $r_4 = 2.600\,39\frac{1}{2}$ ✓

$\beta = 0\ 5\bar{3}\ 59.1$ ✓ $1.288\,70\frac{3}{4}$ ✓

$1\ 5\bar{6}\ 14.0\bar{5}$ ✓ $= \sin$ $8.\bar{5}289\,7\frac{3}{4}$ ✓

$\bar{5}75.082$ ✓ $= 2.\bar{7}59\,73$ ✓

398.470 ✓

$f_4 = 176.612$ ✓

175.896 ✓

0.716 ✓ = Alpha Ath.

brown mark

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log $r_3 = 31.055$ = 1.492137/4 ✓

8.50786 3/4 ✓ = .0322009 ✓ = .0345485 = A p. 32

7.37062 1/2 ✓ = .0023476 ✓

$r_4 = 425.966$ ✓ = 2.629371/2 ✓

$\frac{1}{r_4} = A - \frac{1}{r_3}$

Central B

$n =$ 0.19309 1/2 ✓

$d_3 =$ 1.86421 1/4 ✓

$r_3 =$ 1.49213 1/4 ✓

3.54944 ✓

$d(n-1) = 40.933$ ✓

$r_3 = 31.055$ ✓ / 9.9005 ✓ = 0.99565 3/4 ✓ / 2.55378 1/4 ✓

$f_3 = 357.917$ ✓ = 1.07 / 386.847 ✓ = 2.55248 1/4 ✓

$r_4 = 2.62937\ 1/2$ ✓ / 5.18185 3/4 ✓

$n = 0.19309\ 1/2$ ✓

$r_4 = 2.62937\ 1/2$ ✓ / 2.82247 ✓ = 664.462 ✓

$d = 2.55248\ 1/4$ ✓

$n-1 = 9.74810$ ✓ / 2.30058 1/4 ✓ = 199.794 ✓ / 864.256 ✓ = 2.93664 1/4 ✓ = 2.24521 1/2 ✓

$f_4 = 175.880$ ✓

Sph. Ab. correct when

$r_2 = 30.945$

$r_3 = 30.600$ / .345 — see diagram p. 35.

This is too near $r_2 = 30.945$

Marginal B

$d = 69.882$ ✓

$r_3 = 31.055$ ✓

100.937 ✓ =

XI

2.00405 ✓

8.92738 ✓

0.93143 ✓

$r_4 =$ 1.49213 1/4 ✓

= sin 9.43929 3/4 ✓

$n =$ 0.19309 1/2 ✓

= sin 9.24620 1/4 ✓

$r_3 =$ 1.49213 1/4 ✓

0.73833 1/2 ✓

15° 57′ 38.5″ ✓ = sin

10 9 10.3 ✓

5 48 27.2 ✓

$v =$ 4 51 11.3 ✓

$v' =$ 0 57 15.9 ✓ = sin 8.22159 1/2 ✓

328.655 ✓ = 2.51674 ✓

31.055 ✓

$f_3 = 359.710$ ✓

1.07

$d_4 = 358.640$ ✓

$r_4 = 425.966$ ✓

784.606 ✓ = 2.89465 1/4 ✓

sin $d =$ 8.22159 1/2 ✓

1.11624 3/4 ✓

$r_4 =$ 2.62937 1/2 ✓

$i =$ 1° 45′ 29.45″ ✓ = sin 8.48687 1/4 ✓

$n =$ 0.19309 1/2 ✓

$\lambda =$ 2 44 35.49 ✓ = sin 8.67996 3/4 ✓

0 59 6.04 ✓ 2.62937 1/2 ✓

0 57 15.9 ✓ 1.30934 1/2 ✓

$d =$ 1 56 21.94 ✓ = sin 8.52946 3/4 ✓

602.386 ✓ = 2.77987 1/2 ✓

425.966 ✓

$f_4 = 176.420$ ✓

175.880 ✓

0.540 ✓ Sph. Ab. brown weak

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VI.

$\tau_3 = 30.600 = 1.485^-72\frac{1}{4}$ $.0345485^- = A$
$8.514273\frac{3}{4} = .0326797$
$7.27156\frac{1}{4} = .0018688$
$\tau_4 = 535^-.103 = 2.728433\frac{3}{4}$

Central B

$n = 0.19309\frac{1}{2}$
$d = 1.86421\frac{1}{4}$
$\tau = 1.485^-72\frac{1}{4}$
3.54303

$d(n-1) = 40.9533^-$
$\tau_3 = 30.6000$
$10.3533^- = 1.015^-17$
2.52786

$f_3 = 337.179$
1.07
$d_4 = 336.109 = 2.5^-2648$

II
$\tau_4 = 2.728433\frac{3}{4}$
$5^-.25^-4911\frac{3}{4}$

$n = 0.19309\frac{1}{2}$
$\tau = 2.728433\frac{3}{4}$
$2.921^-53\frac{1}{4} = 834.704$

$d = 2.5^-2648$
$n-1 = 9.74^-810$
$2.2745^-8 = 188.183$
$1022.887 = 3.00982\frac{3}{4}$

$f_4 = 175^-.829 = 2.24509$

$\tau_3 = 30.590$ $f_4 = 175.828$

Marginal B

$d = 69.882$
$\tau_3 = 30.600$
$100.482 = 2.002083\frac{3}{4}$
$\sin d = 8.92738$
$0.92946\frac{3}{4}$
$\tau_3 = 1.485^-72\frac{1}{4}$
$16^\circ\ 7'\ 45^-.95^- = \sin 9.443741\frac{1}{2}$
$0.19309\frac{1}{2}$
$10\ 15^-\ 31.6 = \sin 9.25^-065^-$
$5^-\ 52\ 14.35^-$ $1.485^-72\frac{1}{4}$
$4\ 5^-1\ 11.3$ $0.73637\frac{1}{4}$
$1\ 1\ 3.05^- = \sin 8.24939\frac{1}{2}$
$306.886 = 2.486973\frac{3}{4}$
30.600
$f_3 = 337.486$
1.07
$d_4 = 336.416$
$\tau_4 = 5^-35^-.103$
871.5^-19

XI
$= 2.940273\frac{3}{4}$
$\sin d = 8.24939\frac{1}{2}$
$1.18967\frac{1}{4}$
$\tau_4 = 2.728433\frac{3}{4}$
$1^\circ\ 39'\ 26.5^-1 = \sin 8.461233\frac{1}{2}$
$0.19309\frac{1}{2}$
$2\ 35^-\ 9.00 = \sin 8.65^-433$
$0\ 5^-5^-\ 42.49$ $2.728433\frac{3}{4}$
$1\ 1\ 3.05^-$ $1.382763\frac{3}{4}$
$1\ 5^-6\ 45^-.5^-4 = \sin 8.5^-3093\frac{1}{4}$
$710.943 = 2.85^-1831\frac{1}{2}$
$5^-35^-.103$
$f_4 = 175^-.840$

$175^-.829$
$.011$ between weak

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$r_1 = 98.903$

$r_2 = 30.945$

$r_3 = 30.590$ = 1.485558 ✓ .0345485 = A

8.514422 ✓ = .0326904 ✓

7.269078 ✓ = .0018581 ✓

$r_4 = 538.183$ ✓ = 2.730931 ✓ $f_4 = 175.828$

For $f_4 = 179.30$ ——————— log 2.25358

175.828 2.245083 3/4

0.008491 1/4

$r_1 = 100.856$ } $t = 0.33$
$r_2 = 31.536$ concave }

$r_3 = 31.194$ } $t = 1.07$
$r_4 = 548.810$ }

$(r_1 = 98.903) =$ 1.995321

$r_1 = 100.856 =$ 2.003701/4

0.008491/4

$(r_2 = 30.9448) =$ 1.490558 3/4

$r_2 = 31.5559 =$ 1.49908

0.008491/4

$(r_3 = 30.590) =$ 1.485558

$r_3 = 31.194 =$ 1.494071/4

0.008491/4

$(r_4 = 538.183) =$ 2.730931

$r_4 = 548.810 =$ 2.739421/4

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1 VI

From page 66 & 67. $r_0 = 80.000$ &c.

$r_2 = 28.8146$

Central B

$n = 0.20844\frac{1}{2}$ ✓✓

$r_1 = 1.90309$ ✓

$2.11153\frac{1}{2}$ ✓

$n-1 = 9.78959\frac{1}{4}$ ✓✓

$f_1 = 209.866$ ✓ $= 2.32194\frac{1}{4}$ ✓

.33 ✓

$d_2 = 209.536$ ✓ $= 2.32125\frac{3}{4}$ ✓

$r_2 = 1.45961\frac{1}{4}$ ✓

3.78087 ✓

$d = 2.32125\frac{3}{4}$ ✓

$n-1 = 9.78959\frac{1}{4}$ ✓✓

2.11085 ✓ $= 129.077$ ✓

$n = 0.20844\frac{1}{2}$ ✓✓

$r = 1.45961\frac{1}{4}$ ✓

$1.66805\frac{3}{4}$ ✓ $= 46.5648$ ✓

82.5122 ✓ $= 1.91651\frac{3}{4}$ ✓

$f_2 = 73.1733$ ✓ $= 1.86435\frac{1}{4}$ ✓

$\frac{69.4501}{3.7232}$

Marginal B

p. 67

XIII

$d_2 + r_2 = 180.496$ ✓ $= 2.25646\frac{3}{4}$ ✓

$\sin v = 8.45696\frac{1}{4}$ ✓

0.71343 ✓

$r_2 = 28.8146 = 1.45961\frac{1}{4}$ ✓

$= \sin 9.25381\frac{3}{4}$ ✓

$n = 0.20844\frac{1}{2}$ ✓

$= \sin 9.46226\frac{1}{4}$ ✓

$r_2 = 1.45961\frac{1}{4}$ ✓

$0.92187\frac{1}{2}$ ✓

$\sin 8.92947\frac{3}{4}$ ✓

$= 1.99239\frac{3}{4}$ ✓

$10^\circ\ 20'\ 4.9$ ✓

$16^\circ\ 51'\ 9.1$ ✓

$6\ 31\ 4.2$ ✓

$v = 1\ 38\ 28.09$ ✓

~~7 23.89~~

$v = 4^\circ\ 52'\ 36.11$ ✓ $=$

98.2647 ✓

28.8146 ✓

$f_2 = 69.4501$ ✓

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$r_3 = 31.212$ ✓
$r_4 = 398.470$ ✓ } 8.70 = log. 1.49432½ ✓ = " 2.60039½ ✓

Central B.

"Bangkok"

$n = 0.19309\frac{1}{2}$ ✓✓
$d_3 = 1.86435\frac{1}{4}$ ✓✓
$r_3 = 1.49 \times 32\frac{1}{4}$ ✓✓
3.55177 ✓✓

$d = 1.86435\frac{1}{4}$ ✓✓
$n-1 = 9.74810$ ✓✓
$1.61245\frac{1}{4}$ ✓✓ = 40.9687 ✓✓
31.212 ✓✓
9.7567 = 0.98930¼ ✓✓

$f_3 = \frac{365.155}{1.07}$ ✓✓ = 2.56247¾ ✓✓

$d_4 = \frac{266.847}{}$ ✓ 2.42626¼ ✓
$r_4 = 2.60039\frac{1}{2}$ ✓
5.02665¾ ✓

$n = 0.19309\frac{1}{2}$ ✓
$r = 2.60039\frac{1}{2}$ ✓
2.79349 ✓ = 621.570 ✓

$d = 2.42626\frac{1}{4}$ ✓
$n-1 = 9.74810$ ✓
$2.21036\frac{1}{4}$ ✓ = 162.316 ✓
783.886 ✓ = 2.89425¼ ✓
$f_4 = 135.645$ ✓ = 2.13240½ ✓

$f_3 = \frac{365.155}{1.07}$ ✓
$d_4 = 364.085$ ✓ = 2.56120¼ ✓
2.60039½ ✓
5.16159¾ ✓

621.570 ✓

$nr =$
$d = 2.56120\frac{1}{4}$ ✓
$n-1 = 9.74810$ ✓
$2.30930\frac{1}{4}$ ✓ = 203.846 ✓
825.416 = 2.91667¼ ✓
= 2.24492½ ✓

$f_4 = 175.762$ ✓

Marginal B.

$d_3 = 69.4501$ ✓
$r_3 = 31.212$ ✓
100.6621 ✓ =

$i = 15° 54' 45".2$ ✓ = sin 9.43802 ✓
$\lambda = 10\ 7\ 22.8$ ✓ = sin 9.24492½ ✓
$5\ 47\ 22.4$ ✓
$\delta = 4\ 52\ 36.11$ ✓
$\delta' = 0\ 54\ 46.29$ ✓ = sin 8.20226¼ ✓
344.338 ✓ = 2.53698½ ✓

$r_3 = 31.212$ ✓
$f_3 = \frac{375.550}{1.07}$ ✓
$d_4 = 374.480$ ✓
$r_4 = \frac{398.470}{772.950}$ ✓ = 2.88815¼ ✓

$1°\ 46'\ 12".46$ ✓ = sin 8.49002 ✓
$2\ 45\ 47.38$ ✓ = sin 8.68311½ ✓
$0\ 59\ 34.92$ ✓
$0\ 54\ 46.29$ ✓
$1\ 54\ 21.21$ ✓ = sin
577.584 ✓ = 2.76161½ ✓
398.470 ✓
$f_4 = 179.114$ ✓

175.762 ✓
3.352 ✓ Sph. Sh.

Lesson weak

XI

$(i-\lambda) > \nu$

2.00286½ ✓
sin ν = 8.92947¾ ✓
0.93234¼ ✓
$r_3 =$ 1.49×32¼ ✓
9.43802 ✓
0.19309½ ✓
9.24492½ ✓
1.49432¼ ✓
0.73924¾ ✓
8.20226¼ ✓
2.53698½ ✓

II

2.88815¼ ✓
8.20226¼ ✓
1.09041½ ✓
$r_4 =$ 2.60039½ ✓
8.49002 ✓
$n =$ 0.19309½ ✓
8.68311½ ✓
$r_4 =$ 2.60039½ ✓
1.28351 ✓
8.52189½ ✓
2.76161½ ✓

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XIX

$r_3 = 35.9448$ ✓ = log $1.555\,563\frac{1}{2}$ ✓

$r_4 = 148.633$ ✓ = " $2.172\,11\frac{1}{2}$ ✓

see p. 69

Central B

$n = 0.193\,09\frac{1}{2}$ ✓

$d_3 = 1.864\,85\frac{1}{4}$ ✓

$r_3 = 1.555\,563\frac{1}{2}$ ✓

$3.613\,08\frac{1}{4}$

$d(n-1) = \cancel{44.8096}$

35.9448

$8.5647 = 0.932\,71\frac{1}{4}$

$f_3 = 479.038 = 2.680\,37$

1.07

$d_r = 477.968 = 2.679\,40$

$r_4 = 2.172\,11\frac{1}{2}$

$4.851\,51\frac{1}{2}$

$n = 0.193\,09\frac{1}{2}$

$r = 2.172\,11\frac{1}{2}$

$2.365\,21 = 231.852$

$d = 2.679\,40$

$n-1 = \cancel{9.784\,10}$

$2.463\,50 = 290.737$

$522.589 = 2.718\,16$

$f_4 = 135.942 = 2.133\,35\frac{1}{2}$

$3.613\,08\frac{1}{4}$

$d(n-1) = 40.9687$

35.9448

$5.0239 = 0.701\,04$

$f_3 = 816.660 = 2.912\,04\frac{1}{4}$

1.07

$d_4 = 815.590 = 2.911\,47\frac{1}{4}$

$r_4 = 2.172\,11\frac{1}{2}$

$nr = 231.852$ $5.083\,58\frac{3}{4}$

$d = 2.911\,47\frac{1}{4}$

$n-1 = 9.748\,10$

$2.659\,57\frac{1}{4} = 456.639$

$688.491 = 2.837\,89\frac{3}{4}$

$f_4 = 176.072 = 2.245\,69$

Marginal B

$d_3 = 69.4501$ XI

$r_3 = 35.9448$

$105.3949 = 2.022\,82$

$\sin v = 8.929\,47\frac{3}{4}$

$0.952\,29\frac{3}{4}$

$r_3 = 1.555\,563\frac{1}{2}$

$14\ 26\ 2.6 = \sin 9.396\,66\frac{1}{4}$

$n = 0.193\,09\frac{1}{2}$

$9\ 11\ 42.3 = \sin 9.203\,56\frac{3}{4}$

$5\ 14\ 20.3$ $1.555\,63\frac{1}{2}$

$v = 4\ 52\ 36.11$ $0.758\,20\frac{1}{4}$

$v_0 = 0\ 21\ 44.19 = \sin 7.800\,91\frac{1}{4}$

$908.427 = 2.958\,29$

35.945

$f_3 = 944.372$

1.07

$d_4 = 943.302$

$r_4 = 148.633$

$1091.935 = 3.038\,19\frac{3}{4}$

II

$\sin v = 7.800\,91\frac{1}{4}$

$0.838\,11$

$r_4 = 2.172\,11\frac{1}{2}$

$i = 2^\circ\ 39'\ 44.65'' = \sin 8.666\,99\frac{1}{2}$

$n = 0.193\,09\frac{1}{2}$

$\lambda = 4\ 9\ 18.77 = \sin 8.860\,09$

$2.172\,11\frac{1}{2}$

$v = 1\ 29\ 34.12$ $1.032\,20\frac{1}{2}$

$0\ 21\ 44.19$

$v' = 1\ 51\ 18.31 = \sin 8.510\,16\frac{1}{2}$

$332.690 = 2.522\,04$

148.633

$f_4 = 184.057$

176.072

7.985 Sph. Ab.

Lesson next

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$r_3 = 27.000 = 1.43136\frac{1}{2}$ ✓ $.0345485$ ✓ = A
$8.56863\frac{1}{2}$ ✓ = $.0370370$ ✓
$7.39593\frac{3}{4}$ ✓ = $.0024885$ ✓

$A = \frac{1}{r_3} - \frac{1}{r_4}$ $\quad \frac{1}{r_4} = \frac{1}{r_3} - A$

$r_4 = 401.849$ ✓ = $2.60406\frac{1}{4}$ ✓
concave

Central B

$n = 0.19309\frac{1}{2}$ ✓
$d_3 = 1.86435\frac{1}{4}$ ✓
$r_3 = 1.43136\frac{1}{2}$ ✓
$3.48881\frac{1}{4}$ ✓

$d(n-1) =$ ~~44.5095~~
$r_3 = 27.0000$
$17.5095 = 1.24327\frac{1}{4}$
$= 2.24585\frac{1}{4}$

$f_3 = 176.011$
1.07
$d_4 = 174.941 = 2.24289\frac{1}{4}$
$r_4 = 2.60406\frac{1}{4}$
$4.84695\frac{1}{2}$

$n = 0.19309\frac{1}{2}$ ✓
$r = 2.60406\frac{1}{4}$ ✓
$2.79715\frac{3}{4}$ ✓ = 626.840 ✓

$d = 2.24289\frac{1}{4}$
$n-1 = 9.78410$
$2.02699\frac{1}{4} = 106.412$
$520.428 = 2.71636$

$f_4 = 135.081 = 2.13059\frac{1}{2}$

$d(n-1) = 40.9687$ ✓
$27.$ ✓
13.9687 ✓
$f_3 = 220.626$ ✓
1.07
$d_p = 219.556$ ✓
626.840 ✓

$3.48881\frac{1}{4}$ ✓
$= 1.14575\frac{1}{2}$ ✓
$= 2.34368\frac{3}{4}$ ✓
$= 2.34154\frac{1}{2}$ ✓
$r_4 = 2.60406\frac{1}{4}$ ✓
$4.94560\frac{3}{4}$ ✓

$n =$
$d = 2.34154\frac{1}{2}$ ✓
$n-1 = 9.74810$ ✓
$2.08964\frac{1}{2} = 122.926$ ✓
$503.914 = 2.70235\frac{3}{4}$ ✓

$f_4 = 175.085$ ✓ = 2.24328 ✓

Marginal B.

$d = 69.4501$ ✓
$r_3 = 27.$ ✓
96.4501 ✓

XI

$= 1.98430\frac{1}{4}$ ✓
$\sin d = 8.92947\frac{3}{4}$ ✓
0.91378 ✓
$r_3 = 1.43136\frac{1}{2}$ ✓
$i = 17^\circ\ 40'\ 43.4$ ✓ = $\sin 9.48241\frac{1}{2}$ ✓
$n = 0.19309\frac{1}{2}$ ✓
$\lambda = 11\ 13\ 33.6$ ✓ = $\sin 9.28932$ ✓
$6\ 27\ 9.8$ ✓ $\quad r = 1.43136\frac{1}{2}$ ✓
$d = 4\ 52\ 36.11$ ✓ $\quad 0.72068\frac{1}{2}$ ✓
$d' = 1\ 34\ 33.69$ ✓ = $\sin 8.43938\frac{1}{2}$ ✓
191.117 ✓ = 2.28130 ✓

$r_3 = 27.$ ✓
$f_3 = 218.117$ ✓
1.07
$d_p = 217.047$ ✓
$r_4 = 401.849$ ✓
184.802 ✓

XII

$= 2.26670\frac{3}{4}$ ✓
$\sin d = 8.43938\frac{1}{2}$ ✓
$0.70609\frac{1}{4}$ ✓
$r_4 = 2.60406\frac{1}{4}$ ✓
$0\ 43\ 28.95$ ✓ = $\sin 8.10203$ ✓
$n = 0.19309\frac{1}{2}$ ✓
$1\ 7\ 49.85$ ✓ = $\sin 8.29512\frac{1}{2}$ ✓
$0\ 24\ 20.90$ ✓ $\quad r_4 = 2.60406\frac{1}{4}$ ✓
$1\ 34\ 33.69$ ✓ $\quad 0.89918\frac{3}{4}$ ✓
$1\ 58\ 54.59$ ✓ = $\sin 8.53885\frac{3}{4}$ ✓
229.261 ✓ = 2.36033 ✓
401.849 ✓
$f_4 = 172.588$ ✓

175.085 ✓
2.497 ✓ Ofh. Ah. Lesson strong.

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VI

Central (7)

$n = 0.19682\frac{1}{4}$

$0.21400\frac{1}{2}$

$80.000 = r_1 = 1.90309$

$2.11709\frac{1}{2}$

$n-1 = 9.80402\frac{1}{2}$

$f_1 = 205.622 = 2.31307$

$d_2 = \overset{.33}{205.292} = 2.31237\frac{1}{4}$

$28.815 = r_2 = 1.45961\frac{1}{4}$

$3.77198\frac{1}{2}$

$d = 2.31237\frac{1}{4}$

$n-1 = 9.80402\frac{1}{2}$

$2.11639\frac{3}{4} = 130.737$

$n = 0.21400\frac{1}{2}$

$r_2 = 1.45961\frac{1}{4}$

$1.67361\frac{3}{4} = 47.1648$

~~XII~~

$83.5722 = 1.92206\frac{1}{4}$

$f_2 = 70.782 = 1.84992\frac{1}{4}$

XI

$d_3 =$ $d_3 = 1.84992\frac{1}{4}$

$n = 0.19682\frac{1}{4}$

$27.000 = r_3 = 1.43136\frac{1}{2}$

3.47811

$d = 1.84992\frac{1}{4}$

$n-1 = 9.75841$

$1.60833\frac{1}{4} = 40.582$

27.000

$13.582 = 1.13296\frac{1}{4}$

$f_3 = 221.385 = 2.34514\frac{3}{4}$

1.07

XII

$d_4 = 220.315 = 2.34304\frac{1}{2}$

$r_4 = 2.60406\frac{1}{4}$

$4.94710\frac{3}{4}$

$n = 0.19682\frac{1}{4}$

$r = 2.60406\frac{1}{4}$

$2.80088\frac{1}{2} = 632.244$

$d = 2.34304\frac{1}{2}$

$n-1 = 9.75841$

$2.10145\frac{1}{2} = 126.315$

$505.929 = 2.70409$

$f_4 = 174.992 = 2.24301\frac{3}{4}$

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(20)

Common Weak

7.985



Spk. dk.

Fract. limit of central rays

3.352

Strong

2.497

Weak

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VI

$r_2 = 28.815$

$r_3 = 28.740 = 1.45848\frac{3}{4}$

$.075$

$8.54151\frac{1}{4} = .03454855 = A$

$.03447946$

$6.39111\frac{1}{4} = .00002461$

$r_4 = 4063.38 = 3.60888\frac{3}{4}$ concave

Central B

$n = 0.19309\frac{1}{2}$

$d = 1.86435\frac{1}{4}$

$r_3 = 1.45848\frac{3}{4}$

$3.51593\frac{1}{2}$

$d(n-1) = 40.9687$

28.740

$12.2287 = 1.08738$

$= 2.42855\frac{1}{2}$

$f_3 = 268.260$

1.07

$d_4 = 267.190 = 2.42682$

$r_4 = 3.60888\frac{3}{4}$

$6.03570\frac{3}{4}$

$n = 0.19309\frac{1}{2}$

$r = 3.60888\frac{3}{4}$

$3.80198\frac{1}{4} = 6338.44$

$d = 2.42682$

$m = 9.74810$

$2.17492 = 149.596$

$6188.844 = 3.79161$

$f_4 = 175.427 = 2.24409\frac{3}{4}$

Marginal B

$d_3 = 69.4501$

$r_3 = 28.740$

98.1901

$i = 16^\circ\ 53'\ 3''.7$

$\lambda = 10\ 43\ 50.4$

$6\ 9\ 13.3$

$4\ 52\ 36.11$

$v = 1\ 16\ 37.19$

240.114

28.740

$f_3 = 268.854$

1.07

$d_4 = 267.784$

$r_4 = 4063.38$

3795.596

$1^\circ\ 11'\ 34''.19$

$1\ 51\ 39.18$

$0\ 40\ 4.99$

$1\ 16\ 37.19$

$1\ 56\ 42.18$

3887.60

4063.38

$f_4 = 175.78$

175.427

$.353$ common mark

$= \frac{1}{4}$ X I

$= 1.99206\frac{3}{4}$

$\sin v = 8.92947\frac{3}{4}$

$0.92154\frac{1}{2}$

$r_3 = 1.45848\frac{3}{4}$

$= \sin 9.46305\frac{3}{4}$

$n = 0.19309\frac{1}{2}$

$= \sin 9.26996\frac{1}{4}$

$1.45848\frac{3}{4}$

0.72845

$= \sin 8.34803\frac{1}{4}$

$= 2.38041\frac{3}{4}$

X II

$= 3.57928$

$\sin v = 8.34803\frac{1}{4}$

$1.92731\frac{1}{4}$

$r_4 = 3.60888\frac{3}{4}$

$= \sin 8.31842\frac{1}{2}$

$n = 0.19309\frac{1}{2}$

$= \sin 8.51152$

$r = 3.60888\frac{3}{4}$

$2.12040\frac{3}{4}$

$= 8.53072\frac{1}{2}$

$= 3.58968\frac{1}{4}$

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$r_1 = 80.000$

$r_2 = 28.815^-$

$r_3 = 28.500 = 1.454844\frac{1}{2} \quad .0345485 = A$

$8.545^-15\frac{1}{2} = .0350877$

$6.73175^- = .0005392$

$r_4 = 1854.60 = 3.26825^-$

$f_4 = 175.380$

For $f_4 = 179.30$ ---------- $= \log 2.25385^-8$

$(f_4 = 175.380) = 2.24398$

0.00960

$(r_1 = 80.000) = 1.90309$

$r_1 = 81.788 = 1.91269$

$r_1 = 81.788$
$r_2 = 29.459$ concave } $t = 0.33$

0.00960

$(r_2 = 28.815^-) = 1.45961\frac{1}{4}$

$r_2 = 29.4586 = 1.46921\frac{1}{4}$

$r_3 = 29.137$
$r_4 = 1896.05^-$ concave } $t = 1.07$

0.00960

$(r_3 = 28.500) = 1.454844\frac{1}{2}$

$r_3 = 29.137 = 1.464444\frac{1}{2}$

0.00960

$(r_4 = 1854.60) = 3.26825^-$

$r_4 = 1896.05^- \quad 3.27786^-$

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check for colm

$r_1 = 81.788$
$r_2 = 29.459$
$r_3 = 29.137$
$r_4 = 1896.05$

~~I~~, ~~XIII~~

B

Flint I, ~~XIII~~ I

Barylite XI XII

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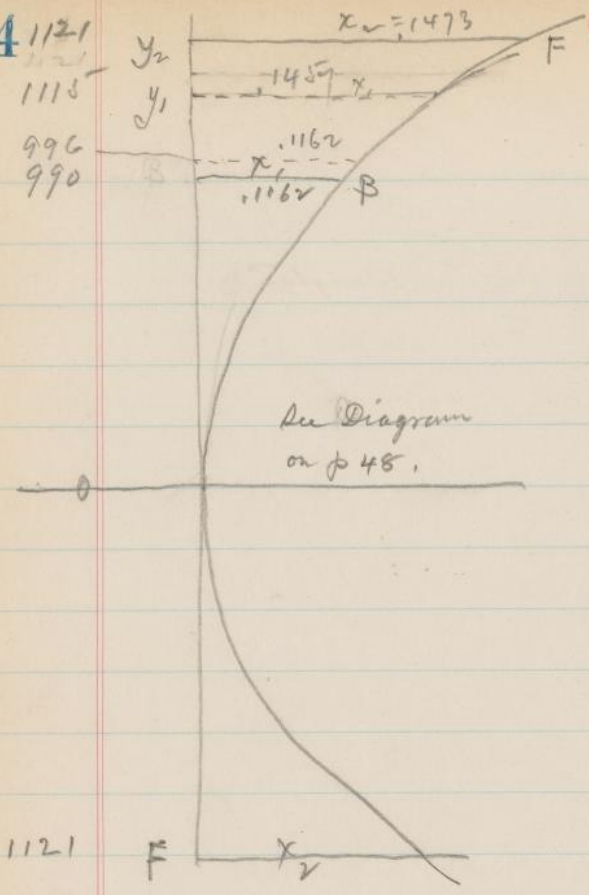
E'

Flint | Bayley

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1903phae.proj.1152P

84 1924 from p. 49



$$\frac{y_1^2}{y_2^2} = \frac{x'}{x_2}$$

$$\frac{1115^2}{1121^2} = \frac{.1457}{x_2}$$

$$x_2 = .1457 \times \frac{1121^2}{1115^2} = .1473$$

$1121 = 3.0496_2$

6.0992

$1115 = 3.0473 x_2 = 6.0946$

0.0046

$.1457 = 9.1635$

$.1473 = 9.1681$

$$\frac{1115^2}{990^2} = \frac{.1457}{x_1} \qquad x_1 = .1457 \times \frac{990^2}{1115^2}$$

$1115^2 = 6.0946$

$990 = 2.9956 x_2 = 5.9913$

9.8967

$.1457 = 9.1635$

$.1149 = 9.0602$

$x_F = .1473$

$x_B = .1149$

$.0324$

repeated from beginning on separate sheet.

$.1472$

$.1148$

$.0324$

For Minimum focus at $\lambda = 5670$

f_F should be .0324 greater than f_B -

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1924

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(1924) 12th

p.44 change in τ_4 to bring minimum focus at $\lambda = 5690$

p. 38 By making τ_4 190.3632. ∴ 3.th shorter

B

$d_4 = 2.268426$

$\tau_4 = 190.3632 = \frac{2.279583}{4.548009}$

$n = 0.208468\frac{1}{2}$

$\tau_4 = \frac{2.279583}{2.488051\frac{1}{2}} = 307.646$

$d(n-1) = \frac{114.308\frac{1}{2}}{193.337\frac{1}{2}} = \frac{2.286316}{2.261693}$

$f_4 = 182.6808$

F

$2.268582\frac{1}{2}$

$\frac{2.279583}{4.548165\frac{1}{2}}$

$n = 0.213557\frac{1}{2}$

$\tau_4 = \frac{2.279583}{2.493140\frac{1}{2}} = 311.272$

$\frac{117.885}{193.387} = \frac{2.286427}{2.261738\frac{1}{2}}$

$f_4 = 182.7000$

182.6808

$.0192$

This should be $.0324$

A change of 3th in τ_4 changed $f_F - f_B$ .0482.

