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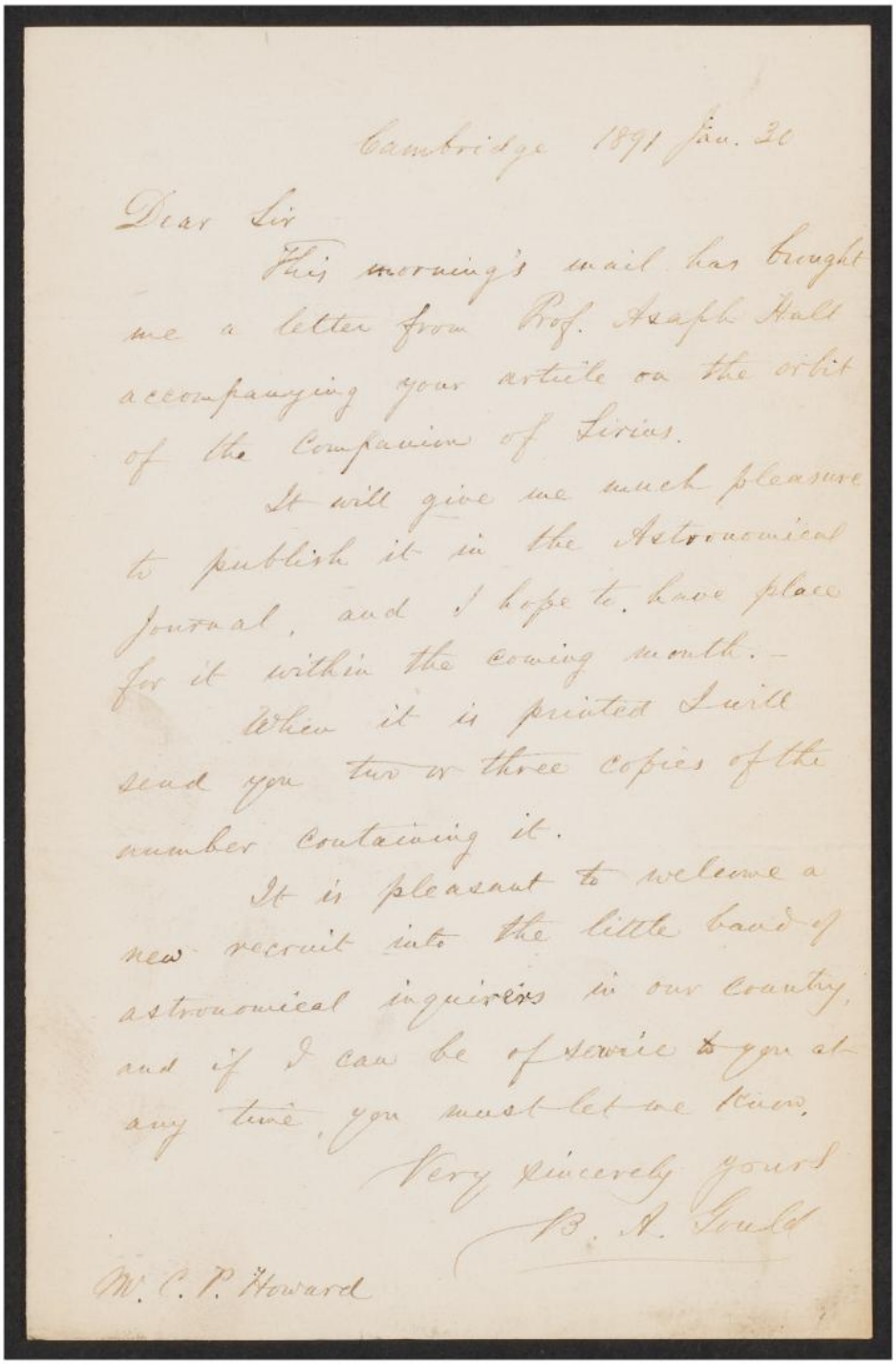
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Cambridge 1897 Jan. 30

Dear Sir

This morning's mail has brought me a letter from Prof. Asaph Hall accompanying your article on the orbit of the Companion of Sirius.

It will give me much pleasure to publish it in the Astronomical Journal, and I hope to have place for it within the coming month. —

When it is printed I will send you ~~two~~ three copies of the number containing it.

It is pleasant to welcome a new recruit into the little band of astronomical inquirers in our country, and if I can be of service to you at any time, you must let me know.

Very sincerely yours
B. A. Gould

W. C. P. Howard

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SHEFFIELD SCIENTIFIC SCHOOL OF YALE UNIVERSITY.

DEPARTMENT OF PHYSICS.

New Haven, Connecticut, Dec 28 1891

My dear Howard:

I have finally got to measuring your prisms with a new pair of telescopes which I have just completed for my spectrometer which require no change of focus from A to h! They are delightful to work with.

With one exception, which appears in the table, I measured each angle but once as I knew you did not care for extreme accuracy. You may, I am quite sure, regard the prob. error as not greater than ± 3"; and be practically certain that there are no errors as much as

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twice this. I also return your table which must surely have some errors of transcription in it — certainly in the case of Cr B and Fl. 5614.

My measures

Barom. 30".2 Temp. 18°.5 C

0.021
58.0

	Comm			Flint		
A	75°	38′	15".2	94°	5′	48".8
B	75	57	58.2	94	44	39.8
C	76	7	24.0	95	4	55.8
✶	76	48	17.8	96	30	{39.5 / 37.4}
F	77	38	17.8	98	22	26.8
G	78	33	30.8	100	34	54.5
H	79	21	8.5	102	34	16.9

There seems to be a systematic error in your flint measures of about + 1′, perhaps from erroneous correction for parallax. Of course there is no parallax with my instrument.

Cordially yours

Charles S. Hastings

P.S. I return prisms by this mail.

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YALE UNIVERSITY
SLOANE LABORATORY
NEW HAVEN, CONN.

October 14, 1915.

My dear Howard;-

I have been an endlessly long time in carrying out my promise to you with respect to your prisms. The delay was generally due to my spectrometer being out of commission; however, I have recently found it necessary to measure some new materials and have naturally taken yours in course with the others. At the bottom of this sheet I will give you such measures as I have made, sufficient in number to determine any other indices with all desirable procision. The compound prism is to be mailed to you this afternoon in an insured package.

If you care to have me calculate the optical constants of your object glass I will very willingly do it after you have supplied me with the mechanical constants, that is the various radii and thicknesses.

Pray remember me to your sister and make a mental resolution to see me when ever you can.

(Dictated)

Very cordially yours,

Charles L. Hastings

Line	Ba. Cr.	Ba. Fl.
C	1.561082	1.617881
λ 5614	1.566067	1.625354
F	1.572259	1.635107
h	1.582722	1.652258

Angle of Prism

60° 1' 10".8

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OBSERVATORY

116 FARMINGTON AVENUE, - HARTFORD, CONN.

LATITUDE,	41°	46′	6″.4
LONGITUDE,	4h	50m	45s.9

Observatory Mean Time is 9m 14s.1 faster than Standard Time.

TELESCOPE.

Diameter of Object Glass,	9.43 inches.
Focal length of Object Glass,	122 "
Focal plane from end of Tube,	$1\frac{2}{8}$ "

MICROMETER.

Value of 1 revolution of Screw,	$21\frac{1}{7}''$
" 4.73 divisions on head of Screw,	1″

1.00 inch Eyepiece magnifies	120 diameters.
0.42 " " "	285 "
0.22 " " "	550 "

SIDEREAL TIME.

Corresponding to Standard Time—Example, April 15th, 1900.

	H.	M.	S.
Standard Time, (75th Meridian,)	4	30	0.0
Reduction from Table III to be added,			44.4
Constant interval to be added,		10	3.4
Sidereal Time, G. M. N. to be added,	1	32	45.1
Sidereal Time,	6	13	32.9

MERIDIAN PASSAGE.

By Standard Time—Example, Polaris, November 20th, 1884.

	H.	M.	S.
Right Ascension,	1	17	45.0
Constant interval to be subtracted,		10	3.4
	1	7	43.9
Sidereal Time G. M. N. to be subtracted,	15	59	36.9
Sidereal interval,	9	8	7.0
Reduction from Table II to be subtracted,		1	29.8
Meridian Passage, Standard Time,	9	6	37.2
Time of next Meridian Passage, earlier,		3	55.91

By Standard Time—Example, Mercury, July 9th, 1884.

	H.	M.
Greenwich Mean Time of Meridian Passage,	23	51.7
One-fifth of daily change,		+ 1.1
	23	52.8
Constant interval to be subtracted,		9.2
Meridian Passage, by Standard Time,	23	43.6

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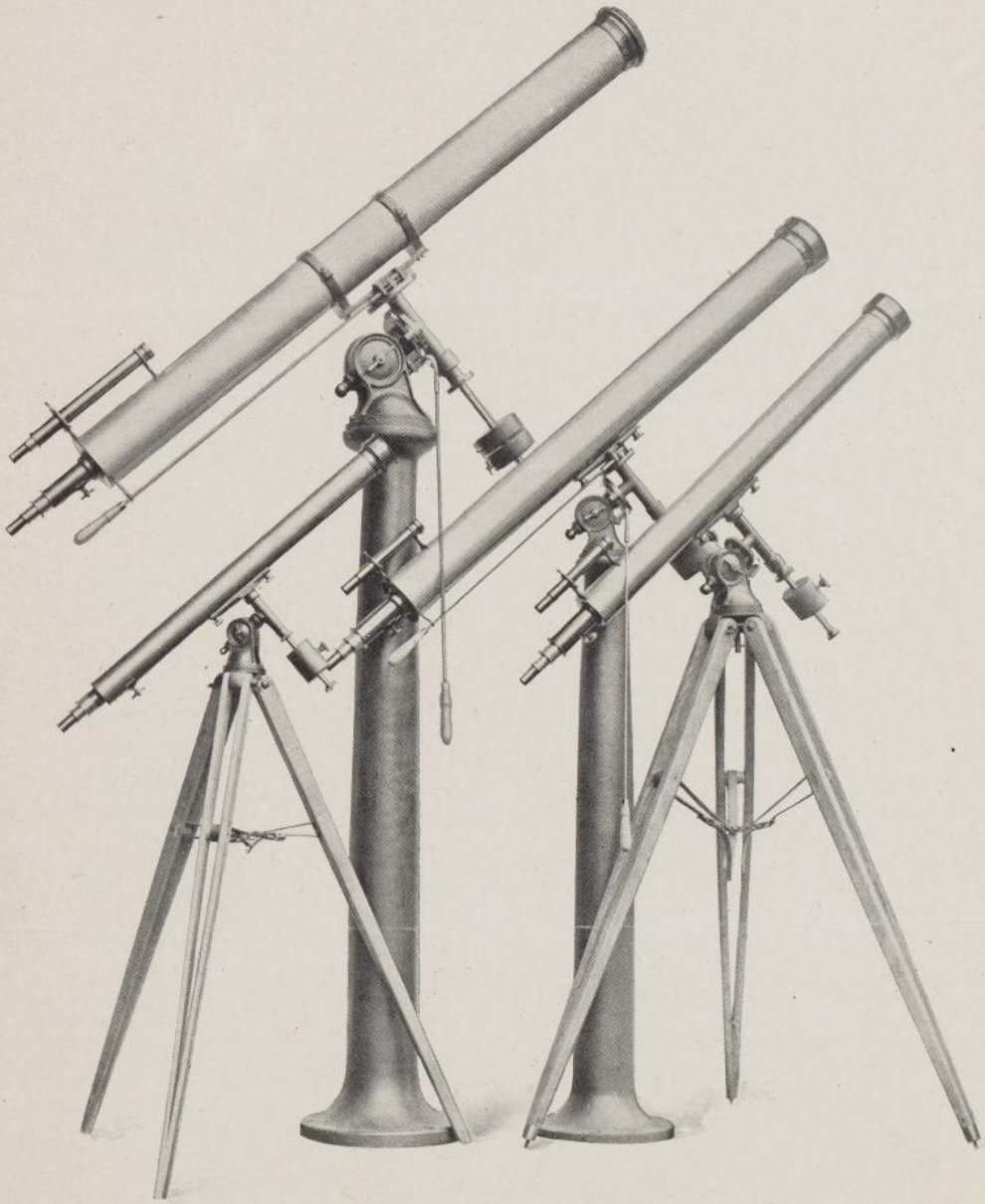
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THE ALVAN CLARK & SONS CORPORATION,

CAMBRIDGEPORT, MASS.



The Alvan Clark & Sons Corporation.

Six-inch Telescope on No. 7 Mounting with Pier.
Five-inch Telescope on No. 6 Mounting with Pier.
Four-inch Telescope on No. 4 Mounting with Tripod.
Three-inch Telescope on No. 3 Mounting with Tripod.

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C. P. Howard – Golf Scores

1897.

		April 28	–	May 1		8	15		18
Date	May 97.								
Plate	Opponents →	Cutter	–	Cutter		Cutter	Cooley		Welch
1		9	6	6	5	8	6	5	6
2		3	6	5	4	6	3	4	4
3		5	7	7	4	4	6	8	4
4		7	9	8	9	15	6	10	10
5		6	6	6	6	6	9	–	6
6		5	9	6	8	9	7	–	6
7		7	6	7	9	10	8	7	6
8		4	5	4	4	5	4	8	6
9		7	4	4	6	7	5	6	4
		53	58	53	55	70	54	–	52
Red									
10		7	8		(4)	5	7	6	6
11		6	(4)		5	6	5	6	4
12		8	(6)		7	6	9	10	7
13		8	8		7	(6)	14	11	9
14		5	5		8	6	7	7	5
15		6	8		6	8	7	8	6
16		5	7		7	6	6	6	(4)
17		5	5		5	5	6	(4)	5
18		7	(4)		7	6	10	7	11
		57	53		56	54	71	65	57
		110	113	–	111	124	125	–	109

Tournament

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1897phae..proj..509H

May 19th		May 30	June 1		June 8	12	14	23	July 9	10	16	Leonid
Mr. Sterling		F. Cooley	Cooley	=	Cooley C. Cooley	Cooley	Cooley	Mark Cooley	alone	Porter Welch	Cooley	
6	8		8	8		8	9	5	7	6	5	5
5	6		6	5		6	4	7	6	5	4	3
3	12		8	5		5	5	5	6	5	9	3
10	11		11	10		9	12	8	11	9	8	6
6	6		8	8		8	7	6	7	5	5	5
8	7		9	8		7	8	6	9	6	9	6
6	8		9	10		6	7	7	7	4	7	4
4	4		6	5		7	7	5	5	7	5	4
5	5		5	4		5	7	6	4	6	5	4
53	67	61	70	63		61	66	55	62	53	57	41
6	7		6		7	6	5	6	5	5	5	4
9	4		6		13	6	6	6	6	5	4	4
10	8		8		6	8	8	9	6	10	9	6
8	8		8		8	9	7	7	7	10	7	6
5	6		6		(4)	7	6	7	6	10	6	4
(5)	7		7		6	5	9	7	6	8	6	5
4	4		6		5	6	6	8	5	7	9	4
7	8		10		7	4	5	6	4	4	5	4
7	10		7		12	7	7	8	9	10	7	4
61	62	59	64		68	58	59	64	54	69	58	41
114	129	120	134			119	125	119	116	122	115	

Immanuel

Abdul Pommanuel

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1897.

	July 17	20	27	29	30	30	Aug 3	5	7	18	21	21	23
White	Welch	Leuthe	Leuthe	Leuthe	Gordon Pinkie	Leuthe	Taylor	Leuthe	Stirling	Cutler	Self	Pinkie	A Bennet
1	6	6		8	7	7	5	7	6	7	6	(4)	7
2	5	5		4	4	4	4	5	4	7	4		3
3	4	5		5	6	7	4	4	5	4	4		4
4	7	9		9	8	7	8	11	11	8	7		10
5	10	8		10	6	7	5	5	6	6	7		5
6	6	7		7	8	6	8	6	8	7	8		6
7	7	7		6	[3]	10	8	8	9	7	7		8
8	4	4		4	5	4	4	5	6	4	5		4
9	6	7		7	6	7	6	6	6	7	7		5
	55	58		60	53	59	52	57	61	59	58		57
Red													Won third Seven
10	9	6	5	4	8			6	7	7	5		5
11	6	8	6	6	5			6	6	6	5		(4)
12	8	9	7	8	8			8	9	6	8		10
13	8	9	8	8	9			7	(5)	8	8		6
14	8	7	8	7	5			7	9	8	6		9
15	8	7	7	10	8			6	8	11	7		9
16	6	8	6	9	6			7	6	6	4		5
17	6	6	4	6	5			5	3	4	8		5
18	7	6	7	6	7			9	6	7	6		6
	66	66	58	64	61			61	59	63	54		59
													Won third Seven
	121	124		124	114			118	120	120	112		111
													Won second third

Medal
7.

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see p.249. see p246. see p246

Sept

25	25	26	27	28	30	31	1	2	3	6	6	10	11	Teams
<Hooker>		ABunce	ABunce	Hooker	ABunce	Leatter	Coulter	Cooley	White	Coulter		Weleh	ABunce	
5-	5-	4	5-	5-	6	8		6	7	7		8	7	4
5-	5-	4	5-	7	3	3		7	5-	4		5-	4	3
4	4	8	5-	3	4	5-		10	3	6		3	Lost ball 5-	3
10	11	7	12	9	7	11		11	7	8		10	7	6
8	9	5-	5-	9	11	7		7	7	7		5-	6 upHill	5-
6	7	5-	6	7	5-	6		4	7	7		6	6 Down	4
7	5-	7	6	7	7	6		6	9	6		6	6	3
5-	4	5-	3	5-	5-	5-		5-	5-	6		5-	5-	4
5-	5-	8	5-	6	5-	7		7	4	6	—	5-	5-	4
53	53	53	52	58	53	58	61	63	54	57	58	53	51	35
		1 up	tie											
3 holes up	3 holes up	6	6	* 6	7	5-		6	5-	4		6	6	4
		5-	5-	4	6	6		4	5-	6		6	7	4
Match for Team 6 holes up		9	7	7	9	10		6	8	8		7	8	6
		7	5-	7	10	8		9	7	5-		7	8	5-
		9	5-	9	7	6		6	7	5-		7	8 upHill	4
		9	6	9	7	7		6	7	6		Lost ball	6 down hill	5-
		7	7	7	5-	4		5-	3	5-		5-	10	3
		4	4	4	5-	4		4	5-	4		4	4	4
		7	8	6	8	6		5-	7	6	—	6	5-	4
		63	53	59	64	56	53	51	54	49	63		62	39
		116	105-	117	117	114	114	114	108	106	121		113	
		Bunce 8 up	APH 2 up							Medal Team				
		Match for Team		* above 15th hole beyond Elm tree						Team				

continued on p.20

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C. P. Howard Golf Scores at South Manchester

	Nov 7 1896 Parlett-		Apr. 16 Lewton		Apr. 16 Austin Cheney		Apr 17. Hooker	
1	8	5-	3-	6	8	5-	6	6
2	6	7	7	6	5-	7	7	6
3	4	7	8	15-	8	9	9	7
4	5-	5-	6	5-	4	4	5-	6
5-	7	7	7	11	5-	8	8	8
6	10	11	14	12	9	11	11	9
7	7	7	9	9	7	8	7-	8
8	7	4	5	6	10	5-	4	7
9	7	7	6	5-	7	6	6	10
	61	60	67	75-	63	63	63	67

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1898

May 22 Tournament H.R. Cheney		May 22 Charles Cheney	June 19 Tournament Monk Cheney		Sept. 18 Tournament Will Cheney		April 2 8 Tournament Horton	Coulter			9 Walter Cheney	16 Cullen				Leonard
9	6	5-	5-	8	6	4	5-	4	5-	5-	3	5-	4	4	3	4
6	7	5-	7	7	6	6	7	5-	5-	8		5-	5-	6		5-
6	8	5-	9	6	5-	5-	4	4	4	8		5-	8	5-		4
6	4	7	4	5-	6	4	4	4	6	5		6	7	4		4
7	9	8	12	9	6	8	5-	7	6	8		6	6	9		5-
9	10	12	9	8	8	9	9	8	9	7		8	7	9	7	8
6	6	5-	7	7	7	6	7	6	5-	5-		5-	6	5-		5-
7	9	4	5-	9	6	6	5-	4	4	7		4	5-	5-		4
6	6	5-	8	8	5-	7	5-	5-	6	4.		4	6	5	4	5-
62	65	56	66	67	55	55	51	47	50	57		48	54	52		44

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	Sept 13	14	20		21	24	25	27	28	29	Oct. 1	2		4
White	A Bunce	Fielder	S.O. Prentice		Cuttler	A Bunce	W. Cheney	alone	A Welch	Cuttler	Cooley	Fuller	—	Hooker
1	7	5	6	8	6	(4)	8	6	5	5	7	7	4	5
2	4		5	4	4	4	5	4	4	4	5	4	6	4
3	6		4	6	6	6	4	5	4	5	5	5	4	4
4	7		12	(5)	(5)	7	6	7	8	10	12	10	10	9
5	7	(4)	5	5	6	4	6	5	4	6	6	5	8	5
6	6		(4)	5	8	6	8	5	9	6	5	6	7	5
7	6		7	6	7	4	8	5	5	7	6	6	6	5
8	6		4	4	4	5	4	6	5	5	6	5	5	5
9	6	—	5	5	4	5	8	6	5	4	6	5	4	5
	53	53	52	48	50	45	57	49	49	52	58	53	54	47
Red								Aleck Bunce						
10	4		6		5	5	5	(3)			6	7		
11	5		5		6	6	5	8						
12	8		8		7	7	(5)	10						
13	7		6		10	7	6	5						
14	7	5	9		6	9	7	6						
15	5		8		6	6	11	6						
16	4	4	4		5	5	7	5						
17	4		3		5	5	3	4						
18	7	—	5		6	6	7	9			6	6		
	51	54	54		56	56	56	56			53	58		
	106	112	106		106	101	113	105			113	111		

Tournament

Medal Tourname

Match with Springfield

Handicap Golf Tournament.

At the handicap tournament of the Hartford Golf club played on the Kenyon street links on Saturday the scores were as follows:

	Gross.	Handicap.	Net.
S. Ferguson	116	29	87
F. F. Small	124	35	89
C. P. Howard	97	4	93
C. H. Tenney	112	16	96
A. Bunce	106	9	97
E. B. Hooker	111	12	99
R. W. Cutler	102	2	100
F. I. Prentice	125	24	101
E. H. Cady	134	32	102
S. O. Prentice	107	4	103
J. S. Camp	126	20	106
E. G. Taylor	130	20	110
A. Perkins	139	29	110
H. C. Welles	155	36	119

S. Ferguson won the first prize, a box of balls, and F. F. Small won the second prize, a golf club. Nov 13. 99.

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	Sept 13	14	20		21	24	25	27	28	29	Oct. 1	2		4
White	A Bunce	Fielder	S.O. Bunce		Lentlin	A Bunce	W. Cheney	alone	A Welch	Lentlin	Worley	Fuller	—	Hobbs
1	7	5	6	8	6	(4)	8	6	5	5	7	7	4	5
2	4		5	4	4	4	5	4	4	4	5	4	6	4
3	6		4	6	6	6	4	5	4	5	5	5	4	4
4	7		12	(5)	(5)	7	6	7	8	10	12	10	10	9
5	7	(4)	5	5	6	4	6	5	4	6	6	5	8	5
6	6		(4)	5	8	6	8	5	9	6	5	6	7	5
7	6		7	6	7	4	8	5	5	7	6	6	6	5
8	6		4	4	4	5	4	6	5	5	6	5	5	5
9	6	—	5	5	4	5	8	6	5	4	6	5	4	5
	53	53	52	48	50	45	57	49	49	52	58	53	54	47
Red								Aleck Bunce						
10	4		6		5	5	5	(3)			6	7		
11	5		5		6	6	5	8			6	6		
12	8		8		7	7	(5)	10			8	6		
13	7		6		10	7	6	5			6	6		
14	7	5	9		6	9	7	6			6	9		
15	5		8		6	6	11	6			7	9		
16	4	4	4		5	5	7	5			6	5		
17	4		3		5	5	3	4			4	4		
18	7	—	5		6	6	7	9			6	6		
	51	59	54		56	56	56	56			55	58		
	106	112	106		106	101	113	105			113	111		

Tournament

Medal Tournament

Match with Springfield

advised the farmer a
harvesting his crops.
largest possible amou
led in all matters pe
and for over half a c
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York City, and a sam
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newspaper cutting effect p.f.

see p202

5	6	7	7	8	13	14	15	16	19	20	21	30	Nov. 5	10	13	Leonard
Crump	S.O. Prentice	S.O. Prentice	Horton	Copley Bogey	Prentice	Prentice	Stirling 4	Brown	Prentice	Curtis	Prentice	Lowther	Sterling	Sterling	Sterling	
5	4	8	6	6	6	6	4	6	8	5	6	7	6	6	6	4
4	4	6	5	4	4	4	4	5	3	6	4	6	4	4	3	3
(3)	5	4	4	5	5	4	4	11	3	5	10	5	5	5	4	3
7	8	8	10	6	6	9	12	7	9	8	6	8	6	8	6	5
4	5	5	5	5	6	6	5	8	8	5	5	5	4	5	6	4
6	7	5	7	6	7	5	6	5	6	7	5	4	4	6	4	4
7	5	6	8	7	4	7	5	5	6	6	5	5	6	5	4	3
5	4	4	4	4	4	5	5	8	3	5	6	4	4	4	5	3
6	5	6	4	5	(3)	5	4	5	5	5	6	5	4	5	6	3
47	47	52	53	48	45	57	49	60	51	52	53	49	43	48	44	32

5	5	5		5	5	7		4	4	5	3	6	5	5	7	3
5	6	6		6	5	5		5	4	4	5	5	6	6	4	4
7	5	7		5	7	7		7	8	5	6	6	7	5	8	5
5	5	=		5	7	6		6	10	7	9	5	5	6	5	5
9	5			6	7	6		8	5	4	6	6	5	8	6	4
5	5			6	5	7		8	5	5	8	7	6	5	5	5
6	6			4	5	6		5	8	8	9	5	7	8	4	3
dark	4			4	5	4		4	4	4	4	5	5	4	7	3
	8			6	6	8		5	7	Left hill dark	6	6	6	5	7	4
	49			47	52	56		52	55	(48)	56	51	52	52	53	36
	96			95	97	107		112	106	(100)	109	100	95	100	97	

Good Golf Play.

Charles Howard is at present playing good golf. His last three scores at the links have been 96, 95 and 97 for the 18 holes.

Evening Post Oct. 14th 97

Bogy Town - lowest score made

Handicap Tournament lowest Score made

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Gillett Cups.
Saturday
p.203

1897

see p.202

November	17	25–	25–	27	Dec 1	3	4	4	6	11	13	18	Jan 22
White	Cuttle	Cooley	Cooley	Cuttle	Cuttle	Brown	Cuttle	Hopkins	Prentice	Prentice	Prentice	Cuttle	Cooley
1	6			8	5 6	8	9	7	5–	4	8	5–	4
2	4			6	5– 5–	5–	5	3	7	3	3	5–	3
3	3			6	6 9	5–	6	5–	4	4	4	4	5–
4	7			8	(5 5–)	7	11	7	7	6	8	7	7
5–	5–			6	4 6	7	5–	5–	5–	4	7	6	4
6	5–			6	6 6	5–	7	5–	6	5–	5–	4	4
7	6			6	6 6	(4	4)	6	6	6	6	5–	6
8	4			4	5– 4	4	5–	5–	4	5–	4	4	7
9	4	—	—	6	– 5–	5–	4	7	5–	6	6	4	6
	44	56		56	52	50	56	50	49	43	51	44	46
Red													
10				6	6		4		6	4	5–	5–	5–
11				5–	6		5		5–	4	4	7	5–
12				6	6		7		7	5–	6	6	7
13				6	7		5–		7	6	6	8	7
14				7	6		6		8	7	4	7	5
15–				6	7		6		5–	(3)	6	4	5–
16				4	6		7		5–	7	5–	5–	5–
17				5–	(2)		4		5–	3	3	4	3
18				5–	7		6		5–	5–	7	6	7
		49		50	52		50		53	44	46	52	49
		105–	101	106	104		106		102	87	97	96	95–
		Handicap 4	Silver Disk 2	Handicap			Handicap 4			Tournament for Gillett Cup		Silver Disk Tournament	Putter not used

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"Post" Dec. 13th 97.

ON THE GOLF LINKS.

Charles P. Howard Winner of the Gillett Trophy.

Charles P. Howard won the Gillett cup at the handicap tournament on the golf links, Saturday, and established a new record for the links. His actual number of strokes was 87, and the best previous record was 89, held by Francis R. Cooley. The cup is to be played for annually until won twice by the same individual. Saturday's scores, with handicap allowances and net scores follow:

	Actual.	Handicap.	Net.
C. P. Howard.....	87	4	83
F. R. Cooley	94	0	94
R. W. Cutler..... ..	96	2	94
I. M. Taylor.....111		16	95
S. O. Prentice.....105		5	100
F. I. Prentice.....128		24	104
C. C. Stearns.....131		27	104
I. S. Camp.....122		14	108
C. P. Cooley.....141		30	111
L. B. Brainard.....119		7	112

"Times" Dec. 13th 1897

New Record for Golf Links.

The Gillett cup contest played on the golf links, Saturday afternoon, was won by Charles P. Howard, who established a new record for the links. His actual number of strokes was 87, and the best previous record was 89, held by Francis R. Cooley. The cup is to be played for annually until won twice by the same individual. Saturday's scores, with handicap allowances and net scores, follow:

	Actual.	Handicap.	Net.
C. P. Howard,	87	4	83
F. R. Cooley,	94	0	94
R. W. Cutler,	96	2	94
S. O. Prentice,	105	5	100
A. P. Day,	126	26	100
C. C. Stearns,	131	27	104
F. I. Prentice,	128	24	104
J. S. Camp,	122	14	108
C. P. Cooley,	141	30	111
L. B. Brainard,	119	7	112
H. H. White,	136	19	117
W. P. Conklkin,	134	16	118
J. L. Goodwin,	138	20	118

The silver scratch medal contest will be played Wednesday, and the handicap prize tournament, Saturday.

Post. Nov. 14th 1898.

THE GILLETT CUP.

Alexander Bunce Won it at the Annual Contest.

The annual tournament for the Gillett cup was played Saturday on the Hartford Golf club links.

Alexander Bunce was the successful competitor and won the cup with a net score of 83, with a handicap of six. His score of 89 gross was two better than his best previous record.

The best scores made were:

	Gross.	Handicap.	Net.
A. Bunce.....	89	6	83
C. E. Shepard.....100		11	89
C. C. Stearns.....107		18	89
R. W. Cutler.....	90	0	90
E. B. Hooker.....106		15	91

C. P. Howard, the winner last year, has been ill and was unable to compete. The cup must be won three times to become the property of the winner. It is a sterling silver loving cup or beautiful design and was presented to the club last fall by Albert B. Gillett.

Loomis

4
3
3
5
4
4
3
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32

3
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6
4
3
3
2
4
33

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1898

New Lenks — course 4 or 5 shots harder than last year

	May 2 Mordini	7 Leuthe	Horker	16 Cooley	18	21 Saturday Stirling		July 23 Whipple	25 Cooley	30 Horker	1 Aug	4 Leuthe	8 Romney Leuthe
1		5	6	8	8	8	5	5	4	7	6	5	5
2		4	3	5	8	4	8	4	6	4	4	5	5
3		5	4	5	4	7	6	3	4	6	6	5	5
4		6	6	9	12	5	9	8	7	9	8	7	7
5		6	6	-	7	5	10	6	8	6	5	6	9
6		5	6	-	6	6	5	5	6	6	5	5	6
7		6	4	15	9	6	9	5	6	10	5	7	8
8		9	7	-	8	7	9	8	8	6	8	7	7
9		4	5	-	4	5	6	5	5	4	5	4	4
		50	47		66	53	67	49	54	58	53	51	56
10	5	4	4	4	5	5	7	4	3	4	6	5	5
11	6	6	9	4	5	4	6	4	5	4	5	4	6
12	5	6	5	4	6	6	8	6	5	10	5	5	6
13	6	6	6	5	6	7	5	6	4	5	5	5	6
14	7	7	6	6	4	8	5	5	5	6	6	8	5
15	5	7	6	6	4	7	7	7	5	6	4	8	4
16	6	4	5	4	5	6	6	4	4	6	5	5	4
17	2	4	2	5	6	6	4	4	5	4	3	5	4
18	7	6	7	5 7	6	6	6	6	7	9	7	10	8
	49	50	50	45	46	53	54	46	43	54	46	53	48
		100	97		112	108	121	95	97	112	104	106	104

Bogey Medal see p. 203 — Silver Disk Handicap — Handicap Cup — Olympian Cup — Handicap

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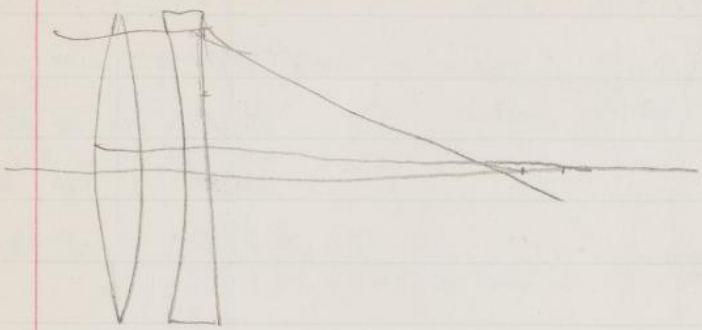
November	1	2	3	Kit 7	8	9	Alice 11	Kit 12	alma 14	Ki 15	Mofa 16	Rankin 21	Hosken 22	Alma 23
	6	5-	7	6		4	5-	7	5-	5-	4	7	6	4
	5-	7	4	7		5-	5-	4	3	6	5-	4	7	3
	5-	4	6	7		5-	5-	5-	4	5	5-	5-	6	3
	7	7	6	7		9	8	5-	7	10	12	8	8	5-
	5-	9	7	7		7	7	6	7	7	5-	5-	6	5-
	7	5-	4	6		5-	6	5-	6	7	5-	5-	5-	5-
	5-	5-	7	9		6	5-	6	4	4	6	6	5-	4
	7	10	7	8		7	8	7	8	11	8	10	9	6
	7	4	5-	5-		5-	4	5-	4	4	4	6	4	4
	54	56	53	62		53	53	50	48	59	54	56	56	39
					6		5-		4	4	6	6	5-	2
					4		6		5-	5-	5-	4	4	4
					4					5-		6	5-	4
					8								5-	4
					9								6	4
					6								4	4
					6								5-	4
					4								5-	2
					10								6	5-
					57								45-	34

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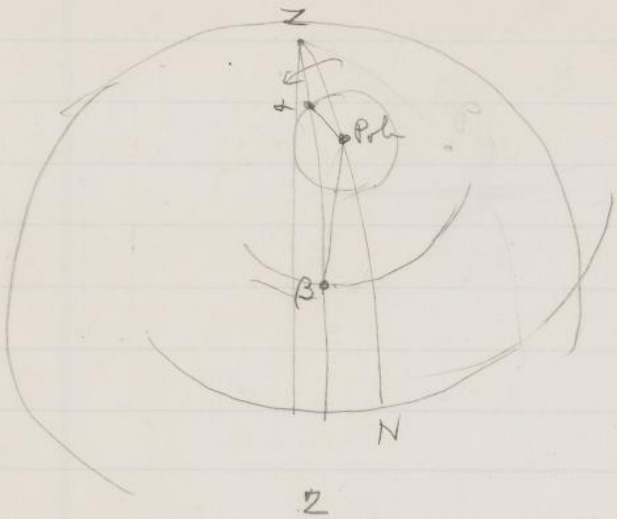




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α and β Ursae Minoris in vertical plane



Jan 20th - 1910

β Ursae Minoris

R.A. $14^h\ 50^m\ 57^s.0$

Decl $74^\circ\ 31'\ 5-$

N.P.D $15-\ 28\ 53-$

Polaris

R.A. $1^h\ 26^m\ 31^s.3$

Decl $88\ 49\ 50$

N.P.D. $1\ 10\ 10$

h	m	s
14	50	57.0
1	26	31.3
13	24	25.7
10	35	34.3

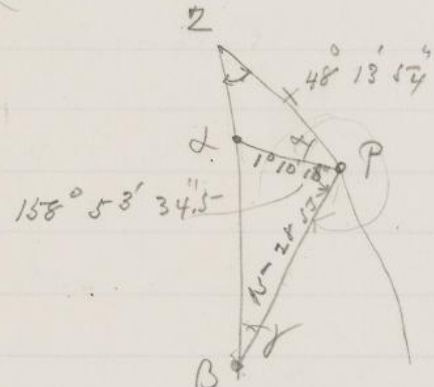
$10^h = 150^\circ$

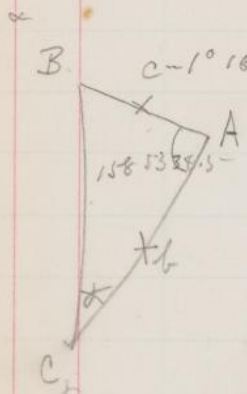
$35^m = 8^\circ\ 45'$

$32^s = 8$

$2.3 = 34.5$

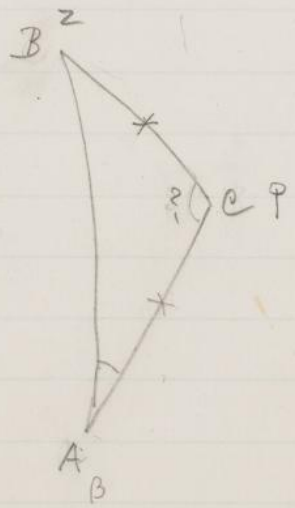
$= 158^\circ\ 53'\ 34''.5$





$\tan X = \tan c \cos A$

$\cot C = \dfrac{\sin(b-X)\cot A}{\sin X}$



$\cot \nu = \tan A \cos b$

$\cos \nu' = \cos \nu \tan b \cot a$

$C = \nu \pm \nu'$

p. 193

41 46 6

48 13 54

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Jan. 1910

C = 1° 10′ 10″ = Tan 8.30992

A = 158° 53′ 34.″5 = − cos 9.96984 −

χ = − 1° 5′ 27.″6 − Tan 8.27976

χ = − 178 54 32.4

b = 15 28 53

− 163 25 37.4 = sin − 9.45373

A = 158 53 34.5 = cot − 0.41340

9.86913

χ = 178° 54′ 32.″4 = sin 8.27968

cot = 1.58945

C = 1° 28′ 27.″3

9005

52 | 60.4 | 7.3

54

260

A = 1° 28′ 27.″3 = Tan 8.41054

b = 15 28 53 = cos 9.98395

d = 88 34 45.″2 = cot 8.39449

d = 88 34 45.″2 = cos 8.39436

b = 15 28 53 = Tan 9.44246

a = 48 13 54 = cot 9.95090

d′ = 89 38 54.8 = cos 7.78772

d = 88 34 45.2

C = 178 13 40.0

158 53 34.5

α = 19 20 5.5 = 1h 16m 0s

1 20 0.37

1h 17m 24.5 after Polaris on meridian

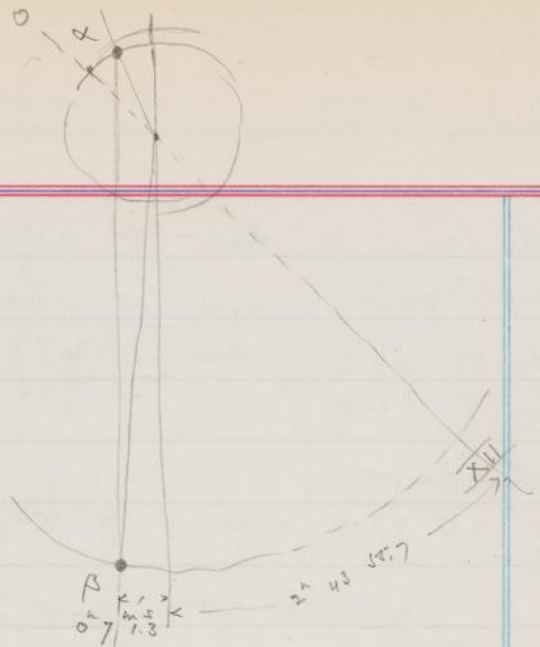
R. A. of Polaris = 1 26 31.3

Sidereal Time = 2 43 55.7 when in vertical plane

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1897phae.proj..539H

continued from p. 29.



14	50	57.0
14	43	55.7
	7	1.3

β vertically under α.

at Sidereal Time = $2^h\ 43^m\ 55.7^s$

α Past Meridian = $1\ 17\ 24.4$

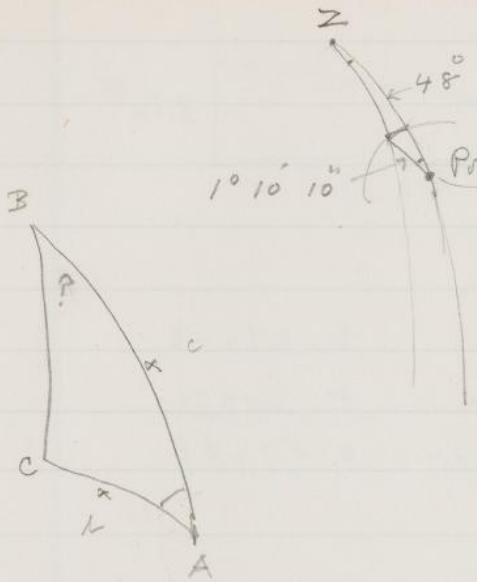
β from " = $0\ 7\ 1.3$



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1897phae.proj..539H

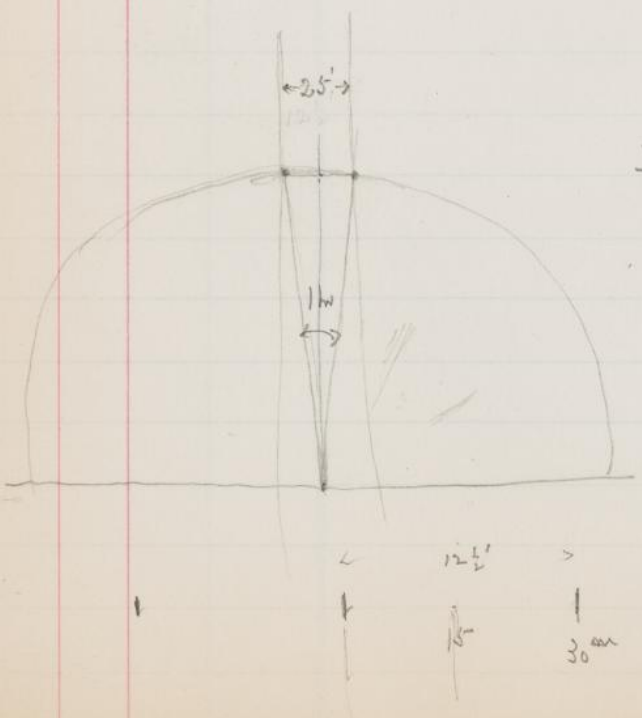
— Polaris — Deviation from true north in 30m from Meridian Pass.



$\tan \varphi = \tan b \cos A$ ✓

$\cot B = \dfrac{\sin (c - \varphi) \cot A}{\sin \varphi}$ ✓

$b = 1° 10' 10''$ ✓	= tan	8.30992
$A = 7° 30' 0''$ ✓	= cos	9.99626
$\varphi = 1° 9' 34''$	= tan	8.30618
$c = 48\ 13\ 37$		
$47\ 4\ 20$	= sin	9.86464
$A =$	cot	0.88057
		0.74521
$\varphi =$	sin	8.30610
$0° 12' 30.4''$	cot	2.43911
$B = 0° 12' 30.4''$		57000 | 25 and 0.4



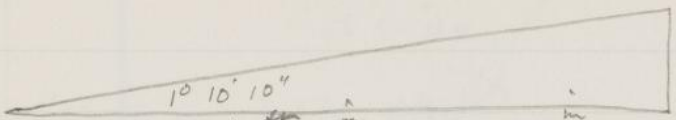
$\frac{12.5'}{30''} = 0.'4$ de min

$0.'007$ de sec

$0''.4$ de sec

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14 mi 4¼ fur = 172.25 mi

172.25 = 2,23616

tan 1°10' 10" = 8,30992

3.5163 = 0.546,08

14
12
168
4¼
172¼

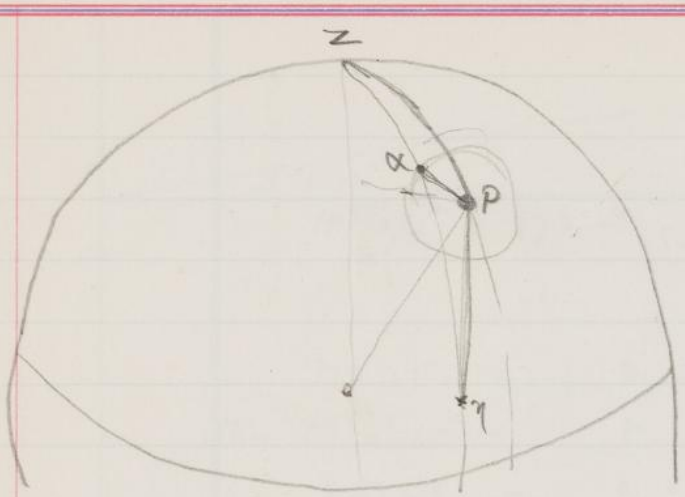
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Feb. 1st 1910 α Ursae Minoris and η Draconis in same vertical plane



α Ursae Minoris

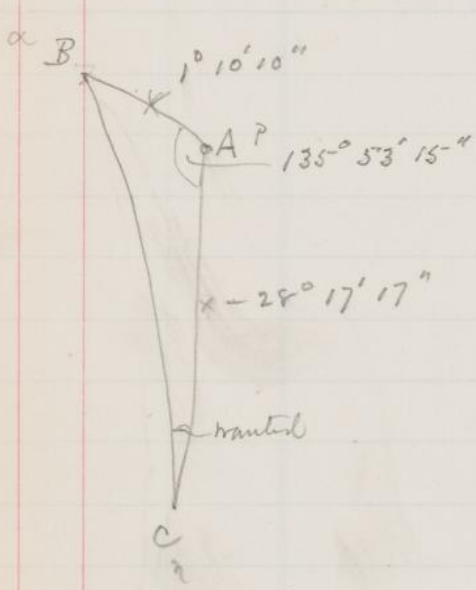
R. A. = 1h 26m 18.s4

N.P.D. = 1° 10' 10"

η Draconis

R. A. = 16h 22m 41s

N.P.D. = 28° 17' 17"



	h	m	s
	16	22	41
	1	26	18
	14	56	27
	24	0	0
A =	9	3	33

$9^h = 135^\circ$

$3^m = 45'$

$32^s = 8'$

$15^s = 15''$

$135^\circ 53' 15''$

$\tan \chi = \tan c \cos A$

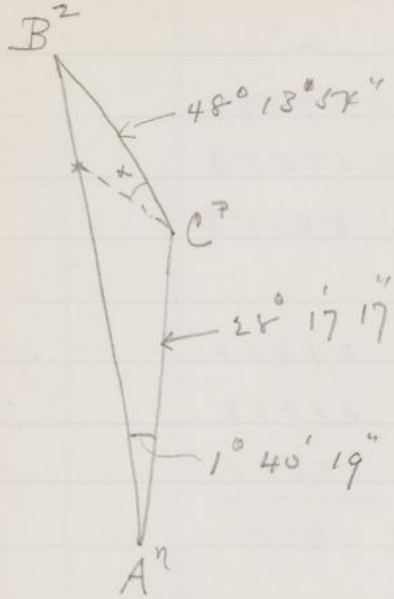
$\cot C = \dfrac{\sin(b-\chi)\cot A}{\sin \chi}$

c =	1° 10' 10"	= log	8.30992
A =	135° 53' 15"	= cos −	9.85611
	0 30 22.9	= log −	8.16603
χ =	179 9 37.1		
b =	28 17 17		
$(b-\chi)$ =	150 52 20	= sin	9.68731
A − 90		= cot	0.01346
			9.70077
χ =		= sin	8.16599
C =	1° 40' 19"	= cot	1.53478

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Continued



$\cot \nu = \tan A \cdot \cos b$

$\cos \nu' = \cos \nu / \tan b \cot a$

$C = \nu + \nu'$

$A =$	1°	40'	19"	$= \tan$ 8.46522
$b =$	28	17	17	$= \cos$ 9.94476
$\nu =$	88	31	39.6	$= \cot$ 8.40998

$\nu =$				$= \cos$ 8.40980
$b =$	28	17	17	$= \tan$ 9.73092
$a =$	48	13	57	$= \cot$ 9.95091
$\nu' =$	89	17	33	$= \cos$ 8.09163
ν	88	31	40	
$C =$	177	49	13	
	135	53	15	
$\alpha =$	41	55	58	

41°	=	2h	44m
55'	=		3 40s
58"	=		4
		2h 47m	44s after Polaris
		1 26	18 = R.A. Polaris
		4h 14m	2s

In Vertical plane — Sidereal Time ——

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The lesrown and Flint glass obtained from Jena for #23 & #31 measured as follows

	n	#23	n'	#31
7	1.5-4437		1.5-9571	
D	1.5-3693	1.5368	1.5-8553	1.5900
b	1.5-3389		1.5-8153	
b − 7	.01048	.01049	.01418	.01438
D − 7	.00744	.00743	.01018	.01022
D − b	.00304	.00306	.00400	.00416
$\frac{n-1}{\Delta n}$	51.2	51.2	41.3	41.1

.01418✓ = 8.1517 ✓
.01048✓ = 8.0204 ✓
0.1313 ✓

$n-1$ = 9.7299 ✓
.7264✓ = 9.8612 ✓

$n'-1$ .5855✓
.7409✓ = 9.1489 ✓
B = 7.0982✓ = 0.8511 ✓
0.1313 ✓
A = 9.647✓ = 0.9844 ✓

Rudp. 154
$\gamma = 0.41$
Book

$\gamma = 5.8$

.01018✓ = .00744✓ + .0000 5536
.00400✓ = .00304✓ +
.00979o✓ + 22620
.00039 ✓ .000032740✓

744 = 7.8716✓ × 2 = 5.7432✓
304 = 7.4829✓ × 2 = 4.9658✓
0.3887 ✓ 0.3887✓
400 = 7.6021✓ 5.3545✓
7.9908

$\gamma = 11.91$
B

$\delta\varphi$ = .00468✓

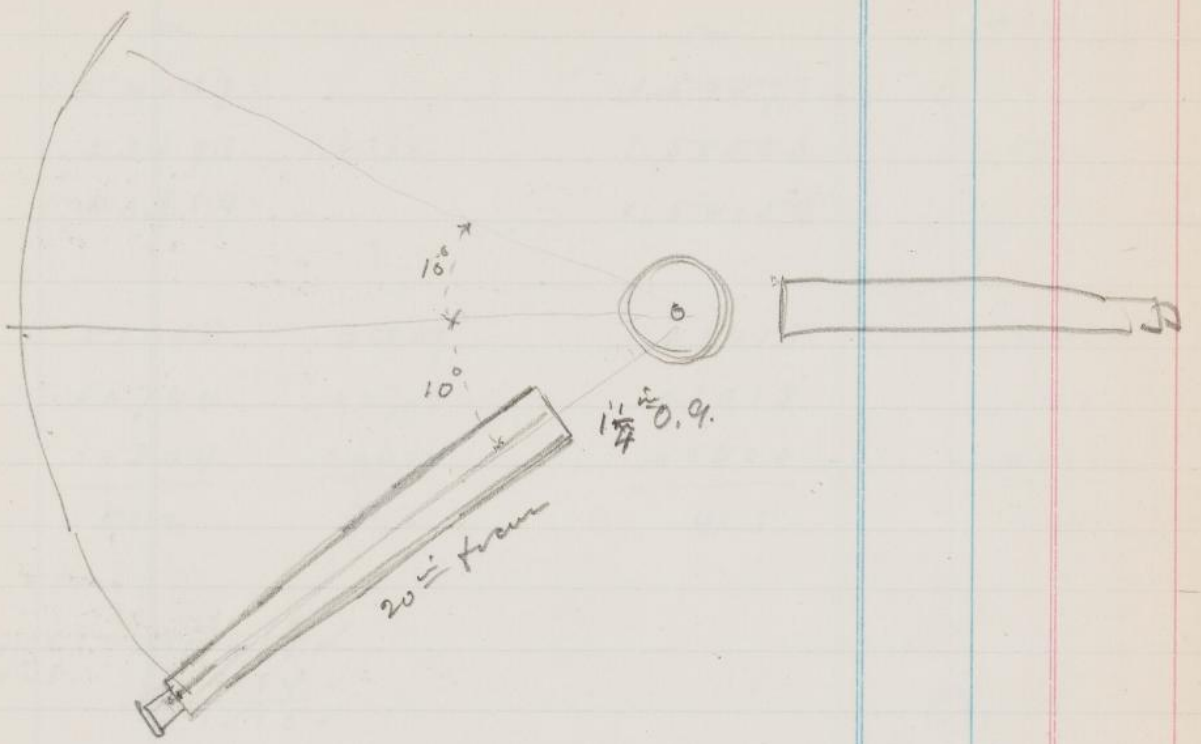
6.5911 ✓
5.5156 ✓
= 1.0700 ✓
= 0.8511 ✓
= 5.7432 ✓
= 7.6703 ✓

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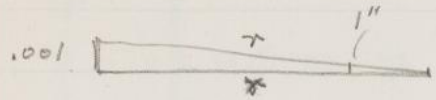
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$\sin 1'' = \frac{.001}{r}$ $\quad r = \frac{.001}{\sin 1''}$

$.001 = 7.000000$
$\sin 1'' = 4.6856$
$= 2.3144$

$r = \begin{cases} 206,26 \text{ m} \\ 17.19 \text{ ft} \end{cases}$

7.0000
$\sin 1'' = 6.4637$
$r = 8.438 = 0.5363$

$\sin \alpha = \frac{.001}{r}$

7.0000
$20 = 1.3010$
$x = 10'' = \sin \quad \bar{1}.6990$

$16 \overline{)20} (1.25$
$\underline{16}$
40

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Nov. 24 1902 3/2ª lesson.

Approximate D

$\delta = 38^\circ\ 39'\ 58''$

$\alpha = 60\ 5^m\ 2^s$

$2 \overline{)\ 98\ 45^m\ 22^s}$

$49\ 22\ 41 = \sin\ 9.880253$

$\sin \tfrac{1}{2}\alpha = 9.699560$

$n_D = 1.515908 \qquad 0.180693$

$n_7 = 1.522246$

$n_c = 1.513291$

$n_7 - n_c = .008955 = 7.96237$

$n_D - n_7 = 0.515591 = 9.712570$

$V = 56.26 = 1.750.20$

1.522246

$1.515591 \overline{)\ .006650\ (714}$

6419

1310

917

3930

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The Crown of 3½" and Flint of 4½" make a remarkably good combination for color-

	n	n'	
7	1.52246	1.63010	
D	1.51598	1.61807	
b	1.51329	1.61323	
b to 7	.00917	.01687	
D to 7	.00648	.01203	
D to b.	.00269	.00484	
$\frac{n-1}{\Delta n}$	56.3 (48 is nearest)	36.6 (35 is nearest)	
	0.114	0.167	

.01687 = 8.2271
.00917 = 7.9624
0.2647
$n-1$ = .5160 = 9.7126
.9491 = 9.9773
$n'-1$ .6181
− .3310 = 9.5198
B = − 3.021 = 0.4802
0.2647
A = 5.588 = 0.7449

0.01203 = .00648 C + .0000414 95 y
.00484 = .00269 C + 17432 y
.01166 =
.00037 = .00002 4063

7.8116 × 2 = 5.6232
7.4297½ × 2 = 4.8595
0.3818½ 0.3818½
7.6848½ 5.2413½
8.0667

y = 15.4 = 6.5682 / 5.3813 / 1.1869
B = 0.4802 / 5.6232 / 7.2903
$\delta\varphi$ = .00195 =

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0.144 and 0.726
#5 #74

$n_7' - n_C' =$ 0.01142 = 8.0577
$n_7 - n_C =$ 0.00797 ✓ = 7.9015 ✓
0.1562

$n_D - 1 =$ 0.5100 ✓ = 9.7076 ✓
0.7308 9.8638 ✓

$n_5' - 1 =$ 0.5398 = 9.
0.1910 = 9.2810

$B =$ −5.236 = 0.7190
0.1562

$A =$ 7.502 = 0.8752

0.00810 = .00554 C + .00023125 y
0.00332 = .00238 C + .00000566 ✓
.00 7797 = .00554 C + .1330 y
.000303 = .1795 y

.00554 = 7.7474 ✓ × 2 = 5.4948 ✓
.00238 = 7.3766 ✓ × 2 = 4.7532 ✓
0.3708 8.3708
.00332 = 7.5211 5.1240
7.8919

6.4814
5.2541
y = 16.88 = 1.2273
B = 0.7190
δn_7^2 = 5.4948
$\delta\varphi$ = .002761 = 7.4411

(7-9)

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0.144 and 0.184
#5 #31

0.01438 = 8.1578
.00797 = 7.9015
0.2563

.5100 = 9.7076
.9202 9.9639
.5900 = ~~9.7709~~

$\frac{1}{B}$ = .3302 = 9.5188
B = −3.028 = 0.4812
0.2563

A = 5.464 = 0.7375

.01022 = .00539 C + .00003125 y
.00416 = .00238 C + .00000566 y
~~.00938~~ .00970 = ~~.00539~~ C + .00001330 y
.00145 .00001795 y

.00539 = 7.7474 × 2 = 5.4948
.00238 = 7.3766 × 2 = 4.7532
0.3708 0.3708
.00416 = 7.6191 5.1240
7.9899

6.6532
5.2539
y = ~~17.89~~ 25.08 = 1.3993
B = 0.4812
δn^2 = 5.4948
δq = .002373 = ~~7.2286~~ 7.3753

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0.57 and 0.184
#6 #31

		8.1578	
	0.00823	= 7.9154	
		0.2424	
$n_2 - 1$	.5086	= 9.7064	
	.8888	= 9.9488	
$n_1 - 1$	.5900		
	.2988	= 9.4757	
B =	3.346	= 0.5246	
		0.2424	
A =	5.848	= 0.7670	

.01022 = .00578 C + .000033404
.00416 = .00245 C + .000006003
.009813 ——— .000014161
.000407 .000019243

.00578	= 7.7619	× 2	= 5.5238	
.00245	= 7.3892	× 2	= 4.7784	
	0.3727		0.3727	6.6096
.00416	= 7.6191		5.1511	5.2842
	7.9918		$\frac{J}{B}$ = 21.15	= 1.3254
			$\frac{B}{\delta n^2}$	= 0.5246
				5.5238
		$\delta\varphi$ =	.002365	7.3738

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0.144 and 0.5$\bar{6}$9
#5$\bar{}$ #6$\bar{}$

0.01385$\bar{}$ = 8.1414
= 7.9015$\bar{}$
0.2399
9.7076

0.8861 9.9475$\bar{}$
0.5738
−0.3123 = 9.4946
B = 3.202 = 0.5$\bar{}$05$\bar{}$4
0.2399
A = 5.563 = 0.7453

.00987 =
.00398 =
.00934 8
.00052 2

on p. 43

0.3708
.00398 = 7.5999
7.9707

6.7177
5.2539
μ = 29.09 = 1.4638
B = 0.5054
Σn^2 = 5.4948
Σq = .002911 = 7.4640

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0.144 and 0.118
#5 #34

0.01660 = 8.2201
= 7.9015
0.3186

9.7076

1.0622 = 0.0262

0.6129

- .4493 = 9.6525

B = -2.226 = 0.3475
0.3186

A = 4.635 = 0.6661

.01184 =

.00476 =
.00118
.00066

0.3708 0

.00476 = 7.6776
8.0484

see p 43

6.8195
5.2539

f = 36.78 = 1.5656
B = 0.3475
δn^2 = 5.4948
$\delta\varphi$ = .002588 7.4079

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0.144 and 0.154
#3 #29

0.01327 = 8.1229
7.9015
0.2214
9.7076
0.8492 = 9.9290
0.5710
0.2782 = 9.4444
B = 3.594 = 0.5556
0.2214
A = 5.984 = 0.7770

.00943 =
.00384 =
.009018 =
.000412

2m p. 43

0.3708
00384 = 7.5843
7.9551

6.6149
V.2539
γ = 22.96 = 1.3610
B = 0.5556
δm^2 = 5.4948
$\delta\varphi$ = .002579 = 7.4114

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0.144 and 0.602
45 d 53

.01072 = 8.0302
7.9015
0.1287
9.7076
− 6.6860 = 9.8363
0.5676 -
0.1184 = 9.0734
B = 8.445 = 0.9266
0.1287
A = 11.36 = 1.0553

.00759 =
.00313 =
.007350
.000240

0.3708
.00313 = 7.4957 -
7.8663

6.3802
5.2539
γ = 13.38 = 1.1263
B = 0.9266
δπ² = 5.4948
δφ = .00353 ✓ 7.5477

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0.144 and 0.318
≠ 66

.01575 = 8.1973
7.9015
0.2958
9.7076

1.0079 = 0.0034
0.6031
0.4048 = 9.6072

B = 2.471 = 0.3928
0.2958

A = 4.882 = 0.6886

.01128 =
.00451 =
.010593
.000647

0.3708
.00451 = 7.6542
8.0250

γ = 35.06 =

$\delta\varphi$ = .002784

6.8109
5.2539
1.5570
0.3928
5.4948
7.4446

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0,144 and 0,340

.01396 = 8.1449
7.9015⁻
0.2434
9.7076
0.8934 = 9.9510
0.5774
0.3160 = 9.4997
B = 3,164 = 0.5003
0,2434
A = 5,542 = 0.7437

.00994 =
.00402 =
.00944
.000499

0.3708
.00402 = 7.6042
7.9750

6.6981
5.2539
.f = 27.81 = 1.4442
0.5003
5.4948
δφ = .002750 7.4393

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0.144 and 0.748

$\bar{.}015\bar{9}9 = 8.2038$

7.9015^-

0.3023

9.7076

1.0230 0.0099

$.6231^-$

$.3995^- = 9.6015^-$

$B = 2.5^-03 = 0.3985^-$

0.3023

$A = 5^-.021 = 0.7008$

.01142 =

.00457 =

.010732 =

.000688

0.3708

7.65^-99

8.0307

6.8376

$5^-.2539$

$J = 38.34 = 1.5837$

0.3925^-

5.4948

$\delta\varphi = .002999 = 7.4770$

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0.144 and 0.167

.01691 = 8.2281
7.9015⁻
0.3266
9.7076
1.0820 = 0.0342
.6169
.4651 = 9.6675⁻
B = 2.150 = 0.3325⁻
0.3266
A = 4.561 = 0.6591

.01206 =
.00485⁻ =
.01139 =
.00067 =

0.3708
7.6857
8.0565⁻

6.8261
5.2539
δ = 37.34 = 1.5722
0.3325⁻
5.4948
8η = .002509 7.3995⁻

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0.144 and 0.93

.01743 = 8.2413
7.9015
0.3398
9.7076

1.1153 = 0.0474
0.6245
0.4908 = 9.6909

B = 2.038 = 0.3091
0.3398

A = 4.456 = 0.6489

.01243 =
.00500 =
.011744
.000686

0.3708
7.6990
8.0698

6.8363
5.2539
1.5824
0.3091
5.4948
7.3863

f = 38.23 =

$\delta\varphi$ = .002434

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0.144 and 0.378

.01193 = 8.0766
7.9015-
0.1751
9.7076
0.7633 = 9.8827
0.5473
0.2160 = 9.3345-
B = 4.629 = 0.6655-
0.1751
A = 6.983 = 0.8406

.00847 =
.00346 =
.008126
.000344 =

0.3708
7.5391
7.9099

6.5366
5.2539
1.2827
0.6653-
5.4948
.002773 = 7.4430

J = 19.17 =

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0.60 and 0.184

#31

$n'_7 - n'_c$ .01438 = 8.1578

$n_7 - n_c$ .00860 = 7.9345

0.2233

$n - 1$ .5179 = 9.7142

.8660 = 9.9375

$n' - 1$ .5900

.2760 = 9.4409

B = 3.623 = 0.5591

0.2233

A = 6.059 = 0.7824

Think

.01022 = .00605 + .0000 3661

.00416 = .00255 + .