.0324
.0192
.0132

3. : .0482 :: x : .0132

$x = .8216$

190.3632
.8216

$\tau_4 = 189.5416$

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1924

B

$d_4 = 2.268426$

$\tau_4 = 189.5416 = \frac{2.277704\frac{1}{2}}{4.546130\frac{1}{2}}$

$n = 0.208468\frac{1}{2}$

$\tau = \frac{2.277704\frac{1}{2}}{2.486173} = 306.3183$

$d(n-1) = \frac{114.3084}{192.0099} =$

$\frac{2.283323\frac{1}{2}}{2.262807}$

$f_4 = 183.1500 = 2.262807$

$.8216 : .0141 :: x : .0009$

$x = .0524$

$\tau_4 = \frac{189.5416}{.0524} \quad \frac{2.268426}{2.277824\frac{1}{2}}$

$189.5940 \quad 4.546250\frac{1}{2}$

$n = 0.208468\frac{1}{2}$

$\tau_4 = \frac{2.277824\frac{1}{2}}{2.486293} = 306.403$

$\frac{114.308\frac{1}{2}}{192.094\frac{1}{2}} =$

$f_4 = 183.1200 = \frac{2.283515}{2.262735\frac{1}{2}}$

As made $\tau_4 = 193.363$

to correct $= 189.594$

$3.769 =$ change in τ_4

F

$d_4 = 2.268582\frac{1}{2}$

$2.277704\frac{1}{2}$

4.546287

$n = 0.213557\frac{1}{2}$

$\tau = \frac{2.277704\frac{1}{2}}{2.491262} = 309.9290$

$\frac{117.8850}{192.0440} =$

$\frac{2.283401}{2.262886}$

$f_4 = 183.1833 = 2.262886$

183.1500

$.0333$

$.0324$

$.0009$

$2.268582\frac{1}{2}$

$2.277824\frac{1}{2}$

4.546407

$n = 0.213557\frac{1}{2}$

$\tau = \frac{2.277824\frac{1}{2}}{2.491382} = 310.0145$

$\frac{117.8850}{192.1295} =$

$\frac{2.283594}{2.262813}$

$f_4 = 183.1526 = 2.262813$

183.1200

$.0326$

change in $f_4 = \frac{181.002}{180.136}$

2.134

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(1924)

Reading of Spherometer - for $r_4 = 189.594$

$h = R - \sqrt{R^2 - d^2}$

$h = R - \sqrt{R^2 - 4}$

$R = 189.594$ ✓

189.583 ✓

$h = .011$ ✓

$.005$

189.589

35945.9 ✓

$4.$

35941.9 ✓

$r_4 = 2.277824 \div 2$ ✓

$= \frac{4.555649}{2}$ ✓

$= 4.555601$ ✓

$= 2.277800$ ✓

$S = \frac{k}{R - \frac{h}{2}} =$

$k = 2.30161$ ✓

$R - \frac{h}{2} = 2.27781$ ✓ $= 189.588$

1.056333 ✓ $= 0.02380$ ✓

Check

$R = \frac{k}{S} + \frac{h}{2}$

$k = 2.30161$

$S = 0.02380$

$= 2.27781$

189.588

$.008$

$R = 189.596$

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1924

Altering first surface of the Flint

p. 44 $B = \frac{1}{r_3} + \frac{1}{r_4}$

$r_3 = 54.4901 = r_3 = 1.736317\frac{1}{2}$

$\frac{1}{r_3} = 0.01835796 = 8.263682\frac{1}{2}$

$r_4 = 2.277824\frac{1}{2}$

$\frac{1}{r_4} = 0.00527443 = 7.722175\frac{1}{2}$

$B = 0.02362639$

$\frac{1}{r_3} = B - \frac{1}{r_4}$

As made — $r_4 = 2.286375$ p. 44

$\frac{1}{r_4} = 0.00517160 = 7.713625$

$\frac{1}{r_3} = 0.01845479 = 8.266109$

$54.1865 = 1.733891$

The color correction would be correct for $\lambda = 5670$ if r_3 was changed to $54.1865\frac{1}{2}$

Spherometer —

$r_3 = 1.733891$

$r_3^2 = \frac{2936.175}{4.} = 3.467782$

$2932.175 = 3.467190$

$\sqrt{r_3^2 - 4} = 54.1496 = 1.733595$

$r_3 = 54.1865$

$h = 0.0369$

$\frac{1}{2}h = 0.0184$

$r_3 - \frac{1}{2}h = 54.1681$ ---- $k = 2.30161$

$S = 3.6972$ $= \frac{1.73374}{0.56787}$

continued on p. 128

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1903phae.proj.1152P

II o

Forward from page 63.



r_1 = Surf.
r_2 = 45.719
D = .040
r_3 = 48.764

Color

d_4 = 912.753 ✓
r_4 = 70.000
842.753

VIII

= 2.925770
sin v = 7.821242½ ✓
0.746941/2
r_4 = 1.845093/4
= sin 8.901843/4
n = 0.193091/2
= sin 9.094941/4
r_4 = 1.845093/4
0.940041/4
= sin 8.858821/4
= 2.385721 3/4

4° 34' 31.54 = sin
7 8 53.26 = sin
2 34 21.72
v = 0 22 46.70 ✓
2 11 35.02 = sin

227.624
70.
157.624

d_4 = 710.961 ✓
70.000
640.961

= 2.806833/4
sin v = 7.925442½ ✓
0.732273/4
r_4 = 1.845093/4
= sin 8.887183
0.196821/4 ✓
sin 9.084001/4
1.845093/4
0.929101/4
sin 8.356421/4
= 2.372673/4

4° 25' 23.43
6 58 9.93
2 32 46.50
0 28 57.30 ✓
2 3 49.20 = sin

235.873
70.000
165.873

d_4 = 912.753
r_4 = 60.000
852.753

= 2.930821/4
sin v = 7.821242½
0.752063/4
r_4 = 1.778151/4
5° 24' 12.88 = sin 8.973911/2
n = 0.193091/2
8 26 49.44 = sin 9.167011
1.778151/4
3 2 36.56
0 22 46.7
2 39 49.86 = sin 8.66723

189.641
60.000
129.641

= 2.277931/4

d_4 = 710.961
r_4 = 60.000
650.961

= 2.813531/2
7.925441/2
0.73900
1.778151/4
5° 14' 34.66 = sin 8.960843/4
0.196821/4
8 15 57.93 = sin 9.15767
3 1 23.27
0 28 57.30
2 32 25.97 = sin

194.608
60.000
134.608

1.778151/4
0.935821/4
8.646661/4
2.28916

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1003phae.proj.1152P

Check

Central

B XV VIII

F'

from p. 62

$f_2 = 74.217$ ✓
$+.040$
$d_3 = 74.257$ ✓ $= 1.87073\frac{3}{4}$ ✓
$n = 0.19309\frac{1}{2}$ ✓
$48.76x = r_3 = 1.68809\frac{3}{4}$ ✓
3.75193 ✓

$d = 1.87073\frac{3}{4}$ ✓
$n-1 = 9.74810$ ✓ $48.76x$ ✓ $= r$
$1.61883\frac{3}{4}$ ✓ $= 41.5755$ ✓
$7.18855 = 0.85663\frac{3}{4}$ ✓

$f_3 = 785.765$ ✓ $= 2.89529\frac{1}{4}$ ✓
$+1.07$
$d_4 = 786.835$ ✓ $= 2.89588\frac{1}{4}$ ✓
$r_4 = 60.000 = 1.77815\frac{1}{4}$
$4.67403\frac{1}{2}$

$d = 2.89588\frac{1}{4}$ ✓
$n-1 = 9.74810$ ✓
$2.64398\frac{1}{4}$ ✓ $= 440.537$ ✓

$n = 0.19309\frac{1}{2}$ ✓
$r_4 = 1.77815\frac{1}{4}$ ✓
$1.97124\frac{3}{4}$ ✓ $= 93.594$ ✓
346.943 ✓ $= 2.54025\frac{3}{4}$ ✓

$f_4 = 136.075$ ✓ $= 2.13377\frac{3}{4}$ ✓
5.234
$.841$

$f_2 = 71.791$ ✓
$+.040$
$d_3 = 71.831$ ✓

$1.85631\frac{1}{4}$ ✓
$0.19682\frac{1}{4}$ ✓
$1.68809\frac{3}{4}$ ✓
$3.74123\frac{1}{4}$ ✓

$d = 1.85631\frac{1}{4}$ ✓
$n-1 = 9.75841$ ✓ $48.76x$ ✓ $= r$
$1.61472\frac{1}{4} = 41.1834$ ✓
7.5806 ✓ $= 0.87970\frac{1}{4}$ ✓

$f_3 = 726.993$ ✓ $= 2.86153$ ✓
$+1.07$
$d_4 = 728.063$ ✓ $= 2.86217$ ✓
$r_4 = 1.77815\frac{1}{4}$
$4.64032\frac{1}{4}$

$d = 2.86217$ ✓
$n-1 = 9.75841$ ✓
$2.62058 = 417.426$ ✓

$n = 0.19682\frac{1}{4}$ ✓
$r = 1.77815\frac{1}{4}$ ✓
$1.97497\frac{1}{2}$ ✓ $= 94.4006$ ✓
323.025 ✓ $= 2.50923\frac{3}{4}$ ✓

$f_4 = 135.234$ ✓ $= 2.13108\frac{1}{2}$ ✓

$d_4 = 786.835$ ✓ $= 2.89588\frac{1}{4}$ ✓
$r_4 = 65.000 = 1.81291\frac{1}{4}$ ✓
$4.70879\frac{1}{2}$ ✓

$d(n-1)$ 440.537 ✓
$n = 0.19309\frac{1}{2}$ ✓
$r = 1.81291\frac{1}{4}$ ✓
$2.00600\frac{3}{4}$ ✓ $= 101.393$ ✓
339.144 ✓ $= 2.53038\frac{1}{2}$ ✓

$f_4 = 150.803$ ✓ $= 2.17841$ ✓
$.159$
$.644$

728.063 ✓ $= 2.86217$ ✓
$1.81291\frac{1}{4}$ ✓
$4.67508\frac{1}{4}$ ✓

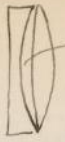
$d(n-1) = 417.426$ ✓
$n = 0.19682\frac{1}{4}$ ✓
$r = 1.81291\frac{1}{4}$ ✓
$2.00973\frac{1}{2}$ ✓ $= 102.267$ ✓
315.159 ✓ $= 2.49853$ ✓

$f_4 = 150.159$ ✓ $= 2.17658\frac{1}{4}$ ✓

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II.



From p. 63.

B

l_3 = 913.823 ✓✓
+1.07
d_4 = 914.893 ✓
r_4 73.635 ✓
841.258 ✓ =

VIII
2.92493 ✓
sin v = 7.82124½ ✓
0.74617½ ✓
r_4 = 1.86708½ ✓
8.87909 ✓
n = 0.19309½ ✓
9.07218½ ✓
1.86708½ ✓
0.93927 ✓
8.55573¾ ✓
2.28351¼ ✓

i = 4° 20′ 29″.00 ✓ = sin
λ = 6 46 53.19 ✓ =
2 26 24.19 ✓
v = 0 22 46.7 ✓
v' = 2 3 37.49 ✓ = sin
241.842 ✓ =
r_4 = 73.635 ✓
168.207 ✓

F′

l_3 = 712.031 ✓✓
+1.07
d_4 = 713.101 ✓
73.635 ✓
639.466 ✓ =

2.80581¾ ✓
7.92544½ ✓
0.73126¼ ✓
1.86708½ ✓
4° 11′ 40″.48 ✓ = sin 8.86417¾ ✓
n = 0.19682¼ ✓
6 36 29.66 ✓ = sin 9.06100 ✓
1.86708½ ✓
2 24 49.18 ✓ 0.92808½ ✓
0 28 57.3 ✓
1 55 51.88 ✓ = sin 8.52789½ ✓
251.472 ✓ = 2.40049 ✓
73.635 ✓
177.837 ✓
~~168.207~~
9.630 "Crown" weak

d_4 = 914.893 ✓
r_4 = 75.365 p. 93 bottom
839.528 =

VIII
2.92403½
sin v = 7.82124½
0.74528
r_4 = 1.87717
8.86811
n = 0.19309½
9.06120½
1.87717
0.93837½
8.54258¾
2.39578¾ =

4° 13′ 58″.08 = sin
6 36 40.95 = sin
2 22 42.87
0 22 46.7
v' = 1 59 56.17 = sin
248.764 =
75.365
f_4 = 173.399

Correct on p 93; check.

d_4 = 713.101 ✓
r_4 = 75.363
637.738 =

2.80464¼
sin v = 7.92544½
0.73008¾
r_4 = 1.87717
8.85291¾
n = 0.19682¼
9.04974
1.87717
0.92691
8.51335½
2.41355½ =

4° 5′ 13″.33 = sin
6 26 18.17
2 21 4.84
0 28 57.3
v' = 1 52 7.54 = sin
259.152
75.363
f_4 = 183.789
73.399
10.390 "Crown" weak

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1903phae.proj.1152p

Central continued from page 91.

(B)

$d_4 = 2.89588\frac{1}{4}$ ✓

$r_4 = \boxed{81.346}$ $= 1.91033\frac{1}{2}$ ✓

$4.80621\frac{3}{4}$ ✓

$d(n-1) = 440.537$ ✓

$n = 0.19309\frac{1}{2}$ ✓

$r = 1.91033\frac{1}{2}$ ✓

$2.10343 =$ ✓ 126.891 ✓

$313.646 = 2.49644$ ✓

$f_4 = 204.069$ ✓ $= 2.30977\frac{3}{4}$ ✓

(F')

$d_4 = 2.86217$ ✓

$1.91033\frac{1}{2}$ ✓

$4.77250\frac{1}{2}$ ✓

417.426 ✓

$n = 0.19682\frac{1}{4}$ ✓

$r = 1.91033\frac{1}{2}$ ✓

$2.10715\frac{3}{4} = 127.984$ ✓

$289.442 = 2.46156\frac{1}{4}$ ✓

$f_4 = 204.617$ ✓ $= 2.31094\frac{1}{4}$ ✓

$.069$

$.548$

$d_4 = 2.89588\frac{1}{4}$

$r_4 = \boxed{74.500}$ $= 1.87215\frac{3}{4}$

4.76804

$n = 0.19309\frac{1}{2}$

$r = 1.87215\frac{3}{4}$ 440.537

$2.06525\frac{1}{4} = 116.212$

$324.325 = 2.51098$

$f_4 = 180.742 = 2.25706$

$.676$

$.066$

$d_4 = 2.86217$

$r_4 = 1.87215\frac{3}{4}$

$4.73432\frac{3}{4}$

$n = 0.19682\frac{1}{4}$

$r = 1.87215\frac{3}{4}$ 417.426

$2.06898 = 117.214$

$300.212 = 2.47742\frac{3}{4}$

$f_4 = 180.676 = 2.25690$

$d_4 = 2.89588\frac{1}{4}$

$r_4 = \boxed{75.430}$ $= 1.87754\frac{1}{2}$

$4.77342\frac{3}{4}$

$n = 0.19309\frac{1}{2}$

$r = 1.87754\frac{1}{2}$ 440.537

$2.07064 = 117.663$

$322.874 = 2.50903\frac{1}{4}$

$f_4 = 183.821 = 2.26439\frac{1}{2}$

$d_4 = 2.86217$

$1.87754\frac{1}{2}$

$4.73971\frac{1}{2}$

$n = 0.19682\frac{1}{4}$

$r = 1.87754\frac{1}{2}$ 417.426

$2.07436\frac{3}{4} = 118.677$

$298.749 = 2.47530\frac{3}{4}$

$2.26440\frac{3}{4}$

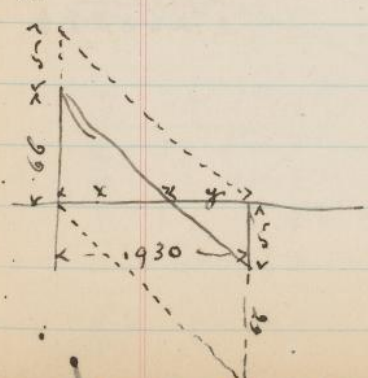
183.826

$.821$

$.005$

75.430

(30)



$71 : .930 :: 66 : x$

$71 : .930 :: 5 : y$

$71)\overline{4.650}(.065\frac{5}{71}$

426

390

355

350

75.430

$= .065\frac{5}{71}$

$75.3648 = r_4$

$75.365 = r_4$ to units

$r_1 = \text{Inf.}$

$r_2 = 45.719$ p. 62

$\Delta = .040$

$r_3 = 48.764$ p. 91

$r_4 = 75.365$ p. 93

B and F' central p. 94. of bottom

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1903phae.proj.1152P

II o

continued from p. 92.

Marginal

B

$d_4 = 914.893$

$T_4 = 75.438$

$839.455 = 2.92399\ \frac{3}{4}$

VIII

$\sin d = 7.82124\ \frac{1}{2}$

$0.74524\ \frac{1}{4}$

$T_4 = 1.87759$

$4^\circ\ 13'\ 42''.00 = \sin 8.86765\ \frac{1}{4}$

$x = 0.19309\ \frac{1}{2}$

$6\ 36\ 15.77 = \sin 9.06074\ \frac{3}{4}$

$2\ 22\ 33.77$

1.87759

$0\ 22\ 46.7$

$0.93833\ \frac{3}{4}$

$1\ 59\ 47.07 = \sin 8.54204$

$249.056 = 2.39629\ \frac{3}{4}$

F'

$d_4 = 713.101$

75.438

$637.663 = 2.80459$

$\sin d = 7.92548\ \frac{1}{2}$

$0.73007\ \frac{1}{2}$

1.87759

$4^\circ\ 4'\ 57''.30 = \sin 8.85244\ \frac{1}{2}$

$0.19682\ \frac{1}{4}$

$6\ 25\ 52.88 = \sin 9.04926\ \frac{3}{4}$

$2\ 20\ 55.58$

1.87759

$0\ 28\ 57.3$

$0.92685\ \frac{3}{4}$

$1\ 51\ 58.28 = \sin 8.51275\ \frac{1}{2}$

$= 2.41410\ \frac{1}{4}$

259.479

249.056

10.423

Crown mark

Central from p. 93.

B

$d_4 = 2.89588\ \frac{1}{4}$

$T_4 = 75.365 = 1.87717$

$4.77305\ \frac{1}{4}$

$x = 0.19309\ \frac{1}{2}$

$T = 1.87717$ $\quad 440.537$

$2.07026\ \frac{1}{2} = 117.561$

$322.976 = 2.50917$

$\frac{\rho}{T_4} = 183.604 = 2.26388\ \frac{1}{4}$

F'

$d_4 \quad 2.86217$

1.87717

4.73934

$x = 0.19682\ \frac{1}{4}$

$T = 1.87717$ $\quad 417.426$

$2.07399\ \frac{1}{4} = 118.575$

$298.851 = 2.47546\ \frac{1}{2}$

$\frac{\rho}{T_4} = 183.605 = 2.26388\ \frac{1}{2}$

Color correct

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Check

B VII

$k=6 = 0.77815^-$

$r_2 = 45.719 = 1.66009\frac{1}{2}$

$i = 7^\circ 32' 27''.81 = \sin 9.11805\frac{1}{2}$

$n = 0.20844\frac{1}{2}$

$\lambda = 12\ 14\ 39.41 = \sin 9.32650$

$v' = 4\ 42\ 11.60$

$1.66009\frac{1}{2}$

$0.98659\frac{1}{2}$

$\sin = 8.91378\frac{1}{2}$

$118.25^-2 = 2.07281$

$r_2 = 45.719$

$f_2 = 72.533$ --- see p. 61.

$.040$

$d_3 = 72.573$

$r_3 = 48.764$

$121.337 = 2.08399\frac{1}{4}$

XV

$\sin d = 8.91378\frac{1}{2}$

$0.99777\frac{3}{4}$

$r_3 = 1.68810$

$i = 11\ 46\ 20.16 = \sin 9.30967\frac{3}{4}$

$n = 0.19309\frac{1}{2}$

$\lambda = 7\ 30\ 55.37 = \sin 9.11658\frac{1}{4}$

$i-\lambda = 4\ 15\ 24.79$

1.68810

$v = 4\ 42\ 11.60$

$0.80468\frac{1}{4}$

$0\ 22\ 46.81 = \sin 7.82128$

Error $962.504 = 2.98340\frac{1}{4}$

48.764

$f_3 = 913.740$ --- see p. 63

1.07

$d_4 = 914.810$

75.365^-

$839.445^- = 2.97287\frac{1}{4}$

$\sin d = 7.82128$

$0.79415\frac{1}{4}$

$r_4 = 1.87717$

$4^\circ\ 44'\ 17''.00 = \sin 8.91698\frac{1}{4}$

$n = 0.19309\frac{1}{4}$

$7\ 24\ 10.73 = \sin 9.11007\frac{1}{2}$

1.87717

$2\ 39\ 53.73$

$0.98724\frac{1}{2}$

$v = 0\ 22\ 46.81$

$2\ 17\ 6.92 = \sin 8.60069\frac{3}{4}$

$= 2.38654\frac{3}{4}$

243.527

75.365^-

$f_4 = 168.162$

→ $839.445^- = 2.92399\frac{1}{4}$

7.82128

$0.74527\frac{1}{4}$

$r_4 = 1.87717$

$4\ 13\ 57.81 = \sin 8.86810\frac{1}{4}$

$n = 0.19309\frac{1}{4}$

$6\ 36\ 40.40 = \sin 9.06119\frac{1}{2}$

1.87717

$2\ 22\ 42.59$

$0.93836\frac{1}{2}$

$0\ 22\ 46.81$

$1\ 59\ 55.78 = \sin 8.54256\frac{1}{2}$

$248.771 = 2.39580$

75.365^-

$f_4 = 173.406$ --- see p. 92

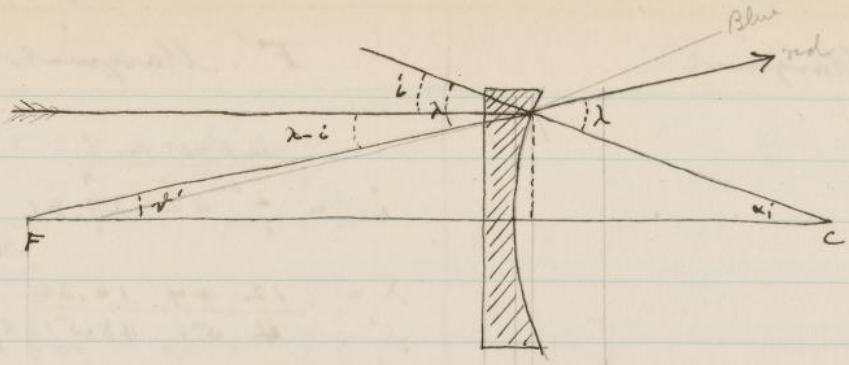
~~corr~~

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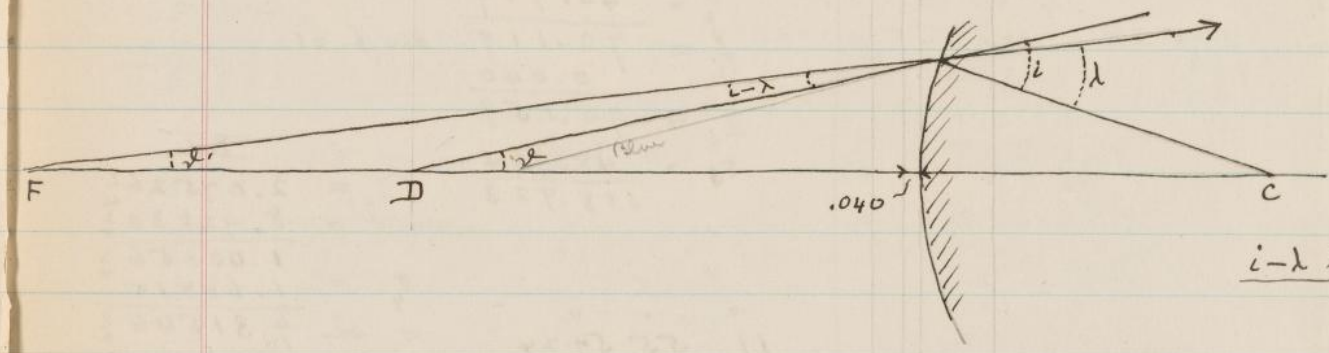
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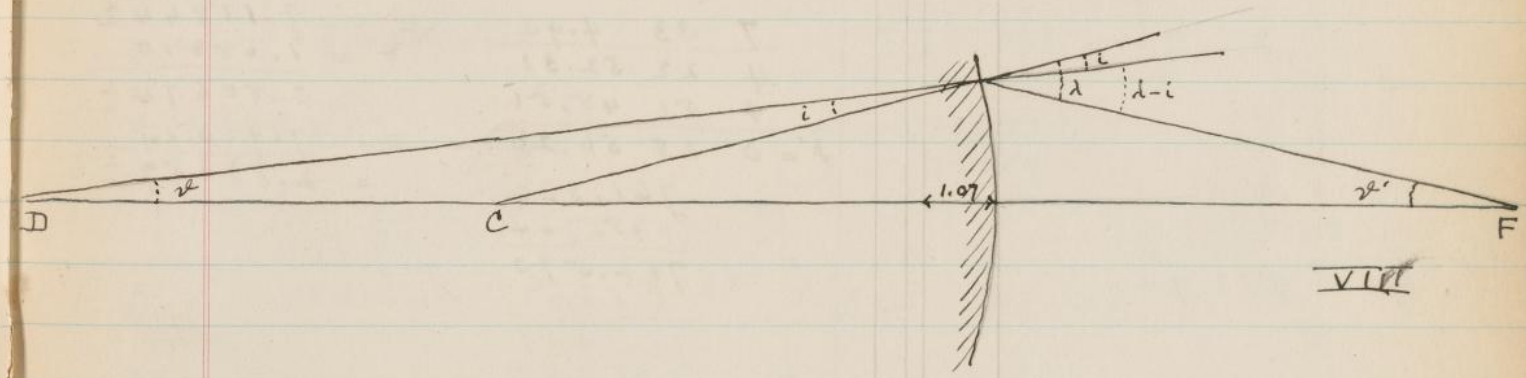


VII



XV

i-λ less than ν



VIII

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II.

Check

$r_2 = 45.719$
$r_3 = 48.764$
$r_4 = 75.365$

B Marginal

see p. 95.

$f_2 = 72.533$

$f_3 = 913.740$

$f_4 = 173.406$

F′ Marginal

see p 95 for i

VII

$i = 7^\circ\ 32'\ 27''.81$ = sin $9.11805\frac{1}{2}$

$n =$ $0.21400\frac{1}{2}$

$\lambda = 12\ 24\ 16.32$ = sin 9.33206

$\lambda' = 4\ 51\ 48.51$ $r_2 =$ $1.66009\frac{1}{2}$

$0.99215\frac{1}{2}$

= sin $8.92830\frac{1}{4}$

115.838 = $2.06385\frac{1}{4}$

$r_2 = 45.719$

$f_2 = 70.119$ see p. 61.

0.040

$d_3 = 70.159$

$r_3 = 48.764$

118.923

XV

= $2.07526\frac{1}{2}$

sin λ = $8.92830\frac{1}{4}$

$1.00356\frac{3}{4}$

$r_4 =$ 1.68810

$11^\circ\ 5'\ 57''.24$ = sin $9.31546\frac{3}{4}$

$n =$ $0.19682\frac{1}{4}$

$7\ 33\ 4.93$ = sin $9.11864\frac{1}{2}$

$4\ 22\ 52.31$ $r =$ 1.68810

$4\ 51\ 48.51$ $0.80674\frac{1}{2}$

$\lambda' = 0\ 28\ 56.20$ = sin 7.92517

= $2.88157\frac{1}{2}$

761.334

48.764

$f_3 = 712.570$ see p. 63.

1.07

$= 713.640$

$r_3 = 75.365$

638.275

= $2.80500\frac{3}{4}$

sin λ = 7.92517

$0.73017\frac{3}{4}$

$r_4 =$ 1.87717

$4^\circ\ 5'\ 16''.38$ = sin $8.85300\frac{3}{4}$

$n =$ $0.19682\frac{1}{4}$

$6\ 26\ 23.02$ = sin 9.04983

$2\ 21\ 6.64$ 1.87717

$0\ 28\ 56.20$ 0.92700

$1\ 52\ 10.44$ = $8.51354\frac{1}{4}$

= $2.41345\frac{3}{4}$

259.094

75.365

$f_4 = 183.729$ see p. 92

Correct

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Check

B central

$r_2 = 45.719 = 1.66009\frac{1}{2}$

$n-1 = 9.78959\frac{1}{4}$

sep. 62 $f_2 = 74.217 = 1.87050\frac{1}{4}$

$.040$

$d_3 = 74.257 = 1.87073\frac{3}{4}$

$n = 0.19309\frac{1}{2}$

$48.764 = r_3 = 1.68810$

$3.75193\frac{1}{4}$

$d = 1.87073\frac{3}{4}$

$n-1 = 9.74810$

$1.61883\frac{3}{4} = 41.5755$

48.764

$7.1885 = 0.85663\frac{3}{4}$

$f_3 = 785.770 = 2.89529\frac{1}{2}$

1.07

$d_4 = 786.840 = 2.89588\frac{3}{4}$

$r_4 = 75.365 = 1.87717$

$4.77305\frac{3}{4}$

$d = 2.89588\frac{3}{4}$

$n-1 = 9.74810$

$2.64398\frac{3}{4} = 440.542$

$n = 0.19309\frac{1}{2}$

$r = 1.87717$

$2.07026\frac{1}{2} = 117.561$

$322.981 = 2.50917\frac{3}{4}$

2.26388

$f_4 = 183.603$

sep 94. Bottom.

F' central

$r_2 = 1.66009\frac{1}{2}$

$n-1 = 9.80402\frac{1}{2}$

$f_2 = 71.791 = 1.85607$

$.040$

$d_3 = 71.831 = 1.85631\frac{1}{4}$

$n = 0.19682\frac{1}{4}$

$r_3 = 1.68810$

$3.74123\frac{1}{2}$

$d = 1.85631\frac{1}{4}$

$n-1 = 9.75841$

48.764

$1.61472\frac{1}{4} = 41.1834$

$7.5806 = 0.87970\frac{1}{4}$

$= 2.86153\frac{1}{4}$

$f_3 = 726.997$

1.07

$d_4 = 728.067$

75.365

$2.86217\frac{1}{4}$

1.87717

$4.73934\frac{1}{4}$

$d = 2.86217\frac{1}{4}$

$n-1 = 9.75841$

$2.62058\frac{1}{4} = 417.429$

$n = 0.19682\frac{1}{4}$

$r = 1.87717$

$2.07399\frac{1}{4} = 118.575$

$298.854 = 2.47546$

$= 2.26388\frac{1}{4}$

$f_4 = 183.604$

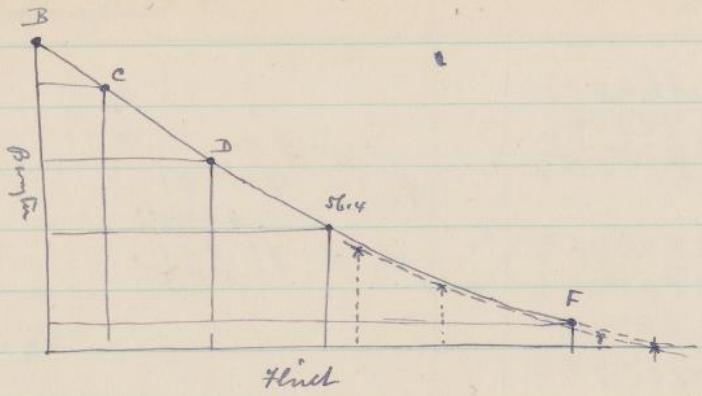
Correct

When the color is correct for central rays, the marginal rays are 10.32 ≒ apart. there must be an error.

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II.



The indices of refraction marked • run on smooth curve showing that they are correct. These were the first lines to be measured.

The lines measured later marked × also run on a smoth curve. but it does not quite agree with the other.

$n' = \alpha + \beta n + \gamma n^2$

(1) B $1.616017 = \alpha + \beta \times 1.539893 + \gamma \times 2.433266$

(2) 56.4 $1.625363 = \alpha + \beta \times 1.566031 + \gamma \times 2.452454$

(3) F $1.635122 = \alpha + \beta \times 1.572231 + \gamma \times 2.471910$

2-1 (4) $.009346 = \beta \times 0.006138 + \gamma \times 0.019188$

3-1 (5) $.019105 = \beta \times 0.012338 + \gamma \times 0.038644$

(4)×a $.018822574 = \beta \times 0.012361\overset{\checkmark}{7}8 + \gamma \times 0.038644$

$.00028246 = -\beta \times 0.00002373$

$\beta = -11.903080 = \log 1.075\overset{-}{6}593$

---

(5) $.019105 = \beta \times 0.012338 + \gamma \times 0.038644$

(4)×a $.018786407 = \beta \times 0.012338 + \gamma \times 0.038\overset{-}{5}6982$

$.00031859\overset{\checkmark}{3} = \gamma \times 0.0000\overset{\checkmark}{7}418$

$\gamma = 4.294864 = \log 0.6329494$

$1.616017 = \alpha - 18.567553 + 10.450555$

$\alpha = +9.732997$

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$$n' = \alpha + \beta \times 1.573339 \checkmark + \gamma \times (1.573339)^2 \checkmark$$

$$\therefore \quad n' = +9.732997 - 18.727573 + 10.631484$$

$$n' = 1.63691 = \log 0.21402\tfrac{1}{2}$$

$$n-1 = 0.63691 = \text{“} \quad 9.80407\tfrac{3}{4}$$

Graphically

$$n' = 1.63690 = \log 0.2140\ \tfrac{1}{4}$$

$$n-1 = 0.63690 = \text{“} \quad 0.804\ \tfrac{1}{2}$$

} ~~The most accurate~~

5614 Fr. line towards F. } 1.566616 Barylā D find corresponding n of flint.

$$n' = 9.732997 \checkmark - 18.647550 \checkmark + 10.540820 \checkmark$$

$$= 1.626267 \checkmark$$

$D_{\frac{1+2}{2}}$ 1.564337

$$n' = 9.732997 - 18.640592 + 10.532964$$

$$= 1.625360$$

C $n = 1.561102$

$n' = 1.617832$

Fr. line from F towards blue $n' = 1.574363$

$n' = 1.638565$

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Check on Index of Refraction March 25th 1906.

see p. 106 for 28. see p 204-10 7th Bork

Baryta Light Flint

p. 206-9 7th Bork

87 20 50 87 44 35 85 4 20

56.4

		F	1st line towards blue	B
86° 11' 52"	2δ =	87° 21' 13" +23	87° 44' 44" +9	85° 4' 30 +10
	½δ =			
86 11 57	2δ	87 21 0	87 44 40	85° 4 25"

to 1 17 (p 206 7th Bork)

Best value.

	B	56.4	F	1st line
2δ =	85° 4 25" ✓	86 11 57 ✓	87 21 0 ✓	87 44 40 ✓
½δ =	21 16 6 ✓	21 32 59 ✓	21 50 15 ✓	21 56 10 ✓
½α =	30 0 38½	30 0 38½	30 0 38½	30 0 38½
½(α+δ) =	51 16 44½	51 33 37½	51 50 53½	51 56 48½
sin ½(α+δ) =	9.8922068	9.8939082	9.8956307	9.8962168
sin ½α =	9.6991103	9.6991103	9.6991103	9.6991103
log n =	0.1930965	0.1947979	0.1965204	0.1971065
n =	1.5598990	1.566020 − 45	1.572247 − 13	1.574368
log (n−1) =	9.7481096	9.7528333	9.7575825	9.7591908
n'/n = N =				
N−1 =				

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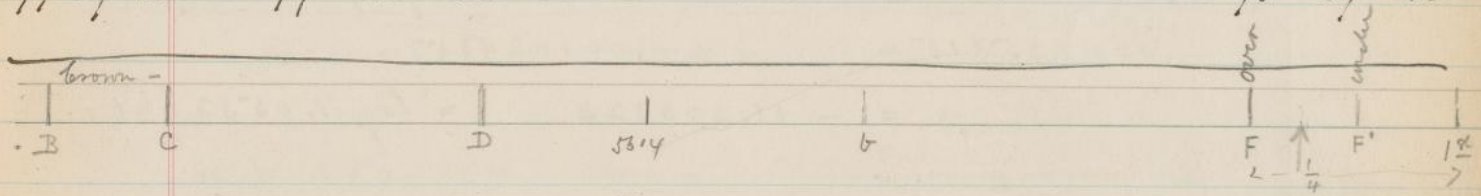
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Angle of Prism = 60° 1′ 5.″70 Apr. 9 and 10 '24 repeated in all 21 times
5.″664 5.″700

March 27, 1906.

Silicate Flint

5614	F	1st line towards Red	B
97 29 15	99 25 30 −9	100 6 45 +21	95 39 30 −21
97 29 15	99 25 35	100 6 32	95 39 45



	B	5614	F	1st line
2δ =	95 39 45 ✓	97 29 15	99 25 35 ✓	100 6 32 ✓
½δ =	23 54 56 ✓	24 22 19 ✓	24 57 24 ✓	25 1 38 ✓
	30 0 38½	30 0 38½	30 0 38½	30 0 38½
	53 55 34½	54 22 57½	54 57 2½	55 2 16½
	9.907 55 09	9.910 05 01	9.912 65 88	9.913 56 53
	9.699 1103	9.699 1103	9.699 1103 ✓	9.699 1103
log n =	0.208 4406	0.210 9398	0.213 5488	0.214 4552
n =	1.615 997	1.625 32 35	1.635 11 58	1.638 533
		− 30½	+ 9	
log (n−1)	9.789 5787	9.796 1047	9.802 85 29	

Prof. Charles S. Hastings measurements - Oct. 14 1915

Lines	Ba Cr	Ba Fl	G.P.H. 60° 1′ 5.″70 Apr 9 '24 ✓
C	1.561682 (102)	1.617881 (30) ← ?	Angle of Prism
k 5614	1.566067 (31)	1.625354 (63)	60° 1′ 10.8″
7	1.572259 (31)	1.635107 (16)	
h	1.582722	1.652258	$\sin \frac{1}{2}\alpha = 9.699\,1056$

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$$n' = \alpha + \beta n + \gamma n^2$$

(1)	B	$1.6159970\surd = \alpha + \beta \times 1.5598990\surd + \gamma \times 2.4332855$
(2)	56.4	$1.6253235\surd = \alpha + \beta \times 1.5660220\surd + \gamma \times 2.4552457$
(3)	F	$1.6351158\surd = \alpha + \beta \times 1.5722457\surd + \gamma \times 2.4719562$
(2-1)	(4)	$.0093265 = \beta \times .0061230 + \gamma \times .0191399$
(3-1)	(5)	$.0191188 = \beta \times .0123467 + \gamma \times .0386707$
(4) × c.		$.0188434855 = \beta \times .0123710557 + \gamma \times .0386707$
		$.0002753155 = \beta \times -.0000243557$

$$\beta = -11.303323 = \log 1.0532061$$

	(5)	$.0191188 = \beta \times .0123467 + \gamma \times .0386707$
(4) × c		$.0188063855 = \beta \times .0123467 + \gamma \times .0385945562$
		$.0003124155 = \gamma \times .0000761138$

$$\gamma = 4.1032726 = \log 0.6131304$$

(1) $1.6159970 = \alpha - 17.632040 + 9.9844326$

$$\alpha = 9.263604$$

F′ $n = 1.573339 = \log 0.1968223\surd$

$n-1 = 0.573339 = \ 9.7584115\surd$

from p. 21

log

$\gamma = 0.613$

$B = 0.600$

$\delta n_F^2 = \underline{5.588}$

$\delta\varphi_F = .000632 = 6.801$

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1.572776 = ¼ 7 to 1st

F′ $n = 1.573339$ Barylite to find n' for the flint.

$n' = 9.263604 - 17.783959 + 10.157222$

$n' = 1.636867 = \log 0.2140134$ $n' = 1.635970 = \frac{1}{4}$ 7 to 1st

$n'-1 = 0.636867 = \quad " \quad 9.8040488$

This is the ray to unite with B to give color correction.

gives flint weak on twisted glass

¼ from 7 to 1st line = $n = 1.572776$ should give correct color

---

$n = 1.574369$ Barylite. 1st line from 7 towards blue.

$n' = 9.263604 - 17.795600 + 10.170524$

$= 1.638528$

1.638533 measured $+.000005$

Brightest Ray

n

B = 1.559899

F′ = 1.573339

2) 3.133238

5614′ = 1.566619 = n = log 0.1949634 ✓

0.566619 = $n-1$ = " 9.7532911 ✓

$n' = 9.263604$ ✓ $- 17.708000$ ✓ $+ 10.070643$ ✓

$n' = 1.626247$ ✓ = log 0.2111865 ✓

$n'-1 = 0.626247 = \quad " \quad 9.7967456$ ✓

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Copy of measurements made March 25 1906. for index of reflection on p. 102.

Baryta Light Limit 2S

B			δ6.4			7			1st line towards Blue		
85°	4′	25″	86	11	35″	87°	21′	25″	87°	44′	45″
–	–	30	–	12	0	–	–	0	–	–	43
–	–	35″	–	12	0	–	–	3			
			–	12	5″	—	–	23			
						–	–	15″			
85°	4′	30″	86°	11′	5″5	87°	21′	13″	87°	44′	44″

Limit

B			δ6.4			7			1st line towards Violet		
95°	39′	22″	97°	29′	8″	99°	25′	30″	100°	6′	44″
–	–	45″	–	–	23	—	–	30	–	–	45″
–	–	15″	–	–	13						
–	–	35″	–	–	15″						
95°	39′	29″	97°	29′	15″	99°	25′	30″	100°	6′	45″

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Measurements with new Spectrometer — April '24

For calculation see p 44.

Angle of Prism = 60° 1′ 5.″70 for both prisms —

Barrytin Leeght Flint

	75° B (head of B)	75° 5614	75° F
2δ	85° 4′ 37.″92	86° 12′ 8.″28	87° 21′ 4.″68
½δ	21 16 9.48	21 33 2.07	21 50 16.17 ✓
½P	30 0 32.85	30 0 32.85	30 0 32.85
½(δ+P)	51 16 42.33	51 33 34.92	51 50 49.02
	9.892 2031 ✓	9.893 9039	9.895 6233
	9.699 0898	9.699 0898	9.699 0898
	0.193 1133	0.194 8141	0.196 5335
75° n =	1.559 9592	1.566 0805	1.572 2931
75° n =	1.559 959	1.566 081	1.572 293
n = log	0.193 113	0.194 814	0.196 533½
n−1 =	0.559 959	0.566 081	0.572 293
" log	9.748 156	9.752 878	9.757 618½

Flint

	72° B (head of B)	76° 5614	75° F
2δ =	95° 40′ 20.″19	97° 29′ 29.″04	99° 25′ 27.″30
½δ =	23 55 5.05	24 22 22.26	24 51 21.82
½P =	30 0 32.85	30 0 32.85	30 0 32.85
½(δ+P) =	53 55 37.90	54 22 55.11	54 51 54.67
sin ½(δ+P) =	9.907 5562	9.910 0465	9.912 6472
sin ½P =	9.699 0898 ✓	9.699 0898	9.699 0898 ✓
log n =	0.208 4664	0.210 9567	0.213 5574
n =	1.616 0933 +81	1.625 3866 −32	1.635 1492 ✓
75° n =	1.616 1014	1.625 3834	1.635 1492
n = log	0.208 468½	0.210 956	0.213 57½
log(n−1) =	9.789 652	9.796 146½	9.802 876

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II

Rays Limits for color correction pp. 22. 102. 105.

	"Barytn"		"Flint" (P. 105)	
	B	F′	B	F′
log n	0.1930965	0.1968223	0.2084406	0.2140134
log (n−1)	9.7481096	9.7584115	9.7895787	9.8040488

		Barytn	Flint
56.4′	log n	0.1949634	0.2111865
1st Line towards bleu Half way between B and F′	" n−1	9.7532911	9.7967456

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VI

r_1 = Inf
r_2 = 48.719
r_3 = 48.764
r_4 = 75.365

Central

see p. 99.

B

$r_2 = 1.66009\frac{1}{2}$ ✓
$n-1 = 9.78958$ ✓
$f_2 = 74.2190$ ✓ $= 1.87051\frac{1}{2}$ ✓
.040
$d_3 = 74.259$ ✓ $= 1.87075$ ✓
$n = 0.19309\frac{3}{4}$ ✓
$r_3 = 1.68810$ ✓
$3.75194\frac{3}{4}$ ✓

$d = 1.87075$ ✓
$n-1 = 9.74811$ ✓ 48.764 ✓
1.61886 ✓ $= 41.5777$ ✓
7.1863 ✓ $= 0.85650\frac{1}{2}$ ✓
$f_3 = 786.036$ ✓ $= 2.89544\frac{1}{4}$
1.07
$d_4 = 787.106$ ✓ $= 2.89603\frac{1}{4}$ ✓
$r_4 = 1.87717$ ✓
$4.77320\frac{1}{4}$ ✓

$d = 2.89603\frac{1}{4}$ ✓
$n-1 = \frac{9.74811}{2.64414\frac{1}{4}}$ ✓ $= 440.700$ ✓

$n = 0.19309\frac{3}{4}$ ✓
$r = 1.87717$ ✓
$2.07026\frac{3}{4}$ ✓ $= 117.562$ ✓
323.138 ✓ $= 2.50938\frac{3}{4}$ ✓
$f_4 = 183.576$ ✓ $= 2.26381\frac{1}{2}$ ✓

.611 ✓
.035 ✓ Sph. Ab.

F'

$r_2 = 1.66009\frac{1}{2}$ ✓
9.80405 ✓
$= 1.85604\frac{1}{2}$ ✓
$f_2 = 71.7869$ ✓
.040
$d_3 = 71.8269$ ✓ $= 1.85628\frac{3}{4}$ ✓
$n = 0.19682\frac{1}{4}$ ✓
$r_3 = 0.68810$ ✓
3.74121 ✓

$d = 1.85628\frac{3}{4}$ ✓
$n-1 = 9.75841$ ✓ 48.764 ✓
$1.61469\frac{3}{4}$ ✓ $= 41.1810$ ✓
7.5830 ✓ $= 0.87984\frac{1}{8}$ ✓
$f_3 = 726.723$ ✓ $= 2.86139\frac{7}{8}$ ✓
1.07
$d_4 = 727.793$ ✓ $= 2.86200\frac{3}{4}$
$r_4 = 1.87717$ ✓
$4.73917\frac{5}{4}$ ✓

$d = 2.86200\frac{3}{4}$
$n-1 = \frac{9.75841}{2.62041\frac{3}{4}}$ ✓ $= 417.270$ ✓

$n = 0.19682\frac{1}{4}$ ✓
$r = 1.87717$ ✓
$2.07399\frac{1}{4}$ ✓ $= 118.575$ ✓
298.695 ✓ $= 2.47523\frac{3}{4}$ ✓
$f_4 = 183.632$ ✓ $= 2.26398\frac{3}{4}$ ✓

.576 ✓
.057 ✓ "Barlow" neck

For marginal rays see p. 110.

.747 ✓ Marginal Ray
.114 ✓ Sph. Ab.

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II

Marginal

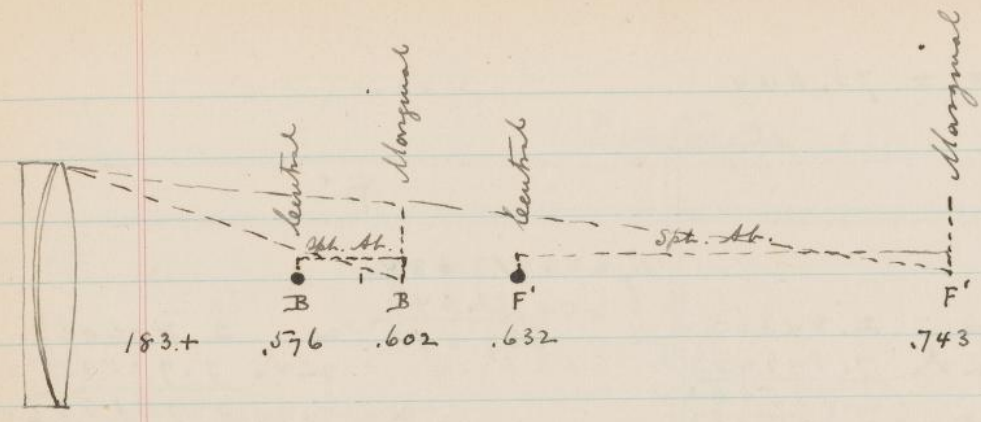
r_1 = Inf.
r_2 = 45.719
r_3 = 48.764
r_4 = 75.365

B	F′
$K = 6 = 0.77815$ ✓	
$\frac{K}{r_2} = 1.66009\frac{1}{2}$ ✓	
sup 95. $7^\circ\ 32'\ 27''.81$ ✓ $= \sin 9.11805\frac{1}{2}$ ✓	$7^\circ\ 32'\ 27''.81$ ✓ $\frac{K}{r} = 9.11805\frac{1}{2}$ ✓
$n = 0.20844$ ✓	$n = 0.21401\frac{1}{4}$ ✓
$12\ 14\ 38.90$ ✓ $= \sin 9.32649\frac{1}{2}$ ✓	$12\ 24\ 17.60$ ✓ $= \sin 9.33206\frac{3}{4}$ ✓
$4\ 42\ 11.09$ ✓	$4\ 51\ 49.29$ ✓
$1.66009\frac{1}{2}$ ✓	$1.66009\frac{1}{2}$ ✓
0.98659 ✓	$0.99216\frac{1}{4}$ ✓
$\sin 8.91377\frac{1}{4}$ ✓	$\sin 8.92832\ 17$
118.284 ✓ $= 2.07281\frac{3}{4}$ ✓	115.836 ✓ $= 2.06384\frac{1}{4}$ ✓
45.719	45.719 ✓
$f_2 = 72.538$ ✓	$f_2 = 70.117$ ✓ sup 98.
$.040$	$.040$
$d_3 = 72.578$ ✓	$d_3 = 70.157$ ✓
$r_3 = 48.764$ ✓	48.764 ✓
121.339 ✓ $= 2.08400$ ✓	118.921 ✓ $= 2.07525\frac{3}{4}\frac{1}{2}$
$\sin d = 8.91377\frac{1}{4}$ ✓	$\sin d = 8.92832\ \frac{1}{4}$ ✓
$0.99777\frac{1}{4}$ ✓	$1.00357\frac{3}{4}$ ✓
$r_3 = 1.68810$ ✓	1.68810 ✓
$11^\circ\ 46'\ 19''.67 = \sin 9.30967\frac{1}{4}$ ✓	$11^\circ\ 53'\ 58''.24$ ✓ $= \sin 9.31547\frac{3}{4}$ ✓
$n = 0.19309\frac{3}{4}$ ✓	$n = 0.19682\frac{1}{4}$ ✓
$7\ 30\ 54.90$ ✓ $= \sin 9.11657\frac{1}{2}$ ✓	$7\ 33\ 55.55$ ✓ $= \sin 9.11865\frac{1}{2}$ ✓
$4\ 15\ 24.77$ ✓ $r_3 = 1.68810$	$4\ 22\ 52.69$ ✓ 1.68810 ✓
$4\ 42\ 11.09$ ✓ $0.80467\frac{1}{2}$	$4\ 51\ 49.29$ ✓ $0.80675\frac{1}{2}$ ✓
$d = 0\ 26\ 46.32$ ✓ $= \sin 7.89140\frac{1}{4}$ ✓	$0\ 28\ 56.60$ ✓ $= \sin 7.92527$ ✓
818.979 ✓ $= 2.91327\frac{3}{4}$ ✓	761.176 ✓ $= 2.88148\frac{1}{2}$ ✓
48.764 ✓	48.764 ✓
$f_3 = 770.215$ ✓	$f_3 = 712.412$ ✓
1.07	1.07
$d_4 = 771.285$ ✓	$d_4 = 713.482$ ✓
$r_4 = 75.365$ ✓	75.365 ✓
695.920 ✓ $= 2.84256$ ✓	638.117 ✓ $= 2.80490$ ✓
$\sin d = 7.89140\frac{1}{4}$ ✓	7.92527 ✓
$0.73396\frac{1}{4}$ ✓	$0.73017\frac{1}{4}$
$r_4 = 1.87717$ ✓	$r_4 = 1.87717$ ✓
$4^\circ\ 7'\ 25''.42$ ✓ $= \sin 8.85679\frac{1}{4}$ ✓	$4^\circ\ 5'\ 16.13$ ✓ $= \sin 8.85300\frac{1}{4}$ ✓
$n = 0.19309\frac{3}{4}$ ✓	$0.19682\frac{1}{4}$ ✓
$6\ 26\ 26.21$ ✓ $= \sin 9.04989\frac{3}{4}$ ✓	$6\ 26\ 22.60$ ✓ $= \sin 9.04982\frac{3}{4}$ ✓
1.87717 ✓	1.87717 ✓
$2\ 19\ 0.79$ ✓	$2\ 21\ 6.47$ ✓
$0\ 26\ 46.32$ ✓	$0\ 28\ 56.60$ ✓
$0.92706\frac{1}{4}$ ✓	$0.92699\frac{1}{4}$ ✓
$1\ 52\ 14.47$ ✓ $= \sin 8.51380\frac{1}{8}$ ✓	$1\ 52\ 9.87$ ✓ $= 8.51350\frac{1}{2}$ ✓
258.976 ✓ $= 2.41325\frac{7}{8}$ ✓	259.112 ✓ $= 2.41348\frac{3}{4}$ ✓
75.365 ✓	75.365 ✓
$f_4 = 183.611$ ✓	$f_4 = 183.747$ ✓
	$.611$ ✓
	$.136$ ✓ Bangkok mean

For central rays see p. 109

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Color — try $r_4 = 73.527 = \log 1.86644\frac{3}{4}$

Marginal

$d_4 =$ B	F'
$d_4 = 771.285$ ✓	$d_4 = 713.482$ ✓
$r_4 = 73.527$ ✓	$r_4 = 73.527$ ✓
697.758 ✓ $= 2.84370\frac{1}{2}$ ✓	639.955 ✓ $= 2.80615$ ✓
$\sin v = 7.89140\frac{5}{4}$ ✓	$\sin v = 7.925271\frac{1}{2}$ ✓
$0.73510\frac{3}{4}$ ✓	$0.73142\frac{1}{2}$ ✓
$r_4 = 8.86644\frac{3}{4}$ ✓	$r_4 = 8.86644\frac{3}{4}$ ✓
$4^\circ\ 14'\ 17''.43$ ✓ $= \sin 8.86866\frac{1}{4}$ ✓	$4^\circ\ 12'\ 8''.19$ ✓ $= \sin 8.86497\frac{1}{4}$ ✓
$n = 0.19309\frac{3}{4}$ ✓	$n = 0.19682\frac{1}{4}$ ✓
$6\ 37\ 11.38$ ✓ $= \sin 9.06175\frac{3}{4}$ ✓	$6\ 37\ 13.44$ ✓ $= \sin 9.06179\frac{1}{2}$ ✓
$2\ 22\ 53.95$ ✓	$2\ 25\ 55.25$ ✓
$1.86644\frac{3}{4}$ ✓	$1.86644\frac{3}{4}$ ✓
$0\ 26\ 46.32$ ✓	$0\ 28\ 56.60$ ✓
$0.92820\frac{1}{2}$ ✓	$9.92824\frac{1}{4}$ ✓
$1\ 56\ 7.63$ ✓ $= \sin 8.52856\frac{3}{4}$ ✓	$1\ 56\ 8.65$ ✓ $= \sin 8.52864$ ✓
$2.39963\frac{3}{4}$ ✓	$= 2.39960\frac{1}{4}$ ✓
250.979 ✓	250.955 ✓
73.527 ✓	73.527 ✓
$f_4 = 177.452$ ✓	$f_4 = 177.432$ ✓
$.432$ ✓	
$.020$ ✓ Barycentric string	

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II

Color. Try $r_4 = 73.649$

Marginal

B	F
$d_4 = 771.285$ ✓	$d_4 = 713.482$ ✓
73.649	73.649
697.636 ✓ $= 2.84363$ ✓	639.833 ✓ $= 2.80606\frac{3}{4}$
$\sin v = 7.89140\frac{1}{4}$ ✓	$\sin v = 7.92527$ ✓
$0.73503\frac{1}{4}$ ✓	$0.73133\frac{3}{4}$ ✓
$r_4 = 1.86716\frac{3}{4}$ ✓	$1.86716\frac{3}{4}$ ✓
4 13 49.47 ✓ $= \sin 8.86786\frac{1}{2}$ ✓	4 11 40.22 ✓ $= \sin 8.86417$ ✓
$n = 0.19309\frac{3}{4}$ ✓	$0.19682\frac{1}{4}$ ✓
6 36 27.60 ✓ $= \sin 9.06096\frac{1}{4}$ ✓	6 36 29.25 ✓ $= \sin 9.06099\frac{1}{4}$ ✓
2 22 38.13 ✓ $1.86716\frac{3}{4}$ ✓	2 24 49.03 ✓ $1.86716\frac{3}{4}$ ✓
0 26 46.32 ✓ 0.92813 ✓	0 28 56.60 ✓ 0.92816 ✓
1 55 51.81 ✓ $= \sin 8.52759$ ✓	1 55 52.43 ✓ $= \sin 8.52763$ ✓
251.501 ✓ $= 2.40054$ ✓	251.495 ✓ 2.40053 ✓
73.649 ✓	73.649 ✓
$f_4 = 177.852$ ✓	177.846 ✓

$.846$ ✓

$.006$ ✓ Color ~~comet~~, Barylin strong

Diagram p. 115

$A = \frac{1}{r_3} + \frac{1}{r_4}$

$r_3 = 48.764$ ✓ $= 1.688100$ ✓
8.311900 ✓ $= .0205069$ ✓

$r_4 = 73.734$ ✓ $= 1.86766\frac{3}{4}$ ✓
$8.13233\frac{1}{4}$ ✓ $= .0135627$ ✓
$.0340696$ ✓ $= A$

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$\tau_3 = 48.76$ ✓
$\tau_4 = 73.649$

central

B	F'
P. 109	
$d_4 = 2.89603\frac{1}{4}$ ✓	$d_4 = 2.86200\frac{3}{4}$ ✓
$\tau_4 = 1.86716\frac{3}{4}$ ✓	$1.86716\frac{3}{4}$ ✓
4.76320 ✓	$4.72917\frac{1}{2}$ ✓
$d(n-1) = 440.700$ ✓	$d(n-1) = 417.278$ ✓
$n = 0.19309\frac{3}{4}$ ✓	$n = 0.19682\frac{1}{4}$ ✓
$\tau = 1.86716\frac{3}{4}$ ✓	$\tau = 1.86716\frac{3}{4}$ ✓
$2.06026\frac{1}{2}$ ✓ $= 114.885$ ✓	2.06399 ✓ $= 115.875$ ✓
325.815 ✓ $= 2.512977\frac{1}{2}$ ✓	301.398 ✓ $= 2.479136$ ✓
$f_4 = 177.922$ ✓ $= 2.250233\frac{1}{2}$ ✓	$f_4 = 177.844$ ✓ $= 2.250039$ ✓
.844 ✓ F'	
.078 ✓ Color - Baryta strong.	
177.852 ✓ marginal	177.846 ✓ marginal
.070 Sph. Ab.	.003 Sph. Ab. nearly correct for F'
Barya strong	Barya weak

diagram p. 58.

τ_3 must be increased .166 to make barya sph. ab. .0365 rep. 58.

$\tau_3 = 48.764$
$.166$
48.930

$\tau_1 = \text{Inf.}$ $\quad \tau_3 = 48.930 = 1.689575 \quad .03406917 = A$
$8.310425 = .02043737$
$8.134553 = .01363180$

$\tau_2 = 45.719 \quad \tau_4 = 73.3580 = 1.865447$

To give perfect correction for both color & sph. Ab.

$f_4 = 178.167$

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April 1st 1906.

Internal Reflection.

1st Reflection (from 3rd Surface)

$r_3 = 48.935$

p 110. $d_3 = 72.575$

$121.510 = 2.08461$

$\sin v = 8.91377$

0.99838

$r = 1.68962$

$i = 11^\circ\ 44'\ 49.5'' = \sin 9.30876$

$2i = 23\ 29\ 39.0$ $\quad r = 1.68962$

$v = 4\ 42\ 11.1$ $\quad 0.99838$

$v' = 18\ 47\ 27.9 = \sin 9.50802$

$r_3 = 48.935 = 1.49036$

30.929

$f = 18.006$

$.040$

$d = 18.046$ $\quad$ 2nd Refl.

$r_2 = 45.719$

$27.673 = 1.44209$

$\sin v = 9.50802$

0.95011

$r_2 = 1.66019$

$i = 11^\circ\ 14'\ 38.7'' = \sin 9.29001$

$22\ 29\ 17.4$ $\quad r = 1.66010$

0.95011

$v = 18\ 47\ 27.9$

$v' = 3\ 41\ 49.5 = \sin 8.80943$

$138.255 = 2.14068$

$r = 45.719$

$f = 92.536$

Refractions

$f = 92.536$

$.040$

$d_3 = 92.576$

$r_3 = 48.935$

$141.511 = 2.15079$

$\sin v = 8.80943$

0.96022

$r_3 = 1.68962$

$i = 10^\circ\ 44'\ 47.9'' = \sin 9.27060$

$n = 0.19310$

$\lambda = 6\ 57\ 55.2 = \sin 9.07750$

$3\ 52\ 52.7$ $\quad r = 1.68962$

$v = 3\ 41\ 49.5$ $\quad 0.76712$

$v' = 0\ 11\ 3.2 = \sin 7.50722$

$= 3.25990$

1819.3

48.93

$f_3 = 1868.23$

1.07

$d_4 = 1867.16$

$r_4 = 73.263$

$1940.42 = 3.28790$

$\sin v = 7.50722$

0.79512

$r = 1.86488$

$i = 4^\circ\ 53'\ 7.0'' = \sin 8.93024$

$n = 0.19310$

$\lambda = 7\ 38\ 2.2 = \sin 9.12334$

$2\ 44\ 55.2$ $\quad r = 1.86488$

$0\ 11\ 3.2$ $\quad 0.98822$

$2\ 55\ 58.4 = \sin 8.70898$

$= 2.27924$

190.213

73.263

$f_4 = 116.950$

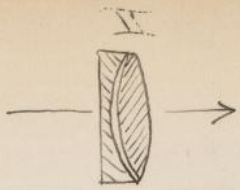
Focal length of A. G. $f_4 = 177.883$

60.933 from f.

The reflection is 61 inches from the principal focus.

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For Focal length = 180.00 eq. focus.

f_4 = 179.450 = 2.253943
177.883 = 2.250134
0.003809

45.719 = 1.660097
r_2 = 46.1218 = 1.663906

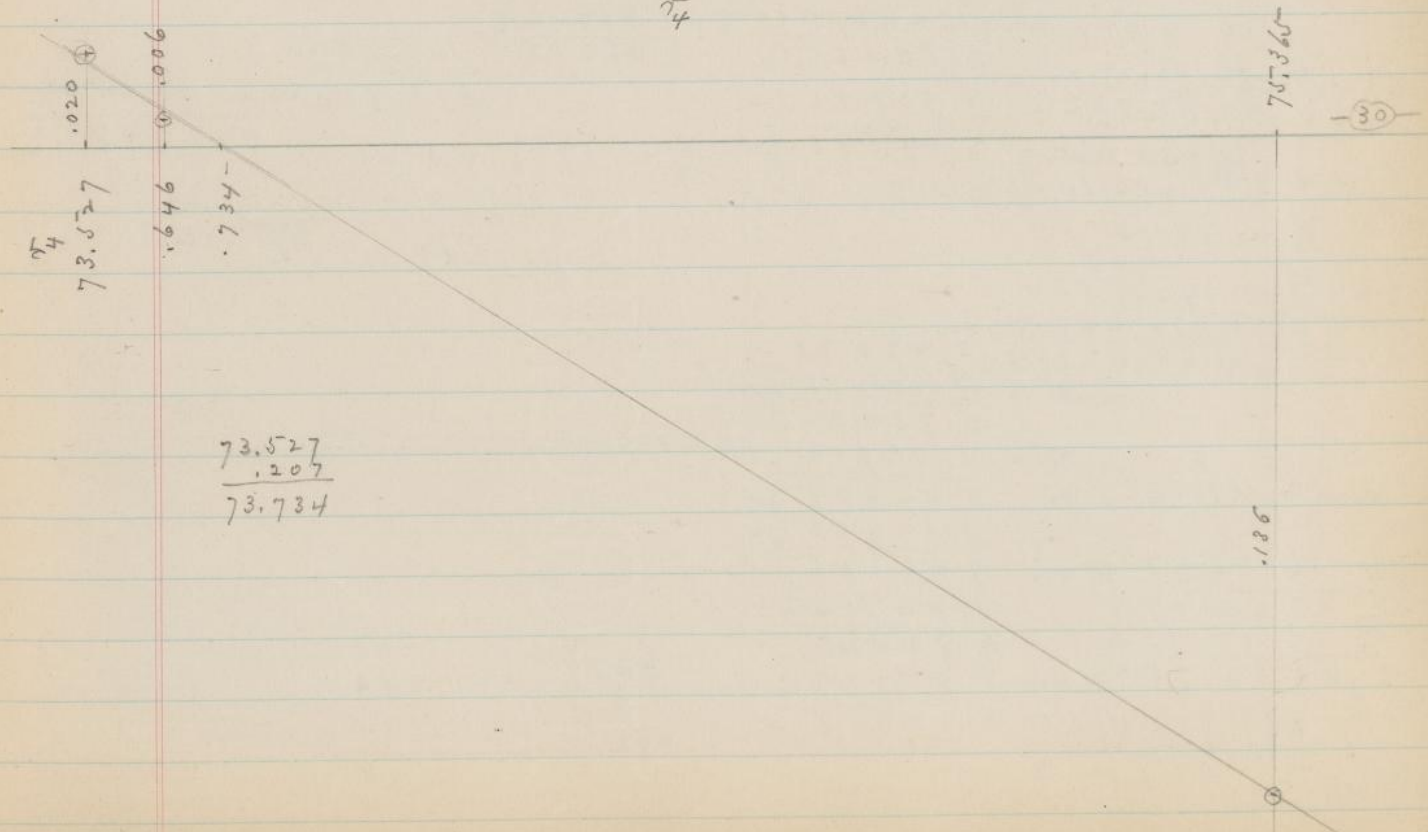
sup p. 117.