.00 9872 .0000 15428

.000348 .0000 21182

7.7818 × 2 = 5.5636 γ

7.4065 × 2 = 4.8130 γ

0.3753 0.3753

7.6191 5.1883

416

7.9944

6.5416

5.3260

γ = 16.43 = 1.2156

0.5391

5.5636

.002179 7.3383

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0.114 and 0.184

8.1578
.00910 = 7.9590
0.1988

.5151 = 9.7119
.8141 = 9.9107
.5900
.2241 = 9.3504
B = 4.463 = 0.6496
0.1988
A = 7.053 = 0.8484

.01022 = .00642 + .00004121
.00416 = .00268 + .00000 ~~+7203~~
.00 99655 .00001 7203
.0002545 .00002 4007

7.8075⁻ × 2 = 5⁻.6150
7.4281 × 2 = 4.8562
0.3794 0.3794
7.6191 5⁻.2356
7.9985⁻

~~6~~.4057
5⁻.3803
10.60 = 1.0254
0.6496
5⁻.6150
δ4 = .001950 7.2900

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0.2164 and 0.184

.0 8.1578

.00873 = 7.9410

0.2168

.5102 9.7077

.8405⁻ = 9.9245⁻

.5900

.2505⁻ = 9.3988

B = 3.992 = 0.6012

0.2168

A = 6.577 = 0.8180

.01022 = .0066 + .00003795 f

.00416 = .00257 + .00001583 f

.00972

.000248

22119

7.7896 × 2 = 5.5792

7.4099 × 2 = 4.8198

0.3797 0.3797

7.6.91 5.1995⁻

7.9988.

f = 11.21

δφ = .001698

6.3945⁻

5.3448

1.0497

0.6012

5.5792

7.2301

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0.381 and 0.184
56 31

8,1578
.01026 = 8,0111
0.1467

.5262 = 9.7211
.7376 = 9.8678
.5900
.1476 = 9.1691
B = 6.775 = 0.8309
0,1467
A = 9.498 = 0.9776

.01022 = .00727 + .00005285
.00416 = .00299 + 21737
.010114
.000106 .00003 1113

7.8615 × 2 = 5.7230
7.4757 × 2 = 4.9514
0.3858 0.3858
7.6191 5.3372
8.0049

6.0253
5.4929
0.5324
0.8309
5.7230
7.0863

$f = 3.407$

$\delta\varphi = .001225$

p48 mark

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0.608 and 0.184

8.1578

.00943 = 7.9745-

9.1833

.0.8149 = 9.7117

.0.7853 = 9.8950

.8900

−0.1953 = 9.2907

B = 5.120 = 0.7093

9.1833

A = 7.809 = 9.8926

.01022 = .00666 C + .00004436 y

.00416 = .00277 C + .00001845 y

.000217 .00002591 y

7.8235- × 2 = 5-.6470

7.4425- × 2 - 4.8850

0.3810 0.3810 6.3365-

7.6191 5-.2660 5-.4135-

8.0001

y 8.376 = 0.9230

B = 0.7093

δn^2 = 5-.6470

$\delta\varphi$ = .001902 = 7.2793

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0.2388 and 0.184

8.1578
.00852 7.9304
9.2274
.5254 9.7205
.08870 9.9479
.5900
0.2970 = 9.4728
B = 3.367 = 0.5272
0.227x
A = 5.683 0.7546

.01022 = .00602 C + .0000 36241 y
.00416 = .00250 C + 15049
.010019 =
.000201 .0000 21192 y

7.7796 × 2 = 5.5592
7.3979 × 2 = 4.7958
0.3817 0.3817
7.6191 5.1775
8.0008

6.3032
5.3261
y = 9.487 = 0.9771
B = 0.5272
δx^2 = 5.5392
.001157 = 7.0635

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0, 2001 and 0.184

8.1878
.01007 = 8.0030
0,1848

.5211 = 9.7169
.7442 = 9.8717
.5900
.1542 = 9.1881
B = 6.485 = 0,8119
.1548
A = 9.262 = 0.9667

.01022 = .00710 C + .0000 5042 y
.0046 = .00299 C
.00945 = + 2109
.000275 .0000 2933

7.8513 x 2 = 5.7026
7.4728 x 2 = 4.9456
0.3785 0.3785
7.6191 5.3241
7.9976

		6.4393
		5.4673
y =	9,273 =	0.9720
B	=	0.8119
δx^2	=	5.7026
δy =	.003065 =	7.4865

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0.2164 and 0.93

flint 7-c .01743 = 8.2413 ✓

Crown 7-c .00873 ✓ = 7.9410 ✓

0.3003 ✓

$n_D - 1$ 0.5102 ✓ 9.7078 ✓

1.0188 ✓ 0.0081 ✓

$n'_D - 1$ 0.6245 ✓

0.3943 ✓ = 9.5958 ✓

B = - 2.537 ✓ = 0.4042 ✓

0.3003 ✓

A = 5.063 ✓ = 0.7045 ✓

.01243 ✓ = .00616 ✓ + .00003795 γ

.00500 ✓ = .00257 ✓

.01199 .00001583 γ

.00044 .00002212 γ

.0616 = 7.7896 ✓ × 2 = 5.5792 ✓

.0257 = 7.4099 ✓ × 2 = 4.8198 ✓

0.3797 ✓ 0.3797 ✓ γ = 19.90 ✓ = 1.2988 ✓

.00500 = 7.6990 ✓ 5.1995 ✓ B = 0.4042 ✓

8.0787 ✓ δn^2 = 5.5792 ✓

$\delta\varphi$ = .001915 ✓ = 7.2822 ✓

6.6435 ✓

5.3447 ✓

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0.381 and 0.93

.01743 = 8.2413 ✓

.01026 ✓ = 8.0111 ✓

0.2302 ✓

$x_2 - 1$ 0.5262 ✓ = 9.7212 ✓

0.8942 ✓ 9.9514 ✓

$x^5 - 1$ 0.6245 ✓

0.2697 ✓ = 9.4309 ✓

B = -3.707 ✓ = 0.5691 ✓

0.2302 ✓

A = 6.300 ✓ = 0.7993 ✓

.01243 ✓ = .00727 ✓ + .00005284 ✓

.00500 ✓ = .00299 ✓ + 2174 ✓

.01215 7

.000273 .00003110 ✓

.00727 = 7.8615 ✓ × 2 = 5.7230 ✓

.00299 = 7.4757 ✓ × 2 = 4.9514 ✓

0.3858 ✓ 0.3858 ✓ 6.4362 ✓

.00500 = 7.6990 ✓ 5.3372 ✓ 5.4928 ✓

8.0848 ✓ γ = 8.778 ✓ = 0.9434 ✓

B = 0.5691 ✓

δn^2 = 5.7230 ✓

$\delta\varphi$ = .001720 ✓ 7.2355 ✓

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0.152 and 0.93

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1897phae.proj..539H

0.2118 and 0.93

.01743 = 8.2413
.00858 = 7.9335-
0.3078

a-1 .5095 = 9.7071
1.0350 = 0.0149
0.6245
0.4105 = 9.6133
B = 2.437 = 0.3867
0.3078
A = 4.949 = 0.6945

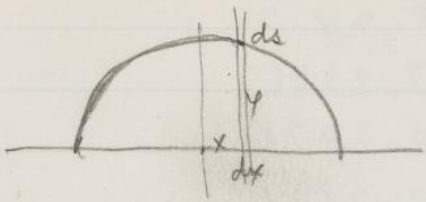
.01243 = .00604 C + .0000364γ
.00500 = .00254 C +
.01189 = .00604 C + 15340 γ
.00054 .0021135 γ

7.7810 × 2 = 5.5620
7.4048 × 2 = 4.8096
0.3762 0.3762
7.6990 5.1858
8.0752

6.7324
5.3250
γ = 25.5 = 1.4074
B = 0.3867
δn² = 5.5620
.002271 = 7.3561

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1897phae.proj..539H



$$ds = \sqrt{dx^2 + dy^2}$$

$$dM = y\,ds = y\sqrt{dx^2 + dy^2}$$

$$r^2 = x^2 + y^2$$

$$0 = 2x\,dx + 2y\,dy$$

$$-x\,dx = y\,dy$$

$$dx = -\frac{y}{x}\,dy$$

$$dx^2 = \frac{y^2}{x^2}\,dy^2$$

$$dM = y\sqrt{\frac{y^2}{x^2}dy^2 + dy^2} = y\sqrt{\frac{y^2}{x^2} + 1}\cdot dy$$

$$x^2 = r^2 - y^2$$

$$y^2 = r^2 - x^2$$

$$y = \sqrt{r^2 - x^2}$$

$$\frac{dy^2}{dx^2} = \frac{x^2}{y^2}$$

$$= y\sqrt{\frac{y^2}{r^2 - y^2} + 1}\cdot dy$$

$$M = \int_0^r y\sqrt{\frac{y^2}{r^2 - y^2} + 1}\cdot dy$$

$$= \left(1 + \frac{dy^2}{dx^2}\right)^{\frac{1}{2}} dx$$

$$= \left(1 + \frac{dy^2}{dx^2}\right)^{\frac{1}{2}} y\,dx$$

$$= \left(1 + \frac{x^2}{y^2}\right)^{\frac{1}{2}} y\,dx$$

$$= \left(1 + \frac{x^2}{r^2 - x^2}\right)^{\frac{1}{2}} \left(r^2 - x^2\right)^{\frac{1}{2}} dx$$

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$W = p \cdot \frac{1}{2}\pi r^2$

$W = p \cdot 2\pi r \frac{1}{4}$

$dM = p\, y\, ds$

$M = 2pr^2$

$\frac{M}{W} = \frac{2pr^2}{\pi pr} = \frac{2r}{\pi} = 0.636r$

$y\sqrt{1 + \frac{x^2}{y^2}} \cdot dx$

$\sqrt{y^2 + x^2} \cdot dx$

$\sqrt{r^2 - x^2 + x^2} \cdot dx$

$\sqrt{r^2}\ dx$

$dM = r\, dx$

$M = r\int_{-r}^{r} dx = r(r + r) = 2r^2$

3.14) 4.00 (1.27
3.14
860
628
2320

3.14) 1.000 (.315
942
580
314
1660

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$\rho : (R \text{ ~~+dσ~~}) :: y : r$

when $y = r$, $\rho = R$

$\rho = \frac{R}{r} y$

$\frac{\rho}{y} = \frac{R}{r}$



$dM = \rho \cdot ds \cdot t y$

ρ is proportional by

$\rho = \frac{R}{r} \cdot y$

$dM = t \frac{R}{r} y^2 ds$

$ds^2 = dx^2 + dy^2$

$ds = \sqrt{dx^2 + dy^2}$

$= \left(1 + \frac{dy^2}{dx^2}\right)^{\frac{1}{2}} dx$

$dM = \frac{tR}{r} y^2 \left(1 + \frac{dy^2}{dx^2}\right)^{\frac{1}{2}} dx$

$r^2 = x^2 + y^2$ circle $\quad 0 = \frac{1}{2} x\,dx + \frac{1}{2} y\,dy$

$y^2 = r^2 - x^2$ $\quad x\,dx = -y\,dy$

$\frac{dy}{dx} = -\frac{x}{y}$

$\frac{dy^2}{dx^2} = \frac{x^2}{y^2} = \frac{x^2}{r^2 - x^2}$

$dM = a\left(r^2 - x^2\right)\left(1 + \frac{x^2}{r^2 - x^2}\right)^{\frac{1}{2}} dx$

$= a\left(r^4 - \cancel{2} r^2 x^2 + \cancel{x^4} + \cancel{r^2 x^2} - \cancel{x^4}\right)^{\frac{1}{2}} dx$

$= a\left(r^4 - r^2 x^2\right)^{\frac{1}{2}} dx$

$= ar\left(r^2 - x^2\right)^{\frac{1}{2}} dx$ ✓

$M = \frac{tR\pi r^2}{r\,4}$ Bowser p 334 half circle

$M = \frac{tR\pi r^2}{2} = 1.57\, tR r^2$

$dM = ar\left(r^2 - x^2\right)^{\frac{1}{2}} dx$

$2M = ar \int 2\sqrt{r^2 - x^2}\, dx$

$2M = ar\left(x\sqrt{r^2 - x^2} + r^2 \sin^{-1} \frac{x}{r}\right)$ Bowser p 56 46.

$M = ar\left(\frac{1}{2} x\sqrt{r^2 - x^2} + \frac{1}{2} r^2 \sin^{-1} \frac{x}{r}\right)_{-r}^{+r}$

$\left(\frac{1}{2} r\sqrt{r^2 - r^2} + \frac{1}{2} r^2 \sin^{-1} 1\right)$

$-\left(\frac{1}{2} r\sqrt{r^2 - r^2} + \frac{1}{2} r^2 \sin^{-1} -1\right)$

$\frac{1}{2} r^2 \sin^{-1} 1 - \cancel{\frac{1}{2} r^2 \sqrt{2}} = \frac{1}{2} r^2 \sin^{-1} -1$

$\cancel{\frac{1}{2} r^2 \arc 90^\circ} - \cancel{\frac{1}{2} r^2 \sqrt{2}} - \cancel{\frac{1}{2} r^2 \arc 270^\circ}$

$M = ar\left(r^2 \cdot \frac{1}{2}\sqrt{2}\right)$

$M = -ar^3 \cdot \frac{1}{2}\sqrt{2}$

3,14

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$R_0 = \frac{4M}{\pi \delta^2}$

$2.7^- = 0.439_2$

0.878

9.903

0.781

3.932

0.781

$= 3.15^{-1}$

$10800 = 8156$

$R_0 = 1430$

$3\overline{)5720}$

$R = 1907$ per sqin

cuf p 229

2.1^-

2.1^-

12^-

$5\text{-}0$

6.25^-

18.75^-

1000

18750.00 u

$2\pi^- = 0.439_2$

0.878

$3.14 = 0.497$

1.375^-

$36000 = 4.886$

1.375^-

3.181

$1520 = 4$

$3\overline{)6080}$

2027

$\int (r^2 - x^2)^{\frac{1}{2}} dx$ ~~p 334 Bowser (9) ← 3. 293 Bowser (9) 39. p 344 Bowser~~

$= \frac{x(r^2 - x^2)^{\frac{1}{2}}}{2} + \frac{r^2}{2} \sin^{-1} \frac{x}{r}$

$M = ar\left(\frac{r(r^2 - r^2)^{\frac{1}{2}}}{2} + \frac{r^2}{2} \sin^{-1} 1 - \frac{-r(r^2 - r^2)^{\frac{1}{2}}}{2} - \frac{r^2}{2} \sin^{-1} -1 \right)$

$= ar\left(\frac{r^2}{2} \sin^{-1} 1 - \frac{r^2}{2} \sin^{-1} -1 \right)$

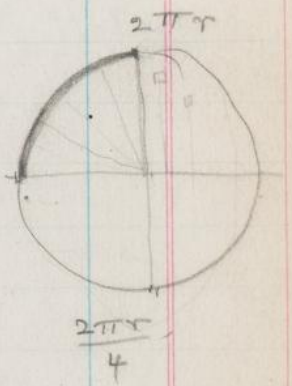
$= \frac{ar^3}{2}\left(\sin^{-1} 1 - \sin^{-1} -1 \right)$

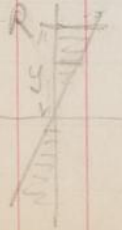
$= \frac{ar^3}{2}\left(\text{arc } 90^\circ - \text{arc } 270^\circ \right)$

$= \frac{ar^3}{2}\left(\frac{1}{2}\pi - \frac{3}{2}\pi \right)$

$= -\frac{ar^3}{4}(\pi)$

$\therefore = \frac{a\pi r^3}{4}$ example (9) p. 334 Bowser. this should be $\frac{a\pi r^3}{4}$ $\sin^{-1} 1 = \frac{1}{2}\pi$. (when $r = 1$)





$p : R :: y : r$

$p = \frac{R}{r} y \quad a_y = \frac{R}{r} y$

$a = \frac{R}{r}$

$M = \frac{R \pi r^3}{r \times 2} = \frac{tR\pi r^2}{2}$ t = thickness of rim

$= \frac{5000 \times 3\frac{1}{2} \times 2.5 \times 2.5^- \times \frac{3}{4}}{4}$

$= 18750 \frac{\text{in lbs}}{\text{sec}^2}$

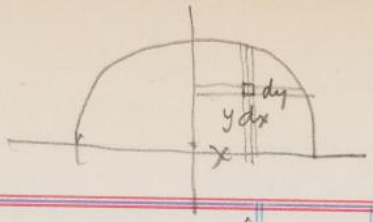
R = resistance of extreme fibre per sq in

$= 10000$ for steel

$= 5000$ for cast iron

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$dM = \rho\, dx\, dy \cdot y$

$\rho = ay$

$dM = ay^2\, dx\, dy$

$= a\left(r^2 - x^2\right)\left(-\frac{x}{y} \cdot dx\right) dx$

$= a\left(r^2 - x^2\right)\left(-\frac{x}{\sqrt{r^2-x^2}} \cdot dx\right) dy$

$= -a\, x \sqrt{r^2 - x^2} \cdot dx^2$

$r^2 = x^2 + y^2$

$0 = 2x\, dx + 2y\, dy$

$dx = -\frac{y}{x}\, dy$

$x = \sqrt{r^2 - y^2}$

$dx = -\frac{y}{\sqrt{r^2-y^2}}\, dy$

$y^2 = r^2 - x^2$

$dy = -\frac{x}{y}\, dx$

$y = \sqrt{r^2 - x^2}$

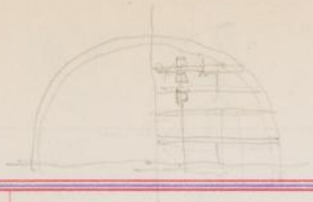
$dM = ay^2\, dx\, dy$

$= a\, y^2 \left(-\frac{y}{\sqrt{r^2-y^2}} \cdot dy\right) dy$

$= -\frac{a y^3}{\sqrt{r^2-y^2}} \cdot dy^2$

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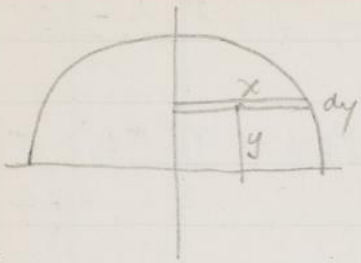
1897phae.proj..539H



$\rho = \frac{R}{r} y$

$x\,dy$

$dM = \rho x y\,dy = \frac{R}{r} x y^2 dy$



$dM = \rho x dy \times y = \rho r y dy$

$= \frac{R}{r} x y^2 dy$

$M = \frac{R}{r} \int_{-r}^{r} x y^2 dy$

$r^2 = x^2 + y^2$

$x = \sqrt{r^2 - y^2}$

$= \frac{R}{r} \int \sqrt{r^2 - y^2} \cdot y^2 \cdot dy$

$\int (r^2 - y^2)^{\frac{1}{2}} y^2 dy$

$\int y^2 (r^2 - y^2)^{\frac{1}{2}} dy$

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$P = \frac{R}{y} t s$

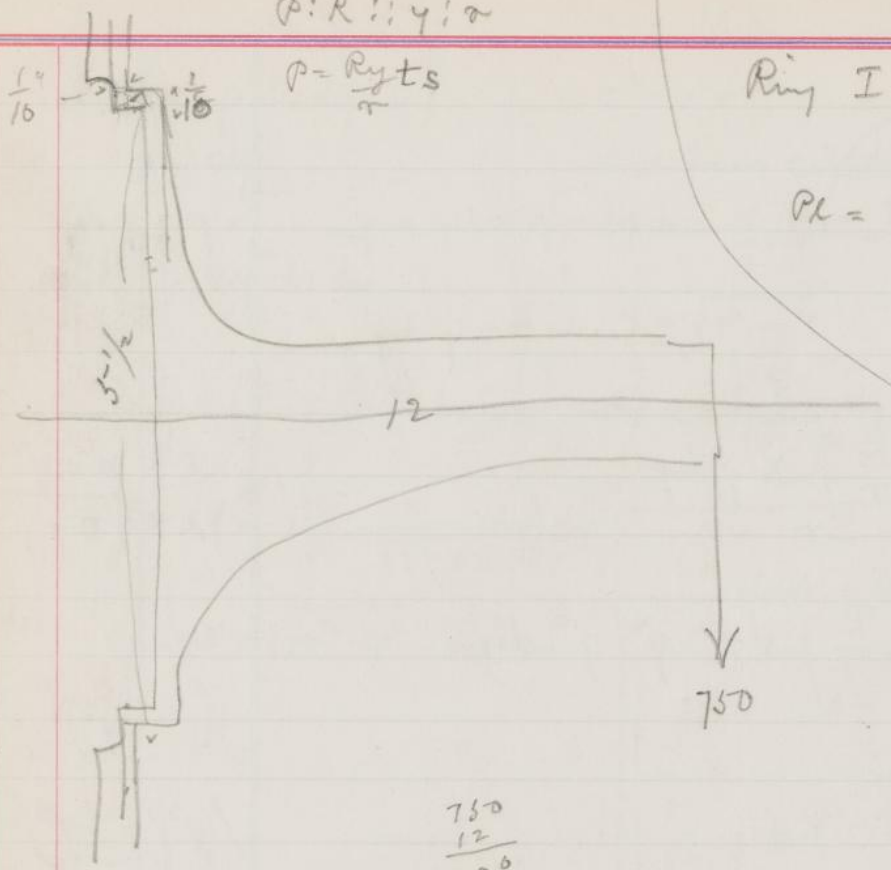
$P : R :: y : r$

$P = \frac{R y}{r} t s$

$Pl = \frac{RI}{c} = \frac{R II}{r}$

Ring $I = \frac{\pi (d^4 - d_1^4)}{64}$

$Pl = \frac{\pi (5.5^4 - 5.4^4) R}{64 \times 2.75}$



750
12
9000

t = .1

$M = \frac{\pi R t r^2}{4} = 9000$

$R = \frac{9000 \times 4}{\pi r^2} = \frac{36000 \times 10}{\pi \times 2.75^2}$

$2.75 = 0.439$
0.878
$3.14 = 0.497$
1.375
$.75 = 9.875$
1.250

$36000 = 5.536$
1.375
$4.181 = 15000$

$36000 = 4.536$
1.250
$R = 2020 = 3.306$

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Leyboldt

$D = \frac{5.50}{.75} = \frac{0.740}{2.960} = 912.$

$D_1 = \frac{0.676}{2.704} = \frac{506}{406}$

$5.5 = \frac{0.740}{3.060} = 1146.$

$406 = 2.608$
0.497
3.105
2.245
0.860

$5.4 = \frac{0.7324}{2.9296} = \frac{850}{298} = 2.474$

$3.14 \quad = 0.497$
2.971

$9000 = 3.95.4$
0.660
3.094

$1242 =$

$64 = 1.806$
$2.75 = \frac{0.439}{2.245}$

$= \frac{2.245}{0.726}$

$5.32 =$

$9000 = 3.95.4$
0.726
3.228

$1690.$

$9000 = 5.32 R$

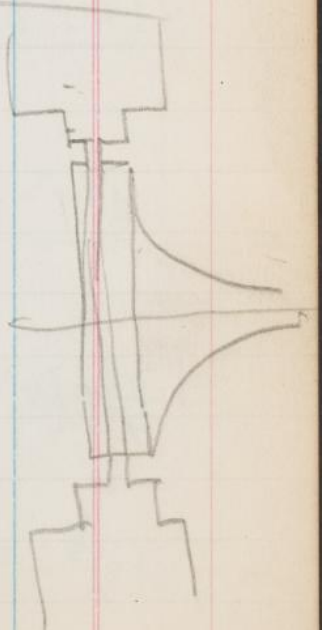
$R = 1690$

Impts

$M = \frac{R + \pi r^2}{2} = 9000$

$R \times \frac{3}{4} \times 3.14 \times 2.75 \times 2.75 = 18000$

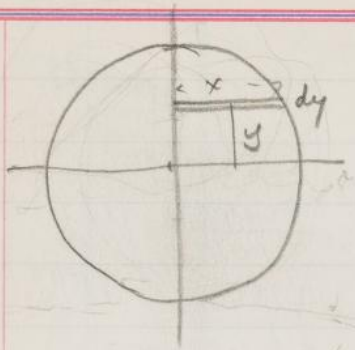
$R = 1010$



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Moment of Inertia of circle



$$dM = a x y^2 dy$$

$$I = \int x y^2 dy$$

$$= \int (r^2 - y^2)^{\frac{1}{2}} y^2 dy$$

$$= \int y^2 (r^2 - y^2)^{\frac{1}{2}} dy$$

Bowser - p. 247

$$\int x^m (a + b x^n)^p dx$$

$$\int x^2 (a + b x^2)^{\frac{1}{2}} dx$$

$$\begin{cases} x^2 = y^2 \\ a = r^2 \\ b = -1 \\ m = 2 \\ n = 2 \\ p = \frac{1}{2} \end{cases}$$

(A) p 287

$$= \frac{y (r^2 - y^2)^{\frac{3}{2}} - (1) r^2 \int (1) (r^2 - y^2)^{\frac{1}{2}} dy}{-1 (1 + 2 + 1)}$$

$$= \left[\frac{y (r^2 - y^2)^{\frac{3}{2}} - r^2 \int (r^2 - y^2)^{\frac{1}{2}} dy}{-4} \right]_{-r}^{+r}$$

$$= \left[\frac{1}{4} y (r^2 - y^2)^{\frac{3}{2}} - \frac{1}{4} r^2 \left(\frac{y (r^2 - y^2)^{\frac{1}{2}}}{2} + \frac{r^2}{2} \sin^{-1} \frac{y}{r} \right) \right]_{-r}^{+r}$$

$$= \cancel{\frac{1}{4} y (0)^{\frac{3}{2}}} - \frac{1}{4} r^2 \left(\cancel{\frac{y (0)^{\frac{1}{2}}}{2}} + \frac{r^2}{2} \sin^{-1} 1 \right) - \left[\cancel{\frac{1}{4} 4 (0)^{\frac{3}{2}}} - \frac{1}{4} r^2 \left(\cancel{\frac{y (0)^{\frac{1}{2}}}{2}} + \frac{r^2}{2} \sin^{-1} -1 \right) \right]$$

$$= \frac{r^2}{4} \left(\frac{r^2}{2} \sin^{-1} -1 - \frac{r^2}{2} \sin^{-1} 1 \right) = \frac{r^4}{8} \left(\frac{3}{2} \pi - \frac{1}{2} \pi \right) = \frac{r^4}{8} (\pi) = \frac{\pi r^4}{8} \text{ for half circle}$$

$$I = \frac{\pi r^4}{4} \text{ for circle}$$

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Tube

$$I = \frac{\pi}{4}\left(r_1^4 - r_2^4\right)$$

$$= \frac{\pi}{4}\left(r_2^4 - n^4 r_2^4\right)$$

$$= \frac{\pi}{4}\left(n^4 - 1\right) r^4$$

$r_1 = n r_2 \qquad n = \frac{r_1}{r_2}$

$t = nr$

$$M = \frac{R}{r} \cdot \frac{\pi r^4}{4}\left(n^4 - 1\right)$$

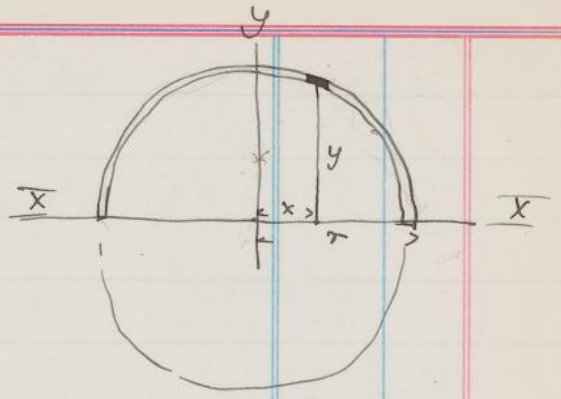
$$M = \frac{\pi R r^2 t}{2} = \frac{\pi R n r^3}{2}$$

$$M = \frac{\pi R r^3}{4}\left(n^4 - 1\right)$$

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Moment of Inertia of circumference of circle –



$\rho \div R :: y : r$

ρ = tension of fibre for sq in
R = " " extreme fibre
r = radius of circle

$$\rho = \frac{R}{r} \cdot y$$

circ $= \pi d$
$= 2\pi r$

$$dM = \rho \cdot ds \cdot y = \frac{R}{r} y^2 ds = \frac{R}{r} \cdot I$$

$$\therefore \quad I = y^2 ds$$

$y^2 = r^2 - x^2$ (circle)

$$ds = \sqrt{dx^2 + dy^2}$$
$$= \left(1 + \frac{dy^2}{dx^2}\right)^{\frac{1}{2}} dx$$

$$\frac{dy}{dx} = -\frac{x}{y}$$

$$\frac{dy^2}{dx^2} = \frac{x^2}{y^2} = \frac{x^2}{r^2 - x^2}$$

$$I = \int (r^2 - x^2)\left(1 + \frac{x^2}{r^2 - x^2}\right)^{\frac{1}{2}} dx$$

$$= \int \left((r^4 - r^2x^2 + x^4) + r^2x^2 - x^4\right)^{\frac{1}{2}} dx$$

$$= \int r\,(r^2 - x^2)^{\frac{1}{2}} dx$$

p. 334 Bowser.

$$= r\left[\frac{x\,(r^2 - x^2)^{\frac{1}{2}}}{2} + \frac{r^2}{2} \sin^{-1}\frac{x}{r}\right]_{-r}^{+r}$$

$$= r\left(\frac{r\,(r^2 - r^2)^{\frac{1}{2}}}{2} + \frac{r^2}{2}\sin^{-1} 1 - \frac{-r\,(r^2 - r^2)^{\frac{1}{2}}}{2} - \frac{r^2}{2}\sin^{-1}-1\right)$$

$$= \frac{r^3}{2}\left(\sin^{-1} 1 - \sin^{-1}-1\right)$$

$$= \frac{r^3}{2}\left(\text{arc } 90^\circ - \text{arc } 270^\circ\right)$$

$$= \frac{r^3}{2}\left(\frac{\pi}{2} - \frac{3\pi}{2}\right) = \frac{r^3}{2}(-\pi) = \frac{\pi r^3}{2}$$

$I = \pi r^3$ (by Polar Axis method)

Remainder $I = \frac{\pi r^3}{2}$ Complete circle $M = \frac{R}{r} \cdot \frac{\pi r^3}{2} = \frac{\pi R r^2}{2}$

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$m^2 \pi A$

$M = 9000$

$r = 2.75$

$$R = \frac{2M}{\pi r^2} = \frac{18000}{3.14 \times 2.75^2} = 760$$

$2.75 = 0.439_{2}$

0.878

$3.14 \quad 0.497$

1.375

$18000 = 4.25$

1.375

$760 = 2.880$

$760 \times \frac{4}{3} = \frac{3040}{1000}$

For circle $I = \frac{1}{4}\pi r^4$

$$M = \frac{R}{r} I = \frac{R}{r} \cdot \frac{\pi r^3}{4} = \frac{R \pi r^2}{4}$$

$$R = \frac{M}{\pi r^2} = \frac{9000}{\pi r^2} = 380 \text{ lbs per in.}$$

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7 in Object Glass. Jena Crown #18 Flint #29
(First one made)

The calculated curves are —

$r_1 = 23000$ in convex } Crown
$r_2 = 9.965$ " }
$r_3 = 9.804$ Flint concave } Flint
$r_4 = 32.691$ " convex }

These curves are too deep for this density of glass, and the flint will not correct the crown for spherical abberation but the edge comes out "short focussed" and the only way to correct this fault is to use instead of spherical surfaces, surfaces shaped like this



which lengthens the focal length of the edge and shortens that of the center.