48.935 = 1.689620
0.003809
r_3 = 49.3661 = 1.693429

73.263 = 1.864883
0.003809
r_4 = 73.9081 = 1.868692

below p. 110-111-112.

r_4



73.527
.207
73.734

.186

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116

VII
XV
VIII

II

Flint τ_1 = Inf. τ_2 = 45.719 } .33
Baryta τ_3 = 48.764 τ_4 = 73.649 } 1.07

Prior. 5614'

Marginal

p. 110 + 61 k = 6

i = 7° 32' 27".81 = 9.11805 ½
n = 0.21118 ¾
sin i' = 9.32924 ¼
i' = 12 19 23.03 = 4 46 55.22
1.66009 ½
0.98933 ¾
sin 8.92098 ¼

f 117.04556 = 2.06835 ½
45.719
f_2 = 71.3266
.04
d_3 = 71.3666
τ_3 = 48.764
120.1306 = 2.07965 ¼
sin i = 8.92098 ¼
1.00063 ½
τ_3 = 1.68810
11° 51' 3.99 = sin 9.31253 ½
n = 0.19496 ¼
7 31 57.50 = sin 9.11757 ¼
4 19 6.49
4 46 53.22
0 27 48.73 = sin 7.90795 ½
2.89771 ¾
790.165 =
48.764
f_2 = 741.401
1.07
d_3 = 742.471
τ_3 = 73.649
668.822 = 2.82531
sin i = 7.90795 ½
0.73326 ½
τ_4 = 1.86716 ¾
4° 12' 47.50 = sin 8.86609 ¾
n = 0.19496 ¼
6 36 32.97 = sin 9.06106
2 23 45.47
0 27 48.73
1 55 56.74 = sin 8.52789 ¾
251.380 = 2.40033
73.649
f_4 = 177.731

Central

τ_2 = 1.66009 ½
$n-1$ = 9.79674 ½
f_2 = 73.0045 = 1.86335
.040
d_3 = 73.0445 = 1.86358 ¾
n = 0.19496 ¼
τ_3 = 1.68810
3.74665

d = 1.86358 ¾
$n-1$ = 9.75329 48.764
1.61687 ¾ = 41.3883
7.3757 = 0.86780 ½
f_3 = 756.567 = 2.87884 ¾
1.07
d_4 = 757.637 = 2.87946
τ_4 = 1.86716 ¾
4.74662 ¾

d = 2.87946
$n-1$ = 9.75329
2.63275 = 429.290
n = 0.19496 ¼
τ = 1.86716 ¾
2.06213 = 115.380
313.910 = 2.49680 ½
f_4 = 177.755 = 2.24982 ¼
177.883 p. 113
(.128) = $\frac{B+F'}{2}$ − 5614'

$\frac{B+F'}{2}$ = 177.849 p. 112
5614' = 177.731
(.118)

Color corrections of the Marginal rays is better than of the central rays. Compare with p. 151

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5614'

Central $f_4 = 177.753$ ✓
Marginal = 177.731 ✓
Sph. Ab = .024 ✓ Bowlin strong

make $\tau_3 = 48.878 = 1.689113 \quad .0340848$
$8.310887 = .0204591$
$8.134359 = .0136257$
$73.3907 = 1.865641$

$f_4 = 177.748$

In Eq. Focus 180.050 $f_4 = 179.450 = 2.253943$
$177.748 = 2.249805$
0.004138

$\tau = 45.719 = 1.660097$
$\tau_2 = 46.1567 = 1.664235$

0.004138
$48.878 = 1.689113$
$\tau_3 = 49.346 = 1.693251$

Dup. 120

0.004138
$73.3907 = 1.865641$
$\tau_4 = 74.0933 = 1.869779$

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II

$\tau_3 = 48.878$

$\tau_4 = 73.3907$

Spherical Aberration

5-6,44

Marginal

P. 116

$d_3 = 71.3666$ ✓

$\tau_3 = 48.878$ ✓

120.2446 ✓ = 2.080006 ½ ✓✓

sin i = 8.920098 ¼ ✓✓

1.001043 ¾ ✓✓

τ_3 = 1.689911 ¼ ✓✓

11° 50′ 4.24″ ✓✓ = sin 9.311931 ½ ✓✓

0.19496 ¼ ✓✓

7 31 19.88″ ✓ = sin 9.116971 ¼ ✓✓

4 18 44.44 ✓✓

4 46 33.22 ✓✓

0 28 10.78 ✓✓ = sin 7.913655 ½ ✓✓

780.598 ✓ = 2.892423 ¾ ✓

48.878 ✓

f_3 = 731.720 ✓

1.07

d_4 = 732.790 ✓

73.3907 ✓

659.3993 ✓ = 2.819143 ¾ ✓

7.913655 ½ ✓

0.732801 ¾ ✓

τ_4 = 1.86564 ✓

4 13 24.90″ ✓ = sin 8.867162 ¾ ✓

n = 0.19496 ¼ ✓

6 37 31.79″ ✓ = sin 9.062123 ¾ ✓

2 24 6.89 ✓

0 28 10.78 ✓

1 55 56.11 ✓ = sin 8.52786 ✓

251.137 ✓ = 2.399901 ¾ ✓

73.391 ✓

f_4 = 177.746 ✓

Central

d_3 = 1.86358 ¾ ✓

n = 0.19496 ¼ ✓

τ_3 = 1.68911 ¼ ✓

3.74766 ¼ ✓

τ_3 = 48.878 ✓

$d(n-1)$ = 41.3883 ✓

7.4897 ✓ = 0.87446 ½ ✓

f_3 = 746.788 ✓ = 2.87319 ¾ ✓

1.07

d_4 = 747.858 ✓ = 2.87382 ✓

τ_4 = 1.86564 ✓

4.73946 ✓

d = 2.87382 ✓

$n-1$ = 9.75329 ✓

2.62711 ✓ = 423.750 ✓

n = 0.19496 ¼ ✓

τ = 1.86564 ✓

2.06060 ¼ ✓ = 114.975 ✓

308.775 ✓ = 2.48964 ¼ ✓

f_4 = 177.753 ✓ = 2.24981 ¾ ✓

.746 ✓

.007 ✓ Barylt strong

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56.4'

by $r_3 = 48.946 = 1.68971\frac{3}{4}$ .0340848 = A see p 112 too strong
8.31028 $\frac{1}{4}$ = .02043066
8,135-26 $\frac{1}{2}$ .01365414

$r_4 = 73.2377 = 1.86473\frac{1}{2}$

Marginal

$d_3 = 71.3666$ ✓
$r_3 = 48.946$ ✓
120.3126 ✓ = sin 2.08031 ✓
8.92098 $\frac{1}{4}$ ✓
1.00129 $\frac{1}{4}$ ✓
r_3 = 1.68971 $\frac{3}{4}$ ✓
11 49 28.37 ✓ = sin 9.31157 $\frac{1}{2}$ ✓
0.19496 $\frac{1}{4}$ ✓
7 30 37.24 ✓ = sin 9.11661 $\frac{1}{4}$ ✓
1.68971 $\frac{3}{4}$ ✓
4 18 31.13 ✓ 0.80633 ✓
4 46 55.22 ✓
0 28 24.09 = sin 7.91706 $\frac{1}{4}$ ✓
2.88926 $\frac{3}{4}$ ✓
774.940 ✓ =
48.946 ✓
725.994 ✓
1.07
727.064 ✓
73.2377 ✓
653.8263 ✓ = 2.81546 $\frac{1}{4}$ ✓
sin 7.91706 $\frac{1}{4}$ ✓
0.73252 $\frac{1}{2}$ ✓
r_4 = 1.86473 $\frac{1}{2}$ ✓
4° 13' 46.84" ✓ = sin 8.86779 ✓
0.19496 $\frac{1}{4}$ ✓
6 38 6.29 ✓ = sin 9.06275 $\frac{1}{4}$ ✓
2 24 19.45 ✓ 1.86473 $\frac{1}{2}$ ✓
0 28 24.09 ✓ 0.92748 $\frac{3}{4}$ ✓
1 55 55.36 ✓ = sin 8.62781 $\frac{1}{4}$ ✓
251.001 ✓ = 2.39967 $\frac{1}{2}$ ✓
73.238 ✓
f_4 = 177.763 ✓
.752 ✓
.011 ✓ ~~Hindstrong~~ Borgstrom weak

Central

$d_3 = 1.86358\frac{3}{4}$ ✓
$n = 0.19496\frac{1}{4}$ ✓
$r_3 = 1.68971\frac{3}{4}$ ✓
3.74826 $\frac{3}{4}$ ✓

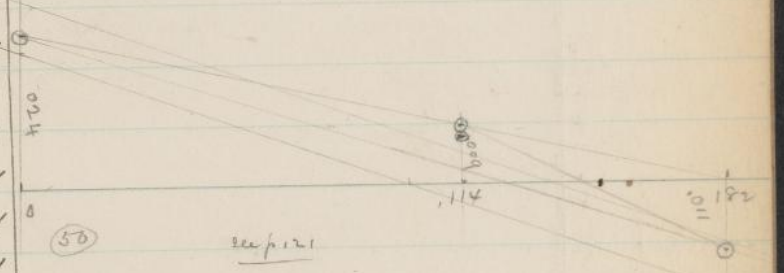
48.946 ✓
41.3883 ✓
7.5577 ✓ = 0.87839 ✓
= 2.86987 $\frac{3}{4}$ ✓
741.100 ✓
1.07
d_4 = 742.170 ✓ = 2.87050 $\frac{1}{4}$ ✓
r_4 = 1.86473 $\frac{1}{2}$ ✓
4.73523 $\frac{3}{4}$ ✓

$d(n-1)$

$d = 2.87050\frac{1}{4}$ ✓
nr = 9.75329 ✓
2.62379 $\frac{1}{4}$ ✓ = 420.525 ✓

$n = 0.19496\frac{1}{4}$ ✓
$r = 1.86473\frac{1}{2}$ ✓
2.05969 $\frac{3}{4}$ ✓ = 114.735 ✓
305.790 ✓ = 2.48542 $\frac{1}{4}$ ✓
= 2.24981 $\frac{1}{2}$ ✓

f_4 = 177.752 ✓



(50)

see p. 121

r_3		Sph. Ab.	
48.764	0	.024	+
.878	114	.009	+
.946	182	.011	−

48.764
.150
48.914

(30)

compare p. 58

.182) 0340 (.068) .0220
.114) 016

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II

$r_3 = 48.893 = 1.689247$ $.0340848 = A$ see p. 112 too strong

$8.310753 = .0204528$

$= .0136320$

8.134560

$73.3567 = 1.865440$ $f_4 = 177.752$

For Eq. Focus = 180.000.

$f_4 = 179.450 = 2.253943$

$177.752 = 2.249814\frac{1}{2}$

$0.004128\frac{1}{2}$

$45.719 = 1.660097$

$r_2 = 46.1537 = 1.664225\frac{1}{2}$

see p. 122

$0.004128\frac{1}{2}$

$48.893 = 1.689247$

$r_3 = 49.3600 = 1.693375\frac{1}{2}$

$0.004128\frac{1}{2}$

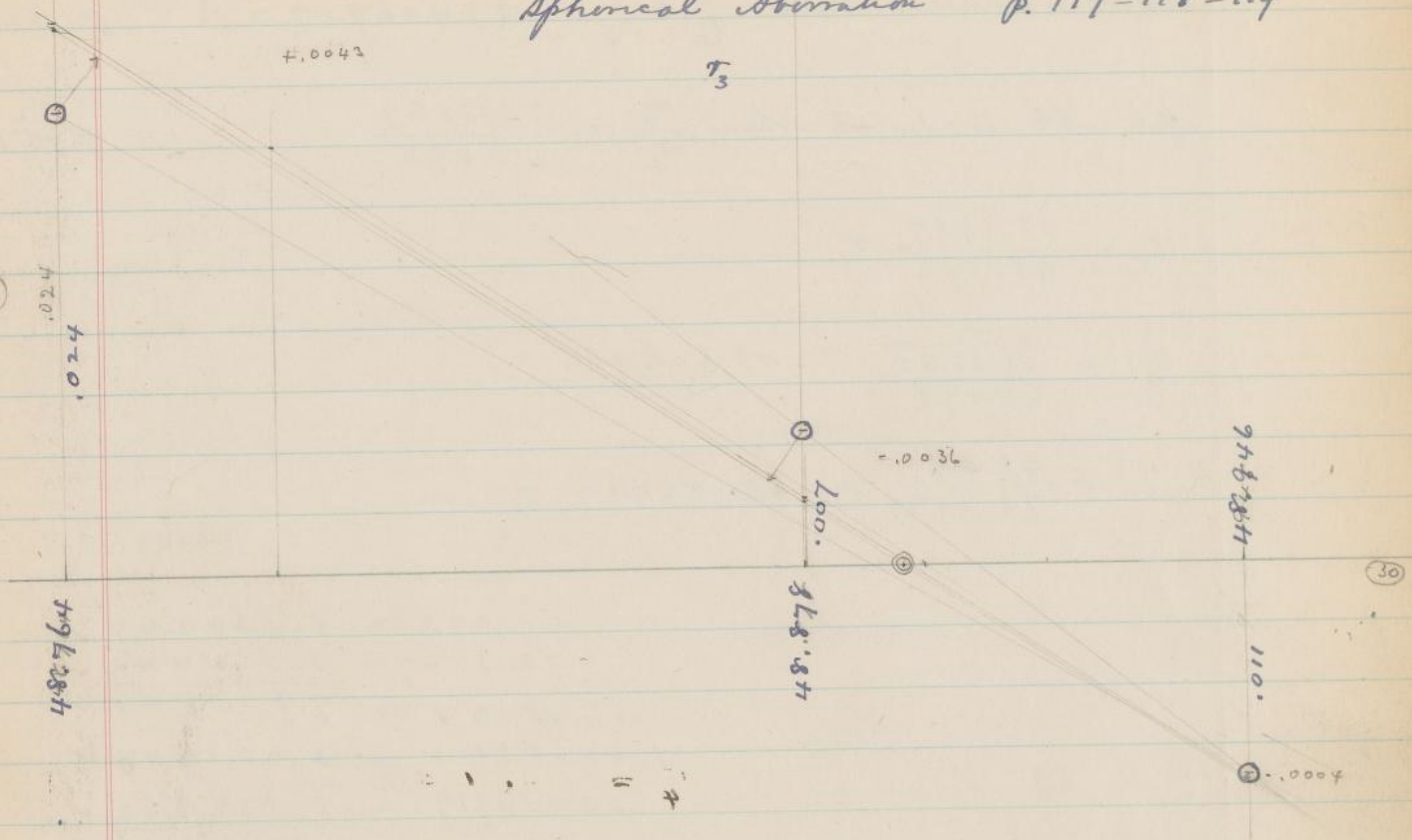
$73.3567 = 1.865440$

$r_4 = 74.0574 = 1.869568\frac{1}{2}$

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Spherical Aberration p. 117-118-119



see p 58. (no space between)

.129
48.764
48.893

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Color is correct when $\frac{1}{r_3} + \frac{1}{r_4} = .03406917 = A$ p. 112

Sph. Ab. is correct when $\frac{r_4}{r_3} = \frac{73.3567}{48.893}$ p. 120-1

$$r_4 = \frac{73.3567}{48.893} \cdot r_3$$

$$\frac{1}{r_3} + \frac{1}{\frac{73.3567}{48.893} r_3} = .03406917$$

$$1 + \frac{48.893}{73.3567} = .03406917\ r_3$$

$48.893 = 1.689247$ ✓
$73.3567 = 1.865440$ ✓
$.666510$ ✓ $= 9.823807$ ✓
1.666510 ✓ $= 0.221808$ ✓
$.03406917 = 8.532362$ ✓
$r_3 = 48.9156 = 1.689446$ ✓
$r_4 = 73.3904$ ✓ $= 1.865639$ ✓

$f_4 = 178.167$
p. 113.

$f_4 = 179.450 = 2.253943$
$f_4 = 178.167 = 2.250827$
0.003116
$45.719 = 1.660097$
$r_2 = 46.0482 = 1.663213$

0.003116
$48.9156 = 1.689446$
$r_3 = 49.2677 = 1.692562$

0.003116
$73.3904 = 1.865639$
$r_4 = 73.9188 = 1.868755$

April 25 1906

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II

Marginal

B

K = 6 = 0.7781513 ✓✓

r_2 = 46.04824 ✓ = 1.6632127 ✓✓

7° 29′ 12″.578 ✓✓ = sin 9.1149386 ✓✓

n = 0.2084406 ✓✓

p108

12 9 18.957 ✓✓ = sin 9.3233792 ✓✓

4 40 6.379 ✓✓ r_2 = 1.6632127 ✓✓

0.9865919 ✓✓

sin = 8.9105684 ✓✓

119.13066 ✓✓ = 2.0760235 ✓✓

r_2 = 46.0482 ✓✓

f_2 = 73.08246 ✓✓

.040

d_3 = 73.12246 ✓✓

r_3 = 49.2677 ✓✓

122.39016 ✓✓ = 2.0877465 ✓✓

sin d = 8.9105684 ✓✓

0.9983149 ✓✓

r_3 = 1.6925623 ✓✓

11° 39′ 53″.500 ✓✓ = sin 9.3057526 ✓✓

n = 0.1930965 ✓✓

7 26 50.497 ✓✓ = sin 9.1126561 ✓✓

4 13 3.003 ✓✓ r_3 = 1.6925623 ✓✓

4 40 6.379 ✓✓

0 27 3.376 ✓✓ = sin 7.8959895 ✓✓

811.3885 ✓✓ = 2.9092289 ✓✓

49.2677 ✓✓

f_3 = 762.1208 ✓✓

1.07

d_4 = 763.1908 ✓✓

r_4 = 73.9188 ✓✓

689.2720 ✓✓ = 2.8383907 ✓✓

sin d = 7.8959895 ✓✓

0.7343802 ✓✓

r_4 = 1.8687549 ✓✓

4° 12′ 30″.989 ✓✓ = sin 8.8656253 ✓✓

n = 0.1930965 ✓✓

6 34 24.652 ✓✓ = sin 9.0587218 ✓✓

2 21 53.663 ✓✓ r_4 = 1.8687549 ✓✓

0 27 3.376 ✓✓

1 54 50.287 ✓✓ = sin 8.5237314 ✓✓

253.3642 ✓✓ = 2.4037453 ✓✓

73.9188 ✓✓

f_4 = 179.4454 ✓✓

F′

7° 29′ 12″.578 ✓✓ = sin 9.1149386 ✓✓

n = 0.2140134 ✓✓

12 18 52.891 ✓✓ = sin 9.3289520 ✓✓

4 49 40.310 ✓✓ r_2 = 1.6632127 ✓✓

0.9921647 ✓✓

sin 8.9251183 ✓✓

116.69343 ✓✓ = 2.0670464 ✓✓

46.0482 ✓✓

f_2 = 70.64523 ✓✓

.040

d_3 = 70.68523 ✓✓

49.2677 ✓✓

119.95293 ✓✓ = 2.0790109 ✓✓

sin d = 8.9251183 ✓✓

1.0041292 ✓✓

r_3 = 1.6925623 ✓✓

11 49 27.604 ✓✓ sin 9.3115669 ✓✓

n = 0.1968223 ✓✓

7 29 0.474 ✓✓ sin 9.1147446 ✓✓

4 20 27.130 ✓✓ r_3 = 1.6925623 ✓✓

4 49 40.310 ✓✓ 0.8073069 ✓✓

0 29 13.181 ✓✓ = sin 7.9293964 ✓✓

754.9367 ✓✓ = 2.8779105 ✓✓

49.2677 ✓✓

f_3 = 705.6690 ✓✓

1.07

d_4 = 706.7390 ✓✓

73.9188 ✓✓

632.8202 ✓✓ = 2.8012803 ✓✓

sin d = 7.9293964 ✓✓

0.7306767 ✓✓

r_4 = 1.8687549 ✓✓

4° 10′ 22″.111 ✓✓ = sin 8.8619218 ✓✓

n = 0.1968223 ✓✓

6 34 25.873 ✓✓ = sin 9.0587441 ✓✓

2 24 3.762 ✓✓ r_4 = 1.8687549 ✓✓

0 29 13.181 ✓✓ 0.9274990 ✓✓

1 54 50.581 ✓✓ = sin 8.5237499 ✓✓

253.3664 ✓✓ = 2.4037491 ✓✓

73.9188 ✓✓

f_4 = 179.4476 ✓✓

.4454 ✓✓

.0022 w/ 7 last strong for color

.4469

.3142

.1327

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Marginal

5614'

7° 29' 12".5784 = sin 9.1149386
n = 0.2111865
12 14 0.793 sin 9.3261251
4 44 48.215 τ_2 = 1.6632127
0.9893378
sin 8.9177747
117.91339 = 2.0715631
46.0482
f_2 = 71.86519
0.040
d_3 = 71.90519
49.2677
121.17289 = 2.0834054
sin 8.9177746
1.0011800
τ_3 = 1.6925623
11 44 35.400 sin 9.3086177
0.1949634
7 27 52.539 sin 9.1136543
4 16 42.861 τ_3 = 1.6925623
4 44 48.215
0 28 5.354 sin 7.9122611
783.3495 = 2.8939554
49.2677
f_3 = 734.0818
1.07
d_4 = 735.1518
73.9188
661.2330 = 2.8203545
sin τ = 7.9122611
0.7326156
τ_4 = 1.8687549
4 11 29.446 sin 8.8638607
n = 0.1949634
6 34 30.252 sin 9.0588241
2 23 0.806 1.8687549
0 28 5.354
1 54 55.452 sin 8.5240567
= 2.4035223
253.2342
73.9188
f_4 = 179.3154

$f_4 B$ = 179.4454.
$f_4 F'$ = 179.4476.
$\frac{1}{2}(f_4 B + f_4 F')$ = 179.4465.
f_4 5614' = 179.3154.
0.1311.

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1903phae.proj.1152P

II

Central

B

$r_2 = 1.6632127$ vv

$n-1 = 9.7895787$ vv

$f_2 = 74.7539$ vv $= 1.8736340$ vv
.040

$d_3 = 74.7939$ vv $= 1.8738664$ vv

$n = 0.1930965$ vv

$r_3 = 1.6925623$ vv

3.7595252 vv

$d = 1.8738664$ vv

$n-1 = 9.7481096$ vv 49.2677 vv

1.6219760 vv $= 41.87704$ vv

7.39066 vv $\doteq 0.8686832$ vv

$f_3 = 777.7536$ vv $= 2.8908420$ vv
1.07 vv

$d_4 = 778.8236$ vv $= 2.8914391$ vv

$r_4 = 1.8687549$ vv

4.7601940 vv

$d = 2.8914391$ vv

$n-1 = 9.7481096$ vv

2.6395487 vv $= 436.0624$ vv

$n = 0.1930965$ vv

$r = 1.8687549$ vv

2.0618514 vv $= 115.3059$ vv

320.7565 vv 2.5061755 vv

$f_4 = 179.4810$ vv $= 2.2540185$ vv

179.4454 vv Marginal

.0356 vv = Sph. Ab.
Barytа strong

F′

$r_2 = 1.6632127$ vv

$n-1 = 9.8040488$ vv

$f_2 = 72.30427$ vv $= 1.8591639$ vv
.040

$d_3 = 72.34427$ vv $= 1.8594041$ vv

$n = 0.1968223$ vv

$r_3 = 1.6925623$ vv

3.7487887 vv

$d = 1.8594041$ vv

$n-1 = 9.7584115$ vv 49.2677 vv

1.6178156 vv $= 41.47780$ vv

7.7899 vv $\doteq 0.8915319$ vv

$f_3 = 719.8745$ vv $= 2.8572568$ vv
1.07 vv

$d_4 = 720.9445$ vv $= 2.8579018$ vv

$r_4 = 1.8687549$ vv

4.7266567 vv

$d = 2.8579018$ vv

$n-1 = 9.7584115$ vv

2.6163133 vv $= 413.3456$ vv

$n = 0.1968223$ vv

$r = 1.8687549$ vv

2.0655772 vv $= 116.2993$ vv

297.0463 vv $= 2.4728242$ vv

$f_4 = 179.4042$ vv $= 2.2538325$ vv

179.4476 vv Marginal

.0434 vv = Sph. Ab.
Barytа Weak

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Central

5614'

r_2 = 1.6632127 ✓✓
$n-1$ = 9.7967456 ✓✓
f_2 = 73.53042 ✓ = 1.8664671 ✓✓
.040
d_3 = 73.57042 ✓ = 1.8667033 ✓✓
n = 0.1949634 ✓✓
r_3 = 1.6925623 ✓✓
3.7542290 ✓✓

d = 1.8667033 ✓✓
$n-1$ = 9.7532911 ✓✓ 49.2677 ✓✓
1.6199944 ✓ = 41.68640 ✓✓
7.5813 0 ✓ = 0.8797437 ✓✓
f_3 = 749.0060 ✓ = 2.8744853 ✓✓
1.07
d_4 = 750.0760 ✓ = 2.8751053 ✓✓
r_4 = 1.8687549 ✓✓
4.7438602 ✓✓

d = 2.8751053 ✓✓
$n-1$ = 9.7532911 ✓✓
2.6283964 ✓ = 425.0074 ✓✓
n = 0.1949634 ✓✓
r = 1.8687549 ✓✓
2.0637183 ✓ = 115.8026 ✓✓
309.2048 ✓ = 2.4902462 ✓✓
f_4 = 179.3139 ✓✓ = 2.2536140 ✓✓

f_4 B = 179.4810
f_4 F' = 179.4042
$\frac{1}{2}(f_4 B + f_4 F')$ = 179.4426
f_4 5614' = 179.3139
.1287

179.3154 ✓✓ Marginal
.0015 ✓✓ = Sph. Ab } Flint strong

Spherical Aberration

B = .0356 Flint Weak
F' = .0434 " strong
.0790 .

5614' = .0015 . Flint strong

179.4) .0363 = .000202
.0426 = .000237

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1903phae.proj.1152P

1924

B

$d_3 = 1.698927\frac{1}{2}$ ✓

$n' = 0.208468\frac{1}{2}$ ✓

$T_3 = 54.1865^-$ ✓ $= T_3 = \frac{1.733891}{3.641287}$ ✓

$d_3(n-1)$ $= 54.1865$ ✓
30.80204 ✓
23.38446 ✓ $=$

$\frac{1.368927}{2.272360}$ ✓

$f_3 = 187.2233$ ✓ $=$
$.3241$ ✓
186.8992 ✓ $= 2.271607\frac{1}{2}$ ✓

$d_4 = 2.271607\frac{1}{2}$ ✓

$T_4 = 193.3632$ ✓ $= \frac{2.286374}{4.557998\frac{1}{2}}$ ✓

$nT = 312.4953$ ✓

$d = 2.271607\frac{1}{2}$ ✓

$n-1 = \frac{9.789652}{2.061259\frac{1}{2}}$ ✓

$= 115.1488$ ✓
197.3465^- ✓ $=$

$\frac{2.295^-229\frac{1}{2}}{2.262753}$ ✓

f_4 183.1272 ✓ $=$

F

$d_3 = 1.689288\frac{1}{2}$ ✓

$n' = 0.213557\frac{1}{2}$ ✓

$T_3 = \frac{1.733891}{3.636737}$ ✓

54.1865^- ✓
31.05735^- ✓
23.12915^- ✓ $=$

$\frac{1.364160}{2.272577}$ ✓

187.3170 ✓ $=$
$.3241$ ✓
186.9929 ✓ $= 2.271825^-$ ✓

$\frac{2.286374}{4.558199}$ ✓

316.1786 ✓

2.271825^- ✓
9.802876 ✓
2.074701 ✓ $= \frac{118.7684}{197.4102}$ ✓

$\frac{2.295^-369\frac{1}{2}}{2.262831\frac{1}{2}}$ ✓

f_4 183.1604 ✓ $=$

183.1273 ✓
$.0331$ ✓

$.0324$ ✓ should be
$.0008$ ✓ too strong

T_3	$f_F - f_B$
54.4901	$-.0295^-$
54.1865^-	$+.0331$
change $.3036$	$.0626$
$\frac{1}{80} = .38$	$.0008$

$T_3 = 54.1903$ ✓ to give the correction

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1903phae.proj.1152P

F

(1924)

$d_3 = 1.689288\frac{1}{2}$

$n' = 0.213537\frac{1}{2}$

$= 1.733921\frac{1}{2}$

$3.636767\frac{1}{2}$

$T_3 = 54.1903$ (changed)

$T_3 = 54.1903$

$(n'-1)d = \frac{31.0573\frac{1}{2}}{23.13295} =$

$\frac{1.364231}{2.272536\frac{1}{2}}$

$f_3 \quad 187.2994$

$\quad\quad .3241$

$d_4 = 186.9753 = 2.271784$

$T_4 = 193.3632$ (not changed) $= \frac{2.286374}{4.558158}$

$nT = 316.1786$

$d_4 = 2.271784$

$n-1 = \frac{9.802876}{2.074660} = \frac{118.7572}{197.4214} =$

$\frac{2.295394}{2.262764}$

$f_4 = 183.1319$

$\frac{1}{T_4} = 189.6402$ (changed)

$\frac{1}{T_3} = .0052731\checkmark$

$.0183519\checkmark$

$.0236251\checkmark = B$

$7.722070\checkmark$

$2.277930\checkmark$

$T_3 = 54.4901\checkmark = 1.736317\frac{1}{2}\checkmark$

(not changed) $8.263682\frac{1}{2}\checkmark$

$.0184535\checkmark$

$.0051711\checkmark$

(color correct for λ 5870)

$B = \frac{1}{T_3} + \frac{1}{T_4}$

$T_3 = 54.1903$ (changed) $= 1.733921\frac{1}{2}\checkmark$

$8.266078\frac{1}{2}\checkmark =$

$T_4 = 193.3632$ (not changed) $= 2.286374\checkmark$

$7.713626\checkmark =$

$\frac{1}{T_4} = B - \frac{1}{T_3}$

For marginal rays see p 131

This gives large spherical aberration

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1903phae.proj.1152P

1924

Marginal to central p 129

F

P. 38 – 44

$k = 6.$ $= 0.778151$ ✓

$r_1 = 57.0923$ ✓ $= 1.756578$ ✓

$6° 1' 57.''080$ ✓ $= \sin 9.021573$ ✓

$n = 0.196533\frac{1}{2}$ ✓

$3° 49' 57.''124$ ✓ $= \sin 8.825039\frac{1}{2}$ ✓

$2° 11' 59.''956$ ✓ $r_1 = 1.756578$ ✓

$0.581617\frac{1}{2}$ ✓

$= \sin 8.584191$ ✓

$= 1.997426\frac{1}{2}$ ✓

99.40920 ✓

$r_1 = 57.0923$ ✓

$f_1 = 156.5015$ ✓

1.0508 ✓

$d_2 = 155.4507$ ✓

$r_2 = 57.0923$ ✓

212.5430 ✓ $= 2.327447$ ✓

$\sin 8.584191$ ✓

0.911638 ✓

$r_2 = 57.0923$ ✓ $= 1.756578$ ✓

$8° 12' 58.''38$ ✓ $= \sin 9.155060$ ✓

$n = 0.196533\frac{1}{2}$ ✓

$12\ 59\ 59.79$ ✓ $= \sin 9.351593\frac{1}{2}$ ✓

$4\ 46\ 7.41$ ✓ $r = 1.756578$ ✓

$2\ 11\ 59.96$ ✓ $1.108171\frac{1}{2}$ ✓

$6\ 58\ 7.37$ ✓ $= \sin 9.083958\frac{1}{2}$ ✓

105.7336 ✓ $= 2.024213$ ✓

57.0923 ✓

$f_2 = 48.6413$ ✓

$.8150$ ✓

$d_3 = 47.8263$ ✓

Continued on p. 132.

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1903phae.proj.1152P

(1924)

Marginal

F

$f_2 = 48.6413$

$.8150$

$d_3 = 47.8263$

$r_3 = 54.1903$

102.0166 $= 2.008671$

$\sin 9.083958\frac{1}{2}$

$1.092629\frac{1}{2}$

$r_3 = 1.733921\frac{1}{2}$

$13^\circ\ 12'\ 11''.75 = \sin 9.358708$

$n' = 0.213557\frac{1}{2}$

$8\ 1\ 46.70 = \sin 9.145150\frac{1}{2}$

$5\ 10\ 25.05$ $r = 1.733921\frac{1}{2}$

$6\ 58\ 7.37$ 0.879072

$1\ 47\ 42.32 = \sin 8.495892$

$= 2.383180$

241.6462

$r_3 = 54.1903$

187.4559

$.3241$

$d_4 = 187.1318$

$r_4 = 193.3632$

6.2314 $= 0.794585\frac{1}{2}$

$\sin 8.495892$

$9.290477\frac{1}{2}$

$r_4 = 2.286374$

$0^\circ\ 3'\ 28''.2234 = \sin 7.004103\frac{1}{2}$

$n' = 0.213557\frac{1}{2}$

$0\ 5\ 40.4762 = \sin 7.217661$

$0\ 2\ 12.2528$ $r_4 = 2.286374$

$1\ 47\ 42.32$ 9.504035

$1\ 49\ 54.573 = \sin 8.504687\frac{1}{2}$

$= 0.999347\frac{1}{2}$

9.9850

193.3632

$f_4 = 183.3782$ marginal

$f_4 = 183.1319$ central P129

$.2463$ Limit too strong for Sph. Ab.

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1903phae.proj.1152P

1924

Marginal F

from p 130-

$d_3 = 47.8263$ ✓

$r_3 = \frac{54.4901}{102.3164}$ ✓ = 2.009945 ✓ not changed

sin 9.083958 ½ ✓

1.093903 ½ ✓

r_3 = 1.736317 ½ ✓

13° 10' 6.89 ✓ = sin 9.357586 ✓

$n' = 0.213577\frac{1}{2}$ ✓

8 0 21.60 ✓ = sin 9.144028 ½

5 9 35.29 ✓ r_3 = 1.736317 ½ ✓

6 58 7.37 ✓ 0.880346 ✓

1 48 32.08 ✓ = sin 8.499222 ½ ✓

240.5046 ✓ = 2.381123 ½ ✓

54.4901 ✓

f_3 = 186.0145 ✓

.3241 ✓

d_4 = 185.6904 ✓

r_4 = 189.640 ✓ changed

3.9496 ✓ = 0.596553 ✓

sin 8.499222 ½ ✓

9.095775 ½ ✓

r_4 = 2.277930 ✓

0 2 15.6043 ✓ = sin 6.817845 ½ ✓

$n' = 0.213577\frac{1}{2}$ ✓

0 3 41.7323 ✓ = sin 7.031403 ✓

0 1 26.1280 ✓ r_4 = 2.277930 ✓

1 48 32.08 ✓ 9.309333 ✓

1 49 58.208 ✓ = sin 8.504927 ✓

6.3739 ✓ = 0.804406 ✓

189.640 ✓

183.2661 ✓ Marginal

183.1251 ✓ Central

.1410 ✓ Flint too strong

Central F

p. 44

$d_4 = 2.268582\frac{1}{2}$ ✓

$r_4 = \frac{2.277930}{4.546512\frac{1}{2}}$ ✓

$n' = 0.213577\frac{1}{2}$ ✓

$r_4 = \frac{2.277930}{2.491487\frac{1}{2}}$ ✓ = 310.090 ✓

$d(n-1)$ = 117.885 ✓

192.205 = ✓

2.283764 ½ ✓

183.1251 ✓ = 2.262748 ✓

183.0935 ✓

.0316 ✓

.0324 Should be.

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1903phae.proj.1152P

(1924)

B

$r_4 - 187.593 = 2.273217$ ✓

35191.2 ✓ $= 4.546434\frac{1}{2}$ ✓

4.0 ✓

35187.2 ✓ $= 4.546384\frac{1}{2}$ ✓ $\quad 2.273192$ ✓

187.593 ✓

187.582 ✓

.011 ✓

$r = 187.593$ ✓

.0055 ✓ $\quad k = 2.30161$

187.5875 ✓ $= 2.273204$ ✓

1.0676 $\quad 0.028406$ ✓

p. 44 $\quad d_x = 2.268426$ ✓

$r_4 = \frac{2.277930}{4.546356}$ ✓

$n = 0.208468\frac{1}{2}$ ✓

$r_4 = \frac{2.277930}{\Sigma 1.486398\frac{1}{2}}$ ✓ $= \frac{306.4774}{114.3084}$ ✓

$d(n-1) = 192.1690 =$ ✓

2.283683 ✓

183.0935 ✓ $= 2.262673$ ✓

Spherometer

$h = R - \sqrt{R^2 - 4}$

$S = \frac{k}{R - \frac{h}{2}}$

7th Ed. Barker p 240-1

$r_4 = 189.640$ ✓ $= \frac{2.277930}{2}$ ✓

35963.34 ✓ $= 4.555860$ ✓

Concave 4.005

3595.934 ✓ $= 4.553812$ ✓

$r_4 = 189.640$ ✓ $= 2.277906$ ✓

189.6296 ✓

$h = .0104$ ✓

$r = 189.6400$ ✓ $\quad K = 2.30161$ ✓

$\frac{1}{2}h = .0052$ ✓ $= 2.27792$ ✓

189.6348 ✓ $= 0.02369$ ✓

$S = 1.05606$ ✓

Concave

$r_4 = 187.570 = \frac{2.273163}{2}$ ✓

35182.4 ✓ $= 4.546326$ ✓

4.0

3517.8.4 ✓ $= 4.546276$ ✓ $\quad 2.273138$ ✓

187.570 ✓

187.559 ✓

.011 $\quad K = 2.30161$

$r = 187.5700$ ✓

.00553 ✓

187.56447 ✓ $= 2.273151$ ✓

1.06773 $= 0.02846$ ✓

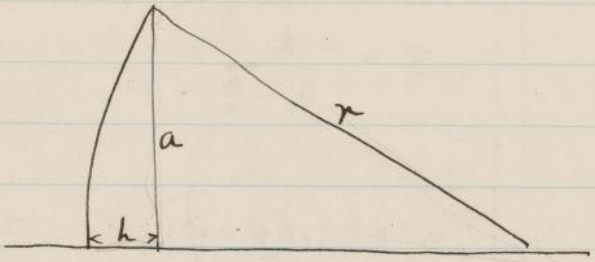
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1924 $R^2 = a^2 + (R-h)^2$

Irwins Bk p. 160

To find how much glass will be taken off at center.



$$h = R - \sqrt{R^2 - a^2}$$

$$h = \frac{a^2}{2R - h}$$

As now made $R = 193.462$ $a = 6.5$

$a^2 = 42.25$

$193.462 = 2.286596$

$R^2 = 37427.60 = 4.573192$

$42.25 = 4.572701\frac{1}{2}$

$37385.35 = 2.286351$

$a^2 = 42.25 = 1.625827$

193.462

193.356

$h = 0.106$

$2R = 386.924$

$h = .106$

386.818

$= 2.587507$

$= 9.038320$

$h_1 = 0.109224$

(R+37)

As will be when altered $R = 187.593 = 2.273216\frac{1}{2}$

$R^2 = 35191.10 = 4.546433$

42.25

$35148.85 = 4.543911$

$R = 187.593 = 2.272955$

187.480

$h = 0.113$

$2R = 375.186$

$.113$

$375.073 = 2.574116$

$a^2 = 1.625827$

$h_2 = 0.112645 = 9.051711$

$h_1 = 0.109224$

Thickness of glass taken off at center $= 0.003421$

$R = 187.61 = 2.273255\frac{1}{2}$

$35199.4 = 4.546512$

42.25

$35156.2 = 4.545999$

$2.272999\frac{1}{2} = 187.497$

$h = .113$

$2R = 375.22$

$.11$

375.11

$a^2 = 1.625837$

$= 2.57416$

$.11263 = 9.05167$

$R = 193.46 - h = .10923$

$.00340$

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P. 240-1 7½ Brok

12½ O.G. measured Oct. 30th 1924 before taking it to Boston.

$R = \frac{k}{S} + \frac{h}{2}$

convex $k = \log 2.30103$

concave $k = $ " 2.30161

$h = \frac{S}{100}$

Temp. 71°

1st surface convex $k = 2.30103$ ✓

$S = 3.5098$ ✓ $= 0.545\,28$ ✓

$\frac{h}{2} = \begin{array}{r} 56.984 \text{ ✓} \\ .017 \text{ ✓} \end{array} = 1.755\,75$ ✓

$R_1 = 57.001$ ✓

2nd surface convex $k = 2.30103$ ✓

$S = 3.5102$ ✓ $= 0.545\,33$ ✓

$\frac{h}{2} = \begin{array}{r} 56.977 \text{ ✓} \\ .017 \text{ ✓} \end{array} = 1.755\,70$ ✓

$R_2 = 56.994$ ✓

$\begin{array}{r} 57.001 \\ 56.994 \\ \hline 2)\,113.995 \end{array}$

Ave 56.998

As calculated 57.092

-0.094

3rd surface concave $k = 2.30161$ ✓

$S = 3.6728$ ✓ $= 0.576\,500$ ✓

$\frac{h}{2} = \begin{array}{r} 54.527 \text{ ✓} \\ .018 \end{array} = 1.736\,61$ ✓

$R_3 = 54.545$ ✓

54.548

or 54.490

$+ .058$

4th surface concave $k = 2.30161$ ✓

$S = 1.0352$ ✓ $= 0.015\,02\frac{1}{2}$ ✓

$\begin{array}{r} 193.457 \text{ ✓} \\ .005 \end{array} = 2.286\,58\frac{1}{2}$ ✓

$R_4 = 193.462$ ✓

187.608 ✓ letter to Lundin

S = 1.0675 ✓

187.57 to correct for λ = 5766

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1924

p. 135 Q. C. as measured Oct 30'24 with back surface altered to correct color to $\lambda = 5670$.

calculate on separate sheet

$r_1 = 57.001$

$r_2 = 56.994$

$r_3 = 54.545$

$r_4 = 187.570$ 193.462 P135

187.57 to correct for 5670

Continued from p. 137

B

$d_4 =$ 2.266166

$r_4 = 187.570 =$ 2.273163½ / 4.539329½

$n = 0.208468\frac{1}{2}$

$r_4 = 2.273163\frac{1}{2} / 2.481631 = 303.132$

$d(n-1) = 113.715 / 189.417 =$ 2.277419

$f_4 = 182.772 =$ 2.261910½

(5614) .65-1 / .121

F

$d_4 =$ 2.266293

2.273163½ / 4.539456½

$n = 0.213537\frac{1}{2}$

$r_4 = 2.273163\frac{1}{2} / 2.486721 = 306.705$

$d(n-1) = 117.265 / 189.440 =$ 2.277472

f_4 182.804 (5614) = 2.261984½

.65-1 ÷ 13-3

182.772

.0310

0332

.804

.772

.032

$h = R - \sqrt{R^2 - 4.005}$

$S = \frac{k}{R - \frac{h}{2}}$

When $S = 1.0675$ $r_4 = 187.608$

" $S = 1.068$ $r_4 = 187.522$

$R = 187.57$ ✓ = 2.273163½ ✓ / 4.546327 ✓

35182.5 ✓ / 4.0 ✓ = 4.546277 ✓

35178.5 ✓ = 4.546277 ✓

187.57 ✓ = 2.273138 ✓

187.559 ✓

$h = 0.011$ ✓

$R = 187.57$ ✓ $K = 2.30161$ ✓

.005 ✓

187.565 ✓ = 2.27315 ✓ / 0.02846 ✓

$S = 1.06772$ ✓ =

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1903phae.proj.1152P

(1924)

B

$n = 0.193113$ ✓

$57.001 = r_1 = \frac{1.755\text{-}882\frac{1}{2}}{1.948995\frac{1}{2}}$ ✓

$n-1 = 9.748156$ ✓

158.796 ✓ $= 2.200839\frac{1}{2}$ ✓

-1.051 ✓

$d_2 = 157.745$ ✓ $= 2.197953\text{-}\frac{1}{2}$ ✓

56.994 $r_2 = \frac{1.755\text{-}829}{3.955378\frac{1}{2}}$ ✓

$n = 0.193113$ ✓

$r_2 = \frac{1.755\text{-}829}{1.948942}$ ✓ $= 88.9082$ ✓

$d_2 = 2.197953\text{-}\frac{1}{2}$ ✓

$n-1 = \frac{9.748156}{1.946111\frac{1}{2}}$ ✓ $= \frac{88.3306}{177.2388} =$ ✓

$f_2 = 50.7254$ ✓ $= \frac{2.248\text{-}579}{1.705225\text{-}\frac{1}{2}}$ ✓

$-.8150$

$d_3 = 49.9104$ ✓ $= 1.698191$ ✓

$n' = 0.208468\frac{1}{2}$ ✓

54.545- ✓ $r_3 = \frac{1.736753\text{-}}{3.643414\frac{1}{2}}$ ✓

$d_3 = 1.698191$ ✓

$n-1 = \frac{9.789652}{1.487843}$ ✓ $= \frac{54.545\text{-}}{30.7499}$ ✓ $= \frac{1.376487\frac{1}{2}}{23.795\text{-}1} =$ ✓

$f_3 = 184.896$ ✓ $= 2.266927$ ✓

$-.324$

$d_4 = 184.572$ ✓ $= 2.266166$ ✓

187.593 $r_4 = \frac{2.273216\frac{1}{2}}{4.539882\frac{1}{2}}$ ✓

$n = 0.208468\frac{1}{2}$ ✓

$r_4 = 2.273216\frac{1}{2}$ ✓

2.481685 ✓ $= 303.169$ ✓

$d_4 = 2.266166$ ✓

$n-1 = \frac{9.789652}{2.055818}$ ✓ $= \frac{113.715\text{-}}{189.454}$ ✓ $=$

$f_4 = 182.759$ ✓ $= \frac{2.277\text{-}04}{2.261878\frac{1}{2}}$ ✓

continued on p 136 - 166

F

$n = 0.196533\frac{1}{2}$ ✓

$r_1 = \frac{1.755\text{-}882\frac{1}{2}}{1.952416}$ ✓

$\frac{9.757618\frac{1}{2}}{2.194797\frac{1}{2}}$ ✓

156.602 ✓ $= 2.194797\frac{1}{2}$ ✓

1.051 ✓

$d_2 = 155.551$ ✓ $= 2.191873$ ✓

$r_2 = \frac{1.755\text{-}829}{3.947702}$ ✓

$0.196533\frac{1}{2}$ ✓

$1.755\text{-}829$ ✓

$1.952362\frac{1}{2}$ ✓ $= 89.6112$ ✓

$d_2 = 2.191873$ ✓

$n-1 = \frac{9.757618\frac{1}{2}}{1.949491\frac{1}{2}}$ ✓ $= \frac{89.0208}{178.6320} =$ ✓

$f_2 = 49.6299$ ✓ $= \frac{2.25\text{-}195\text{-}9}{1.695743}$ ✓

$.8150$

$d_3 = 48.8149$ ✓ $= 1.688553\text{-}2\frac{1}{2}$ ✓

$n' = 0.213557\frac{1}{2}$ ✓

$r_3 = \frac{1.736753\text{-}}{3.638865\text{-}}$ ✓

$d_3 = 1.688553\text{-}2\frac{1}{2}$ ✓

$n-1 = \frac{9.802876}{1.491428\frac{1}{2}}$ ✓ $= \frac{54.545\text{-}}{31.0048}$ ✓ $= \frac{1.371810}{23.5402} =$ ✓

$f_3 = 184.950$ ✓ $= 2.267055\text{-}$ ✓

$-.324$

$d_4 = 184.626$ ✓ $= 2.266293$ ✓

$r_4 = 2.273216\frac{1}{2}$ ✓

$n = 0.213557\frac{1}{2}$ ✓

$r_4 = 2.273216\frac{1}{2}$ ✓

2.486774 ✓ $= 306.743$ ✓

$d_4 = 2.266293$ ✓

$n-1 = \frac{9.802876}{2.069169}$ ✓ $= \frac{117.265\text{-}}{189.478}$ ✓ $=$

182.789 ✓ $= \frac{2.277589}{2.261950\frac{1}{2}}$ ✓

$.759$

$.0300$

Furnished 6.04.

p 166

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(1924)

5614

$n = 0.194814\frac{1}{2}$ ✓

$57.001 = r_1 = \frac{1.755882\frac{1}{2}}{1.950697}$ ✓

$n-1 = 9.752879$ ✓

$= 2.197818$ ✓

$f_1 = 157.695$ ✓ $\frac{1.05}{}$

$d_2 = 156.644 = 2.194914$

$r_2 = \frac{1.755829}{3.950743}$

$n = 0.194814\frac{1}{2}$

$r_2 = \frac{1.755829}{1.950643\frac{1}{2}} = 89.2572$

$d_2 = 2.194914$

$n-1 = \frac{9.752879}{1.947793} = \frac{88.6733}{177.9305} =$

$\frac{2.250250}{}$

$f_2 = 50.1756 = 1.700493$

$\frac{.8150}{}$

$d_3 = 49.3606 = 1.693380\frac{1}{2}$

$n' = 0.210956$

$54.545 = r_3 = \frac{1.736755}{3.641091\frac{1}{2}}$

$d_3 = 1.693380\frac{1}{2}$

$n-1 = \frac{9.796146\frac{1}{2}}{1.489527} = \frac{54.545}{30.8693} = \frac{}{23.6757} =$

$\frac{1.374303}{}$

$f_3 = 184.837 = 2.266788\frac{1}{2}$

$\frac{.324}{}$

$d_4 = 184.513 = 2.266027$

$187.570 = r_4 = \frac{2.273163\frac{1}{2}}{4.539190\frac{1}{2}}$

$n = 0.210956$

$r_4 = \frac{2.273163\frac{1}{2}}{2.484119\frac{1}{2}} = 304.873$

$d = 2.266027$

$n-1 = \frac{9.796146\frac{1}{2}}{2.062173\frac{1}{2}} = \frac{115.391}{189.482} =$

$\frac{2.277568}{}$

$f_4 = 182.657 = 2.261622\frac{1}{2}$

Wave length of Minimum Focus as made

$\frac{y_F^2}{y_B^2} = \frac{x_F}{x_B} = \frac{\cancel{1657}}{\cancel{953}} = \frac{953}{1657}$

$\frac{y_F}{y_B} = \sqrt{\frac{953}{1657}} = .7591$

$y_F + y_B = 21125$

$1.7591\, y_B = 21125$

$y_B = 12090$

$y_F = 9035$

$\frac{1}{\lambda_F^2} = 42312$

$\frac{.9035}{}$

$33277 = 2.522214$

$2) \; 7.47786$

$\lambda = 5482 \quad = 3.73893$

Back surface $r_4 = 187.570$

$S = 1.0677$

Minimum focus at $\lambda = 5667.5$ ✓

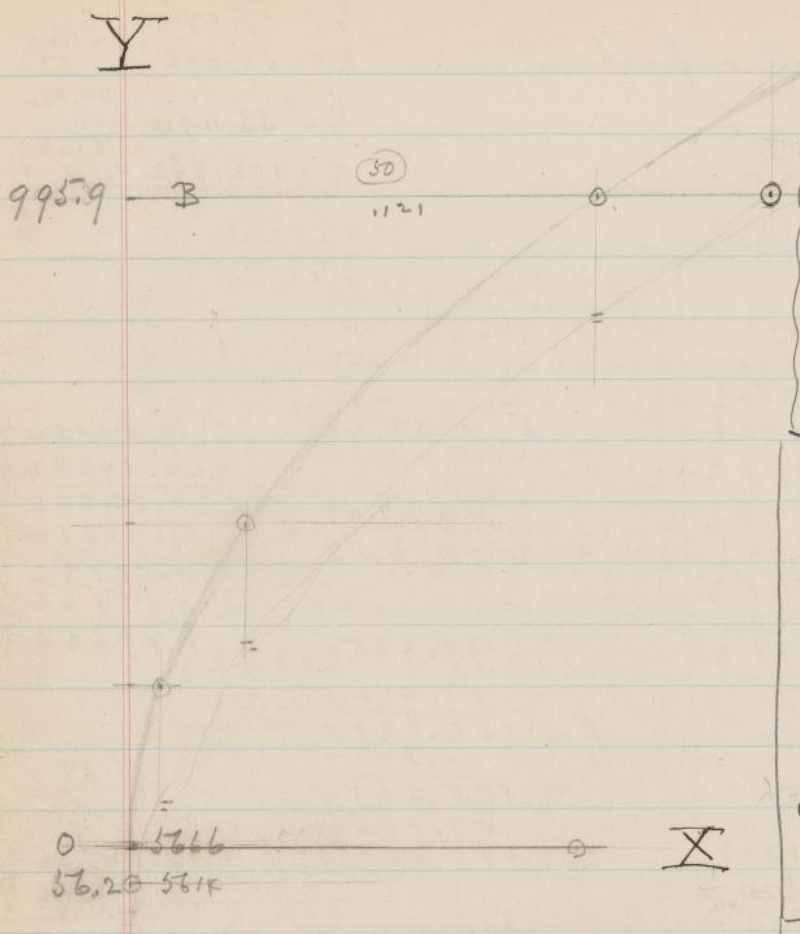
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1924

As first made

5614



P.138 P.135 $d_4 = 2.266027$

$\tau_4 = 193.462 = \frac{2.286596}{4.553623}$

$n = 0.210956$

$\tau_4 = \frac{2.286596}{2.497552} = 314.450$

$d(n-1) = \frac{115.391}{199.059} =$

f_4 179.3250 $\frac{2.298982}{2.253641}$

B

P.134 $d_4 = 2.266166$

$\tau_4 = \frac{2.286596}{4.553762}$

$n = 0.208468\frac{1}{2}$

$\tau_4 = \frac{2.286596}{2.495064\frac{1}{2}} = 312.654$

$d(n-1) = \frac{113.715}{198.939} =$

$f_4 = 179.4907 = \frac{2.298720}{2.254042}$

$\frac{179.3250}{.1657}$

F

P.137 $d_4 = 2.266293$

$\tau_4 = \frac{2.286596}{4.552889}$

$n = 0.213537\frac{1}{2}$

$\tau_4 = \frac{2.286596}{2.500153\frac{1}{2}} = 316.340$

$d(n-1) = \frac{117.265}{199.075} =$

$f_4 = 179.4205 = \frac{2.299017}{2.253872}$

$\frac{179.3250}{.0955}$

179.4907
179.4205
.0702

See p. 189

When F = 1

$\chi_B = .0009186$

$\chi_F = .0005294$

See letter to Mr. Leuschner dated Feb 17'25

$\bar{S} = 1.066 \pm .001 = \begin{cases} 1.067 \\ 1.065 \end{cases}$

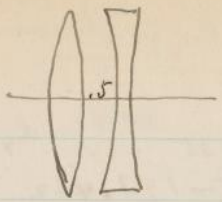
see p. 136

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1903phae.proj.1152P

II.

From p. 24.



Baryta in front. –

$r_1 = 57.096$
$r_2 = 57.096$ } $t = 1.07$
$D = .500$
$r_3 = 53.494$
$r_4 = 192.362$ } $t = .33$

Color

B	F′
I	
$k = 6$ = 0.77815 ✓	
6° 1′ 55.62 ✓ r_1 = 1.75660 ½ ✓	6° 1′ 53.62 ✓ = sin 9.02154 ½ ✓
= sin 9.02154 ½ ✓	n = 0.19309 ¾ ✓
p. 108. ---------- n = 0.19309 ¾ ✓	3 49 47.04 = sin 8.82472 ¾ ✓
v' = 3 51 46.00 ✓ = sin 8.82844 ¾ ✓	v' = 2 12 8.58 r_1 = 1.75660 ½ ✓
2 10 9.62 ✓ r_1 = 1.75660 ½ ✓	0.58132 ¾ ✓
· 0.58505 ¼ ✓	sin 8.58466 ¼ ✓
sin 8.57810	
101.614 ✓ = 2.00698 ¼ ✓	99.23500 ✓ = 1.99666 ½ ✓
57.096 ✓	57.096 ✓
f_1 = 158.710 ✓	f_1 = 156.331 ✓
1.07	1.07
d_2 = 157.640 ✓	155.261 ✓
r_2 = 57.096 ✓	57.096 ✓
214.736 ✓ = 2.33190 ½ ✓	212.357 ✓ = 2.32706 ¾ ✓
II	8.58466 ¼ ✓
sin v = 8.57810 ✓	0.91173 ✓
0.91000 ½ ✓	1.75660 ½ ✓
r_2 = 1.75660 ½ ✓	
8 11 4.79 ✓ = sin 9.15340 ✓	8 13 2.85 ✓ = sin 9.15512 ½ ✓
0.19309 ¾ ✓	0.19682 ¼ ✓
12 49 51.85 ✓ = sin 9.34649 ¾ ✓	12 59 44.58 ✓ = sin 9.35194 ¾ ✓
4 38 46.36 ✓ r_2 = 1.75660 ½ ✓	4 46 41.73 ✓ 1.75660 ½ ✓
2 10 9.62 ✓ 1.10310 ¼ ✓	2 12 8.58 ✓ 1.10855 ¼ ✓
6 48 55.98 ✓ = sin 9.07435 ¼ ✓	6 58 50.31 ✓ = sin 9.08469 ¾ ✓
106.844 ✓ = 2.02875 ✓	105.646 ✓ = 2.02388 ½ ✓
57.096 ✓	57.096 ✓
f_2 = 49.748 ✓	f_2 = 48.550 ✓
.500 ✓	.500 ✓
d_3 = 49.248 ✓	d_3 = 48.050 ✓

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1903phae.proj.1152P

B

d_3 = 49.248 ✓
r_3 = 55.494 ✓
104.742 ✓ = 2.02012 ✓
III
sin v = 9.07435 1/4 ✓
1.09447 1/4 ✓
r_3 = 1.74424 1/2 ✓
12° 56' 36,5" = sin 9.35022 3/4 ✓
n = 0.20844 ✓

P. 108 -
7 58 2.25 = sin 9.14178 3/4 ✓
4 58 34.25 ✓ 1.74424 1/2 ✓
6 48 55.98 ✓ 0.88603 1/4 ✓
1 50 21.73 = sin 8.50647 1/4 ✓
239.640 ✓ = 2.37956 ✓
55.494 ✓
184.146 ✓
f_3 = ,33
d_4 = 183.816 ✓
r_4 = 192.362 ✓
8.546 ✓ = 0.93176 1/4 ✓
XII
sin v = 8.50647 1/4 ✓
9.43823 1/2 ✓
r_x = 2.28412 ✓
0 ' " 0 4 54.1308 = sin 7.15411 1/2 ✓
0.20844 ✓
0 7 55.3141 = sin 7.36255 1/2 ✓
0 3 1.1833 ✓ 2.28412 ✓
1 50 21.73 ✓ 9.64667 1/2 ✓
1 53 22.9133 = sin 8.51819 1/4 ✓
13.4426 = 1.12848 1/4 ✓
192.362 ✓
178.919 ✓

F'

d_3 = ~~48.294~~ ~~55.494~~
103.788 = 2.01614 3/4
9.08469 3/4
1.10084 1/2
1.74424 1/2 ✓
13° 8' 17,4 = sin 9.35660
0.21401 1/4 ✓
7 58 55.5 = sin 9.14258 3/4
5 9 21.9 1.74424 1/2 ✓
6 58 50.31 0.88683 1/4
1 49 28.41 = sin 8.50296 1/4
242.030 = 2.38387
55.494
f_3 = 186.536
.330
d_4 = 186.206
192.362
6.156 = 0.78929 3/4
8.50296 1/4
9.29226
2.28412 ✓
0 ' " 0 3 30,1676 = sin 7.00814
0.21401 1/4
0 5 44.0154 = sin 7.22215 1/4
0 2 13.8478 2.28412 ✓
1 49 28.41 9.50627 1/4
1 51 42.3878 8.51729 3/4
9.8752 = 0.99454 1/2
192.362
182.487

178.919
3.568 Flint stone

See next page

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1903phae.proj.1152P

· I.

B

See p. 141

f_4 = 178.919

~~178.844~~

~~.075~~

~~Hint weak~~

F'

d_3 = 48.050 ✓

55.494 ✓

103.544 ✓ = 2.015 12 ½ ✓

III

sin ϑ = 9.08469 ¾ ✓

1.09982 ¼ ✓

q_3 = 1.74424 ½ ✓

13° 6' 24".3 ✓ = sin 9.35557 ¾ ✓

n = 0.21401 ¼ ✓

7 57 47.44 ✓ = sin 9.14156 ½ ✓

1.74424 ½ ✓

5 8 36.86 ✓

6 58 50.31 ✓

0.88581 ✓

ϑ = 1 50 13.45 ✓ = sin 8.50592 ¾ ✓

= 2.37988 ¼ ✓

239.818 ✓

55.494 ✓

f_3 = 184.324 ✓

,33

d_4 = 183.994 ✓

π_4 = 192.362 ✓

8.368 ✓

XII

= 0.92262 ¼ ✓

sin ϑ = 8.50592 ¾ ✓

9.42855 ✓

π_4 = 2.28412 ✓

0° 4' 47".644 ✓ = sin 7.14443 ✓

n = 0.21401 ¼ ✓

= sin 7.35844 ¼ ✓

0 7 50.834 ✓

2.28412 ✓

0 3 3.190 ✓

9.64256 ¼ ✓

1 50 13.45 ✓

1 53 16.64 ✓ = sin 8.51779 ✓

= 1.12477 ¼ ✓

13.3282 ✓

192.362 ✓

f_4 = 179.034 ✓

178.919 ✓

.115 ✓ Hint strong

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Jy $\tau_4 = 196.87°$

B

$d_4 = 183.816$

196.870

13.054 = 1.115 74 1/4

sin d = 8.50647 1/4

9.62221 1/2

τ_4 = 2.29418

0° 7' 18.996 = sin 7.32803 1/2

n = 0.20844

0 11 49.416 = sin 7.53647 1/2

0 4 30,420 2.29418

1 50 21.73 9.83065 1/2

1 54 52.15 = sin 8.52385

20.2677 1.30680 1/2

196.87

f_4 = 176.602

F'

$d_4 = 183.994$

$\tau_4 = 196.870$

12.876 = 1.10978

sin d = 8.50592 3/4

9.61570 3/4

2.29418

0° 7' 12.467 = sin 7.32152 3/4

n = 0.21401 1/4

0 11 47.890 = sin 7.53554

0 4 35.423 2.29418

1 50 13.75 9.82972

1 54 48.87 = sin 8.52364 1/4

20.2338 = 1.30607 3/4

196.87

176.636

176.602

0.034 Hint strong

Jy $\tau_4 = 198.762$

$d_4 = 183.816$

14.946 = 1.17452 1/2

sin d = 8.50647 1/4

9.68099 3/4

τ_4 = 2,29833 1/4

0 8 17.841 = sin 7.38266 1/2

n = 0.20844

0 13 24.510 = sin 7.59110 1/2

0 5 6.669 2.29833 1/4

1 50 21.73 9.88943 3/4

1 55 28.40 = sin 8.52612 1/2

23.0844 1.36331 1/4

198.762

f_4 = 175.6779

$\tau_4 = 198.762$

$d_4 = 183.994$

14.768 =

1.16932 1/4

8.50592 3/4

9.67525

2.29833 1/4

0 8 11,296 = sin 7.37691 3/4

0.21401 1/4

= sin 7.59093

2.29833 1/4

0 13 24.186 9.88926 1/4

0 5 12.890 8.52399 3/4

1 50 13.45 = 1.36326 1/2

1 55 26.34

23.0816

198.762

f_4 = 175.6804

.16779

.0025 Hint strong

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I

try $r_4 = 198.942$

B	F′
$d_4 = 183.816$	$d_4 = 183.994$
$r_4 = 198.942$	$r_4 = 198.942$
$15.126 = 1.17972\frac{1}{2}$	$14.948 = 1.17458\frac{1}{4}$
$\sin d = 8.50647\frac{1}{4}$	$\sin d = 8.50592\frac{3}{4}$
$9.68619\frac{3}{4}$	$9.68051\frac{0}{4}$
$r_4 = 2.29872\frac{3}{4}$	$2.29872\frac{3}{4}$
$0\ 8\ 23.380 = \sin 7.38747$	$0\ 8\ 16.830 = \sin 7.38178\frac{1}{4}$
$n = 0.20844$	$0.21401\frac{1}{4}$
$0\ 13\ 33.460 = \sin 7.59591$	$0\ 13\ 33.245^- = \sin 7.59579\frac{1}{2}$
$0\ 5^-\ 10.080$	$0\ 5^-\ 16.415^-$
$1\ 50\ 21.73$	$1\ 50\ 13.45^-$
$1\ 55^-\ 31.81 = \sin 8.52634$	$1\ 55^-\ 29.865^- = \sin 8.52621\frac{3}{4}$
$23.3506 = 1.36829\frac{3}{4}$	$23.351 = 1.36830\frac{1}{2}$
198.942	198.942
$f_4 = 175.591$	$f_4 = 175.591$

color is perfect

$$\frac{178.800}{175.591} = \frac{2.25236\frac{3}{4}}{2.24450\frac{1}{4}}$$

$$0.00786\frac{1}{2}$$

$r_1 = r_2 = 57.096 = 1.75660\frac{1}{2}$

$58.1393 = 1.76447$

$0.00786\frac{1}{2}$

$r_3 = 55.479 =$

diagram p 125 Forde

47
25⁻
.069 55.494
.035 = r_3 .015⁻
Make r_3 = 55.479

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I

Central Rays

$T_1 = 57.096$
$T_2 = 57.096$
$T_3 = 55.494$
$T_4 = 198.942$

B

$n = 0.19309\frac{3}{4}$ ✓
$T = 1.75660\frac{1}{2}$ ✓
$1.94970\frac{1}{4}$ ✓
$n-1 = 9.74811$ ✓
$2.20159\frac{1}{4}$ ✓

$f_1 = 159.072$ ✓ $= 2.20159\frac{1}{4}$ ✓
1.07
$d_2 = 158.002$ ✓ $= 2.19866\frac{1}{4}$ ✓
$T_2 = 1.75660\frac{1}{2}$ ✓
$3.95526\frac{3}{4}$ ✓

$n = 0.19309\frac{3}{4}$ ✓
$T = 1.75660\frac{1}{2}$ ✓
$1.94970\frac{1}{4}$ ✓ 89.0640 ✓

$d = 2.19866\frac{1}{4}$ ✓
$n-1 = 9.74811$ ✓
$1.94677\frac{1}{4}$ ✓ $= 88.4652$ ✓
177.5292 ✓ $= 2.24927$ ✓

$f_2 = 50.8157$ ✓ $= 1.70599\frac{3}{4}$
$.500$
$d_3 = 50.3157$ ✓ $= 1.70170\frac{1}{4}$ ✓
$n = 0.20844$
$T_3 = 1.74424\frac{1}{2}$
$3.65438\frac{3}{4}$

~~$n = 0.20844$~~
~~$T = 1.74424\frac{1}{2}$~~
~~$1.96268\frac{1}{2}$~~ =
$d = 1.70170\frac{1}{4}$ ✓
$n-1 = 9.78958$ ✓
$1.49128\frac{1}{4}$ ✓ $= 30.9943$ ✓
$55.494 = T_3$
$24.4997 = 1.38916$
$= 2.26522\frac{3}{4}$

$f_3 = 184.174$
$.33$
$d_4 = 183.844$ $= 2.26445$
$T_4 = 2.29872\frac{3}{4}$
$4.56317\frac{3}{4}$