Although a little was gained in this way, considerable remained that could not be reduced and the image of a star looked fuzzy then



Mr. Leundine of Alvan Clark & Sons regrounded the 1st surface of the flint, but had to give it up as impossible to make perfect.

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Measurment of Object Glass. 18 - 29 Nov. 14th 1898.

After Mr. Lundin worked on some of the surfaces.

Air 75°

After standing 1½ hour. to adjust temperature .167

1st Surface.	"Plane"	0.158 no	.159	.156
		0.148	.148	0.011
		0.010	0.011	convex

log k = 2.30114

.011 = 8.04139

r_1 = log 4.25975⁻ = 18186.5⁻ = r_1

$\frac{h}{2}$ = 0

2nd Surface	Plane	21.159	.158	.168
		.866	.866	.877
		20.293	20.292	20.291
				convex

log k = 2.30114

20.291 = 1.30730 / 0.99384 = 9.8592 = ~~r_1~~

$\frac{h}{2}$ = .1015 / 9.9607 = r_2

log 0.99829

3rd Surface.		21.054	.054	concave .053
	Plane	.411	.411	.410
		20.643	20.643	20.643

log k = 2.30179

20.643 = 1.31477 / 0.98702 = 9.7056

$\frac{h}{2}$ = .1032 / 9.8088 = r_3

Log. 0.99162

4th Surface	Plane	6.158	.158	.168
		.008	.008	convex .018
		6.150	6.150	6.150

log k = 2.30114

6.150 = 0.78888 / 1.51226 = 32.528

$\frac{h}{2}$ = .031 / 32.559 = r_4

log 1.51267

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1897phae.proj..539H

Index of Refraction May 21-1894 Physical Mus. Bark
see p135 for later measurements near middle

№ 18 Lerown

B line $n = 1.5^{-}1164 = \log 0.17945^{-}$

$n-1 = 0.5^{-}1164 = \quad 9.70896$

7 line $n = 1.5^{-}2176 = \quad 0.18235^{-}$

$n-1 = 0.5^{-}2176 = \quad 9.\overset{71747}{\cancel{3}\,2176}$

$\lambda = 5614$ line not used

№ 29 Flint

B line $n' = 1.5^{-}6627 = \log 0.19487$

$n'-1 = 0.5^{-}6627 = \quad 9.75302$

7 line $n' = 1.5^{-}8098 = \quad 0.19892$

$n'-1 = 0.5^{-}8098 = \quad 9.76416$

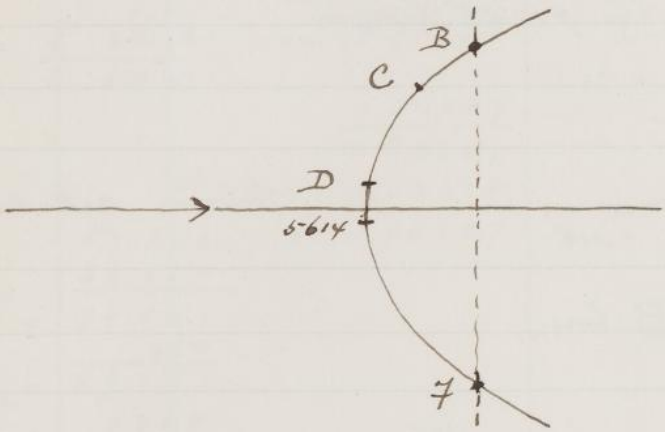
$\lambda = 5614$ line not used

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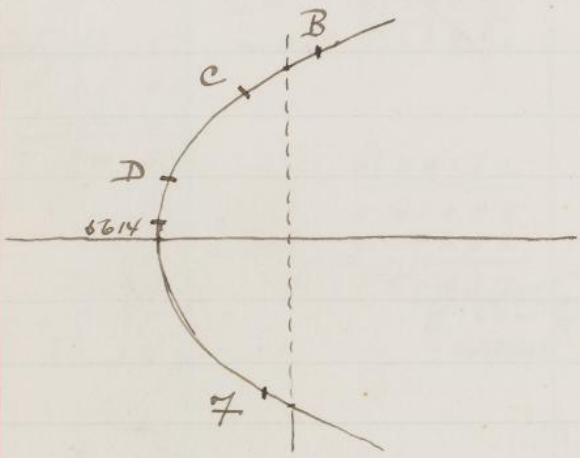
Color Correction

When the marginal B & 7 Rays are united at the same focus ~~the object glass~~ the crown is a little too weak – (Leundine thought 7" slightly under corrected)

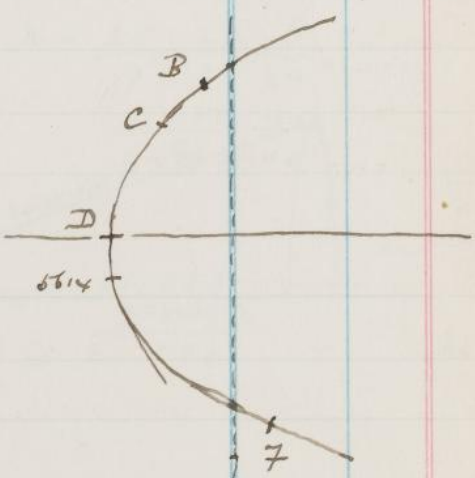


see p. 11 "Blue Book"

To throw B beyond 7. strengthen the crown
" " 7 " B " " flint } thus



Crown made stronger



Flint made stronger

This is towards making a photographic O.G.

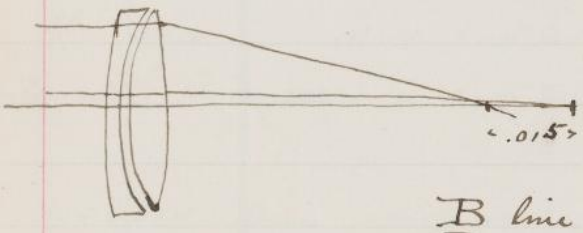
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Spherical Aberration.

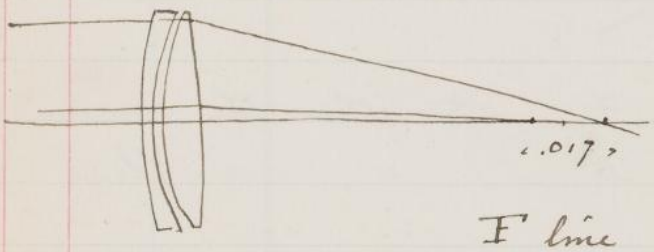
In 23-31 Ob. Gl. $f = 112.8$ in. P. 85 Blue Book.
" 4½" P. 13 " "
6 Manuscript

Assuming 86 in as the focal length



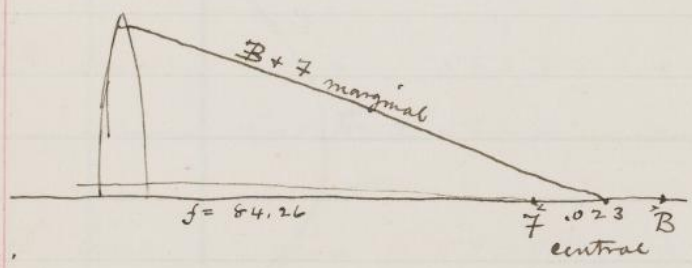
B line

brown .015 strong



F line

brown .017 weak,



P. 13. blue bk.

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Flint in front as measured on p. 101,
brown calculated & corrected it. check by p. 3 Blue Bk,

Marginal Rays

B

I

$k = 3.00 = \log 0.47712$

$r_1 = 32.539 = 1.51267$

$i = 5° 17' 12'' = \sin 8.96445$

0.19487

$\lambda = 3° 22' 21'' = \sin 8.76958$

$\nu = 1\ 54\ 51$

1.51267

0.28225

$\nu = \sin 8.52378$

$57.342 = 1.75847$

32.539

$f_1 = 89.901$

$.250$

$d_2 = 89.651$

$r_2 = 9.809$

$79.842 = 1.90223$ VIII

$\nu = \sin 8.52378$

0.42601

$r_2 \quad 0.99162$

$i = 15° 46' 35'' = \sin 9.43439$

$n = 0.19487$

$\lambda = 25\ 12\ 17 = \sin 9.62926$

$9° 25' 42''$

$\nu = 1\ 54\ 51$

$\nu' = 7\ 30\ 51$

0.99162

0.62088

$\sin 9.11651$

$31.943 = 1.50437$

$r_2 = 9.809$

$f_2 = 22.134$

7

I

0.47712

1.51267

$i = 5° 17' 12'' = \sin 8.96445$

0.19892

$\lambda = 3\ 20\ 28 \quad \sin 8.76553$

$\nu = 1\ 56\ 44$

1.51267

0.27820

$\nu = \sin 8.53084$

$53.893 = 1.74736$

32.539

$f_1 = 88.432$

$.250$

$d_2 = 88.202$

9.809

$78.393 = 1.89428$ VIII

8.53084

0.42512

0.99162

$i = 15° 44' 37'' = \sin 9.43350$

0.19892

$\lambda = 25\ 24\ 6 = \sin 9.63242$

$9° 39' 29''$

$1\ 56\ 44$

$7\ 42\ 45$

0.99162

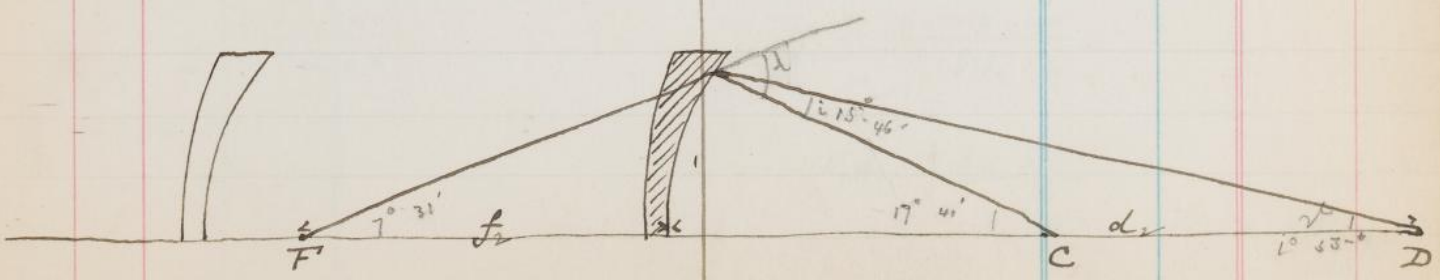
0.62404

$\sin 9.12776$

$31.353 = 1.49628$

9.809

$f_2 = 21.544$



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Flint in front. With curves as made (see p. 101) with the flint in front, the crown lens is ~~nearly correct~~ a little weak for color, ~~and~~ a little weak for spherical aberration. Making the back surface a little more convex will strengthen both.

Central Rays — Flint —

B ray

$n' = 0.19487$

$r_1 = \frac{1.51267}{1.70754}$

$n'-1 = \frac{9.75302}{1.95452}$

$f_1 = \frac{90,058}{.250} = 89.808$

$d_2 = 1.95331$

$r_2 = \frac{0.99162}{2.94493}$

0

$d = \frac{1.95331}{9.75303} = 1.70634 = 50.856$

$n = 0.19487$

$r_2 = \frac{0.99162}{1.18649} = \frac{18.3645}{38.4215} = \frac{1.58012}{1.39481}$

$f_2 = 24.8205$

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Alter the back surface so that the spherometer will read .035 ~ instead of .011

k = log. 2.30114
s = .035 = 8.54407
3.76707 = 5715.7 = r_4

r_4 = 500.

B Marginal

f_2 = 22.134
.010
d_3 = 22.144
r_3 = 9.961
32.105 =

XI

v' = sin 9.11651
1.50657
0.62308

r_3 = 0.99829

i = 24° 55′ 42″ = sin 9.62479

n = 0.17945

λ = 16 11 26 = sin 9.44534
8 44 16

r_3 = 0.99829
6.44363

v = 7 30 51
v' = 1 13 25 = sin 8.32949
130.06 = 2.11414

r = 9.96
f_3 = 140.02
.90 = t
d_4 = 139.12
r_4 = 500.00
639.12 = 2.80558

II

sin v = 8.32949
1.13507
r_4 = 500. = 2.69897

i = 1° 33′ 50.″9 = sin 8.43610
0.17945
λ = 2 21 53.3 = sin 8.61555
2.69897
0 48 2.4 1.31452

v' = 1 13 25.0
2° 1′ 27.″4 = sin 8.54806
584.06 = 2.76646
500.00
f_4 = 84.06

7 Marginal

f_2 = 21.544
.010
d_3 = 21.554
9.961
31.515 =

XI

v' = sin 9.12776
1.49852
0.62628

r_3 = 0.99829

i = 25° 7′ 34″ = sin 9.62799

n = 0.18235 = sin 9.44564
0.99829
0.44393

λ = 16 12 7
8° 55′ 27″
v' = 7 42 45
1 12 42 = 8.32523
131.43 = 2.11870

9.96
f_3 = 141.39
.90 = t
d_4 = 140.49
r_4 = 500.00
640.49 = 2.80651

II

8.32523
1.13174
2.69897

i = 1° 33′ 7.″9 = sin 8.43277
0.18235
λ = 2 21 44.9 = sin 8.61512
2.69897
0 48 37.0 1.31409

v' = 1 12 42.0
2 1 19.0 = sin 8.54756
584.16 2.76653
500.00
f_4 = 84.16

Red 84.06
0.10

Hint string
screw mark

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Strengthen crown for color by making $T_4 = 400.00$.

B

$d_4 = 139.12$ /

$T_4 = 400.00$

539.12 ✓ = 2.73169 ✓

ν = sin 8.32949 ✓

1.06118 ✓

T_4 = 2.60206 ✓

$i = 1^\circ\ 38'\ 57.5$ ✓ = sin 8.45912 ✓

0.17945 ✓

$\lambda = 2\ 29\ 37.0$ ✓ = sin 8.63857 ✓

$0\ 50\ 39.5$ ✓ 2.60206 ✓

$\nu = 1\ 13\ 25.0$ ✓ 1.24063 ✓

$\nu' = 2\ 4\ 4.5$ ✓ = sin 8.58732 ✓

482.24 = 2.68321 /

400.00

$f_4 = 82.29$

E

$d_4 = 140.49$ ✓

400.00

540.49 ✓ = 2.73279 ✓

8.32523 ✓

1.05802 ✓

2.60206 ✓

$i = 1^\circ\ 38'\ 14.5$ ✓ sin 8.45596 ✓

0.18235 ✓

$2\ 29\ 31.6$ ✓ sin 8.63831 ✓

$0\ 51\ 17.1$ ✓ 2.60206 ✓

$1\ 12\ 42.0$ ✓ 1.24037 ✓

$\nu' = 2\ 3\ 59.1$ ✓ = sin 8.58700 ✓

482.36 ✓ = 2.68337 ✓

400.00

$f_4 = 82.36$

.29

0.07 Flint strong

$T_4 = 325.00$ $T = 325 = 27'\ 1''$

$d_4 = 139.12$

$T_4 = 325.00$

464.12 = 2.66663

8.32949

0.99612

T_4 2.51188

$i = 1^\circ\ 44'\ 51.2$ = sin 8.48424

0.17945

$\lambda = 2\ 38\ 32.0$ = sin 8.66369

$0\ 53\ 40.8$ 2.51188

$\nu = 1\ 13\ 25.0$ 1.17557

$\nu' = 2\ 7\ 5.8$ = 8.56776

405.33 = 2.60781

325.00

$f_4 = 80.33$

$d_4 = 140.49$

325.00

465.49 = 2.66791

8.32523

0.99314

2.51188

$i = 1^\circ\ 44'\ 8.1$ = sin 8.48126

0.18235

$\lambda = 2\ 38\ 30.2$ = sin 8.66361

$0\ 54\ 22.1$ 2.51188

$1\ 12\ 42.0$ 1.17549

$2\ 7\ 4.1$ = 8.56766

405.35 = 2.60783

325.00

$f_4 = 80.35$

.33

.02 Flint strong as desired

This gives correct color correction

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Spherical Aberration.

Crown

B ray Central

$f_2 = 24.8205^-$ (P. 106)

$d_3 = \frac{.01}{24.8305^-}$ $= 1.39498$

$n = 0.17945^-$

$\frac{1}{r_3} = 9.961$ $= \frac{0.99829}{2.57272}$

$d = 1.39498$

$n-1 = \frac{9.70896}{1.10394} = 12.704$

$\frac{9.9607}{2.7433} = \frac{0.43827}{2.13445^-}$

$f_3 = 136.286 = 2.13445^-$

$d_4 = \frac{.190}{135^-.386} = 2.13157$

$325^- = \frac{1}{r_4} = \frac{2.51188}{4.64345^-}$

$n = 0.17945^-$

$\frac{1}{r} = \frac{2.51188}{2.69133} = 491.28$

$d = 2.13157$

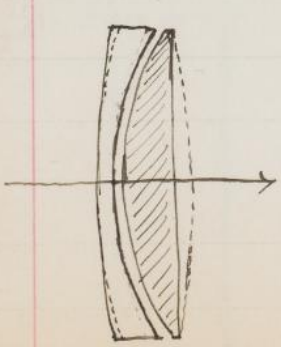
$n-1 = \frac{9.70896}{1.84053} = \frac{69.268}{560.548} = \frac{2.74861}{1.89484}$

$f_4 = 78.495^- = 1.89484$

Marginal $= \frac{80.33}{1.835^-}$

Flint too strong

Crown too weak



$\frac{1}{r_4} = \frac{\text{Int.}}{\text{1818.}}$ Crown is ~~slightly~~ weak ~~for~~ sph. ab.

$\frac{1}{r_4} = 325.$ " " ~~very~~ " " " "

2.444 / 1.835

If the front surface of the flint is made more convex, until the sph. ab. is corrected, the other three surfaces remaining as made, the ~~flint~~ will be ~~nearly correct~~ for color + ~~Sph. ab.~~ also C. C.

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Spherical Aberration, as made with Flint in front,

Marginal B ray

Back surface $r_4 = 18186.5^-$ considered as flat,

$i = -v = 1^\circ\ 13'\ 25''$ $\phi.107 = \sin\ 8.32949$

$n = \underline{0.17945^-}$

$\lambda = 1^\circ\ 50'\ 59''.5^- = \sin\ 8.50894$

$d_4 = 139.12 = 2.14339$

$\tan i = \underline{8.32959}$
0.47298

$\tan\lambda = \underline{8.50917}$

$f_4 = \underline{92.005^-} = 1.96381$

Central B ray

$d_4 = 135^-.386 = 2.13157$

$n = \underline{0.17945^-}$

$f_4 = \underline{89.561} = 1.95212$

2.444 Flint too strong

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To find curvature of front surface of flint to give correct color correction, other surfaces remaining as made.

Color correction is perfect when

$B = \frac{1}{r_1} - \frac{1}{r_2}$ Flint $= \frac{1}{32.539} - \frac{1}{9.8088} = -.0712344$

$A = \frac{1}{r_3} + \frac{1}{r_4}$ Crown $= \frac{1}{9.9607} + \frac{1}{325.0} = .1034719$

$r_1 = \log 1.5\bar{1}267$
$8.48733 = .0307136$

$r_2 = \text{"} \quad 0.99162$
$9.00838 = .101948$
$B = .0712344$

$r_3 = \log 0.99829$
$9.00171 = .100398-$

$r_4 = \text{"} \quad 2.5\bar{1}188$
$7.48812 = .0030769$
$A = .1034719$

Crown as made

$A = \frac{1}{r_3} + \frac{1}{r_4} = \frac{1}{9.9607} + \frac{1}{18186.5\bar{1}} = .100450$

$r_4 = \log 4.25\bar{9}75$
$5\bar{.}74025 = .00005\bar{4}986$
$.100395-$
$.100450$

To correct crown $B = -.0712344$ must be multiplied by
$.100450$
$.103479$

$.0712344 = \log 8.85269$
$.100450 = 9.00195-$
7.85464
$.103479 = 9.01485-$
$-B_1 = .069150 = 8.83979$

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continued.

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

$\frac{1}{r_2} = .101948$
$B = .069150$
$\frac{1}{r_1} = .032798$
~~$= .067202$~~

$\frac{1}{r_1} = .032798 = \log 8.5158\bar{5}$
$r_1 = 30.4895^- = 1.484150$

hence with

$r_1 = 30.4895^-$
$r_2 = -9.8088$
$r_3 = 9.9607$
$r_4 = 18186.5^-$

} unchanged i.e. remaining as now made.

the color would be correct. but for Sph. Ab. Flint is 1.668 in too strong. see next page (113)

Continued from opposite page. Marginal

II

$d_4 + r_4 = 18311.5^- = \log 4.262720$ ✓
$\sin v = 8.375\bar{4}6$ ✓
2.638818 ✓
$r_4 = 4.259758$ ✓
$i = 1^\circ\ 22'\ 10''.6$ ✓ $= \sin 8.378430$ ✓
$n = 0.179485$ ✓
$\lambda = 2\ 4\ 14.2'$ ✓ $= \sin 8.555788$ ✓
$0\ 42\ 3.6$ ✓ $r = 4.259758$ ✓
$v = 1\ 21\ 37.0$ ✓ 2.815630 ✓
$2\ 3\ 40.6$ ✓ $= \sin 8.555099$ ✓
$18268.8 = 4.261719$ ✓
$r_4 = 18186.5^-$
$f_4 = 82.3$

X

$r_4 = \text{Inf.}$
$i = v = 1^\circ\ 21'\ 37'' = \sin 8.375\bar{4}6$
$n = 0.179485$
$\lambda = 2\ 3\ 23.3 = \sin 8.554\bar{9}1$

$d = 125.054 = 2.096\bar{1}0$
$\tan i = 8.375\bar{8}9$
$0.471\bar{6}9$
$\tan \lambda = 8.555\bar{1}9$
$= 1.916\bar{5}0$

$f_4 = 82.509$

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1897phae.proj..539H

To find the spherical aberration, with curves as on opposite page

Ray. Marginal I

$k = 3.00 = \log 0.47712$

$r_1 = 30.4895 = \quad 1.48415^-$

$i = 5^\circ\ 38'\ 48'' = \sin 8.99297$

$n = \quad 0.19487$

$\lambda = 3\ 36\ 6 = \sin 8.79810$

$\nu' = 2\ 2\ 42 \qquad r = \quad 1.48415^-$

0.28225^-

$\sin 8.85248$

$53.675^- = 1.72977$

$r_1 = 30.4895^-$

$f_1 = 84.1645^-$

$.25^-$

$d_2 = 83.9145^-$

$r_2 = 9.8088$

$74.1057 = 1.86985$

8.55248

0.42233

$r_2 = 0.99162$

$i = 15^\circ\ 38'\ 24'' = \sin 9.43071$

$n = 0.19487$

$\lambda = 24\ 58\ 39 = \sin 9.62558$

$9\ 20\ 15^-$

$r_2 = 0.99162$

$\nu = 2\ 2\ 42$

0.61720

$\nu = 7\ 17\ 33 = \sin 9.10358$

$32.630 = 1.51362$

Compare 10$^-$

$r_2 = 9.809$

$f_2 = 22.821$

$.01$

$d_3 = 22.831$

$r_3 = 9.9607$

$32.7917 = 1.51576$

9.10358

0.61934

$r_3 = 0.99829$

$i = 24^\circ\ 42'.\ 2'' = \sin 9.62105^-$

$n = 0.17945^-$

$\lambda = 16\ 2\ 52 = \sin 9.44160$

$8\ 39\ 10$

$r_3 = 0.99829$

$\nu = 7\ 17\ 33$

0.43989

$\nu' = 1\ 21\ 37 = \sin 8.37546$

$115.993 = 2.06443$

9.961

$f_3 = 125.954$

$.90$

$d_4 = 125.054$

$r_4 = 18186.5^-$

$d_4 + r_4 = 18311.5^-$

Central

$n = \quad 0.19487$

$r = \quad 1.48415^-$

1.67902

$n-1 = \quad 9.75302$

$f_1 = 84.3335^- = 1.92600$

$.25^-$

$d_2 = 84.0835^- = 1.92471$ VIII

$r_2 = 0.99162$

2.91633

$d = 1.92471$

$n-1 = 9.75302$

$1.67773 = 47.613$

$n = 0.19487$

$r = 0.99162$

$1.18649 = 15.3635^-$

$32.2495 = 1.50852$ XI

$f_2 = 25.5746 = 1.40781$

$.01$

$d_3 = 25.5846 = 1.40798$

$n = 0.17945^-$

$r_3 = 0.99829$

2.58572

$d = 1.40798$

$n-1 = 9.70896$

$1.11694 = 13.0900$

9.9607

$3.1293 = 0.49545^- = 2.09027$

$f_3 = 123.103$

$.90$

$d_4 = 122.203 = 2.08708$

$n = 0.17945^-$

$f_4 = 80.841 = 1.90763$

82.509 Marginal

1.668 Fint too strong

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1897phae.proj.539H

Recapitulation,

	1. As made	2. Back surface only, altered	3. Front surface only, altered	4. Crown altered	5. 1st of Crown only, altered
r_1	32.559	32.559	30.4898	32.559	32.559
r_2	9.8088	9.8088	9.8088	9.8088	9.8088
r_3	9.9607	9.9607	9.9607	10.1607	9.6697
r_4	18186.5	325.00	18186.5	197.902	18186.5
Color		perfect	(perfect)	(perfect)	(perfect)
Spr. Ab.	2.444 flint too strong P. 110	1.835 flint too strong P. 109	1.668 flint too strong P. 113	3.002 flint too strong P. 115	0.069 flint too strong P. 116

Make $r_3 = 10.1607$ & find r_4

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

$.103472 = A$

$r_3 = 10.1607 = \log 1.00692$

$\quad\quad 8.99308 = .098419 = \frac{1}{r_3}$

$\quad\quad 7.70353 = .005053 = \frac{1}{r_4}$

$r_4 = 197.902 = \quad 2.29645$

---

from p 115

Make $r_3 = 9.6700$ & find r_4 $\quad A = \frac{1}{r_3} + \frac{1}{r_4}$ $\therefore$ $\frac{1}{r_4} = -\frac{1}{r_3} + A$ (concave)

$r_3 = \log 0.98543$

$\quad 9.01457 = .103412 = \frac{1}{r_3}$ $\quad \frac{1}{r_3} = A - \frac{1}{r_4}$

$\quad\quad .103472$

$\quad 5.77815 = .000060 = \frac{1}{r_4}$ convex

$r_4 = 16666.7 = 4.22185$

convex

$r_4 = 18186.6 = 4.25975$

$.00005\,4986 = 5.74025$

$A = .103472$

$\frac{1}{r_3} = .103417 = 9.01459$

$r_3 = 9.6697 = 0.98541$

This leaves back surface as made

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Spherical Aberration, A. G. Columns 4 p. 114,

Marginal B

f_2 = 22.134 .0 p.107

r_3 = 10.1607 r = sin 9.1165-1

$d+r$ = 32.2947 = log 1.50913 / 0.62564

r_3 = 1.00692

i = 24° 33′ 35″ = sin 9.61872

n = 0.17945

λ = 15 57 35 = sin 9.43927

8 36 0 r = 1.00692 / 0.44619

p.105 r' = 7 30 51

r = 1 25 9 = sin 8.27761

147.428 = 2.16858

r = 10.161

f_3 = 157.589 .90

d_4 = 156.689

r_4 = 197.902 / 354.591 = 2.54973

II

r = sin 8.27761 / 0.82734

r = 2.29645- / sin 8.53089

i = 1° 56′ 44.8 = sin 8.53089

n = 0.17945- / sin 8.71034

λ = 2 56 31.5- / 0 59 46.7

r' = 1 56 9. / r 2 45 55.7 = 8.56029 / = 2.44650

279.576

197.902

f_4 = 81.674

78.672

3.002

flint too strong

Central

f_2 = 24.8205- p.106

d = 1.39481

n = 0.17945-

r = 1.00692 / 2.58118

d = 1.39481

$n-1$ = 9.70896 / 1.10377 = 12.6990

10.1607

2.53783 = 0.40454 = 2.17664

f_3 = 150.19 .90

d_4 = 149.29 = 2.17403

r_4 = 2.29645- / 4.47048

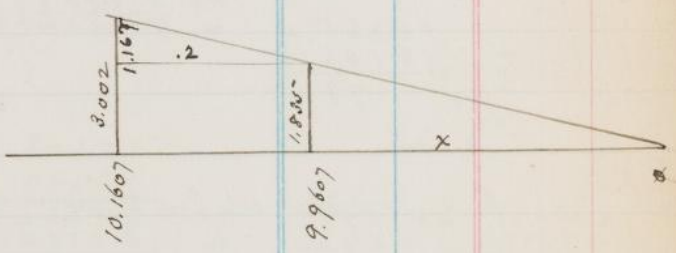
d = 2.17945-

r = 2.29645- / 2.47590 = 299.16

d = 2.17403

$n-1$ = 9.70896 / 1.88299 = 76.382 / 375.542 = 2.57466 = 1.89582

f_4 = 78.672



$\frac{1.167}{1.835-} = \frac{.2}{x}$ ∴ $x = \frac{.2 \times 1.835-}{1.167} = \frac{.3670}{1.167}$

.3670 = log 9.56467

1.167 = 0.06707

.31449 = 9.49760 = x

r_3 = 9.9607 / .3145- / 9.6462

to page 114 bottom

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Spherical Aberration A. G. column 5 p. 114.