$n = 0.20844$
$T = 2.29872\frac{3}{4}$
$2.50716\frac{3}{4} = 321.490$

$d = 2.26445$
$n-1 = 9.78958$
$2.05403 = 113.248$
$208.242 = 2.31856\frac{3}{4}$

$f_4 = 175.635 = 2.24461$

Marginal = 175.591
Sph. Ab = $.044$ flint weak

F'

$n = 0.19682\frac{1}{4}$ ✓
$T = 1.75660\frac{1}{2}$ ✓
$1.95342\frac{3}{4}$ ✓
$n-1 = 9.75841$ ✓
$2.19501\frac{3}{4}$ ✓

156.681 ✓ $= 2.19501\frac{3}{4}$ ✓
1.07
155.611 ✓ $= 2.19204$ ✓
$1.75660\frac{1}{2}$ ✓
$3.94864\frac{1}{2}$ ✓

$n = 0.19682\frac{1}{4}$ ✓
$T = 1.75660\frac{1}{2}$ ✓
$1.95342\frac{3}{4}$ ✓ 89.8313 ✓

$d = 2.19204$ ✓
$n-1 = 9.75841$ ✓
1.95045 ✓ $= 89.2185$ ✓
179.0488 ✓ $= 2.25297\frac{1}{8}$

$f_2 = 49.6220$ ✓ $= 1.69567\frac{3}{8}$ ✓
$.500$
$d_3 = 49.122$ ✓ $1.69127\frac{1}{2}$ ✓
$n = 0.21401\frac{1}{4}$
$T_3 = 1.74424\frac{1}{2}$
$3.64953\frac{1}{4}$

$d = 1.69127\frac{1}{2}$ ✓
$n-1 = 9.80405$ ✓ 55.494
$1.49532\frac{1}{2}$ ✓ $= 31.2842$ ✓
$24.2098 = 1.38399$
$= 2.26554\frac{1}{4}$

$f_3 = 184.307$
$.33$
$d_4 = 183.977$ $= 2.26476\frac{1}{4}$
$2.29872\frac{3}{4}$
4.56349

$n = 0.21401\frac{1}{4}$
$T = 2.29872\frac{3}{4}$
$2.51274 = 325.642$

$d = 2.26476\frac{1}{4}$
$n-1 = 9.80405$
$2.06881\frac{1}{4} = 117.169$
$208.473 = 2.31905$
$= 2.24444$

$f_4 = 175.566$
175.591
Sph. Ab = $.025$ flint strong

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I

Color perfect

$\tau_3 = 55.494 = 1.744424\frac{1}{2}$
$8.255^{-}75^{-}\frac{1}{2} = .0180200$

$\tau_4 = 198.942 = 2.29872\frac{3}{4}$
$7.70127\frac{1}{4} = .005^{-}0265^{-}8$
$.0230465^{-}8 = A$

Sph. Ab. perfect when $\tau_3 = 55.479 = 1.744412\frac{3}{4}$ ✓ $.0230465^{-}8 = A$
$8.25587\frac{1}{4}$ ✓ $= .0180249$ ✓
$7.70085^{-} = .005^{-}02168$

$\tau_4 = 199.136 = 2.2991^{5-}$

Color and Sph Ab are perfect when

$\tau_1 = \tau_2 = 57.096$ $t_1 = 1.07$
$\tau_3 = 55.479$ $t_2 = 0.33$
$\tau_4 = 199.136$

$D = 0.500$

$f_4 = 175.600$

	$\tau_4 = 1$	Sph Ab.	f_4
Color	192.362	0.115	178.977
τ_4	196.870	.034	176.619
	198.942	.000	175.591
			3.386

f_4

.115

192.362 Hand drawn

.034

196.870

198.762

198.942

p. 144

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Check

Marginal

B

p.140. $d_3 = 49.248$ ✓
$r_3 = 55.479$ ✓
104.727 ✓ $= 2.02005\frac{3}{4}\frac{7}{8}$ ✓
$\sin d = 9.07435\frac{1}{4}$ ✓
$1.09441\frac{1}{8}$ ✓
$r_3 = 1.74412\frac{3}{4}$ ✓
12 56 42.6 ✓ $\sin$ $9.35028\frac{1}{4}\frac{3}{8}$ ✓
0.20844 ✓
7 58 6.00 ✓ $= \sin$ $9.14184\frac{1}{4}\frac{3}{8}$ ✓
4 58 36.60 ✓ $1.74412\frac{3}{4}$ ✓
6 48 53.98 ✓ $0.88597\frac{1}{8}$ ✓
1 50 19.38 ✓ $= \sin$ $8.50631\frac{3}{4}$ ✓
239.692 ✓ $= 2.379.65\frac{3}{8}$ ✓
$r = 55.479$ ✓
$f_3 = 184.213$ ✓
$.330$ ✓
$d_4 = 183.883$ ✓
$r_4 = 199.136$ ✓
15.253 ✓ $= 1.18335\frac{1}{2}$ ✓
$\sin d = 8.50631\frac{3}{4}$ ✓
$9.68967\frac{1}{4}$ ✓
$r_4 = 2.29915$ ✓
0° 8′ 26.930 ✓ $= \sin$ $7.39052\frac{1}{4}$ ✓
$x = 0.20844$ ✓
0 13 39.196 ✓ $= \sin$ $7.59896\frac{1}{4}$ ✓
0 5 12.266 ✓ 2.29915 ✓
1 50 19.38 ✓ $9.89811\frac{1}{4}$ ✓
1 55 31.646 ✓ $= \sin$ 8.52633 ✓
23.5387 ✓ $= 1.37178\frac{1}{4}$ ✓
199.136 ✓
$f_4 = 175.597$ ✓

2

.00 ✓ Flint weak

$\frac{1}{r_3} = \frac{1}{55.479} = .0180249$ ✓

198.850 $= 2.298536$ ✓
7.761474 ✓ $.00528891$ ✓
$B = .0230538$ ✓ gives correct color.

F′

$d_3 = 48.050$ ✓
55.479 ✓
103.529 ✓ $= 2.01506\frac{1}{4}$ ✓
$\sin d = 9.08469\frac{3}{4}$ ✓
1.09976 ✓
$1.74412\frac{3}{4}$ ✓
13 6 30.30 ✓ $= \sin$ $9.35563\frac{1}{4}$ ✓
$0.21401\frac{1}{4}$ ✓
7 57 57.12 ✓ $= \sin$ 9.14162 ✓
5 8 39.18 ✓ $1.74412\frac{3}{4}$ ✓
6 58 50.31 ✓ $0.88574\frac{3}{4}$ ✓
1 50 11.13 ✓ $= \sin$ $8.50577\frac{1}{2}\frac{5}{8}$ ✓
239.868 ✓ $= 2.37997\frac{1}{4}\frac{5}{8}$
55.479 ✓
184.389 ✓
$.330$
$d_4 = 184.059$ ✓
199.136 ✓
15.077 ✓ $= 1.17831\frac{1}{2}$ ✓
$8.50577\frac{1}{2}\frac{5}{8}$
$9.68409\frac{1}{8}$ ✓
$r_4 = 2.29915$ ✓
0° 8′ 20.457 ✓ $7.38494\frac{1}{8}$ ✓
$x = 0.21401\frac{1}{4}$ ✓
0 13 39.181 ✓ $7.59895\frac{1}{4}\frac{3}{8}$ ✓
0 5 18.724 ✓ 2.29915 ✓
1 50 11.13 ✓ $9.89810\frac{3}{8}$ ✓
1 55 29.854 ✓ $= \sin$ $8.52621\frac{3}{4}$ ✓
23.5443 ✓ $= 1.37188\frac{5}{8}$ ✓
199.136 ✓
$f_4 = 175.592$ ✓

$r_4 = 199.136$
$.286$
Color correct when $r_4 = 198.850$

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I

Central

B	F′
p. 145	
$d_3 = 1.70170\frac{1}{4}$ ✓	$d_3 = 1.69127\frac{1}{2}$ ✓
$n = 0.20844$ ✓	$n = 0.21401\frac{1}{4}$ ✓
$53.479 = T_3 = 1.74412\frac{3}{4}$ ✓	$T_3 = 1.74412\frac{3}{4}$ ✓
3.65427 ✓	$3.64941\frac{1}{2}$ ✓
53.479 ✓	53.479 ✓
$d(n-1) = 30.9943$ ✓	$d(n-1) = 31.2842$ ✓
$24.4847 = 1.38889\frac{1}{2}$ ✓	$24.1948 = 1.38372\frac{1}{4}$ ✓
$f_3 = 184.236$ ✓ $= 2.26537\frac{1}{2}$ ✓	184.371 ✓ $= 2.26569\frac{1}{4}$ ✓
$.33$	$.33$
$d_4 = 183.906$ ✓ $= 2.26459\frac{1}{2}$ ✓	184.041 ✓ $= 2.26491\frac{1}{2}$ ✓
$199.136 = T_4 = 2.29915$ ✓	2.29915 ✓
$4.56374\frac{1}{2}$ ✓	$4.56406\frac{1}{2}$ ✓
$n = 0.20844$ ✓	$n = 0.21401\frac{1}{4}$ ✓
$T = \frac{2.29915}{2.50759}$ ✓ $= 321.803$ ✓	$T = \frac{2.29915}{2.51316\frac{1}{4}}$ ✓ $= 325.959$ ✓
$d = 2.26459\frac{1}{2}$ ✓	$d = 2.26491\frac{1}{2}$ ✓
$n-1 = 9.78958$ ✓	$n-1 = 9.80405$ ✓
$2.05417\frac{1}{2}$ ✓ $= 113.286$ ✓	$2.06896\frac{1}{2}$ ✓ $= 117.210$ ✓
$208.517 = 2.31914\frac{1}{8}$ ✓	$208.749 = 2.31962\frac{1}{2}$ ✓
$f_4 = 175.632$ ✓ $= 2.24460\frac{3}{8}$	$f_4 = 175.566$ ✓ $= 2.24444$
Marginal $= 175.597$ ✓	175.592 ✓
Sph Ab $= .035$ ✓ Thick weak	Sph Ab $= .026$ ✓ Thick strong

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I

$\tau_1 = 57.096$
τ_2 "
$\tau_3 = 55.479$
$\tau_4 = 199.136$

5614'

I
II
III

Marginal

K=6

p140. $i = 6^\circ\ 1'\ 55''.62$ = sin 9.021547½

$n = 0.19496\frac{1}{2}$

$\lambda = 350\ 46.25$ sin 8.82658

$d' = 2\ 11\ 9.40$ sin 1.75660½

0.58318½

sin 8.58141

2.00177½

$100.4095 = 57.096$

$f_1 = 157.5055$
1.07

$d_2 = 156.4355$

$\tau_2 = 57.096$

$213.5315 = 2.32946\frac{1}{4}$

8.58141

0.91087¼

1.75660½

$8^\circ\ 12'\ 4''.10$ = sin 9.15426¾

$n = 0.19496\frac{1}{2}$

$12\ 54\ 47.96 = 9.34923\frac{1}{4}$

$4\ 42\ 43.86$ 1.75660½

$2\ 11\ 9.40$ 1.10583¾

$d' = 6\ 53\ 53.26$ = sin 9.07956

$106.2374 = 2.02627\frac{3}{4}$

57.096

$f_2 = 49.1414$
,500

$d_3 = 48.6414$

$\tau_3 = 55.479$

$104.1204 = 2.01753\frac{1}{2}$

9.07956

1.09709½

$\tau_2 = 1.74412\frac{3}{4}$

$13^\circ\ 1'\ 36''.54$ = sin 9.35296¾

$n = 0.21118\frac{3}{4}$

$7\ 58\ 1.75$ = sin 9.14178

$5\ 3\ 34.79$ 1.74412¾

$6\ 53\ 53.26$ 0.88590¾

$1\ 50\ 18.47$ = sin 8.50625¾

$239.690 = 2.37965$

55.479

$f_3 = 184.211$

Central

p.108

$n = 0.19496\frac{1}{4}$

$\tau_1 = 1.75660\frac{1}{2}$

$1.95156\frac{3}{4}$

$n-1 = 9.75329$

$f_1 = 157.862 = 2.19827\frac{3}{4}$
1.07

$d_2 = 156.792 = 2.19532\frac{1}{2}$

$\tau_2 = 1.75660\frac{1}{2}$

3.95193

$n = 0.19496\frac{1}{4}$

$\tau = 1.75660\frac{1}{2}$

$1.95156\frac{3}{4} = 89.4474$

$d = 2.19532\frac{1}{2}$

$n-1 = 9.75329$

$1.94861\frac{1}{2} = 88.8413$

$178.2887 = 2.25112\frac{1}{4}$

$f_2 = 50.2120 = 1.70080\frac{3}{4}$
,500

$d_3 = 49.7120 = 1.69646$

$n = 0.21118\frac{3}{4}$

$\tau_3 = 1.74412\frac{3}{4}$

$3.65177\frac{1}{2}$

$d = 1.69646$

$nd = 9.79674\frac{1}{2}$ 55.479

$1.49320\frac{1}{2} = 31.1318$

$24.3472 = 1.38645$

$f_3 = 184.215 = 2.26532\frac{1}{2}$
,33

$d_4 = 183.885 = 2.26454\frac{3}{4}$

$\tau_4 = 2.29915$

$4.56369\frac{3}{4}$

$n = 0.21118\frac{3}{4}$

$\tau = 2.29915$

$2.51033\frac{3}{4} = 323.845$

$d = 2.26454\frac{3}{4}$

$n-1 = 9.79674\frac{1}{2}$

$2.06129\frac{1}{4} = 115.158$

$208.687 = 2.31949\frac{1}{2}$

$f_4 = 175.470 = 2.24420\frac{1}{4}$

$175.599 = \frac{1}{2}(f_B + f_{F'})$ central
P.148

(.129)

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5614 continued

Marginal

$f_3 = 184.211$
$d_4 = 183.881$
$r_4 = 199.136$

$15^{-}.25^{-5} = 1.18341\frac{1}{4}$
$\sin \delta = 8.50625^{-\frac{3}{4}}$
9.68967
$r_4 = 2.29915^{-}$
$\sin = 7.39052$
$\alpha = 0.21118\frac{3}{4}$
$\sin = 7.60170\frac{3}{4}$
2.29915^{-}
$9.90085^{-\frac{3}{4}}$
$\sin = 8.52659\frac{3}{4}$
1.37426

$0^{\circ}\ 8'\ 26.927 = \sin$
$0\ 13\ 44.392 = \sin$
$0\ 5^{-}\ 17.465^{-}$
$1\ 5^{-}0\ 18.47$
$1\ 5^{-}5\ 35.935^{-} = \sin$
$23.6734 =$
199.136
$f_4 = 175^{-}.4626$

$\frac{B+F'}{2} = 175^{-}.5^{-}945^{-}$
$.132$

(compare mich .118 on page 116)
see p 157.

central $f_4 = 175^{-}.470$
Marginal $f_4 = 175^{-}.463$
Sph. Ab = .007
Hinks mark

$r_3 = 55^{-}.479$
$.025^{-}$ see diagram p 125
$55^{-}.45^{-}4$ 7th Book

$r_3 = 55^{-}.454 = 1.74393\frac{1}{4}$ ✓ $.0230465^{-8}$ ✓
$8.25606\frac{3}{4}$ ✓ $.0180330$ ✓
$7.70014\frac{3}{4} = .0050135^{-8}$ ✓
$r_4 = 199.458\frac{1}{2}$ ✓ $= 2.29985^{-}\frac{1}{4}$ ✓
Sph. Ab. correct.

$f_4 = \frac{178.80}{175.470} = 2.25236\frac{3}{4} - 2.24420\frac{1}{4} = 0.00816\frac{1}{2}$

$57^{-}.096 = 1.75660\frac{1}{2}$

$r_1 = r_2 = 58^{-}.1795^{-} = 1.76477$

$0.00816\frac{1}{2}$
$55^{-}.479 = 1.74412\frac{3}{4}$
$r_3 = 56^{-}.5318 = 1.75229\frac{1}{4}$

$0.00816\frac{1}{2}$
$199.136 = 2.29915^{-}$
$r_4 = 202.915^{-} = 2.30731\frac{1}{2}$

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Color is correct when $\frac{1}{r_3} + \frac{1}{r_4} = B = .0230538$ ✓ p. 147

Sph. Ab is correct when $\frac{r_4}{r_3} = \frac{199.4585\frac{1}{2}}{55.4554}$ ✓ p. 151

$$r_4 = \frac{199.4585\frac{1}{2}}{55.4554} \cdot r_3$$

$$\frac{1}{r_3} + \frac{1}{\frac{199.4585\frac{1}{2}}{55.4554} \cdot r_3} = 0.0230538$$

$$1 + \frac{55.4554}{199.4585\frac{1}{2}} = 0.0230538\, r_3$$

		55.4554 ✓	= 1.743933 ✓
		$199.4585\frac{1}{2}$ ✓	= 2.299853 ✓
		.278023 ✓	= 9.444080 ✓
		1.278023 ✓	= 0.106539 ✓
	B =	0.0230538 ✓	= 8.362743 ✓
r_3	=	55.4365 ✓	= 1.743796 ✓
			0.55550920 ✓
r_4	=	199.396 ✓	= 2.299716 ✓

$f_4 = 175.610$

178.80	=	2.252237 ✓
175.61	=	2.244553 ✓
		0.007782 ✓
57.096 ✓	=	$1.756602\frac{1}{2}$ ✓
$r_1 = r_2 =$	58.1333 ✓	= $1.764.42\frac{1}{2}$ ✓

For Eq. Focal length 180.000

		0.007782 ✓
		1.743796 ✓
r_3	= 56.4438 ✓	= 1.751616 ✓

		0.007782 ✓
		2.299716 ✓
r_4	= 203.0187 ✓	= 2.307536 ✓

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I

Marginal

B

K=6 = 0.7781513 ✓

r_1 = 58.1333 = 1.7644249 ✓

5° 55′ 26″.796 ✓₀ = sin 9.0137264 ✓

n = 0.1930965 ✓

3 47 37.538 ✓₀ = sin 8.8206299 ✓

2 7 49.258 ✓₀ 1.7644249 ✓

0.5850548 ✓

sin 8.5702281 ✓₀

103.47293 ✓₀ = 2.0148267 ✓₀

58.1333 ✓

f_1 = 161.60623 ✓

1.07

d_2 = 160.53623 ✓

58.1333 ✓

r_2 = 218.66953 ✓₀ = 2.3397883 ✓₀

sin 8.5702281 ✓₀

0.9100164 ✓₀

r_2 = 1.7644249 ✓

8° 2′ 16″.237 ✓₀ = sin 9.1455915 ✓₀

n = 0.1930965 ✓

12 35 54.288 ✓₀ = sin 9.3386880 ✓

4 33 38.051 ✓₀ 1.7644249 ✓

2 7 49.258 ✓₀ 1.1031129 ✓₀

6 41 27.309 ✓₀ = sin 9.0663756 ✓₀

108.82717 ✓₀ = 2.0367373 ✓₀

58.1333 ✓

f_2 = 50.69387 ✓

.500

d_3 = 50.19387 ✓₀

F′

5° 53′ 26.796 ✓₀ = sin 9.0137264 ✓

n = 0.1968223 ✓

3 45 40.703 ✓₀ sin 8.8169041 ✓

2 9 46.093 ✓₀ 1.7644249 ✓

0.5813290 ✓

sin 8.5767913 ✓₀

101.05033 ✓₀ = 2.0045377 ✓₀

58.1333 ✓

f_1 = 159.18363 ✓

1.07

158.11363 ✓

r_2 = 58.1333 ✓

216.24693 ✓₀ = 2.3349499 ✓₀

sin 8.5767913 ✓₀

0.9117412 ✓₀

r_2 = 1.7644249 ✓

8° 4′ 12″.155 ✓₀ = sin 9.1473163 ✓

n = 0.1968223 ✓

12 45 36.699 ✓₀ = sin 9.3441386 ✓

4 41 24.544 ✓₀ 1.7644249 ✓

2 9 46.093 ✓₀ 1.1085635 ✓₀

6 51 10.637 ✓₀ = sin 9.0767193 ✓₀

107.60792 ✓₀ = 2.0318442 ✓₀

58.1333 ✓

f_2 = 49.47462 ✓₀

.500

d_3 = 48.97462 ✓₀

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I

Marginals

5614'

5° 53' 26.796 ✓₀ = sin 9.0137264 ✓
n = 0.1949634 ✓
3 46 38.868 ✓₀ = sin 8.8187630 ✓
2 8 47.928 ✓₀ 1.7644249 ✓
0.5831879 ✓
sin 8.5735364 ✓₀
102.24722 ✓₀ = 2.0096515 ✓₀
58.1333 ✓
f_1 = 160.38052 ✓
1.07
159.31052 ✓
58.1333
217.44382 ✓₀ = 2.3373470 ✓₀
sin 8.5735364 ✓₀
0.9108834 ✓₀
ϑ_2 = 1.7644249 ✓
8° 3' 14.449 ✓₀ = sin 9.1464583 ✓₀
n = 0.1949634 ✓
12 40 45.454 ✓₀ = sin 9.3414219 ✓₀
4 37 31.005 ✓₀ 1.7644249 ✓
2 8 47.928 ✓₀ 1.1058468 ✓₀
6 46 18.933 ✓₀ = sin 9.0715780 ✓₀
108.21035 ✓₀ = 2.0342688 ✓
58.1333 ✓
f_4 = 50.07705 ✓₀
.500
d_3 = 49.57705 ✓₀

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I Separation 0.500

Marginal – continued

B

$d_3 = 50.19387$ √₀
$r_3 = 56.4438$ ✓
106.637671₀ = 2.0279106 √₀
sin 9.0663756 √₀
1.0942862 √₀
r_3 = 1.7516163 ✓
12° 42′ 59″.003 √₀ ≐ sin = 9.3426699 √₀
n = 0.2084406 ✓
7 49 44.265 √₀ = sin 9.1342293 √₀
4 53 14.738 √₀ 1.7516163 ✓
6 41 27.309 √₀ 0.8858456 √₀
1 48 12.571 √₀ ≐ sin 8.4979198 ✓
244.3013 √₀ = 2.3879258 √₀
56.4438 ✓
f_3 = 187.8575 √₀
.33
d_4 = 187.5275 √₀
r_4 = 203.0187 ✓
15.4912 √₀ = 1.1900851 √₀
sin 8.4979198 √₀
9.6880049 √₀
r_4 = 2.3075360 ✓
0° 8′ 15.33006 √₀ sin 7.3804689 √₀
n = 0.2084406 ✓
0 13 20.45291 √₀ sin 7.5889095 √₀
0 5 5.12285 √₀ r_4 = 2.3075360 ✓
1 48 12.571 ✓ 9.8964455 √₀
1 53 17.69385 √₀ ≐ sin 8.5178578 ✓
23.91045 √₀ = 1.3785877 √₀
203.0187 ✓
f_4 = 179.10825 √₀

"F"

$d_3 = 48.97462$ √₀
$r_3 = 56.4438$ ✓
105.41842 √₀ = 2.0229165 √₀
sin 9.0767193 √₀
1.0996358 √₀
r_3 = 1.7516163 ✓
12 52 36.080 √₀ = sin 9.3480195 √₀
n = 0.2140134 ✓
7 49 29.694 √₀ = sin 9.1340061 √₀
5 3 6.386 √₀ 1.7516163 ✓
6 51 10.637 √₀ 0.8856224 √₀
1 48 4.251 √₀ = sin 8.4973631 √₀
244.4890 √₀ = 2.3882593 √₀
56.4438 ✓
f_3 = 188.0452 √₀
.33
d_4 = 187.7152 √₀
r_4 = 203.0187 ✓
15.3035 √₀ = 1.1847908 √₀
sin r_4 = 8.4973631 √₀
9.6821539 √₀
r_4 = 2.3075360 ✓
0° 8′ 8.7015 √₀ = sin 7.3746179 √₀
n = 0.2140134 ✓
0 13 19.9402 √₀ = sin 7.5886313 √₀
0 5 11.2387 √₀ 2.3075360 ✓
1 48 4.251 √₀ 9.8961673 √₀
1 53 15.4897 √₀ = 8.5177171 √₀
23.9029 √₀ = 1.3784502 √₀
203.0187 ✓
f_4 = 179.1158 √₀
.1082½ √₀
.0075½ √₀ Think string for color

$r_4 = 207.429$ should give perfect color.

(see diagram p 146)

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Marginal - continued

5614'

$d_3 = 49.5\bar{7}705\ \sqrt{0}$

$r_3 = \dfrac{56.4438\ \sqrt{}}{106.02085\bar{5}\ \sqrt{0}} = 2.025\bar{3}913\ \sqrt{0}$

$\sin \quad 9.0715\bar{7}80\ \sqrt{0}$

$1.0969693\ \sqrt{0}$

$r_3 = 1.75\bar{1}6163\ \sqrt{}$

$12^\circ\ 47'\ 47.\bar{5}08\ \sqrt{0} = \sin 9.3453\bar{5}30\ \sqrt{0}$

$n = 0.2111865\bar{5}\ \sqrt{}$

$7\ 49\ 40.163\ \sqrt{0} = \sin 9.1341665\ \sqrt{0}$

$4\ 5\bar{8}\ 7.3\bar{4}5\bar{5}\ \sqrt{0}$ $\quad 1.75\bar{1}6163\ \sqrt{}$

$6\ 46\ 18.933\ \sqrt{0}$ $\quad 0.8857828\ \sqrt{0}$

$1\ 48\ 11.\bar{5}88\ \sqrt{0} = \sin 8.4978\bar{5}41\ \sqrt{0}$

$244.30294\ \sqrt{0} = 2.3879287\ \sqrt{0}$

$56.4438\ \sqrt{}$

$t_3 = 187.85914\ \sqrt{0}$

$,33$

$d_4 = 187.\bar{5}2914\ \sqrt{0}$

$r_4 = \dfrac{203.0187\ \sqrt{}}{15.489\bar{5}6\ \sqrt{0}} = 1.1900391\ \sqrt{0}$

$\sin 8.4978\bar{5}41\ \sqrt{}$

$9.6878932\ \sqrt{0}$

$2.3075\bar{3}60\ \sqrt{}$

$0\ 8\ 15.2026\ \sqrt{0} = \sin 7.3803\bar{5}72\ \sqrt{0}$

$n = 0.2111865\bar{5}\ \sqrt{}$

$0\ 13\ 25.3229\ \sqrt{0} = \sin 7.5915\bar{4}37\ \sqrt{0}$

$0\ 5\bar{}\ 10.1203\ \sqrt{0}$ $\quad 2.3075\bar{3}60\ \sqrt{}$

$1\ 48\ 11.\bar{5}88\ \sqrt{0}$ $\quad 9.8990797\ \sqrt{0}$

$1\ 5\bar{3}\ 21.7083\ \sqrt{0} = \sin 8.5\bar{1}81142\ \sqrt{0}$

$24.04172\ \sqrt{0} = 1.3809655\bar{}\ \sqrt{0}$

$203.0187\ \sqrt{}$

$178.9770\ \sqrt{0}$

	Marginal	
$f_4\ B$	$= 179.1082\frac{1}{2}\ \sqrt{0}$	
$f_4\ F'$	$179.11\bar{5}8\ \sqrt{0}$	
$\frac{1}{2}(f_4 B + f_4 F') =$	$179.111\bar{5}\ \sqrt{0}$	
$f_4\ 5614' =$	$178.9770\ \sqrt{0}$	
	$0,1345\bar{}\ \sqrt{0}$	

$\dfrac{0.1345\bar{}}{180.2} = \dfrac{(F=1)}{.0007465\bar{}}$

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I

Central

B

$n = 0.1930965$ ✓
$r_1 = 1.7644249$ ✓
1.9575214 ✓
$n-1 = 9.7481096$ ✓

$f_1 = \frac{161.96150}{1.07}$ ✓ $= 2.2094118$ ✓

$d_2 = 160.89150$ ✓ $= 2.2065331$ ✓
$r_2 = 1.7644249$ ✓
3.9709580 ✓

$n = 0.1930965$ ✓
$r = 1.7644249$ ✓
1.9575214 ✓ $= 90.68206$ ✓

$d = 2.2065331$ ✓
$n-1 = 9.7481096$ ✓
1.9546427 ✓ $= 90.08296$ ✓
180.76502 ✓ $= 2.2571144$ ✓

$f_2 = \frac{51.742048}{.500}$ ✓ $= 1.7138436$ ✓

$d_3 = 51.242048$ ✓ $= 1.7096265$ ✓
$n = 0.2084406$ ✓
$56.4438 = r_3 = 1.7516163$ ✓
3.6696834 ✓

$d = 1.7096265$ ✓
$n-1 = 9.7895787$ ✓ 56.4438 ✓ $= r_3$
1.4992052 ✓ $= 31.564957$ ✓
24.878843 ✓ $= 1.3958302$ ✓

$f_3 = \frac{187.86818}{.33}$ ✓ $= 2.2738532$ ✓

$d_4 = 187.53818$ ✓ $= 2.2730897$ ✓
$203.0187 = r_4 = 2.3075360$ ✓
4.5806257 ✓

$n = 0.2084406$ ✓
$r = 2.3075360$ ✓
2.5159766 ✓ $= 328.0776$ ✓

$d = 2.2730897$ ✓
$n-1 = 9.7895787$ ✓
2.0626684 ✓ $= 115.5230$ ✓
212.5546 ✓ $= 2.3274705$ ✓

$f_4 = 179.12460$ ✓ $= 2.2531552$ ✓

$.10825$ ✓ Marginal
$.0163\frac{1}{2}$ ✓ $=$ Sph. Ab. Flint weak

F'

$n = 0.1968223$ ✓
1.7644249 ✓
1.9612472 ✓
$n-1 = 9.7584115$ ✓

$\frac{159.52755}{1.07}$ ✓ $= 2.2028357$ ✓

$d_2 = 158.45775$ ✓ $= 2.1999130$ ✓
$= 1.7644249$ ✓
3.9643379 ✓

$n = 0.1968223$ ✓
$r = 1.7644249$ ✓
1.9612472 ✓ $= 91.46338$ ✓

$d = 2.1999130$ ✓
$n-1 = 9.7584115$ ✓
1.9583245 ✓ $= 90.84992$ ✓
182.31330 ✓ $= 2.2608184$ ✓

$f_2 = \frac{50.526535}{.500}$ ✓ $= 1.7035195$ ✓

50.026535 ✓ $= 1.6992005$ ✓
$n = 0.2140134$ ✓
$r_2 = 1.7516163$ ✓
3.6648302 ✓

$d = 1.6992005$
$n-1 = 9.8040488$ ✓ 56.4438 ✓
1.5032493 ✓ $= 31.860255$ ✓
24.583542 ✓ $= 1.3906444$ ✓

$f_3 = \frac{188.01212}{.33}$ ✓ $= 2.2741858$ ✓

$d_4 = 187.68212$ ✓ $= 2.2734229$ ✓
$r_4 = 2.3075360$ ✓
4.5809589 ✓

$n = 0.2140134$ ✓
$r = 2.3075360$ ✓
2.5215494 ✓ $= 332.31457$ ✓

$d = 2.2734229$ ✓
$n-1 = 9.8040488$ ✓
2.0774717 ✓ $= 119.5285$ ✓
212.78600 ✓ $= 2.3279430$ ✓

$f_4 = 179.06715$ ✓ $= 2.2530159$ ✓

$.1158$ ✓ Marginal
$.0486 \div 2$ ✓ $=$ Sph. Ab. Flint strong.

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Central

5614'

n = 0.1949634 ✓

1.7644249 ✓

1.9593883 ✓

$n-1$ = 9.7532911 ✓

160.73011 ✓ = 2.2060972 ✓

1.07

159.66011 ✓ = 2.2031964 ✓

= 1.7644249 ✓

3.9676213 ✓

n = 0.1949634 ✓

r = 1.7644249 ✓

1.9593883 ✓ = 91.07271 ✓

d = 2.2031964 ✓

$n-1$ = 9.7532911 ✓

1.9564875 ✓ = 90.46644 ✓

181.53915 ✓ = 2.2589703 ✓

f_2 = 51.127082 ✓ = 1.7086510 ✓

.500

50.627082 ✓ = 1.7043829 ✓

n = 0.2111865 ✓

r_3 = 1.7516163 ✓

3.6671857 ✓

d = 1.7043829

$n-1$ = 9.7967456 ✓ 56.4438 ✓

1.5011285 ✓ = 31.705057 ✓

24.738749 ✓ = 1.3933777 ✓

f_3 = 187.84861 ✓ = 2.2738080 ✓

.33

d_4 = 187.51861 ✓ = 2.2730444 ✓

r_4 = 2.3075360 ✓

4.5805804 ✓

n = 0.2111865 ✓

r = 2.3075360 ✓

2.5187225 ✓ = 330.15848 ✓

d = 2.2730444 ✓

$n-1$ = 9.7967456 ✓

2.0697906 ✓ = 117.43295 ✓

212.72553 ✓ = 2.3278196 ✓

f_4 = 178.9620 ✓ = 2.2527608 ✓

.9770 ✓ Marginal

.0150 ✓ Sph. Ab. Flint strong

$f_4 B$ = 179.1246

$f_4 F'$ = 179.0671½

$\frac{1}{2}(f_4 B + f_4 F')$ = 179.0959

f_4 5614' = 178.9620

0.1339

Spherical Aberration

B = .0163½ ✓ Flint weak

F' = .0486½ ✓ " strong

.0650 ✓

5614' = .0150 ✓ Flint strong

.01631 .04865

.187 150

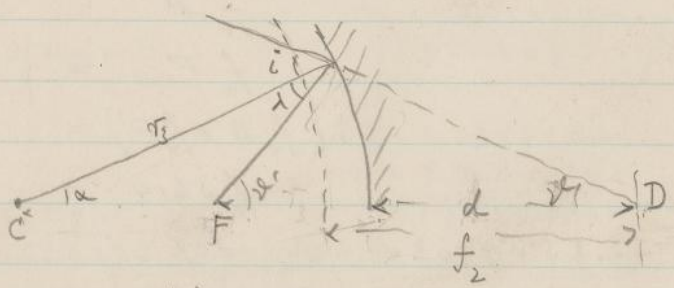
.03135 03361

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Reflection between inner surfaces.



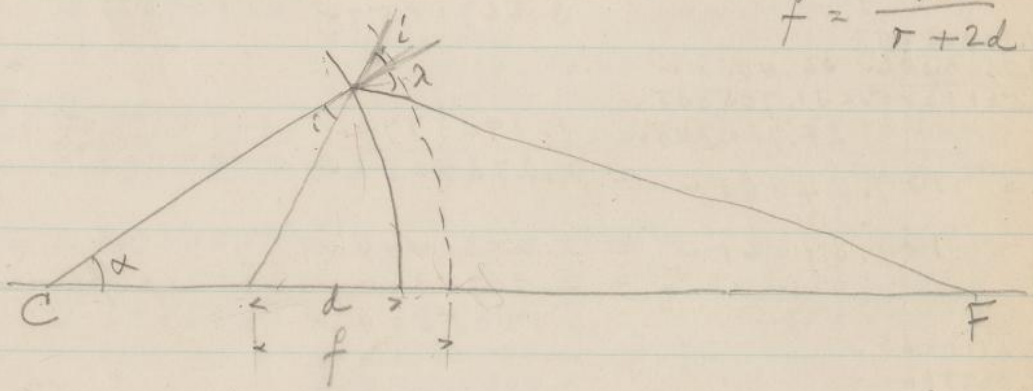


1st Reflection

central $\quad \frac{\sin i}{\sin \lambda} = 1 = \frac{\frac{\sin i}{\sin \alpha}}{\frac{\sin \lambda}{\sin \alpha}} = \frac{\frac{d+r}{d}}{\frac{r-f}{f}}$ $\qquad \frac{r-f}{f} = \frac{d+r}{d}$ ∴ $rd - fd = fd + fr$

$$rd = 2fd + fr$$

$$f = \frac{rd}{r+2d}$$



2nd Reflection

$$\frac{\sin i}{\sin \lambda} = 1 = \frac{\frac{\sin i}{\sin \alpha}}{\frac{\sin \lambda}{\sin \alpha}} = \frac{\frac{r-d}{d}}{\frac{r+f}{f}} \quad \therefore \quad \frac{r+f}{f} = \frac{r-d}{d} \quad \therefore \quad rd + fd = fr - fd$$

$$\therefore \quad rd = fr - 2fd$$

$$f = \frac{rd}{r-2d}$$

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Reflection – Finished O. G.

B

p 137
166

$f_2 = 50.72$

$\frac{.815-}{d_2' \quad 49.905} = 1.6981$

$r_3 = 54.545 - \frac{1.7368}{3.4349}$

$2d = \frac{99.810}{154.355} = \frac{2.1885-}{1.2464}$

$f_3' = 17.636 =$

$\frac{.815-}{d_3' = 16.821} = 1.2258$

$r_2 = 87.99 = \frac{1.7358}{2.9816}$

$2d' = \frac{33.64}{23.35} = \frac{1.3683}{1.6133}$

$f' = 41.05- = 1.6133$

$\frac{.815-}{d_3 = 40.235-} = 1.6046$

$n' = 0.2065-$

$r_3 = \frac{1.7368}{3.5499}$

p 137 $d = 1.6046$

$n-1 = \frac{9.7897}{1.3943} \quad r = 54.545- = \frac{24.791}{29.754} = \frac{1.4735-}{2.0764}$

$f_3 = 119.24$

$\frac{.32}{d_4 = 118.92} = 2.0753$

p 166 $r_4 = 193.46 = \frac{2.2866-}{4.3619}$

$nr_4 = 303.17$

$d = 2.0753$

$d-1 = \frac{9.7897}{1.8650} = \frac{73.29}{229.88} = \frac{2.3615-}{2.0004}$

$f_4 = 100.01$

$f_4 = 179.49$

100.01

79.48 under inside of main focus

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I

In the preceeding calculation the color and Spherical Aberration are both slightly off.

They should be corrected when

$r_1 = r_2 = 58.1333$

$r_3 = 56.504$ } $f_4 = 176.862$

$r_4 = 206.6201$ }

Diagram p146.

For $f_4 = 178.80$ - = 2.2523675

176.862 = 2.2476345

0.0047330

58.1333 = 1.7644249

$r_1 = r_2 =$ 58.7703 = 1.7691579

0.0047330

56.504 = 1.7520792

$r_3 =$ 57.1232 = 1.7568122

0.0047330

206.6201 = 2.3151726

$r_4 =$ 208.8842 = 2.3199056

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Spherometer Readings sup 179. (P 2407 ½ 04.Bk)

$h = R - \sqrt{R^2 - d^2}$

$s = \frac{k}{R - \frac{h}{2}}$

$r_1 = 58.7703 = 1.7691579_2$

$r_1^2 = 3453.95 = 3.5383158$

4.00

$3449.95 = 3.5378127$

$58.7703 = 1.7689063$

58.7363

$h = .0340$

$\frac{1}{2}h = 58.7703$

$.0170$

$58.7533 = 1.7690322$

$k = 2.30103$ convex

$s = 3.40041 = 0.53200$

$r_3 = 57.1232 = 1.7568122_2$

$3263.06 = 3.5136244$

4.005

$2359.055 = 3.5130918$

$57.1232 = 1.7565459$

57.0881

$h = .0351$

$\frac{1}{2}h = 57.1232$

$.0175$

$57.1057 = 1.7566795$

$k = 2.30161$ Concave

$s = 3.50695 = 0.54493$

$r_4 = 208.8842 = 2.3199056_2$

$43632.6 = 4.6398112$

4.0

$43628.6 = 4.6397711$

208.8842

$208.8745 = 2.3198855$

$h = .0097$

208.8842

$\frac{1}{2}h = .0049$

$208.8793 = 2.3198954$

$k = 2.30161$ concave

$s = 0.9588 = 9.981715$

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I

$r_1 = r_2 = 58.133$
$r_3 = 56.504 \; 1.629$
$r_4 = 206.62$

Reflection between inner surfaces.

$\delta = 1.54$

$d_3 = 50.194$
$r_3 = 56.504$
$106.698 = 2.02815\,5^{-\frac{3}{4}}$
$\sin v = 9.06637\,\frac{1}{2}$
$1.09453\,\frac{1}{4}$
$r_2 = 1.75208$
$i = 12^\circ\ 42'\ 35''.7 = \sin 9.34245\,5^{-\frac{1}{4}}$
$r = 1.75208$
$1.09453\,\frac{1}{4}$
$2i = 25\ 25\ 11.4$
$v = 6\ 41\ 27.3$
$v' = 18\ 43\ 44.1 = \sin 9.50662\,\frac{3}{4}$
$1.58790\,\frac{1}{2}$
56.504
38.7173
$f_3 = 17.7867$
$.50$
$d_4 = 17.2867$
$r_4 = 206.62$
$189.3333 = 2.27722\,\frac{3}{4}$
$\sin v = 9.50662\,\frac{3}{4}$
$1.78385\,5^{-\frac{1}{2}}$
$r_4 = 2.31517\,\frac{1}{4}$
$i = 17^\circ\ 6'\ 40''.3 = \sin 9.46868\,\frac{1}{4}$
$2.31517\,\frac{1}{4}$
$2i = 34\ 13\ 20.6$
$v = 18\ 43\ 44.1$
$1.78385\,5^{-\frac{1}{2}}$
$v' = 15\ 29\ 36.5 = \sin 9.42672$
$= 2.35713\,\frac{1}{2}$
227.580
206.620
$f_4 = 20.960$

2nd

$d_4 = 17.2867$
$r = 58.1333$
$40.8466 = 1.61115^{-\frac{1}{2}}$
$\sin v = 9.50662\,\frac{3}{4}$
$1.11778\,\frac{1}{4}$
$r_3 = 1.76442\,\frac{1}{2}$
$i = 13^\circ\ 2'\ 19''.0 = 9.35335\,5^{-\frac{3}{4}}$
$1.76442\,\frac{1}{2}$
$2i = 26\ 4\ 38.0$
$v = 18\ 43\ 44.1$
$1.11778\,\frac{1}{4}$
$v' = 7\ 20\ 53.9 = \sin 9.10687\,\frac{1}{4}$
$f = 102.544$
$= 2.01091\,\frac{1}{2}$
$.50$
$d = 102.044$
58.1333
$d_3 = 43.9107$

XII IX

$d_3 = 102.044$
$r_3 = 56.504$
$158.548 = 2.20016$
$\sin v = 9.10687\,\frac{1}{4}$
$8.30703\,\frac{1}{4}$
$r_3 = 1.75208$
$i = 21^\circ\ 1'\ 53''.8 = \sin 9.55495\,5^{-\frac{1}{4}}$
$n = 0.20844$
$= \sin 9.34685\,1^{-\frac{1}{4}}$
$r = 1.75208$
$\lambda = 12\ 49\ 52.8$
$1.09859\,\frac{1}{4}$
$i - \lambda = 8\ 12\ 1.0$
$v = 7\ 20\ 53.9$
$v = 0\ 51\ 7.1 = \sin 8.17228\,\frac{3}{4}$
$= 2.92630\,\frac{1}{2}$
843.93
56.504
$f_3 = 900.434$
$.33$
$d_4 = 900.764$
$r_4 = 206.62$
694.144

XIII

$= 2.84145\,5^{-\frac{1}{4}}$
$\sin v = 8.17228\,\frac{3}{4}$
$1.01373\,\frac{3}{4}$
$r_4 = 2.31517\,\frac{1}{4}$
$i = 2^\circ\ 51'\ 48''.0 = \sin 8.69856\,\frac{1}{2}$
$n = 0.20844$
$= \sin 8.90700\,\frac{1}{2}$
$2.31517\,\frac{1}{4}$
$\lambda = 4\ 37\ 48.7$
$1.22217\,\frac{3}{4}$
$\lambda - i = 1\ 46\ 0.7$
$v = 0\ 51\ 7.1$
$v' = 0\ 54\ 53.6 = \sin 8.20322\,\frac{3}{4}$
$= 3.01891\,5^{-\frac{1}{4}}$
1044.60
206.62
$f_4 = 837.98$

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29

$d_3 = 43.9107$ III

$r_3 = \underline{56.504}$

$100.4147 = 2.00179\frac{3}{4}$

$\sin d = 9.10687\frac{1}{4}$

1.10867

$r_3 = 1.75208$

$i \quad 13^\circ\ 8'\ 16.3'' = \sin 9.35659$

$n = 0.20844$

$\lambda \quad 8\ 5^\circ\ 8.4 = \sin 9.14815^-$

$5\ 3\ 7.9$ $\quad 1.75208$

$v = 7\ 20\ 53.9$ $\quad 0.90023$

$2\ 17\ 46.0 = \sin 8.60275^{-\frac{1}{2}}$

$= 2.29747\frac{1}{2}$

$r_3 = \underline{198.370}$
$\quad\ \ 56.504$

$f_3 = 141.866$

$\quad\ \ .33$

$d_4 = 141.536$

$r_4 = \underline{206.620}$
$65^\circ.084 = 1.81347\frac{1}{2}$

$\sin d = 8.60275^{-\frac{1}{2}}$

0.41623

$r_4 = 2.31517\frac{1}{4}$

$i \quad 0^\circ\ 43'\ 23.12'' = \sin 8.10105^{-\frac{3}{4}}$

$n = 0.20844$

$\lambda \quad 1\ 10\ 6.81 = \sin 8.30949\frac{3}{4}$

$0\ 26\ 43.69$ $\quad 2.31517\frac{1}{4}$

$v = 2\ 17\ 46.0$ $\quad 0.62467$

$2\ 44\ 29.7 = \sin 8.67971\frac{1}{4}$

$88.096 = 1.94495^{-\frac{3}{4}}$

$\underline{206.620}$

$f_4 = 118.524$

Principle focus = 176.862

Reflection = 58.338 from focus

$58.34 = 1.7660$

$\underline{.0047}$

$58.98 = 1.7707$

May 13th 1906

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1003phae.proj.1152P

166

Finished Q. 9,

p. 135

p. 137

B

$d_4 =$ 2,266166 ✓
2,286596 ✓
4,552762 ✓

$\tau_4 = 193.462$

$n = 0,208468\frac{1}{2}$ ✓
$\tau = 2,286596$ ✓
$2,495064\frac{1}{2}$ ✓ $= 312,6574$ ✓

$d(n-1) =$ 113,715 ✓
198,9394 ✓ =
2,298721 ✓

$f_4 =$ 179.490 ✓ $= 2,254041$ ✓

.420
.070 undercorrected

.490
.325
.165

$f_B - f_{5614}$

5614

p. 138

$d_4 =$ 2,266027
2,286596
4,552623

$n = 0,210956$
$\tau = \frac{2,286596}{2,497552} = 314,450$
$= \frac{115,391}{199,059} =$
2,298982

$179.325 = 2,253641$

see p. 167. 179.327

F

$d_4 =$ 2,266293 ✓
2,286596 ✓
4,552889 ✓

$n = 0,213557\frac{1}{2}$ ✓
$\tau = 2,286596$ ✓
$2,500153\frac{1}{2} = 316.340$ ✓ (396)

$d(n-1) =$ 117,265 ✓ ✓
199,075 =
2,299017 ✓

$f_4 = 179,420$ ✓ $= 2,253872$ ✓

.325
$f_F - f_{5614} =$ .095

.165 = 9,2175
180.4 = 2,2562
.000915 = 6.9613

.095 = 8.9777
180.4 = 2,2562
.000527 = 6.7215

1.051
.815
.324
2 | 2.190
1.095
179.49
180.588

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1003phae.proj.1152P

8614

$n = 0.194814$ ✓ Marginal on p. 191

57.051 = $\tau_1 = 1.755882\frac{1}{2}$ ✓

~~$(n-1) = 0.6253834$~~ $1.950696\frac{1}{2}$ ✓

p.107 $n-1 = 9.752878$ ✓

$f_1 = 157.6952$ $= 2.197818\frac{1}{2}$ ✓

-1.051

$d_2 = 156.6442$ $= 2.194914\frac{1}{2}$ ✓

56.994 = $\tau_2 = 1.755829$ ✓

$3.950743\frac{1}{2}$ ✓

$n = 0.194814$

$\tau = \frac{1.755829}{1.950643}$ ✓ $= 89.2571$ ✓

$d = 2.194914\frac{1}{2}$

$n-1 = \frac{9.752878}{1.947792\frac{1}{2}}$ ✓ $= \frac{88.6732}{177.9303} =$ ✓

$\frac{2.250250}{1.700493\frac{1}{2}}$ ✓

$f_2 = 50.1757$ ✓

$-.815$

$d_3 = 49.3607$ ✓ $= 1.693381\frac{1}{2}$ ✓

$n' = 0.210956$ ✓

1.6253834 — 54.545 = $\tau_3 = \frac{1.736785}{3.641092\frac{1}{2}}$ ✓

$d = 1.693381\frac{1}{2}$ ✓

$n'-1 = \frac{9.796146\frac{1}{2}}{1.489528}$ ✓ 54.545 ✓ $= \frac{30.8694}{23.6756}$ ✓ =

$\frac{1.374301}{2.266791\frac{1}{2}}$ ✓

$f_3 = 184.8738$ ✓

$-.324$ ✓

$d_4 = 184.5514$ ✓ $= 2.266029\frac{1}{2}$ ✓

193.46 ✓ = $\tau_4 = \frac{2.286596}{4.552625\frac{1}{2}}$ ✓

$n' = 0.210956$ ✓

$\tau = \frac{2.286596}{2.497552}$ ✓ $= 314.4503$ ✓

$d = 2.266029\frac{1}{2}$

$n'-1 = \frac{9.796146\frac{1}{2}}{2.062176} = \frac{115.392}{199.0583}$ ✓ =

$\frac{2.298980}{2.253645\frac{1}{2}}$ ✓

$f_4 = 179.327$ ✓

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1903phae.proj.1152P

Separation = 1.20 inch

Marginal

B

p. 154

f_2 = 50.69387 ✓
1.20
d_3 = 49.49387 ✓
assume – r_3 = 56.300
105.79387 = ✓
2.0244605
sin ϑ = 9.0663756
1.0908361
r_3 = 56.300 = 1.7505084
12° 38′ 48″.67 = sin 9.3403277
n = 0.2084406
7 47 11.727 = sin 9.1318871
1.7505084
4 51 36.943 — 0.8823955
6 41 27.309
ϑ = 1 49 50.366 = sin 8.5044105
238.7729 = 2.3779850
56.300
f_3 = 182.4729
.33
d_4 = 182.1429
as before r_4 = 203.0187
20.8758 — 1.3196431
sin ϑ = 8.5044105
9.8240536
r_4 = 2.3075360
0° 11′ 17″.553 = sin 7.5165176
n = 0.2084406
0 18 14.928 = sin 7.7249582
0 6 57.375 — 2.3075360
1 49 50.366 — 0.0324942
1 56 47.741 = sin 8.5310693
31.7267 = 1.5014249
203.0187
f_4 171.2920
170.9092
0.3828 ——— Flint neck

F

f_2 = 49.47462 ✓
1.20
d_3 = 48.27462 ✓
r_3 = 56.300
104.57462 = ✓ — 2.0194263
9.0767193
1.0961456
1.7505084
12° 48′ 18″.18 = sin 9.3456372
0.2140134
7 46 54.636 = sin 9.1316238
1.7505084
5 1 23.544 — 0.8821322
6 51 10.637
1 49 47.093 = sin 8.5041948
238.7467 = 2.3779374
56.300
f_3 = 182.4467
.33
d_4 = 182.1167
r_4 = 203.0187
20.9020 = 1.3201878
8.5041948
9.8243826
2.3075360
0 11 18.067 = sin 7.5168466
n = 0.2140134
0 18 29.909 = sin 7.7308600
0 7 11.842 — 2.3075360
1 49 47.093 — 0.0383960
1 56 58.935 = sin 8.5317623
32.1095 = 1.5066337
203.0187
170.9092

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1903phae.proj.1152P

Central -

B

P. 158 $f_2 = \frac{51.7420\,48}{1.20}$

$d_3 = 50.5420\,48 = 1.7036528$

$n = 0.2084406$

$r_3 = 1.7505084$

3.6626018

$d = 1.7036528$

$n-1 = 9.7895787$

$1.4932315 = \frac{56.30000}{31.13376}$

$25.16624 = 1.4008183$

2.2617835

$f_3 = \frac{182.7189}{.33} = 182.3889 = 2.2609984$

$r_4 = 2.3075360$

4.5685344

$n =$

$r =$

$= 328.0776$

$d = 2.2609984$

$n-1 = 9.7895787$

$2.0505771 = 112.35104$

$215.7266 = 2.3339036$

$f_4 = 171.6449 = 2.2346308$

171.2920 Marginal

0.3529 - Faint weak

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1903phae.proj.1152P

Separation = 1.20 continued

Marginal

B

F'

$d_3 = 49.49387$

try $r_3 = 53.8000$

$105.29387 = 2.0224031$

$\sin v = 9.0663756$

1.0887787

$r_3 = 1.7466342$

$12^\circ\ 42'\ 2.727 = \sin 9.3421445$

$n = 0.2084406$

$7\ 49\ 9.974 = \sin 9.1337039$

$4\ 52\ 52.753$ 1.7466342

0.8803381

$6\ 41\ 27.309$

$1\ 48\ 34.556 = \sin 8.4993874$

2.3809507

$240.4090 =$

53.8000

$f_3 = 184.6090$

$.33$

$d_4 = 184.2790$

$r_4 = 203.0187$

$18.7397 = 1.2727626$

$\sin v = 8.4993874$

9.7721500

$r_4 = 2.3075360$

$0^\circ\ 10'\ 1.229 = \sin 7.4646140$

$n = 0.2084406$

$0\ 16\ 11.586 = \sin 7.6730546$

$0\ 6\ 10.357$ $r_4 = 2.3075360$

$1\ 48\ 34.556$ 9.9805906

$1\ 54\ 44.913 = \sin 8.5233927$

$28.6548 = 1,457.1979$

203.0187

$f_4 = 174.3639$

d

n4

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1903phae.proj.1152P

Central

B

d = 1.7036528

n = 0.2084406

r_3 = 1.7466342

3.6587276

r_3 = 53.8000

$d(n-1)$ = 31.13376

24.66624 = 1.3921029

f_3 = 184.7671 = 2.2666247

.33

d_4 = 184.4371 = 2.2658483

r_4 = 2.3075360

4.5733843

nr = 328.0776

d = 2.2658483

n_4 = 9.7895787

2.0554270 = 113.6127

214.4649 = 2.3313562

f_4 = 174.5935 = 2.2420281

174.3639 Marginal

0.2296 Think weak

Separation	
.500	r_3 = 56.4438
1.200	" = 54.8689
.700	1.5749
.100	.224986
.500	1.124930

For separation = 1.00

56.4438

1.1249

r_3 = 55.3189

When r_3 = 56.30 Sph Ab = 0.3529

" = 55.80 " 0.2296

Change .50 .1233

1.00 .2466) 2296.0 (.9311

2219 4

7660

7398

2620

2466

1540

55.8000

.9311

r_3 = 54.8689 to correct sph. Ab.

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1903phae.proj.1152P

VII

Separation = 1.0000

Marginal

B

p.164 f_2 = 50.69387 ✓
1.000 ✓
d_3 = 49.69387 ✓

p.171 r_3 = 53.3189 ✓
105.01277 ✓ = 2.0212422 ✓
sin δ = 9.0663756 ✓
1.0876178 ✓
r_3 = 1.7428735 ✓
12° 46' 41.892" ✓ = sin 9.3447443 ✓
n = 0.2084406 ✓
7 52 0.059 ✓ = sin 9.1363037 ✓
4 54 41.833 ✓ 1.7428735 ✓
6 41 27.309 ✓ 0.8791772 ✓
1 46 45.476 ✓ = sin 8.4920565 ✓
243.8488 ✓ = 2.3871207 ✓
55.3189 ✓
f_3 = 188.5299 ✓
.33 ✓
d_4 = 188.1999 ✓
r_4 = 203.0187 ✓
14.8188 ✓ = 1.1708130 ✓
sin δ = 8.4920565 ✓
9.6628695 ✓
r_4 = 2.3075360 ✓
0° 7' 47.476" ✓ = sin 7.3553335 ✓
n = 0.2084406 ✓
0 12 35.441 ✓ = sin 7.5637741 ✓
0 4 47.965 ✓ 2.3075360 ✓
1 46 45.476 ✓ 9.8713101 ✓
1 51 33.441 ✓ = sin 8.5111481 ✓
22.9172 ✓ = 1.3601620 ✓
203.0187 ✓
f_4 = 180.1015 ✓
.0835 ✓ central
Sph. Ab = 0.0180 ✓ Hint strong

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1903phae.proj.1152P

Central

B

p.158 $f_2 = 51.742048$ ✓

1.000

$d_3 = 50.742048$ ✓ $= 1.7053680$ ✓

$n = 0.2084406$ ✓

$r_3 = 1.7428735$ ✓

3.6566821 ✓

$d = 1.7053680$ ✓

$n-1 = 9.7895787$ ✓ 53.3189 ✓

$1.4949467 = 31.25696$ ✓

$24.06194 = 1.3813306$ ✓

$f_3 = 188.51743$ ✓ $= 2.2753515$ ✓

$.33$ ✓

$d_4 = 188.18743$ ✓ $= 2.2745906$ ✓

$r_4 = 2.3075360$ ✓

4.5821266 ✓

$nr = 328.0776$ ✓

$d_4 = 2.2745906$ ✓

$n-1 = 9.7895787$ ✓

$2.0641693 = 115.9229$ ✓

$212.1547 = 2.3266526$ ✓

$f_4 = 180.0835$ ✓ $= 2.2554740$ ✓

$r_3 = 53.3189$

$.0735$ to correct for .0180 sph. Ab.

to $r_3 = 55.3924$

1903phae.proj.1152P

VII

Separation = 1.0000 Continued

Marginal

B

F'

$\alpha_3 = 49.69387$ ✓

$r_3 = \frac{55.3924}{105.08627}$ ✓ = 2.0215460 ✓

sin α = 9.0663756 ✓

1.0879216 ✓

r_3 = 1.7434502 ✓

12° 46' 12.505" ✓ = sin 9.3444714 ✓

n = 0.2084406 ✓

7 51 42.158 ✓ = sin 9.1360308 ✓

4 54 30.347 ✓ 1.7434502 ✓

6 41 27.309 ✓ 0.8794810 ✓

1 46 56.962 ✓ = sin 8.4928342 ✓

243.5829 ✓ = 2.3866468 ✓

55.3924 ✓

f_3 = 188.1905 ✓

.33

α_4 = 187.8605 ✓

$r_4 = \frac{203.0187}{15.1582}$ ✓ = 1.1806476 ✓

sin α 8.4928342 ✓

9.6734818 ✓

r_4 = 2.3075360 ✓

0° 7' 59.0395" ✓ = sin 9.3659458 ✓

n = 0.2084406 ✓

0 12 54.1277 ✓ = sin 9.5743864 ✓

0 4 55.0882 ✓ 2.3075360 ✓

1 46 56.962 ✓ 9.8819224 ✓

1 51 52.0502 ✓ sin 8.5123535 ✓

23.41903 ✓ = 1.3695689 ✓

203.0187 ✓

f_4 = 179.5997 ✓

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1903phae.proj.1152P

central

B

d_3 = 1.7053680 ✓

n = 0.2084406 ✓

τ_3 = 1.7434502 ✓

3.6572588 ✓

τ_3 = 55.3924 ✓

$d(n-1)$ = 31.25696 ✓

24.13544 ✓ = 1.3826532 ✓

188.1931 ✓ = 2.2746036 ✓

,33

d_4 = 187.8631 ✓ = 2.2738415 ✓

τ_4 = 2.3075360 ✓

4.5813775 ✓

nr. = 328.0776 ✓

d = 2.2738415 ✓

n = 9.7895787 ✓

2.0634202 = 115.7231 ✓

212.3545 = 2.3270615 ✓

f_4 = 179.6040 ✓ = 2.2543160 ✓

179.5997 Marginal

Sph Ab. 0.0043 Flint weak {should be .0320 weak see p. 159}

	τ_3	Sph. Ab.		
	55.3189	0.0180	Flint strong	.0320
	55.3924	0.0043	" weak	.0043
Change =	.0735	0.0223		.0277
	.0184	.0056		
	.0919	.0279		
	.0912	.0277		
	55.3924			
	55.4836			

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VII

Leolw

Separation = 1.0000 Continued

Marginal

B

$d_3 =$

$d_3 = 49.69387$ ✓

$r_3 = 55.4836$ ✓

105.17747 ✓ $= 2.0219227$ ✓

$\sin \vartheta = 9.0663756$ ✓

1.0882983 ✓

$\vartheta_3 = 1.7441646$ ✓

$12^\circ\ 45'\ 36,172$ ✓ $= \sin\ 9.3441337$ ✓

$\pi = 0.2084406$ ✓

$7\ 51\ 20,020$ ✓ $= \sin\ 9.1356931$ ✓

$4\ 54\ 16.152$ ✓ 1.7441646 ✓

$6\ 41\ 27.304$ ✓ 0.8798577 ✓

$1\ 47\ 11.157$ ✓ $= \sin\ 8.4937934$ ✓

243.25647 ✓ $= 2.3860643$ ✓

55.4836 ✓

$f_3 = 187.77529$ ✓

$.33$

$d_4 = 187.44429$ ✓

$r_4 = 203.0187$ ✓

15.5759 ✓ $= 1.1924531$ ✓

$\sin \vartheta = 8.4937934$ ✓

9.6862465 ✓

$\vartheta_4 = 2.3075360$ ✓

$0^\circ\ 8'\ 13,3286$ ✓ $= \sin\ 7.3787105$ ✓

$\pi = 0.2084406$ ✓

$0\ 13\ 17,218$ ✓ $= \sin\ 7.5871511$ ✓

$0\ 5'\ 3.8894$ ✓ 2.3075360 ✓

$1\ 47\ 11.157$ ✓ 9.8946871 ✓

$1\ 52\ 15.0464$ ✓ $= \sin\ 8.5138383$ ✓

24.0353 ✓ $= 1.3808488$ ✓

203.0187 ✓

178.9834 ✓

$.8812$ ✓

Leolw = $.1022$ ✓ Limit near

(P. 154) F'

$f_2 = 49.47462$ ✓

1.0000

$d_3 = 48.47462$ ✓

55.4836 ✓

103.95822 ✓ $= 2.0168589$ ✓

$\sin \vartheta = 9.0767193$ ✓

1.0935782 ✓

1.7441646 ✓

$12^\circ\ 55'\ 7,685$ ✓ $= \sin\ 9.3494136$ ✓

0.2140134 ✓

$7\ 51\ 0.830$ ✓ $= \sin\ 9.1354002$ ✓

$5\ 04\ 6,855$ ✓ 1.7441646 ✓

$6\ 51\ 10.637$ ✓ 0.8795648 ✓

$1\ 47\ 3.782$ ✓ $= \sin\ 8.4932955$ ✓

243.3713 ✓ $= 2.3862693$ ✓

55.4836 ✓

187.8877 ✓

$.33$

187.5577 ✓

203.0187 ✓

15.4610 ✓ $= 1.1892376$ ✓

$\sin \vartheta = 8.4932955$ ✓

9.6823331 ✓

2.3075360 ✓

$0^\circ\ 8'\ 9,128$ ✓ $\sin\ 7.3749971$ ✓

0.2140134 ✓

$0\ 13\ 20.639$ ✓ $= \sin\ 7.5890105$ ✓

$0\ 5'\ 11,511$ ✓ 2.3075360 ✓

$1\ 47\ 3.782$ ✓ 9.8965465 ✓

$1\ 52\ 15.293$ ✓ $= \sin\ 8.5138542$ ✓

24.1375 ✓ $= 1.3826923$ ✓

203.0187 ✓

178.8812 ✓

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1903phae..proj.1152P

Ecliv. – continued

B

try $r_4 = 197.1710$

$d_4 = 187.4428$

9.7282 = 0.9880325⁻

sin d = 8.4937934

9.4818259

r_4 = 2.2948430

0° 5′ 17″.253 = sin 7.1869829

x = 0.2084406

0 8 32.683 = sin 7.3954235⁻

0 3 15.428 2.2948430

1 47 11.157 9.6902665⁻

1 50 26.585⁻ = sin 8.5067899

15.2573 = 1.1834766

197.1710

f_4 181.9137

.9090

Ecliv .0047 Limb neak

F′

$r_4 = 197.1710$

$d_4 = 187.5377$

9.6133 = 0.9828725⁻

sin d = 8.4932955⁻

9.4761680

2.2948430

0° 5′ 13″.149 = sin 7.1813250

0.2140134

0 8 32.583 = sin 7.3953384

0 3 19.134 2.2948430

1 47 3.782 9.6901814

1 50 23.216 = sin 8.5065692

15.2620 = 1.1836122

197.1710

f_4 = 181.9090

try $r_4 = 196.8891$

$d_4 = 187.4428$

9.4463 = 0.9752617

sin d = 8.4937934

9.4690551

r_4 = 2.2942217

0° 5′ 8″.503 = sin 7.1748334

x = 0.2084406

0 8 18.540 = sin 7.3832740

0 2 10.037 r_4 = 2.2942217

1 47 11.157 9.6774957

1 50 21.194 = sin 8.5064366

14.8272 = 1.1710591

196.8891

182.0619

$r_4 = 196.8891$

$d_4 = 187.5377$

9.3314 = 0.9699468

sin d = 8.4932955⁻

9.4632423

2.2942217

0° 5′ 4″.401 = sin 7.1690206

0.2140134

0 8 18.264 = sin 7.3830340

0 3 13.863 2.2942217

1 47 3.782 9.6772557

1 50 17.645⁻ = sin 8.5062038

14.82695⁻ = 1.1710519

196.8891

182.0621

182.0619

0.0002 Color correct

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Separation = 1.0000 continued

Central

B

$d_3 = 1.7053680$
$n = 0.2084406$
$\overline{57.4836} = r_3 = 1.7441646$
3.6579732

57.4836
$d(n-1)$ 31.25696
$24.22664 = 1.3842932$
$f_3 = 187.7933 = 2.2736800$
.33
$d_4 = 187.4633 = 2.2729163$
$\overline{196.8891} = r_4 = 2.2942217$
4.5671380

$r = 2.2942217$
$n = 0.2084406$
2.5026623
$= 318.1723$

$d = 2.2729163$
$n = 9.7895787$
2.0624950
$= 115.4769$
$202.6954 = 2.3068439$
$f_4 = 182.0934 = 2.2602941$
.0619 Marginal
Diff Ab = .0315 Flint mark