Marginal

s'_2 = 22.134
.01
d_3 = 22.144
r_3 = 9.6697
31.8137 = 1.502 61 XI
sin v = 9.1165-1
0.61912
r_3 = 0.98541
i = 25° 28' 58" = sin 9.63371
n = 0.17945
λ = 16 32 10 = sin 9.45426
8 56 48 r = 0.98541
v' = 7 30 51 0.43967
v = 1 25 57 = sin 8.39793
110.088 = 2.04174
r_3 = 9.670
f_3 = 119.758
.90
d_4 = 118.858
r_4 = 18186.5-
18306.36 = 4.262578
sin v 8.397930
2.660508
r_4 = 4.25975-
i = 1° 26° 30".73 = sin 8.400758
n = 0.17945-
λ = 2 10 47.62 = sin 8.580208
0 44 16.89 r_4 = 4.25975-
v' = 1 25 57. 2.839958
2 10 13.9 = sin 8.578339
18265.0 = 4.261619
r_4 = 18186.5-
f_4 = 78.5-

Central

24.8205-
.01
d_3 = 24.8305- = 1.39499 XI
n = 0.17945-
r_3 = 0.98541
2.55985-
d = 1.39499
$n-1$ = 9.70896
1.10395- = 12.7043
9.6697
3.0346 = 0.48210
= 2.07775-
f_3 = 119.605-
.90
d_4 = 118.705- = 2.07447
r_4 = 4.25975- ✓
8.33422 ✓
n = 0.17945- ✓
r = 4.25975- ✓
4.439207 = 27491.6 ✓
d = 2.07447 ✓
$n-1$ = 9.70896 ✓
1.78343 ✓ = 60.73 ✓
2755-2.33 ✓ = 4.44016 ✓
= 1.89406 ✓
f_4 = 78.354

---

i = 1° 25' 57" = sin i = 8.39793
n = 0.17945-
λ = 2° 9' 56".7 = sin 8.57738

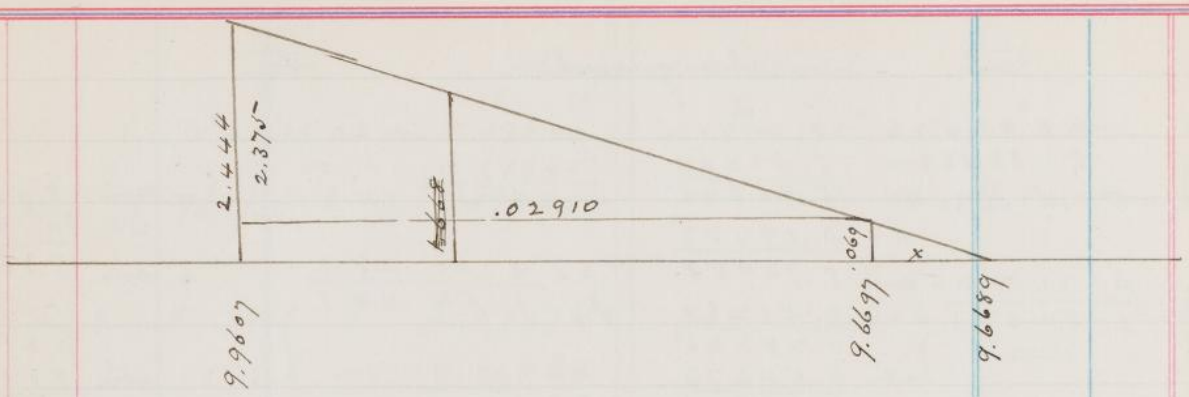
d_4 = 118.858 = 2.07503
tan i = 8.39806
0.47309
tan λ = 8.57769
f_4 = 78.596 = 1.89540
.527
.069 Flint too strong

d_4 = 2.07447
n = 0.17945-
f_4 = 78.527 = 1.89502

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Result



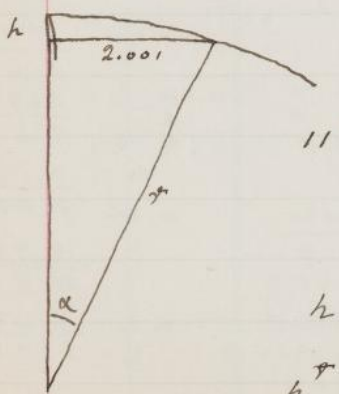
$$\frac{2.375}{.069} = \frac{.02910}{x} \quad \therefore \quad x = \frac{.02910 \times .069}{2.375} = .0008$$

8.46389
8.83885
7.30274
0.37566
6.92708 = 0.00084 = x

.03
.07
.0021
.0008

Make $r_3 = 9.6691$

Spherometer reading for this radius



$11° 56' 37''$

$r = 0.30126$
$\sin = 0.98539$
$\sin = 9.31586$
$\cos = 9.99049$

$9.6691 \quad 0.98539$
$9.4598 = 0.97588$
$h = .2093$

$\frac{h}{2}^r = 9.6691$
$.1046$
$9.5645 = 0.98066$
$S = 20.916 = 1.32048$

check

$\log k = 2.30114$
$20.916 = 1.32048$
$0.98066 = 9.5645$
$.1046$
9.6690

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7 limit { $\tau_1 = 32.559$ convex ; $\tau_2 = 9.8088$ concave

Check on calculation, Leverrier { $\tau_3 = 9.6691$ convex Attend, ; $\tau_4 = 18186.8$ convex

p. 105

B. Marginal 7.

I

$k = 3.00 = 0.47712$

$\tau_1 = 32.559 = 1.51267$

$i = 5^\circ 17' 12''.3$ = sin 8.96445^-

$n = 0.19487$

$\lambda = 3^\circ 22' 21''.0$ - sin 8.76958

$\nu = 1\ 54\ 51.3$ 1.51267

0.28225^-

→ sin 8.52378

$57.342 = 1.75847$

32.559

$f_1 = 89.901$

$,250$

$d_2 = 89.651$

$\tau_2 = 9.809$

$79.842 = 1.90223$ VIII

sin ν = 8.52378

0.42601

$\tau_2 = 0.99162$

$i = 15^\circ 46' 36''.0$ = sin 9.43439

0.19487

$\lambda = 2^\circ 12' 17''.0$ = sin 9.62926

$9\ 25\ 41.0$ $\tau_2 = 0.99162$

$1\ 54\ 51.3$ 0.62088

$7\ 30\ 49.7$ = sin 9.11649

$= 1.50439$

31.944

9.809

$f_2 = 22.135^-$

$,01$ ← Leverrier

$d_3 = 22.145^-$

p. 116, $\tau_3 = 9.669$

$31.814 = 1.50262$ XI

sin ν = 9.11649

0.61911

$\tau_3 = 0.98539$

$i = 25^\circ 29' 0''$ = sin 9.63372

$n = 0.17945^-$

$16\ 32\ 10,0$ = sin 9.45427

$8\ 56\ 50.$ 0.98539

$\nu = 7\ 30\ 49.7$ 0.43966

$\nu = 1\ 26\ 0.3$ = sin 8.39820

$110.017 = 2.04146$

9.669

$f_3 = 119.686$

$,90$

$d_4 = 118.786$

II

$i = 5^\circ 17' 12''.3$ = sin 8.96445^-

$n = 0.19892$

$\lambda = 3\ 20\ 28.2$ = sin 8.76553

$\nu = 1\ 56\ 44.1$ 1.51267

0.27820

sin 8.53084

$= 1.74736$

55.898

32.559

$f_1 = 88.457$

$,250$

$d_2 = 88.207$

9.809

$78.398 =$ 1.89428

8.53084

0.42512

0.99162

$i = 15^\circ 44' 36''.6$ = sin 9.43350

0.19892

$\lambda = 25\ 24\ 6.4$ = sin 9.63242

$9\ 39\ 29.8$ 0.99162

$1\ 56\ 44.1$ 0.62404

$7\ 42\ 45.7$ = sin 9.12777

$= 1.49627$

31.352

9.809

$f_2 = 21.543$

$,101$

$d_3 = 21.553$

9.669

$31.222 =$ 1.49446

sin ν = 9.12777

0.62223

$\tau_3 = 0.98539$

$25^\circ 40' 50''$ = sin 9.63684

$n = 0.18235$

$16\ 32\ 42$ = sin 9.45449

0.98539

$9\ 8\ 8$ 9.43988

$7\ 42\ 45.7$ = sin 8.39500

$1\ 25^- 22.3$ $= 2.04488$

110.887

9.669

$f_3 = 120.556$

$,90$

$d_4 = 119.656$

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Check - continued,

B Marginal continued 7

t_4 = Inf, $i = r^t = 1°\,26'\,0''.3$ sin 8.39820 (IX)
n = 0.17945
$\lambda = 2°\,10'\,1''.6$ = sin 8.57765

$d_4 = 118.786$ = 2.07476
tan $1°\,26'\,0''.3$ = 8.39834
0.47210
tan λ = 8.57797
$f_4 = 78.547$ = 1.89513

$i = 1°\,25'\,22''.3$ = sin 8.39500
0.18235
8.57735

$\lambda = 2\ 9\ 56,1$ = sin

$d_4 = 119.656$ = 2.07793
tan i = 8.39521
0.47314
tan λ = 8.57766
$f_4 = 78.610$ = 1.89548
.547
.063 flint strong as desired for color

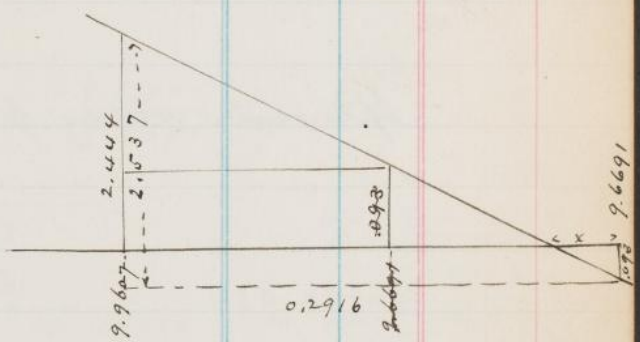
B, n = 0.19487 (central),
r_1 = 1.51267
1.70754
$n-1$ = 9.75302
$f_1 = 90.065$ = 1.95452
.25
$d_2 = 89.807$ = 1.95331
r_2 = 0.99162
2.94493

$d = 1.95331$
$n-1 = \frac{9.75302}{1.70633} = 50.855$

$n = 0.19487$
$r = \frac{0.99162}{1.18649} = \frac{15.3635}{35.4915} = \frac{1.53012}{1.39481}$

p. 106 $f_2 = 24.820$ = 1.39481
.01
$d_3 = 24.830$ ✓ = 1.39499 ✓
$n = 0.17945$
$r = 0.98539$
= 2.55983

$d = 1.39499$
$n-1 = \frac{9.70896}{1.10398} = 12.7043$ ✓
$r_3 = \frac{9.6691}{3.0352} = \frac{0.48219}{2.07764}$
$f_3 = 119.575$
.90
$d_4 = 118.875$ = 2.07509
$n = 0.17946$
= 1.89564
$f_4 = 78.640$
.093 Crown strong for Sph. Ab.



$\frac{2.537}{.093} = \frac{.2916}{x}$ $\therefore x = \frac{.2916 \times .093}{2.537} = .0107$

9.4648
8.9685
8.4333
0.4043
8.0290 = .010691

9.6691
.0107
9.6798
12
9.6786

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Make r_3 9.6750 Find Spherometer reading

2.001 = log 0.30125−

9.6750 = 0.98565−

11° 56′ 10″ = sin 9.31560

cos 9.99051

0.98565

= 0.97616

9.6750

9.4659

h = .2091

Check

log k = 2.30114

20.903 = 1.32021

0.98093 = 9.5704

.1045−

r = 9.6749

r_3 = 9.6750

.1045−

9.5705− = 2.30114 = k

= 0.98093

S = 20.903 = 1.32021

Spherometer reading for Concave Tool.

2.30179 = k

0.98093

S = 20.934 = 1.32086

Thickness of edge reduced 0.0318 in.

diagram p. 121

9.9607

9.6750

a = .2857

2) 7.75

3.875 = 0.57403

9.6750 = 0.98565−

22° 48′ 18″ = 9.58838

$\frac{1}{2}(A+B)$ = 11° 24′ 9″ = tan 9.30468

a − b = 0.97363

0.27829

a + b = 0.99829

$\frac{1}{2}(A-B)$ = 10° 47′ 17½″ = tan 9.28000

B = 12 11 26½″

b = 9.6750

a = .2857

a − b = − 9.3893

a + b = 9.9607

b = 9.98565−

sin = 9.57713

1.40852

sin 9.58838

= 0.99690

C

9.9607

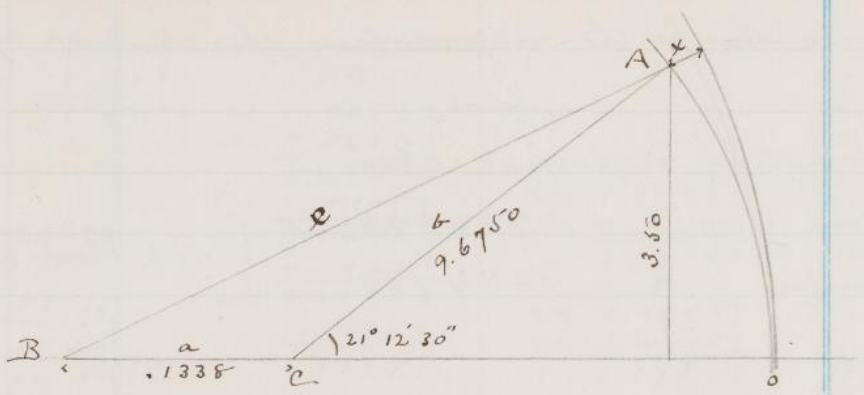
c = 9.9289

x = .0318

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Space between inner surfaces at edge, centers in contact, = .0089 in



9.8088
9.6750
.1338

3.50 = 0.544 07
0.98565⁻
21° 12' 30" = sin 9.55842

b = 9.6750
a = 0.1338
a − b = −9.5412
a + b = 9.8088

$A + B = 180 - C = 21^\circ\ 12'\ 30''$

$\frac{1}{2}(A + B) = \quad = 10^\circ\ 36'\ 15''$

$\tan \frac{1}{2}(A - B) = \frac{a-b}{a+b} \tan \frac{1}{2}(A + B) = \frac{-9.5412}{9.8088} \tan 10^\circ\ 36'\ 15'' =$

$\frac{1}{2}(-A + B) = 10^\circ\ 19'\ 16''$

$\frac{1}{2}(A + B) = 10\ 36\ 15''$

$B = 20^\circ\ 55'\ 31''$

0.9.7960
tan 9.27235⁻
0.25195⁻
0.99162

$10^\circ\ 19'\ 16'' = \tan 9.26033$ (266/640)

$c = b \sin C \operatorname{cosec} B$

b = log 0.98565⁻
sin C = 9.55842
~~cosec~~ B = 0.54407
sin B = 9.55285⁻
= 0.99122

9.8088
c = 9.7999
x = .0089

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If correction can be made by altering the back surface of the flint - a greater focal length will result, with a considerable saving of labor as this is the only surface operated on by Leundine.

---

p. 111, Color correction is perfect when

for Flint $-B = .0712344$
" Crown $A = .1034719$
} with Flint as made.

p. 111

Flint $-B = .069150$
Crown $A = .100450$
} with Crown as made,

Front surface of Flint = 32.559 as made, to find curvature of back surface

$-B = \frac{1}{r_1} - \frac{1}{r_2} \quad \therefore \quad \frac{1}{r_2} = B + \frac{1}{r_1}$

$B = .069150$
$\frac{1}{r_1} = .0307136$ p111
$= .0998636$

$r_2 = 10.0136 = \frac{8.99941}{1.00059}$

P. 114 - 6

	2nd surface only altered
r_1	32.559
r_2	10.0136
r_3	9.9607
r_4	18186.5 -
Color	(perfect)
Spr. Al	0.872 Flint Strong
	p.123

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Spherical Aberration of 6.

B

p.118

$d_2 = 89.651$

$r_2 = \dfrac{10.0136}{79.6374} = 1.90112$ (VIII)

sin $v_2 = 8.52378$

$\tau_2 = 0.42490$

$\tau_2 = 1.00059$

$i = 15^\circ\ 24'\ 20.0'' = \sin 9.42431$

0.19487

$\lambda = 24\ 35\ 15.0 = \sin 9.61918$

$9\ 10\ 55.0$ $\quad 1.00059$

$1\ 54\ 51.3$ $\quad 0.61977$

$v = 7\ 16\ 3.7 = 9.10211$

$32.935 = 1.51766$

$f_2 = \dfrac{10.0136}{22.9214}$

$.01$

$d_3 = 22.9314$

$r_3 = \dfrac{9.9607}{32.8921} = 1.51709$ (XI)

sin $v_2 = 9.10211$

0.61920

$\tau_3 = 0.99829$

$i = 24^\circ\ 41'\ 31.6'' = \sin 9.62091$

$n = 0.17945$

$\lambda = 16\ 2\ 33.0 = \sin 9.44146$

$8\ 38\ 58.6$ $\quad \tau_3 = 0.99829$

$7\ 16\ 3.7$ $\quad 0.43975$

$v = 1\ 22\ 54.9 = \sin 8.38232$

$114.138 = 2.05743$

$f_3 = \dfrac{9.961}{124.099}$

$.90$

$d_4 = 123.199$

$i = v = 1^\circ\ 22'\ 54.9'' = \sin 8.38232$ (IX)

$n = 0.17945$

$\lambda = 2^\circ\ 5'\ 21.3'' = \sin 8.56177$

$\tan i = 8.38244$

$d_3 = 2.09061$

0.47305

$\tan \lambda = 8.56206$

$f_4 = 81.468 = 1.91099$

80.896 central

$.572$ flint too strong

Central

p.119.

$d_2 = 1.95331$

$r_2 = 1.00059$

2.95390

$d = 1.95331$

$n-1 = \dfrac{9.75302}{1.70633} = 50.855$

$n = 0.19487$

$\tau = 1.00059$

1.19546 $\quad 15.684$

$35.171 = 1.54618$

$f_2 = 25.5694 = 1.40772$

$.01$

$d_3 = 25.5794 = 1.40789$

$n = 0.17945$

$\tau = 0.99829$

2.58563

$d = 1.40789$

$n-1 = \dfrac{9.70896}{1.11685} = 13.0873$

9.9607

$3.1266 = 0.49507$

$f_3 = 123.186 = 2.09056$

$.90$

$d_4 = 122.286 = 2.08738$

$n = 0.17945$

$f_4 = 80.896 = 1.90793$

$\dfrac{1.872}{.572} = \dfrac{.2048}{x} \quad \therefore \quad x = \dfrac{.2048 \times .572}{1.872}$

9.31133

9.75740

9.06873

10.0136 $\quad 0.27231$

$.06258 = 8.79642$

$r_2 = 10.0762$

To give correction for Sph. Ab.

but this would make flint weak for color

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Object Glass - 23 - 31 Dec. 2nd 1898.

To find ray to unite with F ray to give best color correction by Hastings's method.

$$n' = \alpha + \beta n + \gamma n^2$$

	Flint	Crown		
B ray	$1.5795^{-1} = \alpha + \beta\ 1.53285^{-} + \gamma\ 2.349645$			(1)
5614 ρ 128	$1.58748 = \alpha + \beta\ 1.53895^{-} + \gamma\ 2.36894^{-}$			(2)
F	$1.5^{-}9524 = \alpha + \beta\ 1.54443 + \gamma\ 2.38527$			(3)
(2) − (1)	$.00782 = + \beta\ .00590 + \gamma\ .018095^{-}$			(4)
(3) − (2)	$.00791 = + \beta\ .00^{-}568 + \gamma\ .01753$			(5)
(4) × 568/890 · 558/600	$.00753 = + \beta\ .00^{-}568 + \gamma\ .017421$			(6)
(5) − (6)	$.00038 = + \gamma\ .000109$			

$$\gamma = 3.49$$

(5) $.00791 = \beta\ .00^{-}568 + .061180$

$$-.05327 = \beta\ .00^{-}568$$

$$\beta = -9.3784$$

(2) $1.^{-}8733 = \alpha - 14.4310 + 8.2634$

$$\alpha = 7.7^{-}493$$

$$1 = (n-1)A + (n'-1)B$$
$$A = -B(\beta + 2\gamma n)$$
$n = 5614$ ray

$$1 = 0.53875\,A + .^{-}8733\,B$$
$$A = -B(-9.3784 + 2 \times 3.49 \times 1.^{-}3875)$$
$$A = -1.3622\,B$$
$$1 = -0.73387\,B + 0.^{-}8733\,B$$
$$1 = -0.1465^{-}4\,B$$
$$B = -6.8240$$
$$A = +9.2957$$
for $F = 1$

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$$\varphi_7 = (n_7 - 1)\,A + (n'_7 - 1)\,B$$
$$= 0.54443 \times 9.2957 - 0.59524 \times 6.8240$$
$$= 5.0608 - 4.0619$$
$$= 0.9989$$

Finds two values of n that will satisfy the equation

$$0.9989 = \gamma B n^2 + (A + \beta B)n + (\alpha - 1)B - A$$

$$0.9989 = \begin{cases} 3.49 \times \left(\frac{-6.8240}{-0.14654}\right) n^2 + \left(9.2957 + (-9.3784 \times -6.8240)\right) n + \\ 6.75493 \times -6.8240 - 9.2957 \end{cases}$$

$$0.9989 = -23.816\,n^2 + 73.2947\,n - 55.3917$$
$$23.816\,n^2 - 73.2947\,n = -56.3906$$
$$n^2 - 3.07755\,n = -2.36777$$
$$n^2 - 3.07755n + (1.53875)^2 = -2.36777 + 2.36777$$
$$= 0.00000$$
$$n - 1.53875 = \pm 0$$

This should be. $n^2 - (\;)n + (\;)^2 = .00003226$

$$n - 1.53875 = \pm .00568$$
$$n = 1.53875 \pm .00568$$

} in eq. 5

$n_{5614} = 1.53875 \pm 568$

$n_7 = 1.54443$

$n_x = 1.53307$ for lemon

$n_B = 1.63285$

$.00022$

For Flints $n' = \alpha + \beta n + \gamma n^2$

$n'_x = 7.75493 + (-9.3784 \times 1.53307) + 3.49n^2$

$= 7.75493 - 14.3777 + 8.2026$

$= 1.57983$

$n'_B = 1.57985$

This must be uncertain on account of last two terms

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Object Glass, 18 – 29

1469) 7460(5·07 7345 1150

1012) 5220(5·16 5060 1600 1012 5880

$$n' = \alpha + \beta n + \gamma n^2$$

B ray	$1.5\,66\,39 = \alpha + 1.5\,115\,7\beta + 2.28483\gamma$	(1)	
5614 "	$1.5\,73\,85 = \alpha + 1.5\,167\,9\beta + 2.30066\gamma$	(2)	
F "	$1.5\,81\,08 = \alpha + 1.5\,216\,9\beta + 2.31\,5\,5\,5\gamma$	(3)	(1)
(2) – (1).	$.00746 = + .005222\beta + .01\,5\,83\gamma$	(4)	
(3) – (2)	$.00723 = + .00490\beta + .01489\gamma$	(5)	
(4) × 490/522	$.00700 = + .00490\beta + .01486\gamma$	(6)	
(5) – (6)	$.00023 = + .00003\gamma$		

$$\gamma = 7.6$$

(5) $.00723 = + .00490\beta + .113162$

$$-.105932 = +.00490\beta$$

$$\beta = -21.619$$

$$1 = 0.51679A + 0.57385B$$

$$A = -B(-21.619 + 2 \times 7.6 \times 1.51679)$$

Should be about $A = 1.5B$.

$$A = -2.436B$$

$$1 = -1.25904B + 0.57385B = -0.68519B$$

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Approximate method of finding γ. (Hastings)

$$n'_7 - n'_{56.4} = (n_7 - n_{56.4})(\beta + 2\gamma n) + (n_7 - n_{56.4})^2 \gamma$$
$$n'_{56.4} - n'_B = (n_{56.4} - n_B)(\beta + 2\gamma n) + (n_{56.4} - n_B)^2 \gamma$$

$$.00723 = .00490\,(\beta + 2\gamma n) + .0000\,24007\,\gamma \qquad (1)$$
$$.00746 = .00522\,(\beta + 2\gamma n) + .0000\,27248\,\gamma \qquad (2)$$
$(1) \times \frac{522}{490}$ $$.00770 = .00522\,(\beta + 2\gamma n) + .0000\,25576\,\gamma$$
$$-.00024 = \qquad\qquad + .0000\,01672\,\gamma$$

$$n'_0 = \alpha + \beta n_0 + \gamma n_0^2 \qquad (n + \delta n)^2$$
$$n'_m = \alpha + \beta(n_0 + \delta n) + \gamma(n_0^2 + 2n_0\delta n + \delta n^2)$$
$$\delta n' = \beta \delta n_0 + \gamma(2n_0\delta n + \delta n^2)$$
$$\delta n' = \delta n(\beta + 2\gamma n_0) + \gamma \delta n^2$$
$$\delta n' = \delta n\, C + \gamma \delta n^2$$

$$\delta n = n_0 - n_m$$
$$\delta n^2 = n_0^2 + 2n_0 n_m + n_m^2$$
$$n_0^2 - n_m^2 = n_0^2 - 2n_0 n_m + n_m^2$$
$$-2n_m^2 = -2n_0 n_m$$
$$n_m^2 = n_0 n_m$$

$$\delta n' = \delta n\, C + \gamma(n_0^2 - n_m^2)$$

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3½" Object Glass -

Lerebour Prism

Lines of Spectrum	Circle Reading at Minimum Deviation			Deviation from B					
A	50°	11′	45″	0°	9′	55″	9.9′	182	+ 1
B	50	1	50	0	0	0	0	0	0
C	49	56	0		5′	50	5.8′	107	+ 8
D	49	41 / 14	45″ / 15″		20	5″	20.1′	370	+ 12
5614	49	33	50		28	0	28.0′	515″	+ 9
E	49	23	15″		38	35″	38.6′	711	+ 16
F	49	7 / 48	30 / 30		54	20	54.3′	1000	0
G	48	37	15″	1	24	35″	84.6′	1558	− 33
H,	48	10	22	1	57	28	111.5′	2053	

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3½" Object Glass

Flint Prism

Line of Spectrum	Circle Reading.	Deviation from B		
A	51° 17′ 48″	15′ 55″	15.9′	181
B	50 1/1 50/30	0	0	0
C	49 53/52 0/48″	8 45	8.75″	99
D	49 30/30 30/0	31 20	31.5″	358
5614	49 17/17 48″/0	44 30	41.5″	506
E	49 1/0 7/2	1° 1′ 8″	61.17	695″
F	48 34/33 30/0	1 28 0	88.0	1000
G	47 42/41 18″/30	2 20 0	140.0	1591
H1	46 53/54 7/48″	3 6 48″	186.75″	2122

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4½" Object Glass

Crown Prism

Line of Spectrum	Circle Reading			Deviation from B.				
A	5°0	10′	15″	10′	15″	10.25	204	+ 22
B	30	0 0	45″ 45″		0	0	0	0
C	49	53″ 53″	30 15″	5″	15″	5′.25″ ~~104~~	104	+ 8
D	49	42 42	~~30~~ 15″	18	15″	18′.25″ ~~363~~	363	+ 10
5614	49	35″ 35″	7 0	25″	38	25′.63 ~~510~~	510	+ 8
E	49	25″ 25″	15″ 0	35″	30	35′.5″ ~~706~~	706	+ 15″
F	49	10 10	30 30	50″	15″	50′.25 ~~1000~~	1000	0
G	48	43 43	0 30	1 17	45″	77′.75″ ~~15″47~~	1547	- 35″
H,	48	18	45″	1 42	0	102′.0 ~~2030~~	2030	

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4 1/2 in Object Glass.

Flint Prism

Genus of Spectrum	Circle Reading			Deviation from B				
A	50°	20′	0″		20′	0″	20.0	182	
B	50	0 0	45″ 45″		0		0	0	
C	49	50 50	15″ 15″		10	30	10.50	96	
D	49	22 22	0 0		38	45″	38.75	353	
	Fine Star	7 7	30 15″		53.23		53.4	(487)	?
5614	49	6″ 6″	45″ 45″		53″	0	53.0	502	
E	48	45 45″	0 0	1	15″	45″	75.75″	691	
F	48	11 11	15″ 0	1	49	38	109.6	1000	
G	47	6	~~45~~ 15″	2	54″	30	174.5″	1592	
H_1	46	6	0 15″	3	54″	38	234.6	2140	
H_2	45″	49	15″	4	11	30	251.5″	(2295″)	?

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7" Object Glass - #18 - #29. Jena Glass -

Crown Prism
#18

Line of Spectrum	Circle Reading	Deviation from B.			
A	220° 24' 15" / 50 10 45	11 0 / 9 0	10	186	+ 4
B	220 13 15 / 50 1 45	0	0	0	0
C	220 8 15 / 49 56 0	5 0 / 5 45 ✓	5.75	100 / 107	+1
D	219 53 45 / 49 41 45	19 30 / 20 0	19.75	368	+16
5614	219 45 15 / 49 34 0	28 0 / 27 45	27.7	516	+13
E	219 35 15 / 49 23 30	38 0 / 38 15	38.1	709	+21
F	219 19 30 / 49 7 30	53 45 ✓ / 53 53 ✓	53.7	1000	0
G	218 49 0 / 48 37 30	1 24 15 / 1 24 15	84.25	1568	-20
H,	218 22 45 / 48 11 15	1 50 30 / 1 50 30	110.5	205-8	

Dec. 13th 1898.

$\alpha = 60° 8' 20''$

Index of Refraction Log

B = 1.51157 = 0.179427

5614 = 1.51679 = 0.180926

F = 1.52169 = 0.182327

Double Deviations

B = 76 39 15

δ = 38 19 37

0

0

5614 = 77 34 30

38 47 15

27 38

516

7 = 78 26 30

39 13 15

53 38

1000

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Flint Prism

#29

Line of Spectrum	Circle Reading			Deviation from B.			
A	220	17	30	15′	30″	15	182
	50	16	38	14	38		
B	220	2	0		0	0	0
	50	2	0				
C	219	53	52	8	8	8.2	99
	49	53	45	8	15		
D	219	33	0	29	0	29.1	352
	49	32	45	29	15		
5614	219	20	30	41	30	41.5	503
	49	20	15	41	45		
E	219	5	15	56	45	56.8	688
	49	5	0	57	0		
F	218	38	45	1 23	15	82.5	1000
	48	39	30	1 22	30		
G	217	51	12	2 10	38	131.0	1588
	47	50	30	2 11	30		
H,	217	8	0	2 54	0	174.5	2115
	47	7	0	2 55	0		

Index of Refraction. $\alpha = 60° 0' 20''$ Dec. 16th 1895.

B = 1.566139 = Log 0.194900

5614 = 1.573855 = " 0.196962

F = 1.581108 = " 0.198954

Double Deviations

B =	86	13	45	5614 =	87	36	30	H =	88	57	20	
δ =	43	6	57		43	48	15		44	28	45	
			0			41	18	41.3	1	21	48	81.8
						0	5.05		40	30	1000	

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7in Object Glass #23 – #31 Jena Glass.