Should be .0320 for B ray p.159

$f_0 = 178.80 = 2.2523675^-$
$182.06 = 2.2602145^-$
9.9921530
.9821
$58.1333 = 1.7644249$
$r_1 = 57.0923 = 1.7565779$
$r_2 = 57.0923$

9.9921530
1.7441646
$r_3 = 54.4901 = 1.7363176$

$196.8891 = 9.9921530$
2.2942217
$r_4 = 193.3632 = 2.2863747$

9.9921530
0.0293838
$t_1 = 1.0508 = 0.0215368$

9.9921530
$0.$
$D = 0.9821 = 9.9921530$

9.9921530
9.5185139
$t_2 = 0.3241 = 9.5106669$

Compare with p. 24

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Spherometer Readings

p. 241 } 7" Book }

$h = \frac{s}{100}$

convex $R = \frac{k}{s} + \frac{h}{2}$

$d^2 = 4.0000$

$\log k = 2.30103$

$h = R - \sqrt{R^2 - d^2}$

$\frac{k}{s} = R - \frac{h}{2} \therefore s = \frac{k}{R - \frac{h}{2}}$

concave } $d = 2.00133$

$\log k = 2.30161$

4.0005-3 = " $d^2 = 0.60264$

p. 38

	Radius	C.P.W.'s Spherometer Reading	
$r_1 = r_2$	= 57.0923	3.5042 ✓	Convex
r_3	= 54.4901	3.6765 ✓	Concave
r_4	= 193.3632	1.0357 ✓	"

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Result of calculation –

Equivalent focal length = 180 inches

Thickness of Baryta Light Flint Lens = 1.051 inches (# 573)
" . Silicate Flint " = .324 (# 93)
Separation – .982

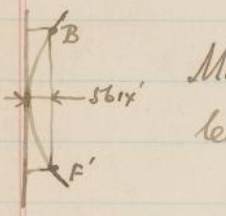
Color correction – B and F' marginal rays united

Approximate distance of reflection from focus
= 88 inches – see 7" Book pp. 192 & 193, reduced to 179" = f_x

---

VII = I Separation = 0.982 p.178
0.815 p.38 p166

r_1 = 57.0923
r_2 = 57.0923
r_3 = 54.4901
r_4 = 193.3632

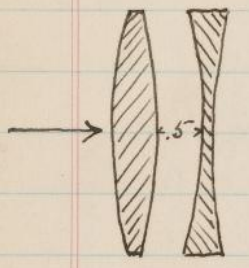


	inches	
Marginal	0.1392	color
Central	0.1375	color
Sph. Ab. of B_1 + F_1	0.0562	p.183

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1905phae.proj.1152p

VII

	I	II	III	IV	V	VI
						
Sep = 1.00						
p 178	p. 159	p. 122 / 127	p. 36	p 112 7" Brtk	p 73	p 81
57.0923 r_1	58.770	Inf.	208.835	166.450	100.856	81.788
57.0923 r_2	58.770	46.048	37.540	34.565	31.536	29.459
54.4901 r_3	57.123	49.268	37.540	34.495	31.194	29.137
193.3632 r_4	208.884	73.919	135.903	166.450	548.810	1896.05
i 1st S.	6° 2′	0° 0′	1° 35′		3° 29′	4 18
λ 2nd	12 53	12 19	14 3		16 0	16 51
i 3rd	13 2	11 51	14 3		16 8	16 53
λ 4th	0 14	6 37	4 36		2 35	1 52
B / 5614′ / F′ Marg'l	0.1345	0.1311	} color			
Central	0.1339	0.1287				
Sph Ab. B+F	0.0650	0.0790	} sph. Ab.			
Reflection from Frame	59.00	61.00				

I and II give dark field

II gives slightly better color correction than I

I " better spherical aberration for all rays

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VII

Separation = 1.0000 continued

Central —

7'

p.158 $f_2 = \frac{50.5265\,35^-}{1.000} = 49.5265\,35^-$

$d_3 = 1.6948379$

$n = 0.2140134$

$r_3 = \frac{1.7441646}{3.6530159}$

$d_3 = 1.6948379$

$n-1 = \frac{9.8040488}{1.4988867} = \frac{53.4836}{31.5\bar{4}1\bar{8}1} = \frac{23.94179}{1.3791666}$

$f_3 = \frac{187.8708}{.33} = 187.5408 = 2.2738593$

$d_4 = 2.2730958$

$r_4 = \frac{2.2942217}{4.5673175^-}$

$r = 2.2942217$

$n = \frac{0.2140134}{2.5082351} = 322.2813$

$d = 2.2730958$

$n-1 = \frac{9.8040488}{2.0771446} = \frac{119.4386}{202.8427} = \frac{2.3071594}{2.2601581}$

$f_4 = 182.0363 = 182.0621$ Marginal

Sph. Ab. $= .0258$ Flint strong

Spherical Aberration

For B ray = 0.0315 Flint weak

" 7' " = 0.0258 " strong

0.0573 = (0.0562 for f_4 = 179.40)

180) .05730 (.000318

540

330

180

1500

1440

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Separation 1.ov continued

56.4'

p.155 Marginal

f_2 = 50.07705
1.000

d_3 = 49.07705
r_3 = 55.4836
104.56065 = 2.0193683
sin d = 9.0715780
1.0909463
r_3 = 1.7441646
12° 50' 21".892 = sin 9.3467817
n = 0.2111865
7 51 13.591 = sin 9.1355952
1.7441646
0.8797598
4 59 8.301
6 46 18.933
1 47 10.632 = sin 8.4937582
243.2207 = 2.3860016
r_3 = 55.4836
f_3 = 187.7371
.33
d_4 = 187.4071
r_4 = 196.8891
9.4820 = 0.9769000
sin 8.4937582
9.4706582
r_4 = 2.2942217
0° 5' 9.'6437 = sin 7.1764365
n = 0.2111865
0 8 23.5372 = sin 7.3876230
0 3 13.9135
2.2942217
1 47 10.632
9.6818447
1 50 24.5455 = sin 8.5066563
14.9688 = 1.1751884
r_4 = 196.8891
f_4 = 181.9203

---

f_4
B = 182.0619
$7'$ = 182.0621
$\frac{1}{2}(B+7')$ = 182.0620 for f_4 = 178.80
56.4' = 181.9203
0.1417 = 1392

p.159 Central

f_2 = 51.127082
1.
d_3 = 50.127082 = 1.7000724
n = 0.2111865
r_3 = 1.7441646
3.6554235
d_3 = 1.7000724
$n-1$ = 9.7967456 55.4836
1.4968180 = 31.39193
24.09167 = 1.3818669
= 2.2735566
f_3 = 187.7399
.33
d_4 = 187.4099 = 2.2727926
r_4 = 2.2942217
4.5670143
r = 2.2942217
n = 0.2111865
2.5054082 = 320.1903
d = 2.2727926
$n-1$ = 9.7967456
2.0695382 = 117.3649
202.8254
= 2.3071224
f_4 = 181.9248 = 2.2598919
.9203
.0045 Aph. Ab.

---

f_4
B = 182.0934
$7'$ = .0363
.1297
$\frac{1}{2}(B+7')$ = 182.0648
56.4' = 181.9248
0.1400 = 1375 for f_4 = 178.80

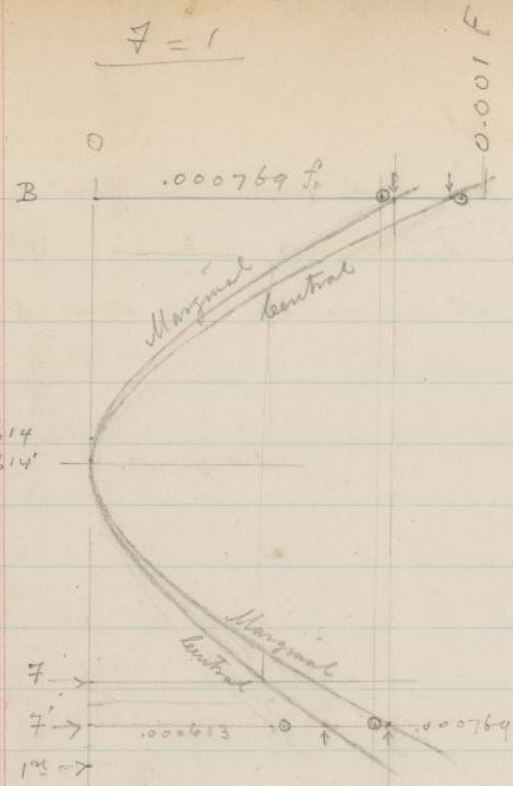
(Reduce to 178.80 = f_4)

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7 = 1

Seal 52



↓ = Crown in front
⊙ = Flint in front

Marginal rays

Uniting B + 7' makes Flint weak

" B + 7 " " strong

.00077
.00009
.00068

B+7 = .00068 about

2.0363
1.9248
182) .1115 (.00061
1092
230
182

2.0934
1.9248
182) .1686 (.00092
1638
480

VII

177-8
p.183-4

	f_4		Sph. Ab.	
	Marginal	Central		
B	182.0619	182.0934	+.0315	.1686
F=182 F-1= .0007740 .1416		.0009214 .1686	.0000024	
5614'	181.9203	181.9248	+.0045	.1115
.0007750 .1418		.0006094 .1115		
7'	182.0621	182.0363	-.0258	

(7=1 .000147)
+.0270
.000164
-.0303

573
286

+.0315
.0041
.0270

-.0258
41
.0303

The "crown" was too strong (slightly)

Flint in front for comparison

	Marginal	Central	Sph Ab.		Sph Ab
					.000204
p.124-7 B	179.4454	179.4810	+.0356	.1671	.0370
F=180.3	.0007210 .01300	.0009268 .01671	.0000083		
5614'	179.3154	179.3139	-.0015	.0903	0
	.0007331 .01322	.0005008 .00903			.000283
7'	179.4476	179.4042	-.0434		.0419

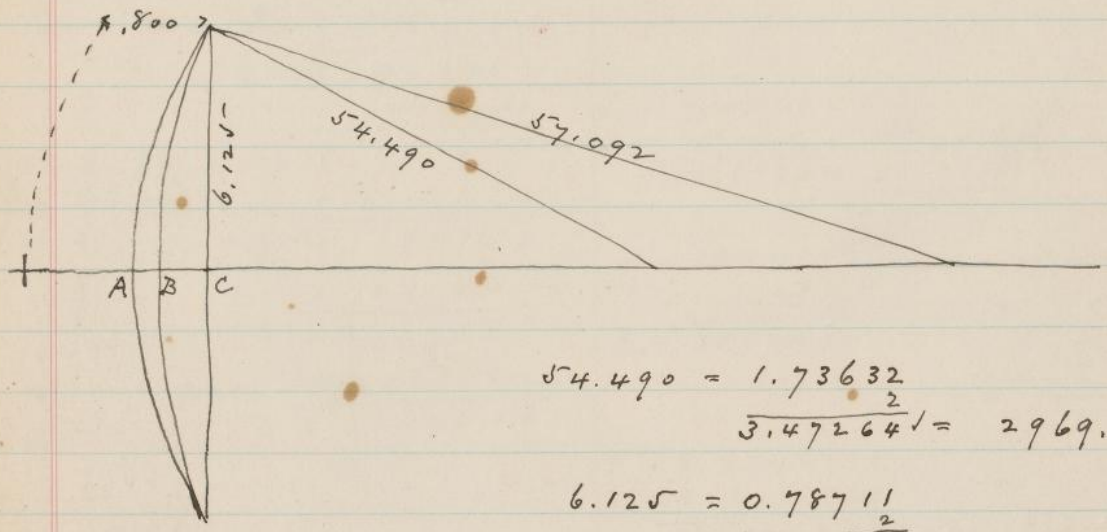
8.80

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June 22 1908. Mr. Leundin, said A.H. was finished unless he could find some error by testing it on a star

The separation of the lenses at inside of cell was 0.800 in at distance of 6.125 in from center —



$\sqrt{54.490} = 1.73632$

$3.47264 \checkmark = 2969.2$

$6.125 = 0.78711$

$1.57422 \checkmark = 37.5$

$2 \mid 3.46712 = 2931.7 \checkmark$

$54.145 = 1.73356 \checkmark$

$AC = 0.345 \checkmark$

$\sqrt{57.092} = 1.75685$

$3.51315 \checkmark = 3259.5$

$2 \mid 3.50813 = 3222.0 \checkmark$

$36.762 = 1.75406 \checkmark$

$BC = 0.330 \checkmark$

$AB = 0.015 \checkmark$

$.800$

Separation = $0.815 \checkmark$ for correct color

calculated 0.982 to mite B & 7° marginal rays

0.167 difference

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1003phae.proj.1152p

surface

Baryta

Completed O.4. {8.15 cut / cut 28-9

⊙ central rays in finished O.4.

7 = 1.000

1.589899

B

(12040)'

.000774

.001

B

C

Marginal rays

central rays

⊙ Baryta in front

□ Flint in "

D

1.565150

8191

1.566022

58.4

.000028 Sph. Ab.

(7817)

1.566619

58.4'

.001

(6720)

.001

b_1

1.570450

2900

1.572246

F

(1093)

F

marginal

central

.000775

1.573339

F'

(0)

C

M

.000607

1/20

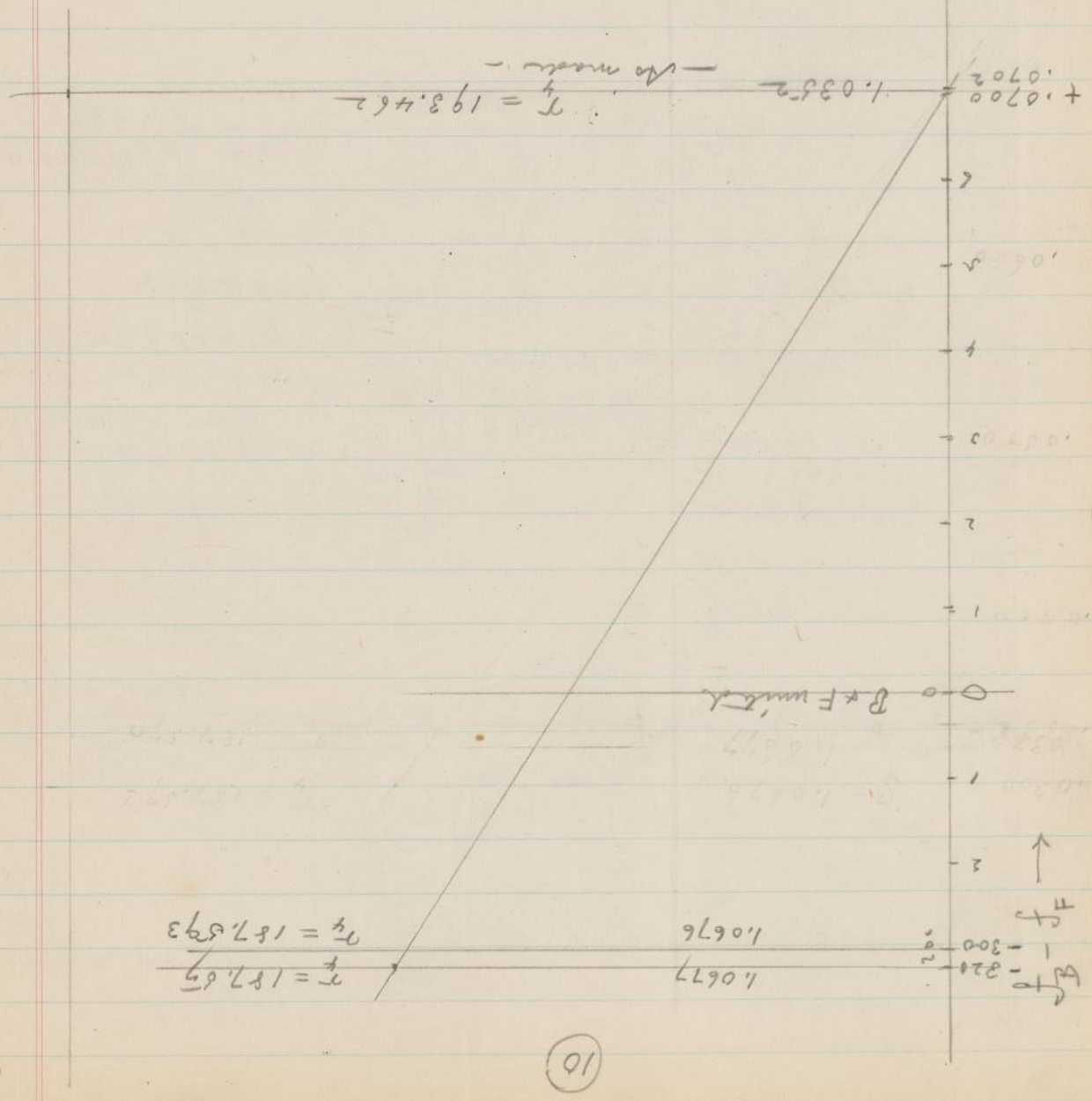
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12" as fundamental, & change color correction Ann ph 139



.0320
.0702
1.022

1.0677
1.0352
.0325

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C and D from B and 5614

	Lerown n	Flint n'
B	1.539959 ✓	1.616101 ✓
C	1.561139	1.617891
D_{1+2}	1.564534	1.622812
5614	1.560081 ✓	1.625383 ✓
F	1.572293 ✓	1.635149 ✓

$$n_{5614} - n_D = (n_{5614} - n_B)\frac{\frac{1}{\lambda^2_{5614}} - \frac{1}{\lambda^2_D}}{\frac{1}{\lambda^2_{5614}} - \frac{1}{\lambda^2_B}} = (n_{5614} - n_B)\frac{2913.7}{10521.0}$$ log 9.464238

$n_{5614} = 1.56608$

$n_B = \frac{1.53996}{.00612} = 7.78675-$

$\frac{9.44238}{7.22913}$

$-.0016948$

$n_{5614} = 1.5662293$

$n_{D_{1+2}} = 1.5645345-$

$n'_{5614} = 1.625383$

$n'_B = \frac{1.616101}{.009282} = 7.96764$

$\frac{9.44238}{7.41002}$

$.0025705- = n_{5614} = 1.625383$

$n'_{D_{1+2}} = 1.622812$

$$n_C - n_B = (n_{5614} - n_B)\frac{\frac{1}{\lambda^2_C} - \frac{1}{\lambda^2_B}}{\frac{1}{\lambda^2_{5614}} - \frac{1}{\lambda^2_B}} = n_{5614} - n_B \frac{2029.3}{10521.0}$$ log 9.285529

$7.78675-$

$\frac{9.28529}{7.07204}$

$+.0011804$

$n_B = 1.539959$

$n_C = 1.561139$

7.96764

$\frac{9.28529}{7.25293}$

$+.0017903$

$n'_B = 1.616101$

$n'_C = 1.617891$

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5574 Marginal Rays through finished O. G.

measurements on p. 135 - (Cert 35" 24)

$6 = 8.772815$ ✓

$r_1 = 57.001 = 1.755882\frac{1}{2}$ ✓

$i = 6° 2' 32",000$ ✓ $= \sin 9.022268\frac{1}{2}$ ✓

$n = 0.194814$ ✓

P. 107

$d = 3\ 57\ 14.176$ ✓ $= \sin 8.827454\frac{1}{2}$ ✓

$2\ 11\ 17.824$ ✓ $r = 1.755882\frac{1}{2}$ ✓

0.583337 ✓

$\sin 8.581875\frac{1}{2}$ ✓

100.3371 ✓ $= 2.001461\frac{1}{2}$ ✓

$r_1 = 57.001$ ✓

$f_1 = 157.3381$ ✓

-1.051 ✓

$d_2 = 156.2871$ ✓

$r_2 = 56.994$ ✓

213.2811 ✓ $= 2.328952\frac{1}{2}$ ✓

$\vartheta = \sin 8.581875\frac{1}{2}$ ✓

0.910828 ✓

$r_2 = 1.755829$ ✓

$i = 8° 12' 54",20$ ✓ $= \sin 9.154999$ ✓

$n = 0.194814$ ✓

$\lambda = 12\ 53\ 57,23$ ✓ $= \sin 9.349813$

$4\ 42\ 57,03$ ✓ $r = 1.755829$ ✓

$2\ 11\ 17.824$ ✓ 1.105642 ✓

$\vartheta = 6\ 54\ 14,854$ ✓ $= \sin 9.079934\frac{1}{2}$ ✓

106.0981 ✓ $= 2.025707\frac{1}{2}$ ✓

$r_2 = 56.994$ ✓

$f_2 = 49.1041$ ✓

$-.8155$ ✓

$d_3 = 48.2891$ ✓

$r_3 = 54.5455$ ✓

102.8341 ✓ $= 2.012137$ ✓

$\sin \vartheta = 9.079934\frac{1}{2}$ ✓

$r_3 = 1.092071\frac{1}{2}$ ✓

$i = 18° 5' 5",39$ ✓ $= 1.736753$ ✓

$1.625-383\frac{1}{2} =$ $\sin 9.355316\frac{1}{2}$ ✓

$n = 0.210956$ ✓

$\lambda = 8\ 0\ 53.79$ ✓ $= \sin 9.144360\frac{1}{2}$ ✓

$5\ 5\ 1,60$ ✓ $r = 1.736753$ ✓

$6\ 54\ 14.854$ ✓ $0,881111\ 5-\frac{1}{2}$ ✓

$1\ 49\ 13,254$ ✓ $\sin 8.501959$ ✓

239.418 ✓ $= 2.379156\frac{1}{2}$ ✓

$f_3 = 54.545$ ✓ $= 184.873$ ✓

$f_3 = 184.873$ ✓

$-.324$ ✓

$d_4 = 184.549$ ✓

$r_4 = 193,462$ ✓

$8,913$ ✓ $= 0,950024$ ✓

$\vartheta = \sin 8.501959$ ✓

$9,451983$ ✓

$r_4 = 2.286596$ ✓

$i = 0\ 5'\ 1".865$ ✓ $= \sin 7,165387$ ✓

$n = 0.210956$ ✓

$\lambda = 0\ 8\ 10,646$ ✓ $= \sin 7.376343$ ✓

$0\ 3\ 8,781$ ✓ $r = 2.286596$ ✓

$9,662939$ ✓

$1\ 49\ 13,254$ ✓ $\sin 8.514288\frac{1}{2}$ ✓

$1\ 52\ 22,035$ ✓ $= 1.148650\frac{1}{2}$ ✓

14.081 ✓

193.462 ✓

$179.380\frac{1}{2}$ ✓

179.327 central p. 167

$.053\frac{1}{2}$ Sph. Ab.

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1903phae.proj.1152P

B + F – Marginal Rays through the finished O. G.

measurements on p. 135 Oct 30 '24

Central rays p. 166.

B

$\delta = 0,778\,15^{-1}$ ✓

$\tau_1 = 5^{-}7,001$ ✓ $= 1,75^{-}88\,2\frac{1}{2}$ ✓

$i = 6\ \ 2\ 32,000$ ✓ $= \sin\ 9,022268\frac{1}{2}$ ✓

$n = 0,193113$ ✓

$\lambda = 3^\circ\ 5^{-}2'\ 8''.70^{6}$ ✓ $= \sin\ 8,829\,15^{-}5^{-}\frac{1}{2}$ ✓

$\tau = 1,75^{-}88\,2\frac{1}{2}$ ✓

$\nu = 2\ 10\ 23.29^{5}$ ✓ $0.58^{-}5038$ ✓

$\sin = 8.5^{-}7886\,1$ ✓

101.4325^{-} ✓ $= 2,006177$ ✓

$\tau = 57,001$ ✓

$f_1 = 15^{-}8.4335^{-}$ ✓

$-1.05^{-}1$

$d_2 = 15^{-}7.3825^{-}$ ✓

$\tau_2 = 56.994$ ✓

214.3765^{-} ✓ $= 2,331177^{-}$ ✓

$\nu = \sin\ 8.5^{-}7886\,1$ ✓

$0,910038$ ✓

$\tau_2 = 1,75^{-}829$ ✓

$i = 8^\circ\ 12'\ 0''.096$ ✓ $= \sin\ 9,15^{-}4209$ ✓

$n = 0,193113$ ✓

$\lambda = 12\ 5^{-}1\ 20.413$ ✓ $= \sin\ 9.347322$ ✓

$4\ 39\ 20.317$ ✓ $\tau = 1,75^{-}829$ ✓

$\nu = 2\ 10\ 23.29^{5}$ ✓ $1,10315^{-}1$ ✓

$\nu' = 6\ 49\ 43,61^{2} = \sin\ 9.075^{-}192$ ✓

106.6495^{-} ✓ $= 2,027959$ ✓

$\tau_2 = 56.994$ ✓

$f_2 = 49,65^{-}5^{-}$ ✓

$-,815^{-}$ ✓

$d_3 = 48,8405^{-}$ ✓

$\tau_3 = 54.545^{-}$ ✓

$103.385^{-}5^{-}$ ✓ $= 2,014459\frac{1}{2}$ ✓

$\nu = \sin\ 9.075^{-}192$ ✓

$1,08965^{-}1\frac{1}{2}$ ✓

$\tau_3 = 1,73675^{-}$ ✓

$i = 13^\circ\ 1'\ 28''.74$ ✓ $= \sin\ 9,35^{-}2896\frac{1}{2}$ ✓

$1,616101\frac{1}{2}$ $n' = 0,208468\frac{1}{2}$ ✓

$\lambda = 8\ 0\ 5^{-}8,29$ ✓ $= \sin\ 9,144428$ ✓

$5^{-}0\ 30.45^{-}$ ✓ $\tau = 1,73675^{-}$ ✓

$\nu = 6\ 49\ 43.61$

$\nu' = 1\ 49\ 13,16$ ✓ $= \sin\ 8,5^{-}0195^{-}2\frac{1}{2}$ ✓

$239.45^{-}9$ ✓ $= 2,379230\frac{1}{2}$ ✓

$\tau_3 = -54.5^{-}45^{-}$ ✓

$f_3 = 184.914$ ✓

F

$i = 6\ \ 2\ 32.000$ ✓ $= 9,022268\frac{1}{2}$ ✓

$n = 0.196^{-}533\frac{1}{2}$ ✓

$\lambda = 3^\circ\ 5^{-}0'\ 19''.27^{1}$ ✓ $= \sin\ 8,82^{-}5735^{-}$ ✓

$\tau = 1,75^{-}882\frac{1}{2}$ ✓

$\nu = 2\ 12\ 12.729$ ✓ $0.^{-}581617\frac{1}{2}$ ✓

$\sin = 8.^{-}584\ 890\frac{1}{2}$ ✓

99.2492 ✓ $= 1,996727$ ✓

$\tau = 57.001$ ✓

$f_1 = 15^{-}6.2502$ ✓

$-1.05^{-}1$ ✓

$d_2 = 15^{-}5.1992$ ✓

$\tau_2 = 56.994$

212.1932 ✓ $= 2,326731\frac{1}{2}$ ✓

$\nu = 8.^{-}584\ 890\frac{1}{2}$ ✓

$0,911622$ ✓

$\tau_2 = 1,75^{-}829$ ✓

$i = 8^\circ\ 13'\ 48''.68$ ✓ $= \sin\ 9.1^{-}5^{-}793$ ✓

$n = 0,196^{-}33\frac{1}{2}$ ✓

$\lambda = 13\ 0\ 26.16$ ✓ $= \sin\ 9.35^{-}2326\frac{1}{2}$ ✓

$4\ 46\ 37.48$ ✓ $\tau = 1,75^{-}829$ ✓

$2\ 12\ 12.73$ ✓ $1,10815^{-}5^{-}\frac{1}{2}$ ✓

$\nu' = 6\ 5^{-}8\ 50.21$ ✓ $= \sin\ 9.084696$ ✓

$105.5^{-}503$ ✓ $= 2,023459\frac{1}{2}$ ✓

$\tau_2 = 56.994$ ✓

$f_2 = 48.5^{-}5^{-}63$ ✓

$-.815^{-}$

$d_3 = 47.7413$ ✓

$\tau_3 = 54.545^{-}$ ✓

102.2863 ✓ $= 2,009817\frac{1}{2}$ ✓

$\nu = \sin\ 9.084696$ ✓

$1,09451\,3\frac{1}{2}$ ✓

$\tau_3 = 1,73675^{-}3^{-}$ ✓

$i = 13^\circ\ 1'\ 0''\ 26.06$ ✓ $= \sin\ 9.35^{-}7758\frac{1}{2}$ ✓

$n' = 0,213^{-}5^{-}7\frac{1}{2}$ ✓

$\lambda = 8\ 0\ 43,13$ ✓ $= \sin\ 9,144201$ ✓

$5^{-}9\ 42.93$ ✓ $\tau = 1,73675^{-}3^{-}$ ✓

$6\ 5^{-}8\ 50.21$ ✓ $0,880956$ ✓

$\nu' = 1\ 49\ 7.28$ ✓ $= \sin\ 8.5^{-}0153$ ✓

$239.5^{-}48$ ✓ $= 2,379393$ ✓

$54.5^{-}45^{-}$ ✓

$f_3 = 185^{-}.003$ ✓

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B

f_3 = 184,914 ✓
−.324 ✓
d_4 = 184.590 ✓
XII r_4 = 193.462 ✓
$(r-d)$ = 8.872 ✓ = 0,948021 ½ ✓
ν = sin 8.501952 ½ ✓
9,449974 ✓
r_4 = 2.286596 ✓
i = 0° 5′ 0.472 ✓ = sin 7.163378 ✓
n' = 0.208468 ½ ✓
λ = 0 8 5.592 ✓ = sin 7.371846 ½ ✓
0 3 5.120 ✓ r = 2.286596 ✓
ϑ = 1 49 13.16 ✓ 9.658442 ½ ✓
ϑ' = 1 52 18.28 = sin 8.514046 ½ ✓
13.9443 ✓ = 1.144396 ✓
r_t = 193.462 ✓
f_4 = 179.518 ✓ marginal

p.166 179.490 ✓ central
.028 ✓

F

f_{13} = 185.003 ✓
−.324 ✓
d_4 = 184.679 ✓
r_4 = 193.462 ✓
8.783 ✓ = 0,943643 ✓
ν = sin 8.501563 ✓
9,445206 ✓
r_4 = 2.286596 ✓
i = 0° 4′ 57.191 ✓ = sin 7.158610 ✓
n' = 0.213557 ½ ✓
λ = 0 8 5.952 ✓ = sin 7.372167 ½ ✓
0 3 8.761 ✓ r = 2.286596 ✓
ϑ = 1 49 7.28 ✓ 9.658763 ½ ✓
ϑ' = 1 52 16.04 ✓ = sin 8.513902 ✓
13.9592 ✓ = 1,144861 ½ ✓
193.462 ✓
f_4 = 179.503 ✓ marginal

179.420 ✓ central p 166
.083 ✓

f_4B = 179.518 Marginal
5614 = 179.380 ½ "
.137 ½

f_4F = 179.503 Marginal
5614 = 179.380 ½ "
.122 ½

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Contents -

Cost of Glass - 0.3786 (543) and 0.1479 (93) p. 1, 2, 3.
" " Fixtures for Grinding &c p. 6, 7.
" " Mounting p. 8

"Color" by approximate formulae p. 20
" Of finished object glass 0.982 sep. p. 185 + 187
" " " " " final 0.815 sep. p. 38 44
" of 6ct 7ct + 12ct compared p. 47

Index of Refraction with "Hastings" Spectrometer 107
Index of Refraction p. 102 - 108. C and D 190
Internal Reflection I p. 164 - 165
" " II p. 114
" " Finished O. G. p. 161
Radius of curvature of the finished O. G. p. 179 38
Measurement of Objective - Oct 30 1924 - p. 135
T_4 = 187.608 sent Mr. Leundin Nov. 6 '24 p. 136

Separation of finished lenses = 0.815 inches p 186
" to give perfect color correction 0.715 p. 46 from 1 1/3 Lens

Change in T_4 to give perfect color correction (λ=5670) p. 136
~~from 2.134 in Lens~~ (λ=5666) p. 138

C and D from B and 5614 - to compare with Jena data - p 190

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completed calculation I 0.5 separation p. 156 – 9

~~I 1.0 " 177 – 185~~

II [.04 " (p63)] 124 – 127

III 36

IV y = 0. & trok p. 112

V 73

VI 81

VII 1.0 separation 178 – 185

VIII 0.815 separation 38 186

ditto accurate index of Refrt, 44

Sagitta Formulae p 137

Completed Objective (Oct 30 1924) p. 135; 137, 138, 166
(n - p107)

" " Marginal rays p. 191-2-3

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"The Corona of May 29th 1900" sent to

Prof. Charles B. Richards	New Haven	July 14 1905
Dr. Charles S. Hastings	"	"
Mr. C. A. Leundin	Cambridgeport Mass	"
Mr. Garrett P. Serviss	Brooklyn N. Y.	"
Mr. Geo. H. Peters	Washington	Dec. 17th 1905

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1993plae.proj..115ZP

Mr. George E. Howard	Springfield Mass.	July	17th 05
Mr. G. E. Barnes	Hartford	"	21 "
Mr. D. B. Parmelee	"	"	24 "
Miss Beeman	"	"	24 "

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Mr. George E. Howard	Springfield Mass.	July	17th 05
Mr. G. C. Barnes	Hartford	"	21 "
Mr. D. B. Parmelee	"	"	24 "
Miss Beeman	"	"	24 "

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