Brown Prism #23

	Circle Reading			Deviation from B						
A	50°	11′ 45″ 12	0	11′	30″	11.5″	184	+ 2	700	544
B	50	0	-45- 20	0		0	0	0	516	360
C	49	54 54	15 15	6	15	6.25	100	+ 1	416	260
D	49	38 38	0 0	22	30	22.5	360	+ 8	156	0
5614	49	28	15	32	15	32.25	516	+ 12	0	156
E	49	17 16	30 30	43	30	43.5	696	+ 2	180	336
F	48	57 58 58	45 15	1	2	28	62.5	1000	0	484	640
G	48	22	0	1	38	30	98.5	1576	- 1	1060	
H,	47	51	0	2	9	30	129.5	2072			

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Flint Prism

31

	Circle Reading			Deviation from B			
	°	′	″	′	″		
A	50	18	15	17	15	17.25	182
B	50	1 1	0 0	0		0	0
C	49	51 51	30 45	9	22	9.37	99
D	49	27	45	33	15	33.25	352
	true	14	15	46	45		495
56.4	49	13 13	15 30	47	38	47.63	504
E	48	53 53	15 30	1 5	38	65.63	694
F	48	26 26	30 30	1 34	30	94.5	1000
G	47	32 31	15 45	2 29	0	149.0	1577
H_1	46	41	0	3 20	0	200.0	2116
H_2	46	35	45	3 25	15	205.25	2172

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Identification of the 5614 Lenie.

No 18 Iceron Prism,

Cauchy's formulae is $n = A + \frac{B}{\lambda^2} \ldots\ldots$

For B, $1.5^{-}1187 = A + \frac{B}{.00068668^2}$

For F, $\frac{1.52169}{3.03326}$ $\frac{}{1.51663} = A + \frac{B}{.00048606^2}$

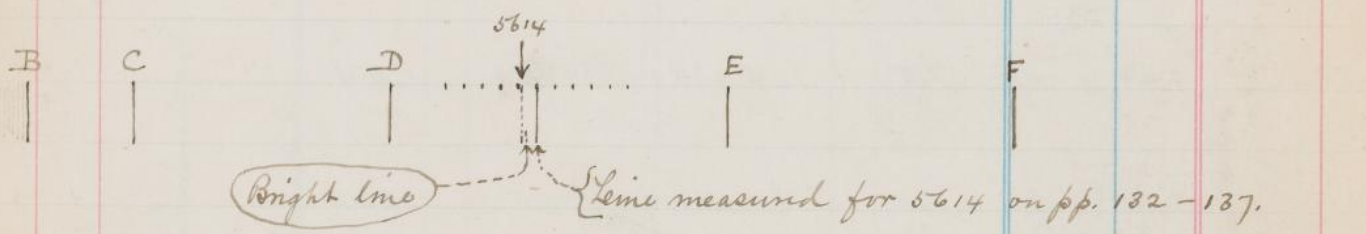
From which

$A = 1.5^{-}0138$

$B = .0000000004481$

Hence $n_{5614} = A + \frac{B}{.0005614^2}$

$n_{5614} = 1.5^{-}1664$ = exactly halfway between B and F



Lenie measured for 5614 $n = 1.5^{-}1679$

$n_{5614} = 1.5^{-}1664$

$.0001 5^{-}$ towards red.

Check by D line. $n_D = 1.5^{-}1525^{-}$

By Cauchy's formulae, $\lambda = 58920$ $n = 1.51524$

D_1 $\lambda = .00058950$

D_2 $\lambda = .00058890$ 0.00001

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№ 23 Lerowx Prism

B $1.53273 = A + \frac{B}{.00068668^2}$

F $\frac{1.54437}{2)\ 3.07710} = A + \frac{B}{.00048606^2}$

1.53855

$1.53273 = A + 2120750\,B$

$1.54437 = A + 4232720\,B$

$.01164 = 2111970\,B$

$B = .000000005511 14$

$1.53273 = A + .011688$

$A = 1.52104$

$n_{5614} = A + \frac{B}{.0005614^2}$

$= 1.52104 + .017487$

$= .01749$

1.53853

$1.54437 = A + .023328$

$A = 1.52104$

6,836754 / 3.67355 / 6.32649

6,68669 / 3.37338 / 6.62662 / 1.74126 / 8.36788

8,06595 / 6,32469 / 1.74126 / 6.32649 / 8.06775

$B = .011688$

1.53273 / .01169 / 1.52104

6,74927 / 3.49854 / 1.74126 / 8.24272

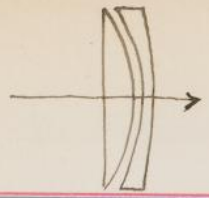
1.54437 / .02333 / 1.52104

see p. 157

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18-29



$r_1 = 18187. =$
$r_2 = 9.6750 = \log. 0.98565^- \checkmark$
$r_3 = 9.8088 = \,\,\,\, 0.99162 \checkmark$
$r_4 = 32.553 = \,\,\,\, 1.5^-12767 \checkmark$

To find color correction.

.5116
.5217
5333/4
5167

	B	F
Lerom, n =	1.5^-1164 – p.102	1.52176
	1.5^-1157 – p.134	1.52169
Ave	1.5^-1160 = log 0.17944	1.52172 = log 0.18233
Klinkerfues n' =	1.56627	1.58098
	1.56639	1.5^-8108
Ave.	1.56633 = log 0.19488	1.5^-8103 = log 0.19894

B

XII

$k = 3.5 = 0.54407$
$r_2 = 0.98565^-$
$i = 21^\circ\ 12'\ 30'' = \sin 9.55842$
$n = 0.17944$
$\lambda = 33\ 9\ 2 = \sin 9.73786$
$v' = 11\ 56\ 32$ $r = 0.98565^-$
0.72351
$= \sin 9.31581$
$25.568 = 1.40770$
9.6750
$f_2 = 15.8930$
$.01$
$d_3 = 15.8830$
$r_3 = 9.8088$
$25.6918 = 1.40979$

III

$\sin v = 9.31581$
0.72560
$r_3 = 0.99162$
$i = 32^\circ\ 49'\ 6'' = \sin 9.73398$
$n = 0.19488$
$\lambda = 21\ 40\ 38.5^- = \sin 9.55454$
$11\ 48\ 27.5^-$ $r_3 = 0.99162$
$11\ 56\ 32.0$ 0.54616
$v' = 0\ 8\ 5.5^- = \sin 7.37177$
$1494.14 = 3.17439$
9.81
$f_2 = 1484.33$

F

XII

$21^\circ\ 12'\ 30'' = \sin 9.55842$
$n = 0.18233$
$= \sin 9.74078$
$33\ 24\ 2$ 0.98565^-
$v' = 12\ 11\ 32$ 0.72640
$= \sin 9.32468$
$25.2186 = 1.40172$
9.6750
$f_2 = 15.5436$
$.01$
$d_3 = 15.5336$
9.8088
25.3424

III

$= 1.40385$
9.32468
0.72853
$r_3 = 0.99162$
$= \sin 9.73691$
$33^\circ\ 4'\ 7''$ $n = 0.18233$
$21\ 0\ 46$ $= \sin 9.55458$
$12\ 3\ 21$ 0.99162
$12\ 11\ 32$ 0.54620
$0\ 8\ 11 = \sin 7.37666$
$1477.54 = 3.16954$
9.81
$f_3 = 1467.73$

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B

f_3 = 1484.33
.25
d_4 = 1484.08
r_4 = 32.56 / 1516.64 = 3.18088 II
sin v = 7.37177
0.55265
r_4 = 1.51267
6° 17′ 41.0 = sin 9.03998

F

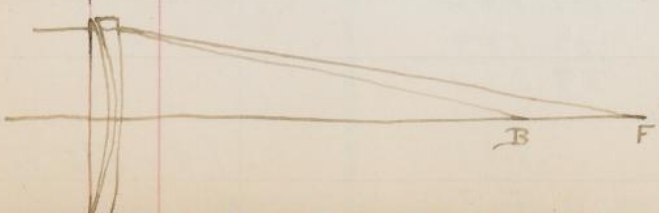
f_3 = 1467.73
.25
d_4 = 1467.48
r_4 = 32.56 / 1500.04 = 3.17610 II
7.37666
0.55276
1.51267
6° 17′ 46.7 = sin 9.04009

B

i = 32° 49′ 6″ = sin 9.73398 VII
n = 0.19488
λ = 20 14 38 = sin 9.53910
12 34 28 r_3 = 0.99162
v' = 11 56 32 0.53072
v = 0 37 56 = sin 8.04274
307.596 = 2.48798
r = 9.809
f_3 = 317.406
+.25
d_4 = 317.656
r_4 = 32.559 / 285.096 = 2.45499
sin v 8.04274
0.49773
r_4 = 1.51267
i = 5° 32′ 40″ = sin 8.98506
n = 0.19488
λ = 8 42 15.5 = sin 9.17994
3 9 35.5 r_4 = 1.51267
v' = 0 37 56.0 0.69261
v = 2 31 39.5 = 8.64445
111.728 = 2.04816
32.559
f_4 = 89.169

F

i = 33° 4′ 7″ = sin 9.73691
n = 0.19894
λ 20 11 21 = sin 9.53797
12 52 46 0.99162
12 11 32 9.52959
0 41 14 8.07896
282.25 = 2.45063
9.81
f_3 = 292.06
+.25
d_4 = 292.31
32.559 / 259.751 = 2.41456
8.07896
0.49352
1.51267
i = 5 29 27 = sin 8.98085
0.19894
λ 8 42 4.6 = sin 9.17979
3 12 37.6 1.51267
v = 0 41 14.0 9.69246
v = 2 31 23.6 = 8.64369
111.885 2.04877
32.559
89.326
.169
.157



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Calculation (p. 140) repeated.

B Crown F

XII

$k = 3.5^- = 0.54407$

$\frac{r}{r_2} = 0.98565^-$

$i = 21^\circ\ 12'\ 30'' = \sin 9.55842$ — $21^\circ\ 12'\ 30''$ — $n = 9.55842$

$n = 0.17944$ — $n = 0.18233$

$\lambda = 33\ 9\ 2 = \sin 9.73786$ — $33\ 24\ 2.5 = \sin 9.74075^-$

$i' = 11\ 56\ 32$ — $r = 0.98565^-$ — $i' = 12\ 11\ 32.6^-$ — $r = 0.98565^-$

0.72351 — 0.72640

$\sin 9.31581$ — $\sin 9.32468$

$25.568 = 1.40770$ — $25.2186 = 1.40172$

9.675

$f_2 = 15.893$ — 9.6750

$.01$ — $f_2 = 15.5436$ — $.01$

Flint — $d_3 = 15.5336$

$d_3 = 15.883$

$r_3 = 9.8088$ — 9.8088

VII

$25.6918 = 1.40979$ — $25.3424 = 1.40385^-$

$\sin i' = 9.31581$ — 9.32468

0.72560 — 0.72853

$r_2 = 0.99162$ — 0.99162

$i = 32^\circ\ 49'\ 5.''7 = \sin 9.73398$ — $i = 33^\circ\ 4'\ 7.''4 = \sin 9.73691$

$n = 0.19488$ — 0.19894

$\lambda = 20\ 14\ 38.5^- = \sin 9.53910$ — $20\ 11\ 21.0 = \sin 9.53797$

$12\ 34\ 27.2$ — $r = 0.99162$ — $12\ 52\ 46.4$ — 0.99162

$i' = 11\ 56\ 32.$ — 0.53072 — $12\ 11\ 32.5^-$ — 0.52959

$0\ 37\ 55.2 = \sin 8.04259$ — $0\ 41\ 13.9 = \sin 8.07895^-$

2.48813 — 2.45064

$30.770 =$ — 28.2254

9.81 — 9.809

$f_3 = 317.51$ — $f_3 = 292.063$

$+ .25^-$ — $.25^-$

VI

$d_4 = 317.76 +$ — $292.313 +$

32.589 — 32.539

$285.201 = 2.45515$ — $259.754 = 2.41456$

$\sin i' = 8.04259$ — 8.07895^-

0.49774 — 0.49351

$r = 1.51267$ — 1.51267

$i = 5^\circ\ 32'\ 40.6 = \sin 8.98507$ — $5^\circ\ 29'\ 26.5 = \sin 8.98084$

$n = 0.19488$ — 0.19894

$\lambda = 8\ 42\ 16.2 = \sin 9.17995^-$ — $8\ 42\ 3.9 = \sin 9.17978$

$3\ 9\ 35.6$ — $r = 1.51267$ — $3\ 12\ 37.4$ — 1.51267

$0\ 37\ 55.2$ — 0.69262 — $0\ 41\ 13.9$ — 0.69245^-

$2\ 31\ 40.4 = \sin 8.64450$ — $2\ 31\ 23.5^- = \sin 8.64369$

$111.717 = 2.04812$ — $111.882 = 2.04876$

32.539 — 32.539

89.158 — 89.323

$.158$

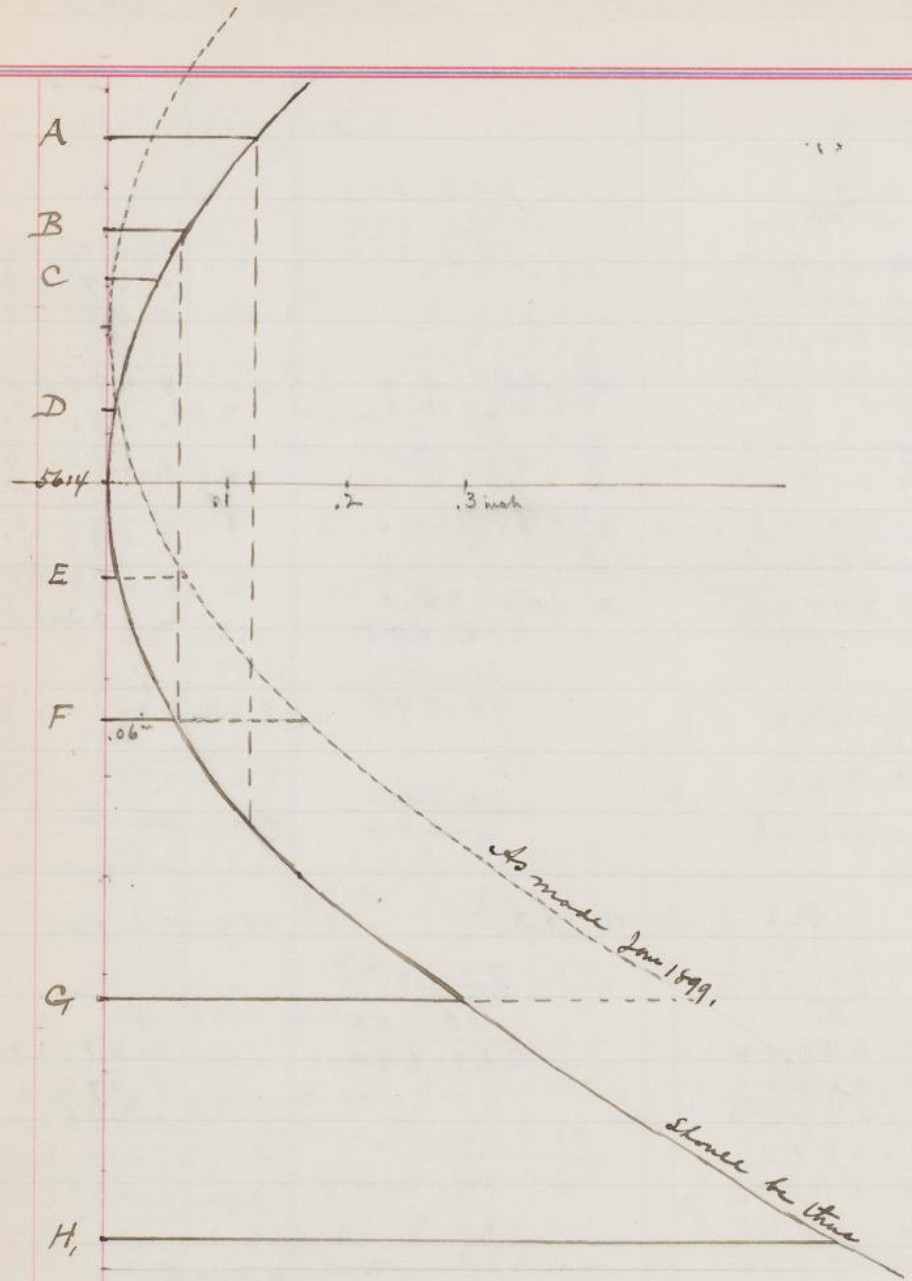
$.165$

[for Sph. Ab.

Flint is too strong for color but correct

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18 – 29 Color correction, Try $r_4 = 30.000$ in.

B

$d_4 =$ 317.76
$r_4 =$ 30.00
287.76 =

VI
2.45903
sin d = 8.04259
0.60162
r_4 = 1.47712
i = 6° 4′ 24.5″ = sin 9.02450
n = 0.19488
λ = 9 32 21.0 = sin 9.21938
3 27 56.5 r_4 = 1.47712
d' = 0 37 55.2 0.69650
d = 2 50 1.3 = sin 8.69405
2.00245

100.563 =
30.000
70.563

70.498
.065 Flint too weak

7

292.313
30.000
262.313 =

2.41882
8.07895
0.49777
1.47712
9.02065
0.19894
λ = 9 32 37.8 = sin 9.21959
3 31 27.0 1.47712
0 41 13.9 0.69671
2 50 18.1 8.69453
100.498 = 2.00216
30.000
70.498

~~70.563~~
~~288~~ ~~Flint too strong~~

Try $r_4 = 30.723$ = 32.559 – 1.836

$d_4 =$ 317.76
$r_4 =$ 30.723
287.037 =

VI
2.45794
d = 8.04259
0.50053
r_4 = 1.48746
5′ 54′ 54.5″ = sin 9.01307
n = 0.19488
9 17 21.0 = sin 9.20795
3 22 26.6 1.48746
0 37 55.2 0.69541
2 44 31.3 = 8.67978
103.665 = 2.01563
30.723
72.942

22
.020 Flint too weak

292.313
30.723
261.690

2.41779
8.07895
0.49674
1.48746
9.00928
0.19894
5′ 51′ 48.8 sin 9.20822
1.48746
9 17 42.0 = sin 0.69568
3 25 53.2 8.68013
0 41 13.9 2.01555
2 44 39.3 =
103.645
30.723
72.922

r_4 = 30.8.23 should give correct color correction.

$-B = \frac{1}{r_3} - \frac{1}{r_4} = .069504$

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18–29 Spherical Aberration.

r_1 = Int
r_2 = 9.6750
r_3 = 9.9371
r_4 = 32.125

B Marginal

d_3 = 15.883

r_3 = 9.9371 / 25.8201 = 1.41196 (VII)

sin V = 9.31581
0.72777
r_3 = 0.99726
32° 31′ 29.9 = sin 9.73051
n 0.19488
20 4 33.3 = sin 9.53563
12 26 56.6 r = 0.99726
V. 11 56 32. 0.53289
0 30 24.6 = sin 7.94673
38.562 = 2.58616
9.9371
f_3 = 395.557
.25
d_4 = 395.807

32.125 / 363.682 = 2.56972 (VI)

sin V = 7.94673
0.50745
r_4 = 1.50684
5° 44′ 50.0 = sin 9.00061
n = 0.19488
9 27.2 = sin 9.19549
3 16 37.2 r = 1.50684
0 30 24.6 0.70233
2 46 12.6 = sin 8.68421
104.260 = 2.01812
32.125
f_4 = 72.135

B Central

r_2 = 9.6750 = 0.98565
n − 1 = 0.51160 = 9.70893
f_2 = 18.911 = 1.27672
.01
d_3 = 18.901 (VII) 1.27648
n = 0.19488
r_3 = 0.99726
2.46862

d = 1.27648
n−1 = 9.75307
1.02955 = 10.704
9.9371
.7669 = 9.88474
f_3 = 383.60 = 2.58388
.25
d_4 = 383.85 = 2.58416
r_4 = 1.50684
4.09100

d = 2.58416
n−1 = 9.75307
2.33723 = 217.385
n = 0.19488
r = 1.50684
1.70172 = 50.318
167.067 = 2.22289
f_4 = 73.809 = 1.86811

72.135 / 1.674 Flint two mak

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18-29 Spherical Aberration.

$r_1 = \text{Inf}$
$r_2 = 9.6750$
$r_3 = 9.8953$
$r_4 = 31.691$

B. Marginal

$d_3 = 15.883$

$r_3 = \frac{9.8953}{25.7783} = 1.41625$

VII

$\sin i = 9.31589$
0.72706
$r = 0.99543$
$= \sin 9.73163$
$n = 0.19488$
$= \sin 9.53675$
$r = 0.99543$
0.53218

32° 37' 9.8
20 7 48.0
12 29 21.8
11 56 32.0
0 32 49.8 $= \sin 7.97999$
$356.607 = 2.55219$
9.895
$f_3 = 366.502$
.25
$d_4 = 366.752$
31.691
$335.061 = 2.52512$

VI

$\sin i = 7.97999$
0.50511
$f_4 = 1.50094$
5° 47' 41.0 $= \sin 9.00417$
$n = 0.19488$
9 5 57.0 $= \sin 9.19905$
3 18 16.0 $r = 1.50094$
32 49.8
2 45 26.2 $= \sin 8.68219$
$104.184 = 2.01780$
31.691
$f_4 = 72.493$

central 73.809
72.493
1.316

Hint too weak

$r_3 = 9.8088$
$r_4 = 30.823$

$d_3 = 15.883$
$r_3 = \frac{9.809}{25.692} = \sin i = 1.40980$
9.31581
0.72561
$r_3 = 0.99162$
$= \sin 9.73399$
$n = 0.19488$
$= \sin 9.53911$
$r_3 = 0.99162$
0.53073
32° 49' 10" $\sin 8.04312$
20 14 40 $= 2.48761$
12 34 30
11 56 32
0 37 58 $= 307.334$
9.809
$f_3 = 317.143$
.25
$d_4 = 317.393$
$r_4 = 30.823$
$286.570 = 2.45723$
$\sin i = 8.04312$
0.50035
$r_4 = 1.48887$
5° 53' 36.4 $= \sin 9.01148$
$n = 0.19488$
9 15 17.8 $= \sin 9.20636$
3 21 41.4 $r = 1.48887$
0 37 58.0 0.69523
2 43 43.4 $= 8.67767$
$= 2.01756$
104.126
30.823
73.303

73.809 - central
Hint too weak } 0.506

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		Sph. Ab.
r_3 = 9.9371	.1283	1.674
= 9.8953	.0865	1.316
= 9.8088	0	.506
9.7528	.0560	.000

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

$B = 0.069504$

call $r_3 = 9.7530 =$ log 0.98914

$9.010.86 = 0.102532$

~~$9.235-97 = 0.172174$~~

~~$= 0.764403$~~

$8,512888 \quad 0.033028$

$r_4 = 30.2775^{\circ} = 1.481112$

	r	r_2	r_3	r_4	γ
	Lut (1818?)	9.6750	9.7530	30.2775	73.809
add $\frac{1}{2}$		4.8375	4.8765	15.1388	36.904
		14.5125	14.6295	45.4163	110.713

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$\tau_1 = 18187.$
$\tau_2 = 14.5125^-$ } $t = .625^-$
$\tau_3 = 14.6295^-$ } $t = .200$
$\tau_4 = 45.4163$

.01

B

$k = 3.000 = 0.47712$
$\tau_1 = 18187'' = 4.25976$
$0^\circ\ 0'\ 34.0243 = \sin = 6.21736$
$n = 0.17944$
$0\ 0\ 22.5139 = \sin 6.03792$
$\nu = 0\ 0\ 11.5104$ 4.25976
0.29768
$\sin 5.74625^-$
$= 4.55142^-$

P. 140

I

$35^-598.$
$18187.$
$f_1 = 5^-3785^-.$
$.625^-$
$d_2 = 5^-3784.4$

II

$\tau_2 = 14.5^-$
$5^-3798.9 = 4.73077$
$5^-.74625^-5^-$
0.477025
$\tau_2 = 1.161742$
$\dot\delta = 11^\circ\ 53'\ 38''.5^- = \sin 9.31528$
$n\ 0.17944$
$\dot\alpha' = 18\ 12\ 15.5^- = \sin 9.49472$
$6\ 16\ 37.0$ $\tau = 1.16174$
0.65646
$\dot\nu = 11.5^-$
$\dot\alpha' = 6\ 16\ 48.5^- = \sin 9.03898$
$41.446 = 1.61748$

VII

$\tau_2 = 14.5^-125^-$
$f_2 = 26.9335^-$
$.01$
$d_3 = 26.9235^-$
$\tau_3 = 14.6295^-$
$41.5^-5^-30 = 0.61860$
$\sin\nu = 9.03898$
0.65758
$\tau_3 = 1.16523$
$i = 18^\circ\ 6'\ 6''.5^- = \sin 9.49235^-$
$n = 0.19488$
$\lambda = 11\ 26\ 29.4 = \sin 9.29747$
$6\ 39\ 37.1$ 1.16523
$6\ 16\ 48.5^-$ 0.46270
$0\ 22\ 48.6 = \sin 7.82185^-$
$= 2.64085^-$
437.37
14.63
$f_3 = 452.00$

7

I

$0^\circ\ 0'\ 34.0243 = \sin 6.21736$
$n = 0.18233$
$0\ 0\ 22.3643 = \sin 6.03503$
$\nu = 0\ 0\ 11.6600$ 4.25976
0.29479
$\sin 5.75191$
$= 4.54288$

34904
18187
$f_1 = 5^-3091.$
$.625^-$
$d_2 = 5^-3090.4$
14.5^-
$5^-3104.9 = 4.72513$

II

5.75191
0.47704
1.16174
$\dot\delta = 11^\circ\ 53'\ 40''.0 = \sin 9.31530$
$n = 0.18233$
$\dot\alpha' = 18\ 19\ 51.8 = \sin 9.49763$
$6\ 24\ 11.8$ 1.16174
11.7 0.65937
$\dot\nu' = 6\ 24\ 23.5^-$ 9.04759
$40.906^- = 1.61178$

14.5^-125^-
$f_2 = 26.3925^-$
$.01$
$d_2 = 26.3825^-$
14.6295^-
$41.0120 = 1.61291$
9.04759
0.66050
1.16523
$18^\circ\ 13'\ 41''.6 = \sin 9.49527$
$n' = 0.19894$
$11\ 24\ 40.0 = \sin 9.29633$
$6\ 49\ 1.6$ 1.16523
$6\ 24\ 23.5^-$ 0.46156
$0\ 24\ 38.1$ 7.85357
$403.64 = 2.60599$
14.63
$f_3 = 418.27$

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B.

f_3 = 452.00
+.20
d_4 = 452.20

r_4 = 45.416 / 406.784 = 2.60936

VI

7.8218 5-
= sin 0.43121
r_4 = 1.65721

i = 3 24 25.4 = sin 8.77400
n' = 0.19488

5 20 28.0 = sin 8.96888
1 56 2.6 q = 1.65721
0 22 48.6 0.62609
1 33 14.0 = sin 8.43324
= 2.19285

15-5.901
45.416
f_4 = 110.485

.

.331
.154 brown strong. Hint weak } for color

7.

f_3 = 418.27
+.20
418.47

45.416 / 373.054 = 2.57177

7.8587
0.42734
1.65721

3 22 36.4 = sin 8.77013
n' = 0.19894

5- 20 36.5- = sin 8.96907
1 58 0.1 1.65721
0 24 38.1 0.62628
1 33 22.0 = sin 8.43386
= 2.19242

15-5.747
45.416
f_4 = 110.331

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23 – 31

from p 126.

	#23			#31		
	n			n1		
B	1.53285	1158	1000	1.53951	1573	1000
56.4	1.53885	558	482	1.58748	776	493
7	1.54443	0	0	1.59524	0	0

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#23 Prism reground flat. Remeasurement

Feb. 24th 1901



See 7" Book p6 Latter measurement

		300	1	45"		290	3	0	310	3	15	2 45
B line	2δ =	220	0	15"		210	2	15	230	2	7	2 0
	δ =	80	1	0		80	0	45	80	1	7	0 45
		311	5-	30		312	9	7	300	1	30	1 45
F		229	59	45		230	3	22	217	55	25	55 45
		82	5-	45		82	5	45	82	6	8	6 0
		298	58	20		302	0	45	230	10	30	
Hγ		217	57	15		220	57	30	311	13	50	
"White Line" 4/10 C-E		81	3	5		81	3	15	81	3	30	

2nd eyepeth, spaced line from F towards B

311	13	30	311	13	45
229	14	0	229	14	0
81	59	30	81	59	15

Angle of Prism

120	4	5-2	10	1	0	20	2	37	120	4	45
0	2	45	130	3	15	140	5-	15	0	2	15
120	2	7	120	2	15	120	2	38	120	2	30

130	4	5-0
10	2	22
120	2	38

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#23

$$n = \frac{\sin \frac{1}{2}(\delta + A)}{\sin \frac{1}{2} A}$$



5614.

	B		F	
	80° 0′ 60″	81° 3′ 5″	82° 5′ 45″	81 59 30
	0 45	3 15	5 45	15
	0 67	3 20	68	41
	0 45	40	60	40
	217		218	
Ave.	80, 0 54	81 3 13	82 5 55	81 59 22
	1° 2′ 19″	1° 2′ 32″	0° 56′ 9″	
$\frac{1}{2}\delta$ =	20 0 13	20 15 48	20 31 29	
$\frac{1}{2}A$	29 58 47	29 58 47	29 58 47	
	49 59 0	50 14 35	50 30 16	
sin	9.884148	9.885793	9.887434	
	9.698704	9.698704	9.698704	
	0.185444	0.187089	0.188730	
	29	69	035	
	150	200	24 35	
n =	1.53265	1.53847	1.54429	
	20	28	14	
	582	572		

120 | 2 | 7
15
38
30
38
128

120° 2′ 26″

Angle = 59 57 34

$\frac{1}{2}A$ = 29 58 47

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Rowlands Standard Wave Lengths. Scheiners. Ast. Spec.

				Index of Refr.
A	7621.277	one of group		1.53057 (1.53055)
B	6870.186	4 one of group		1.53273
C	6563.054	30		1.53389 (1.53385)
D	5893 1	D_2 = 5890.182	15	(1.53694)
	Shorter lines 5614	D_1 = 5896.154	10	1.53693
	Comma 5304			(1.53691)
E	E_2 = 5269.722		8	1.54084
	E_1 = 5270.495		4	(1.54090)
	10540.217			
	5270.109			
F	4861.496	15		1.54437
G	4308.034	2 + 5		(1.55075) 1.55100
g	4226.892	10		
H,	3968.620	200		(1.55604) 1.55669
	5615.9 B+F / 2	6		(1.53853 / 7)

B = 1.53273

F = 1.54437

2 | 3.07710

n = 1.53855 half way between B and F

A .00076213 = 6.88203 / 2 = 3.76406

1.74115

7.97709

1.52106

.00949

1.53055

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#23 Iverson -

$B = 1.5\bar{3}278 = A + \frac{B}{.0006870.2^2}$

$F = 1.5\bar{4}437 = A + \frac{B}{.0004861\bar{8}^{-2}}$

$1.5\bar{3}273 = A + 2118650\,B$

$1.5\bar{4}437 = A + 4231170\,B$

$.01164 = 2112\bar{5}20\,B$

$B = .000000000055\bar{1}00$

$1.\bar{5}3273 = A + .0116737$

$.01167$

$1.\bar{5}2106 = A$

To find $n_{5615.9} = A + \frac{B}{.00056\overline{15.9}^2}$

$= 1.52106 + .0174703$

$.01747$

$n = 1.5\bar{3}885$

C $= 1.\bar{5}2106 + .012792$

$.01279$

$1.\bar{5}3385$

D_2 $n_{D_2} = 1.\bar{5}2106 +$

$.01\bar{5}88$

$1.\bar{5}3694$

$1.\bar{5}2106$

$.01\bar{5}85$

$n_{3,} = 1.\bar{5}3691$

E $1.\bar{5}2106$

$.01984$

$1.\bar{5}4090$

G $.00043080 = 6,634\overline{28}_2$

3.26856

1.74115

8.47259

1.52106

$.02969$

1.55075 ✓

H, $= .00039686 =$

$1.\bar{5}2106$

$.03498$

$1,\bar{5}\bar{5}604$

$B = .000056\overline{31} =$

6.83697_2

3.67394

6.32606

6.68677_2

3.37354

6.62646

$8.06\bar{5}95$

6.32480

1.74115

6.32606

8.06721

6.74942_2

3.49884

1.74115

8.24231

6.81711_2

3.63422

1.74115

8.10693

$.000\bar{5}8902$

6.77013_2

$3.\bar{5}4026$

1.74115

8.20089

58962

$6.770\bar{5}7_2$

$3.\bar{5}4114$

1.74115

8.20001

$.000\bar{5}2701$

6.72182_2

3.44364

$1.7411\bar{5}$

$8.29\bar{5}71$

$6.\bar{5}7864_2$

3.19728

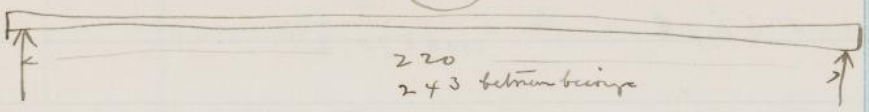
1.74115

$8.\bar{5}4387$

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P

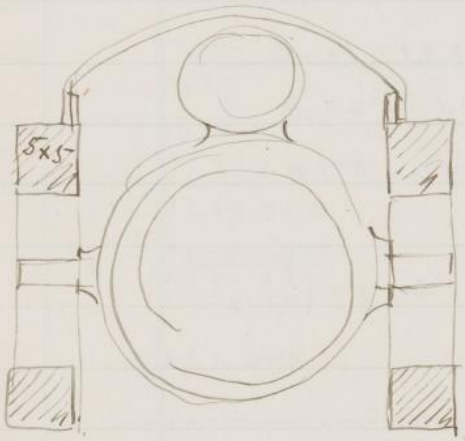


18
12
216

$P = \frac{2}{3}\frac{R\,b\,d^2}{l} = \frac{2}{3} \times \frac{500}{1000} \times \frac{8}{220} \times \frac{8}{11} = \frac{4000}{11} = 363\ lbs$ at middle

4

1452 total

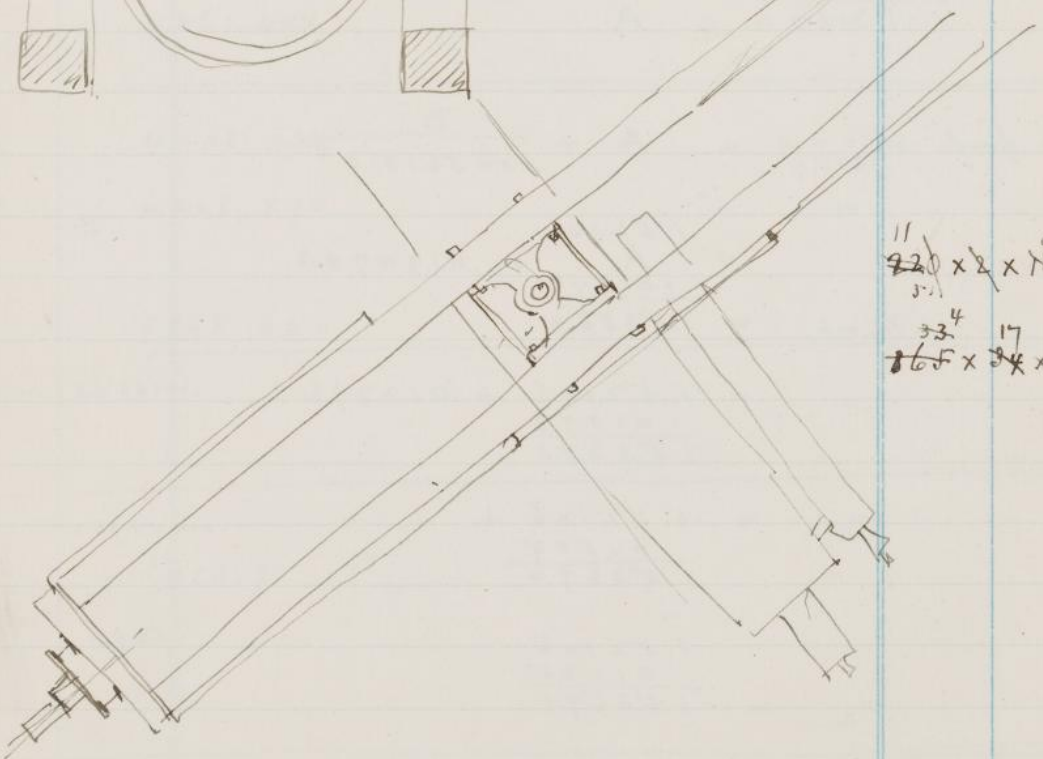


$10 \times \frac{5}{10} \times \frac{11}{220} \times \frac{1}{2} = 550\ lbs$

275

Tube ca 350

1175



$\frac{11}{220} \times 2 \times \frac{9}{18} \times \frac{1}{2} \times \frac{1}{2} = 99\ lbs$

$\frac{33}{165} \times \frac{4}{34} \times \frac{17}{1} \times \frac{1}{5} = 68$

167

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$$\text{Deflection} = \frac{Pl^3}{4Ebd^3} = \frac{\cancel{1450}\ 390 \times 220^3}{4 \times 1700000 \times 5^- \times 5^3} = 0.905$$

$220 = 2.342$ (3) $= 7.026$

$1450 = 3.161$ $\quad 10.187$

9.628

$0.559 = \cancel{3.621}$

$4 = 0.602$

$9.957 = 0.906$

$5^- = 0.699$ (4) $= 2.796$

$6800000 = 6.832$

9.628

$P = \frac{1}{3} \times \frac{\cancel{1000}\ 25^- \times 5 \times 5 \times 5^-}{\cancel{240}\ \cancel{12}\ 3} = 347$ lbs at Center

$\times 4$

1388 at Center

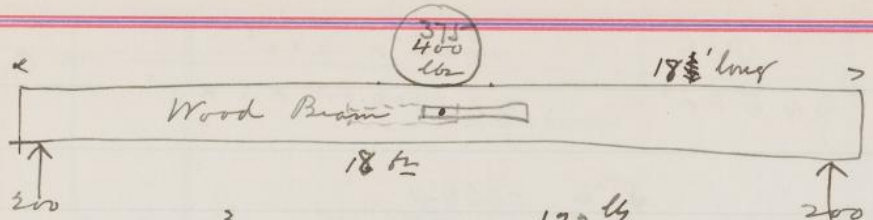
25^-
25^-
125^-
50
625^-
5
3125^-

9 | 3125
$\cancel{34}7$

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1897phae.proj..539H

Mounting for 12" Telescope January 1908.



18½" long

$Wt = 18 \times 2 \times \frac{3}{2} \times \frac{3}{2} \times \frac{1}{44} = 144$ lbs

$\frac{300}{72}$ / $\frac{372}{}$

$\frac{16'}{12}$ / 192" $\left(18 \times 2 \times 16 \times 12 \times \frac{1}{36} = 192\right)$

$17 \times 2 \times \frac{35}{2} \times \frac{3}{2} \times \frac{1}{44} =$

$P = \frac{2}{3} \frac{R b d^2}{e} = \frac{2}{3} \cdot \frac{333 \times 2 \times 16 \times 16}{16 \times 12} = 2664$ lbs

$\frac{111}{333} \times 1000 \times 2 \times 16 \times 12 \times 16 = 1776$ lbs

$\frac{2664}{3} = 888$ / $\frac{5328}{1776}$ = safe load at middle

Deflection $= \frac{Pl^3}{4 E b d^3} = \frac{400 \times 192^3}{4 \times 1700000 \times 2 \times 16^3} = 0.0508 \times \frac{1}{2} = 0.0254$

$= \frac{400 \times 216^3}{4 \times 1700000 \times 17^3 \times 2} = .0604$

Def = .045

$16' = 1.204$

$8 = 0.903$

$1700000 = 6.230$ / 10.745

$192 = 2.283$ / 6.849 / 2.602 / 9.451 / 10.745 / $8.706 = 0.0508$

400

2.334 / 7.002 / 2.602 / 9.604 / 10.823 / 8.781

$\frac{1}{2} = 0.0254$

$3PL = 2Rbd^2$

$R = \frac{3PL}{2bd^2}$

Top and bottom planks

$25 \times \frac{3}{4} \times 14 \times \frac{3}{2} \times \frac{1}{44} = 75$ lbs

$25 \times 1 \times 14 \times \frac{3}{2} \times \frac{1}{11} = 96$ lbs

$\times 1 \times \frac{31}{2} \times \frac{6}{12} \times \frac{1}{44} = 101$

$24 \times 1 \times \frac{31}{2} \times 12 \times \frac{1}{44} = 101$ lbs

$24 \times 1 \times 16 \times 12 \times \frac{1}{44} = 105$

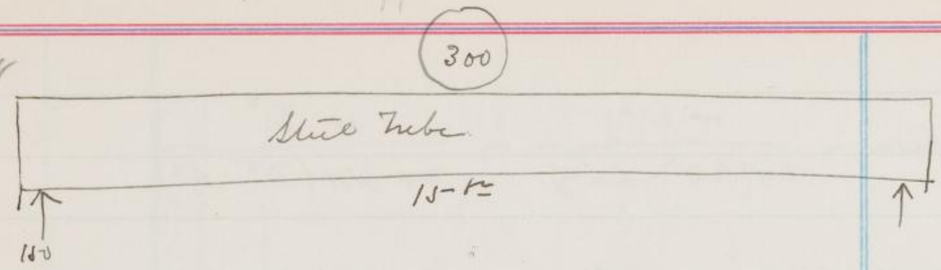
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$18\frac{1}{4} \times 12 \times 2 \times 18 \times \frac{1}{36} =$

$\frac{73}{4} \times 3 \times 2 \times 18 \times \frac{1}{36} = 219$

73
27
511
146
11) 1971
180 lbs

17 6 long
12
204
6
210



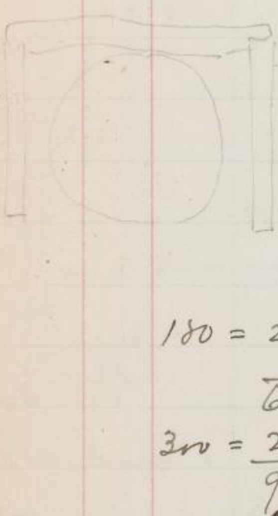
Kent p. 268 – Deflection $= \frac{1}{48} \cdot \frac{Pl^3}{EI} = \frac{1}{48} \cdot \frac{300 \times 180^3}{28000000 \times \frac{AD^2 - ad^2}{16}} = .0187$

$A = \pi R^2 = \pi\left(\frac{D}{2}\right)^2 = \frac{\pi D^2}{4} \qquad a = \pi \frac{d^2}{4}$

$\frac{AD^2 - ad^2}{16} = \frac{\frac{\pi D^4}{4} - \frac{\pi d^4}{4}}{16} = \frac{\pi}{64}(D^4 - d^4)$

$D = 15^{in} \qquad = 1.176$
$\qquad\qquad\qquad 4$
$\qquad\qquad\qquad 4.704 = 50600.$

$d = 14.9^{in} \qquad = 1.173$
$\qquad\qquad\qquad 4$
$\qquad\qquad\qquad 4.692 = 49200.$



1400. = 3.146 | 3.146
π = 3.141 = 0.497 | 0.497
2.649 | 3.643
64 = 1.806 | 1.806
0.843 | 1.837
28000000 = 7.447 | 7.447
48 = 1.681 | 1.681
9.971 | 0.965

180 = 2.255
3
6.765
300 = 2.477
9.242
0.965
0.0189 = 8.277

See next page – by another formula

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Thickness of Tube = $\frac{1}{20}$ inch

Kent p. 269 $\quad$ Deflection $= \dfrac{w L^3}{24(AD^2 - ad^2)} = \dfrac{w L^3}{6\pi(D^4 - d^4)}$

$$AD^2 - ad^2 = \frac{\pi D^4}{4} - \frac{\pi d^4}{4} = \frac{\pi}{4}(D^4 - d^4)$$

$w = \frac{300}{2000}$
$L = 15'$
$D = 15''$
$d = 14.9''$

$$\text{Defl} = \frac{\frac{300}{2000} \times 15^3}{6 \times 3.142 \left(15^4 - 14.9^4\right)} = .0192$$

$15 = 1.176$
$\quad\ 3$
3.528
$300 = 2.477$
6.005
$2000 = 3.301$
2.704
4.421

Defl $= .0192 = 8.283$

$1400 = 3.146$
$\pi = 0.497$
$6 = 0.778$
4.421
27

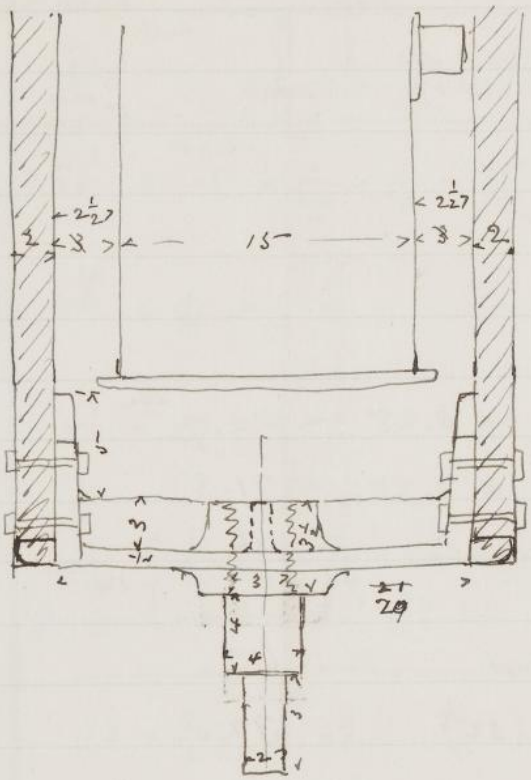
Weight

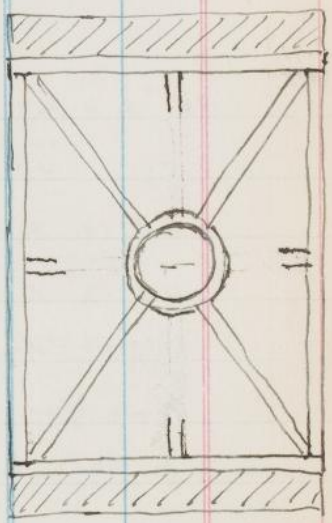
17½ pr. long

2 Side planks ~~142~~ 172 ~~144~~ each	=	~~288~~ 344 lbs			Nov. 26 08 400	344
2 Top + bottom planks	=	~~96~~ 101		1" thick	105	
2 " " " iron castings	=	190	225		200	225
2 " " " " pivots	=	45		Screws	43	
				Nuts	23	45
Bolts + Screws.	=	7			7	7
		626	687		40	20
			105		150	75
2 Trunion Bearings		20	75		863	80
		646	867	(1899)		901
4 Inside wood braces		85				
		731				
		35				
Iron castings add		766				
		40				
		807		+5		

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$21 \times \cancel{14}^{2} \times \frac{1}{2} \times \frac{1}{4} = 42^{lbs}$

$\cancel{74}^{18} \times \cancel{3} \times \frac{1}{2} \times \frac{1}{4} = 18$

$\cancel{14}^{7} \times \frac{7}{2} \times \frac{1}{4} = 12$

$27 \times \cancel{3} \times \frac{1}{2} \times \frac{1}{4} = 7$

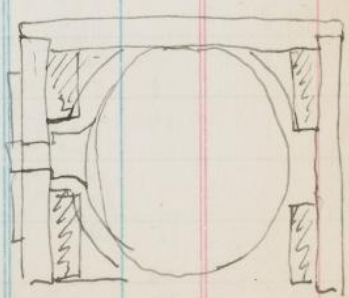
$10 \times \cancel{4}^{4} \times \frac{1}{3} \times \frac{1}{4} = 13$

92^{lbs} = Weight of end casting

$\cancel{20}^{5} \times 17 \times \frac{1}{2} \times \frac{1}{4} = 42\frac{1}{2}^{lbs}$

$\begin{array}{r} 42 \\ 32 \\ \hline 74 \end{array}$ $\begin{array}{r} 85 \\ 42 \\ \hline \end{array}$

$\begin{array}{r} 16 \\ 11 \\ \hline 27 \end{array}$



$7 \times \frac{7}{2} \times \frac{1}{4} = 6$

$12 \times 4 \times \frac{1}{4} = 12$

$3 \times 3 \times \frac{1}{4} = 3$

21^{lbs} = wt of Pin

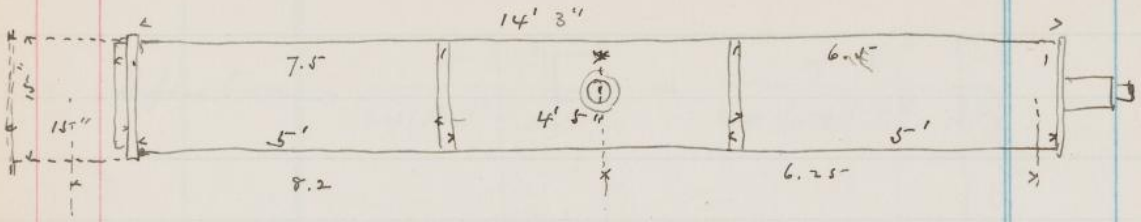
$\cancel{4} \times 13 \times 72 \times \frac{1}{44} = 85^{lbs}$

$\begin{array}{r} 72 \\ 13 \\ \hline 216 \\ 72 \\ \hline 936 \end{array}$ $\left.\begin{array}{l} 85 \\ 8 \end{array}\right]$

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Weight of Tube = ~~350~~ lbs



7' 4"
10
6 6
3
6 3

15" d = 47.12 cu in
48.12

48.12 × ~~120~~ 6 × 1/20 × 0.28 = 80.7 lbs

48.12 × √3 × 1/10 × 0.28 = 71.3

Object Glass actual on scales -	=	46.0
Ring for seat	=	8.0
To balance at the end	=	62.0
Trunions (32 lbs)	=	37.0
Diaphragms	=	2.0
Rivets	=	3.
		~~285.~~ ~~287.~~ ✓
		~~290.~~
		310

Dew Cap Counterpoise

13
17.
~~320~~ lbs
340
4
344

1.682
0.778
9.447
80.7 = 1.907

1.682
0.724
9.447
71.3 = 1.853

√4 = 1.732
7.5 = 0.875
2.607
6.5 = 0.813
62.2 = 1.794

3 Spans
1 3 " - Cap
14 3 - Tube
9 - Eyepiece
6 - Spar
15 30

~~18'~~
17' 6" = length of Plank

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Wt of Dew leaf $\frac{1}{40}$" thick

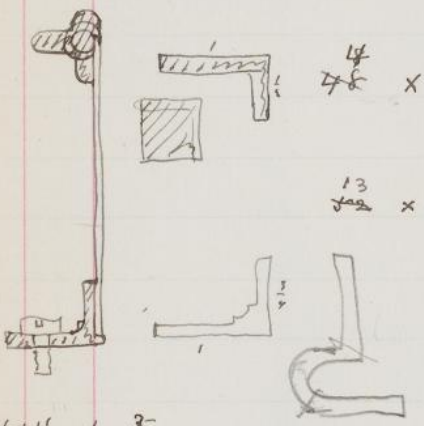
16" = $\frac{16\frac{1}{2}}{48}$

15"d = 48" circ

$50 \times 21 \times \frac{1}{40} \times .007 = 7.35$ lbs

21
50
1050
.007
7.350

$\frac{48}{48} \times 15 \times \frac{1}{40} \times \frac{1}{4} = \frac{45}{10} = 4\frac{1}{2}$ lbs $= 7.35$



$\frac{4}{48} \times \frac{1}{4} \times \frac{1}{3} =$ $= \frac{1}{48}$ ✓

$\frac{13}{52} \times \frac{1}{4} \times \frac{1}{3} =$ $= 4\frac{1}{2}$ ✓

13 lbs

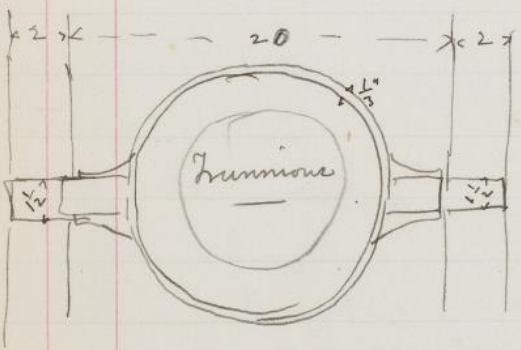
$\frac{3}{8} \times \frac{3}{32} = \frac{9}{64} \times \frac{16}{48} \times \frac{1}{3} =$

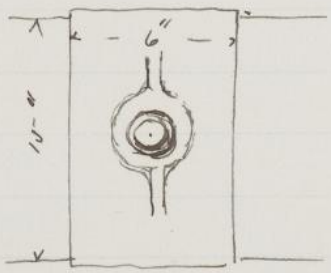
$\frac{2.25}{10}$ lbs

$1\frac{1}{2} \times \frac{1}{8} = \frac{3}{16}$

$13 \times \frac{8.2}{6.25} = 17.1$

1.114
0.914
2.028
0.796
= 1.232





21
15 2/3
5 1/3

See p. 169 for better trunnion

$49 \times \frac{1}{2} \times \frac{2}{8} \times .28 = 27.4$ lbs

$1.8 \times 4 \times .28 = 2.1$

$5 \times 5\frac{1}{3} \times .28 = 7.5$

37.0 lbs

Wt =

1.690
9.748
1.438

0.699
0.727
9.447
0.873

0.295
0.602
9.447
0.304

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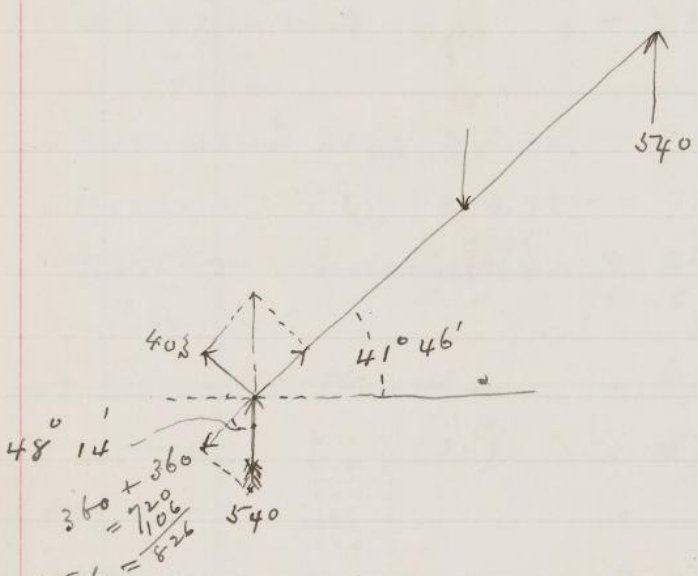
1897phae.proj..539H

~~2~~ × 7 × 7 × ~~16~~ × ~~2~~ × $\frac{1}{\cancel{44}}$ = 441 lbs

2 × 7 × 7 × 1 × .28 = 28 lbs

49
9
441.

14
7
98



360 + 360 = 720
106
826
total =

350
730
2 | 1080
540

540 = 2.732 ✓
~~48° 46 = co. 9.873~~
~~403 = 2.605~~

540 = 2.732 ✓
~~Sin 9.824~~
~~360 = 2.556~~

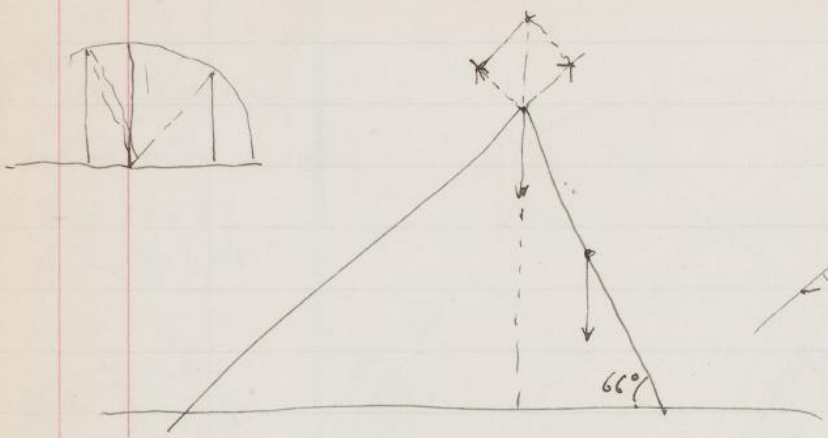
48° 14' = cos 2.732 ✓
9.824 ✓
360 ✓ = 2.556 ✓

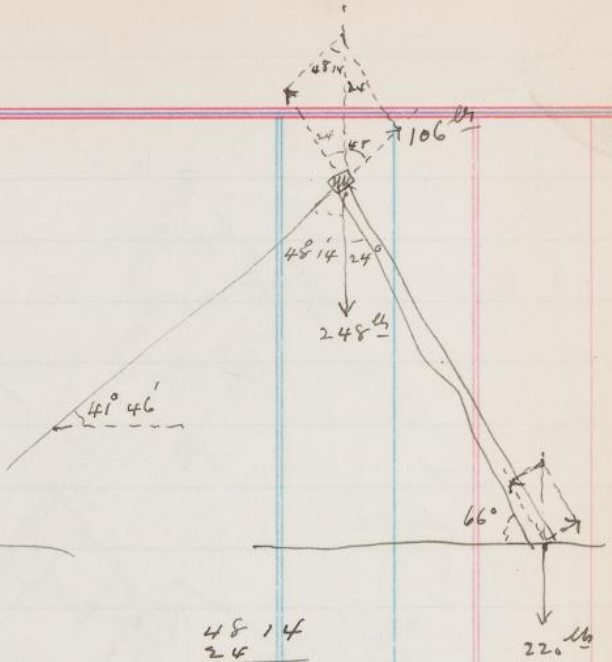
2.732 ✓
sin 9.873 ✓
403 ✓ = 2.605 ✓

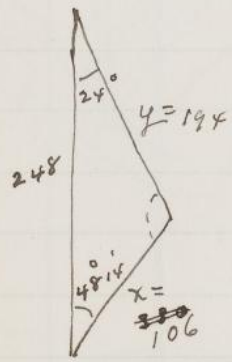
100 lbs per sq in pressure on projection drawing

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$248 : x :: \sin 107°46' : \sin 24°$

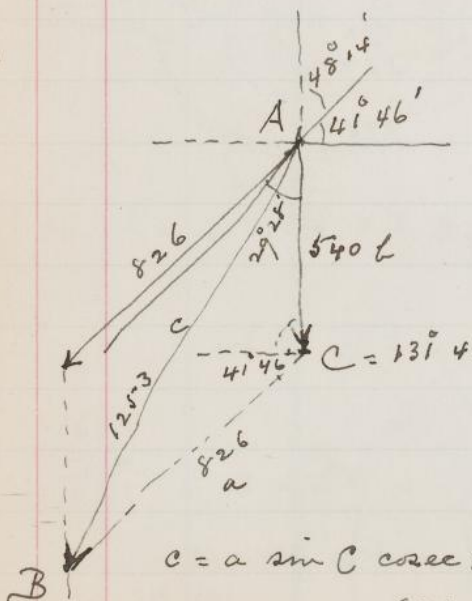
$x = \dfrac{248 \sin 24°}{\sin 107°46'}$

48 14
24
72 14
180
107 46

$248 = 2.394$
$\sin 24° = 9.609$
2.003
$\sin 107\ 46 = 9.999$
$106 = 2.024$

$248 : y :: \sin 107\ 46 : \sin 48°14'$

$248 = 2.394$
$\sin 48\ 14 = 9.873$
2.267
9.999
$194 = 2.288$



41 46
90
131 46
180
48 14

$C = 131°46'$

$A + B = 48\ 14$

$\frac{1}{2}(A+B) = 24°\ 7'$

$\tan \frac{1}{2}(A-B) = \dfrac{a-b}{a+b} \cdot \cot \frac{1}{2}(A+B)$

826
540
286
1366

$\cot 24°7' = 9.651$
$286 = 2.456$
2.107
$1366 = 3.135\frac{1}{2}$
$\tan = 8.971\frac{1}{2}$

$\frac{1}{2}(A-B) = 5°21'$
$\frac{1}{2}(A+B) = 24\ 7$

$A = 29°28'$
$B = 18\ 46$

$c = a \sin C \operatorname{cosec} A$

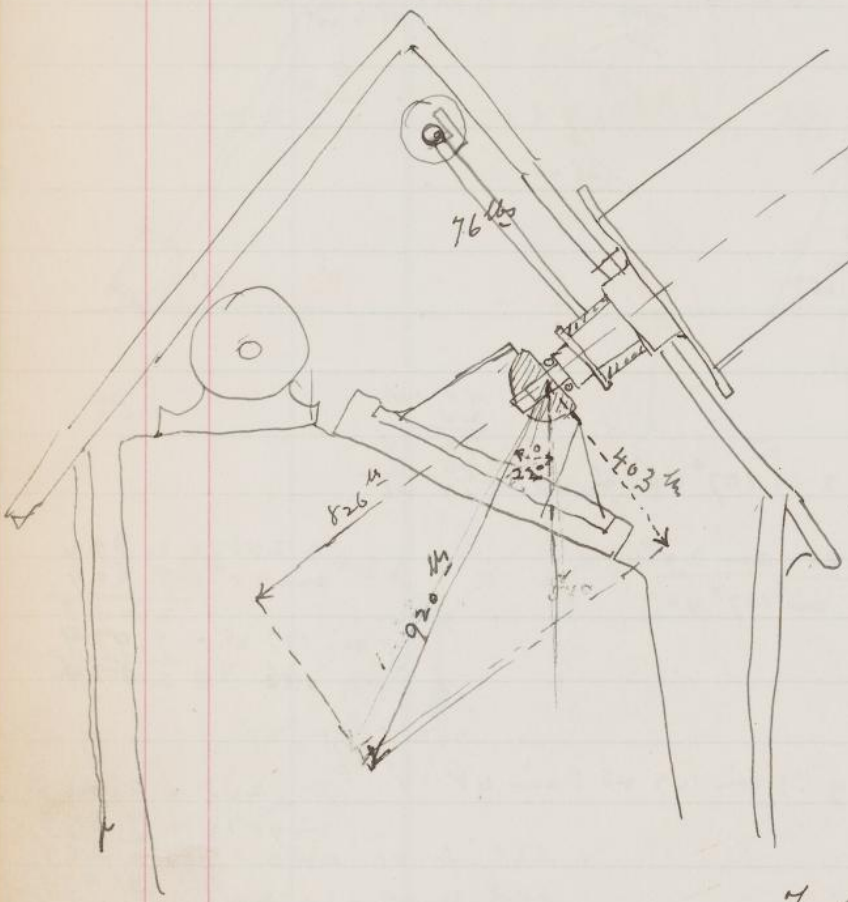
$826 = 2.917$
$C = 131°46' = \sin 9.873$
$A = 29\ 28 = \operatorname{cosec} 2.790$
$\sin 9.692$
$c = 125.3 \checkmark = 3.098$

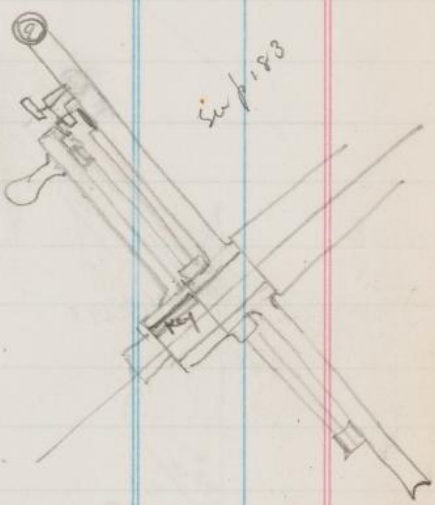
$\operatorname{cosec} A = \dfrac{1}{\sin A}$

see p 173 for check

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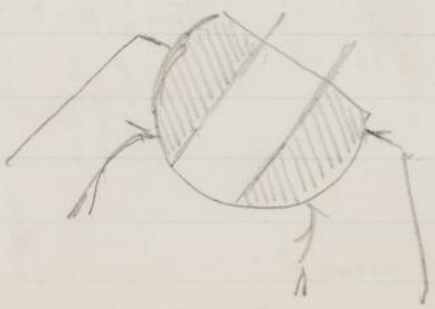
	lbs
Tube	350
Axis	775
Arc	

Tube = 350

Axis = 770

2 | 1120

560



900

350

2) 1250

625

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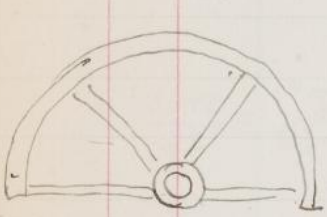
1897phae.proj...539H

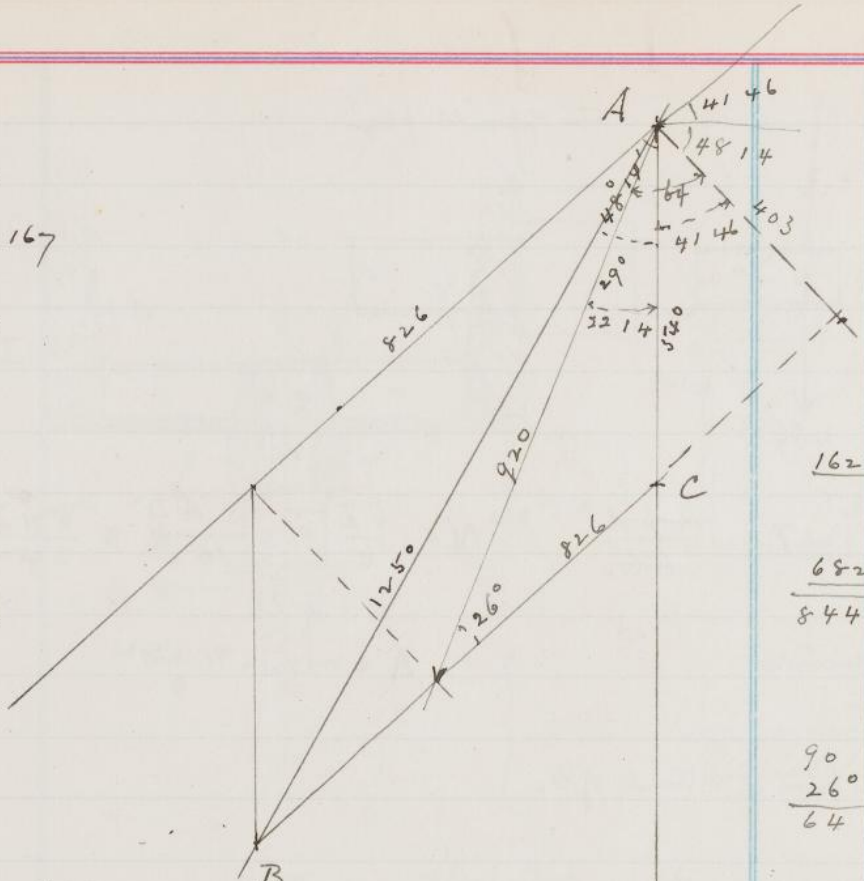
check

By calculation p. 167

AB = 125-3

A = 29° 28'





403 = 2.605-
2

162200 = 5.210

826 = 2.917
2

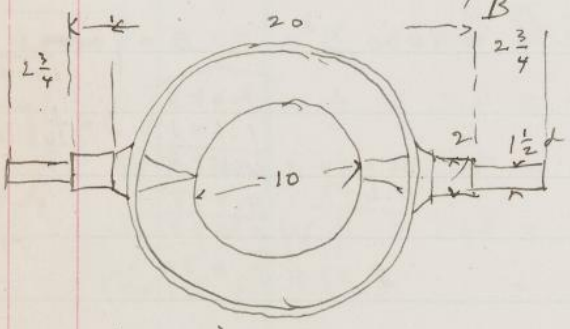
682460 = 5.834

844600 = 5.927

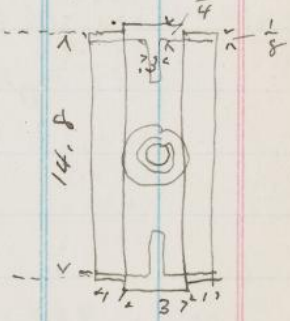
920 = 2.964

2.605-
2.917
9.688

90
26° 0' = 1m
64



25-1/2
10
15-1/2



$14\frac{3}{4}d = 46.34 \times 2 \times \frac{1}{2} \times .07 = 3.24$ lbs

$46.5^- \times 3 \times \frac{1}{2} \times .07 = 9.76$

$\frac{78.5^-}{87.5^-} \times .3 \times .28 = \frac{166}{} = 7.38^-$

$2.75^- \times 15\frac{1}{2} \times .28 = 11.91$

Weight = 32.26 lbs

14.8
.25-
14.5-5-

46.34
.07
3.2438

46.5-
.21
465-
1930
9761-

.28
.3
.084

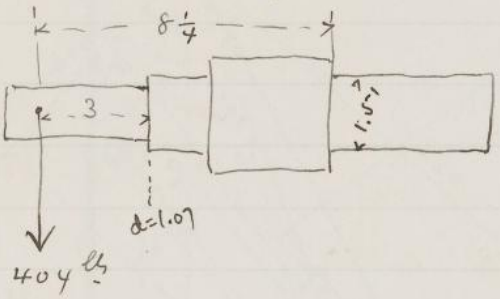
0.439
1.190
9.447
1.076

1.942
8.924
0.866

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See opposite page



$$D = \sqrt[3]{\frac{M}{1648}}$$

$$D = \frac{1}{12}\sqrt[3]{M}$$

$$P = \frac{\cancel{R\,b\,d^2}}{\cancel{6\,t}} \qquad M = \frac{S\,I}{c} = \frac{S\,A\,D^2}{16\,c} = \frac{S\,\pi D^4}{64 \times \frac{1}{2}D} = \frac{S\pi D^3}{32}$$

A = area of section
D = Diameter
c = $\frac{1}{2}D$
S = Stress on fibre at extremity of D.

$$A = \pi r^2 = \pi \frac{1}{4} D^2$$

$\frac{3.14}{32} = 0.1$

$S = 10000$ $\qquad M = 1212 = \frac{10000 \times \pi D^3}{32} = 1000 D^3$

$$D^3 = \frac{1212 \times 32}{10000\,\pi}$$

$$D = \sqrt[3]{\cancel{1000}\,M.}\,/\,1000$$

$$D = \frac{1}{10}\sqrt{M.}$$

3.083
1.505
4.588
4.497
3 | 0.091
1.07 = 0.030

4.000
0.497

$r^2 = 64$
$\frac{1}{\sqrt{12}}$

$M = \frac{404 \times 8\frac{1}{4}}{101}$

$\frac{3232}{3333} = \frac{10000 \times \pi D^3}{32}$

$$D^3 = \frac{3333 \times 32}{10000 \times 3.14}$$

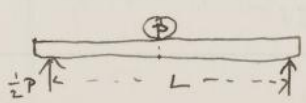
$M = \frac{16800 \times \pi D^3}{32} = \frac{16800 \times 3.14 \times D^3}{32}$

3.523
1.505
5.028
4.497
3 | 0.531
1.51 = 0.177

3.699
0.497
4.196

5.028
4.196
0.832
0.277
1.90

Solid keyl.



$PL = \frac{700\,AD}{}$

$\frac{1}{2}P\,\frac{1}{2}L = \frac{700\,AD}{4}$ Link. $\qquad A = \frac{1}{4}\pi D^2$

$\frac{1}{2}P\,\frac{1}{2}L = \frac{8400\,AD}{4}$ Links

$M = \frac{2100\,AD}{4} = 2100 \times \frac{1}{4} \times \pi \times D^3$

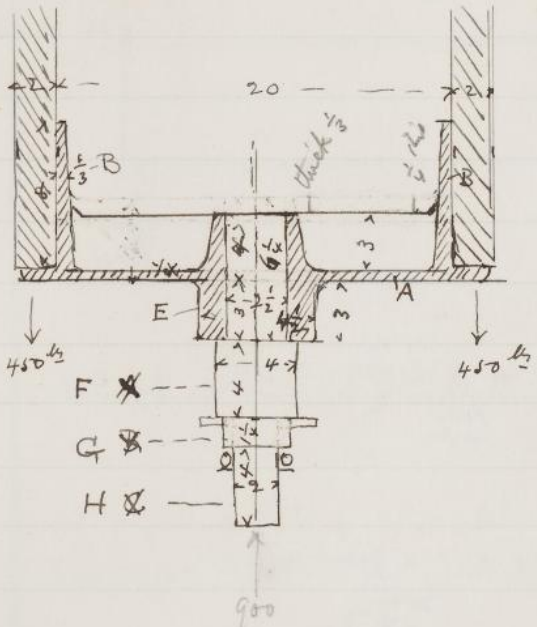
$= 1648\,D^3$

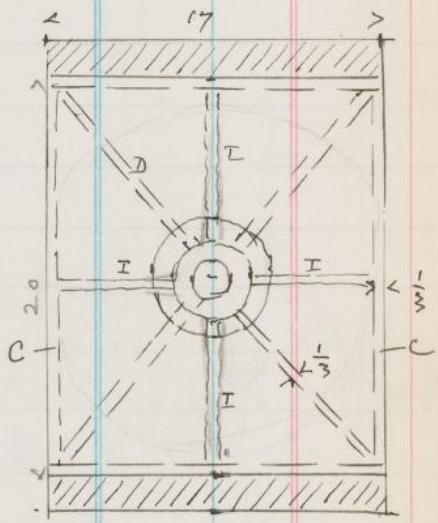
4 | 3.141
.7854
2100
78500
1570
1648.500

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1897phae.proj...539H

1648 = 3.2170
11.81 = 1.0723





				lbs	Thick	lbs		
Plate	A	23 × 17 × $\frac{1}{2}$ × .28	= 54.7		$\frac{5}{16}$	29.	1.362 1.230 9.146 1.738	2.204 8.969 1.173
Flanges	B	16 × 17 × $\frac{1}{3}$ × .28	= 25.4			25.		
Ribs	C	4 × 40 × $\frac{1}{3}$ × .28	= 14.9		$\frac{1}{4}$	8.4	2.435 9.522 9.447 1.404	2.100 8.969 1.069
X Ribs	D	3 × 42 × $\frac{1}{3}$ × .28	= 11.7		$\frac{1}{4}$	9.		
Hub	E	29.5 × 6 × .28	= 49.6			29.		1.470 0.778 9.447 1.695
~~A~~	F	12.6 × 4 × .28	= 14.1			14.1	1.100 0.602 9.447 1.149	
~~C~~	G	3.14 × 4 × .28	= 3.5			3.5		0.983 0.097 9.447 0.527
~~B~~	H	9.62 × 1.25 × .28	= 3.4			3.4	0.497 0.049 0.546	
			177.3 lbs			177.4		
					I =	5.7		
					Total Wt =	123.1 lbs		

	C	3 × $\frac{10}{40}$ × $\frac{1}{4}$ × .28 =	.96 24 768 192 26.88
	E	16 × 6 × .28 =	
	I	27 × 3 × $\frac{1}{4}$ × .28 = 5.67	

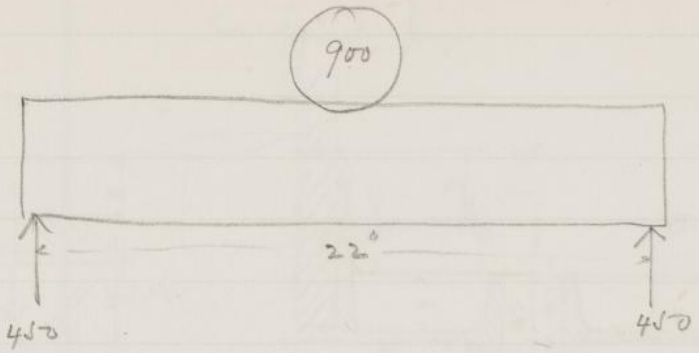
11.7
4 | 35.1
9.

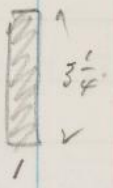
27
.21
27
54
5.67

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Strength of End Plates.





$$P = \frac{S}{3} \cdot \frac{10000 \times 1 \times 3.25 \times 3.25}{22} = 3250$$

10,000
3.25
325000.00
0.1
3250.

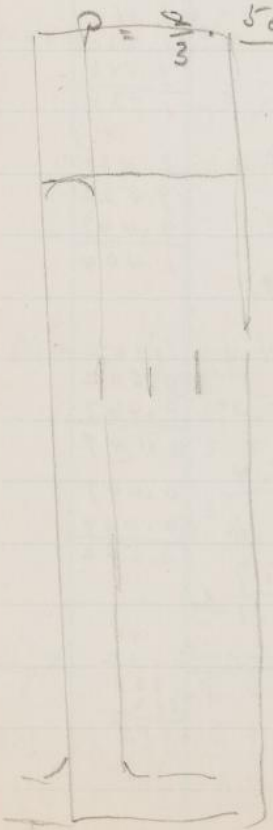
δ / 40.000

$$\therefore P = \frac{S}{3} \cdot \frac{5000 \times 1 \times 3.25 \times 3.25}{22} = 1625$$

.325
5000
1625.000

$$P = \frac{S}{3} \cdot \frac{5000 \times 1 \times 4 \times 4}{11} = 2400$$

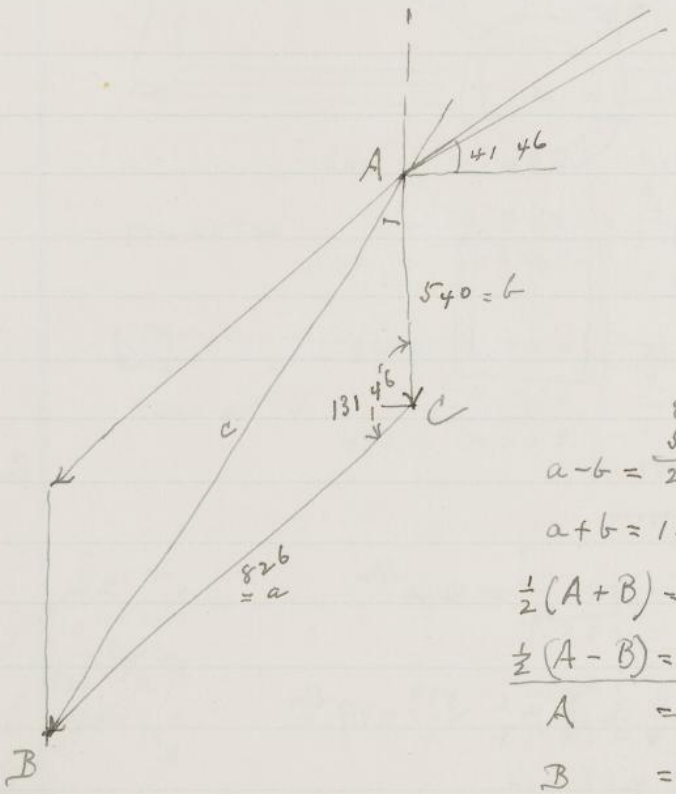
16
5000
33) 80000 (2420
66
140
132
80



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Check on p. 167



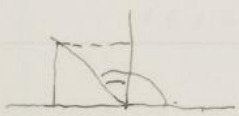
$$41^\circ\ 46'$$
$$90$$
$$C = 131\ 46$$

$$180^\circ\ 0'$$
$$C = 131\ 46$$
$$A+B = 48\ 14$$
$$\tfrac{1}{2}(A+B) = 24\ 7$$

$$a-b = 826 - 540 = 286 \quad \log = 2.456$$
$$a+b = 1366 \quad \log = 3.135\tfrac{1}{2}$$
$$\tfrac{1}{2}(A+B) = 24^\circ\ 7' \quad \log\tan = 9.3201\tfrac{1}{2}$$
$$\tfrac{1}{2}(A-B) = 5^\circ\ 21 \quad \log\tan = 9.6591$$
$$9.9711\tfrac{1}{2}$$

$$A = 29\ 28$$
$$B = 18\ 46$$
$$C = 131\ 46$$
$$180\ 0$$

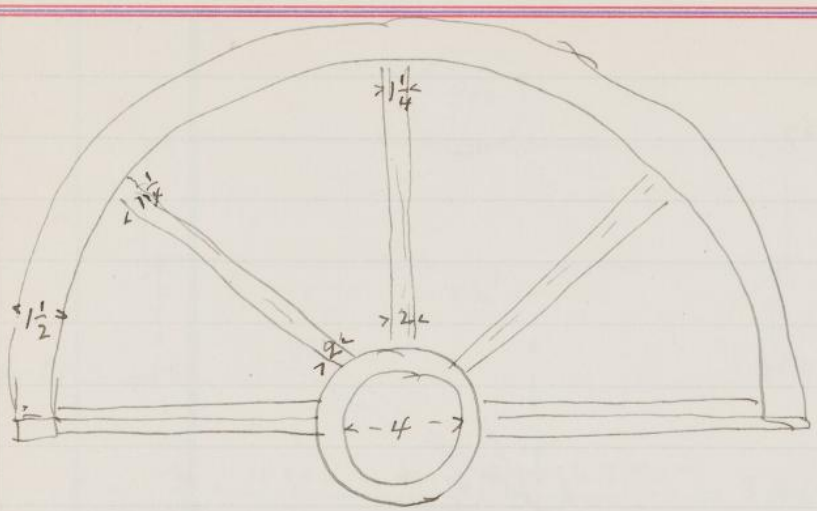
$$c = a\,\frac{\sin C}{\sin A}$$

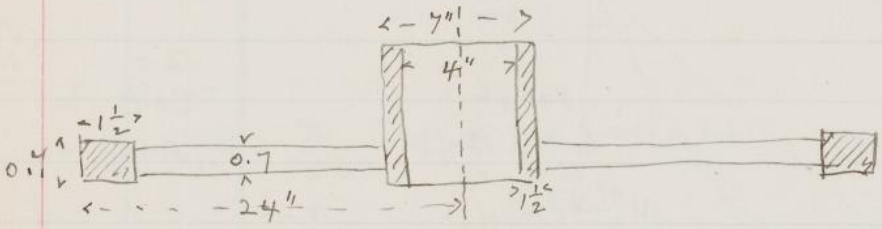


$$a = 826 \quad = 2.917$$
$$C = 131\ 46 \quad = \sin 9.873$$
$$2.790$$
$$A = 29\ 28 \quad = \sin 9.692$$
$$c = 1254 \quad = 3.098$$

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48
3½
7
144
151

Circles

Hub — 38 sq. in

$\frac{12}{26} \times 4 \times \frac{1}{4} = 26$ lbs = 26 26

Rim $\frac{75}{150} \times \frac{3}{4} \times \frac{3}{4} \times \frac{1}{4} \times \frac{1}{4} = 19$ lbs = 20 8

1.25
2.00
3.25
1.62½ = 1⅝

Spokes $5 \times \frac{75}{8} \times \frac{3}{4} \times 19 \times \frac{1}{4} = 30$ = 30 10

75
19
18
112

76 44 40

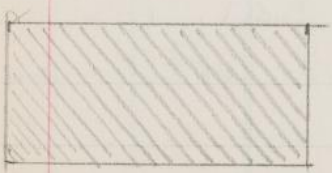
40

116 = Complete circles

Complete circles = 112

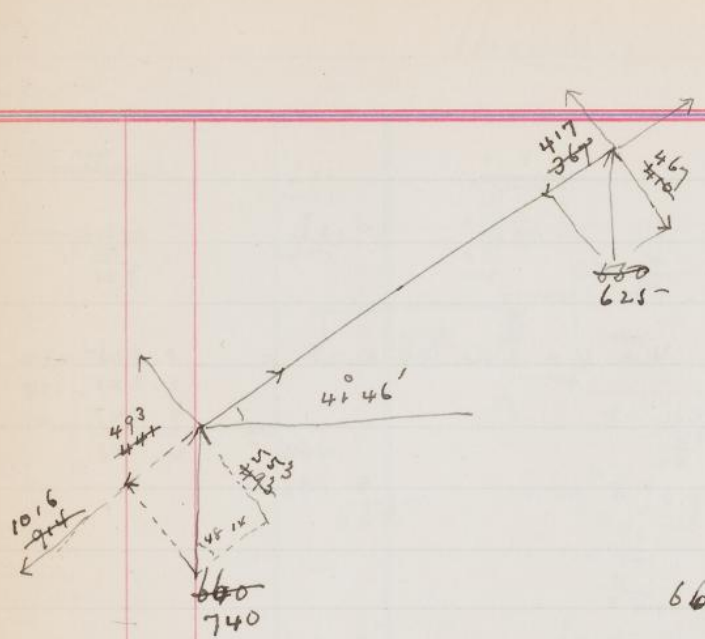
25
19
225
25
4.75) 30

16



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Tube = 350 lbs

Axis = 900 — 9.162

2 | 1250

625 = 625

bottom end 625

Arc 115

740

End Thrust

106	106
367	417
441	493
914	1016

660 = 2.820 | 740 | 2.869

cos. 48° 14' = 9.824 | 9.824

441 = 2.644 | 2.693

= 493

530 = 2.740 | 625 | 2.796

367 = 2.564 | 9.824 | 2.620

417

660 = 2.820 | 2.869

sin 48 14 = 9.873 | 9.873

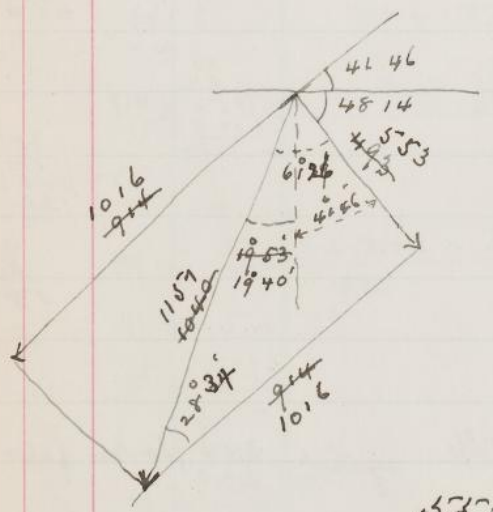
493 = 2.693 | 2.742

= 553

530 = 2.740 | 2.796

410 = 2.613 | 9.873 | 2.669

467



493 = 2.693

$5.386^{\frac{1}{2}}$ = 243200.

914 = 2.961

$5.922^{\frac{1}{2}}$ = 835700

6.033 = 1078900

1040 = 3.016½

61° 39'

41 46

19 53

1157^2 = 1338065

1016^2 = 1032256

115.7 = 6.126

3.0632

2.693

2.961

28° 21' = 1m 9.732

61 39

90 0

48 14

41 46

553 = 2.743

1016 = 3.007

28° 34' = 1m 9.736

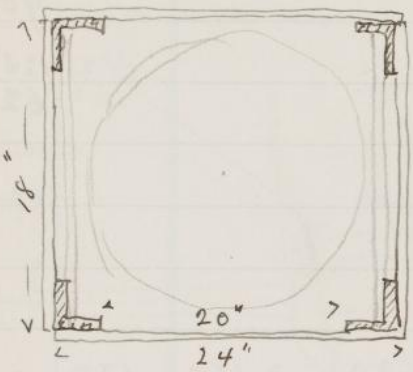
61° 26'

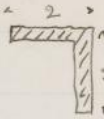
41 46

19 40

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$\frac{7}{32} =$

$14\frac{1}{2}$ / 12 / 6 / 165 / 174

16 / .2 / 3.2

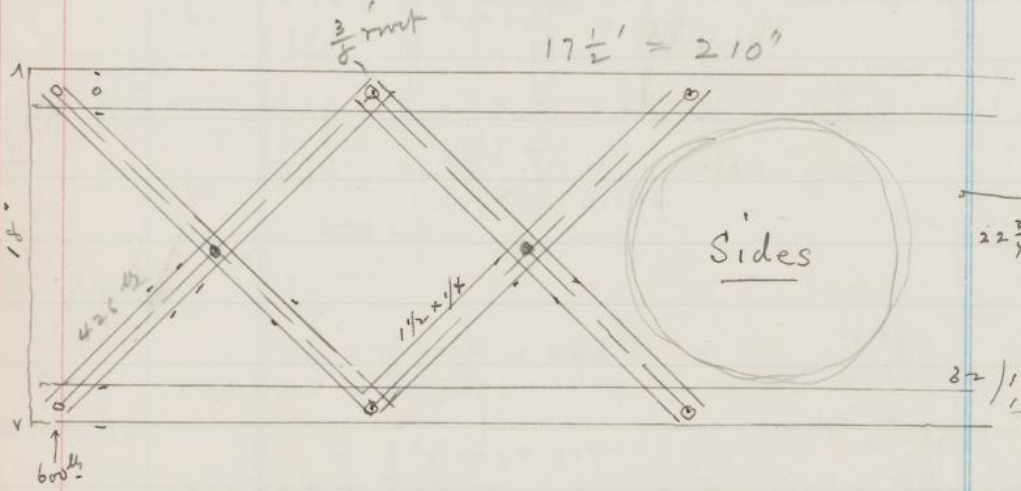
$4 \times 4 \times .2 \times 174 \times .28 =$

0.505 − 3.2
2.2×1 − 174
9.447 − .28
2.193

32) 7.0 (.22
64
60

27) 8.3 (.3 lbs per in
8.1
.174
5 = 2.2
4
208

~~466~~ lbs
196 lbs



32" long

$22\frac{3}{4} \times 4 = 91"$

5-4
45-4

13 / 12 / 156 / 128 / 280
32) (4.9

15 / 12 / 180 / 160 / 200
32) (5.6

91
6.
5-46

Bottom Lattice $\frac{5-7}{45-5} \times \frac{3}{4} \times \frac{1}{4} \times \frac{1}{4} = 5\frac{7}{8}$ lbs

2 Sides $\frac{17}{5-46} \times 2 \times \frac{5}{4} \times \frac{3}{46} \times \frac{1}{2} = 85$

~~196~~ / ~~298~~ / 338 lbs against ~~384~~ / 429 planks p. 62

17½' / 12 / 204 / 2 / 210" / 105 / 600

M = 63000
18) 63000 (3500 lbs
54
90
90

2 / 1.8 / 3.8 / .2 / .76 sq in.) 3500. (4605 lbs
304
460
456
400

Rivet = 3.8 / .4 out / 3.4 / 12 / 40.8) 3500 (5150 lbs at rivet
340
1008
816
320

1.42 / 600 / 2 / 852000 / 426 lbs (0.085 sq in

1.42 / 23/4 / 35 / 426 / 284 / 35.01

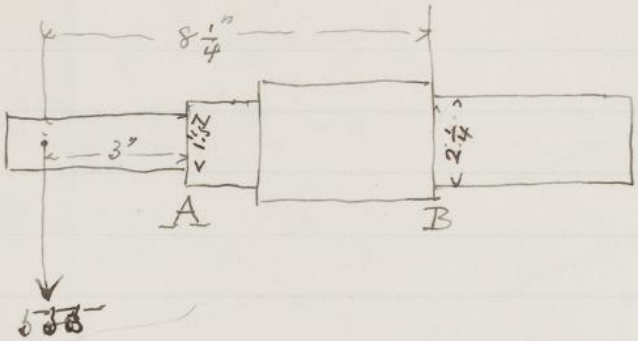
Rivet = 3/8 d = 0.110 sq in

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Breaking

continued from p170



$d = \frac{1}{12}\sqrt[3]{M}$ ($f = 5000$ lbs per sq in $d = \frac{1}{8}\sqrt[3]{M}$)

At A $M = 500 \times 3 = 1500$

$d = \frac{12}{8} = 1.5$ ✓

At B $M = 500 \times 8\frac{1}{4} = 4125$

$d = \frac{18}{8} = 2.25$

4000
125
4125

$M = \frac{5000 \times 3.14 \times D^3}{32}$

$M = 500\, D^3$

$D^3 = \frac{M}{500}$

$D = \frac{1}{8}\sqrt[3]{M^8}$

$M = 6000 \times .1 \times D^3$

$M = 600\, D^3$

$D^3 = \frac{M}{600}$

$D = \frac{1}{8\frac{1}{2}}\sqrt[3]{M}$

3.14
250
1570
628
785.00

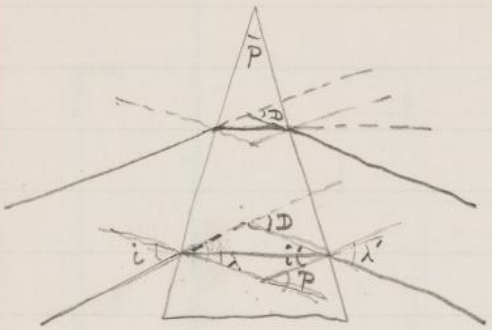
23) 210 (9.1
207
03
2

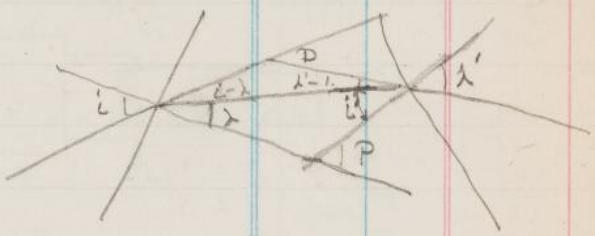
33/66 = 9/594 ×

33/66 = 1/528 × 3/2 × 1/4 × 1/3 = 66

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$D = i - \lambda + \lambda' - i'$ ✓ $\quad D = i + \lambda' - P$

$P = \lambda + i'$ ✓

$n = \frac{\sin i}{\sin \lambda} = \frac{\sin \lambda'}{\sin i'}$

$i = n\lambda \qquad \lambda' = n i'$

$$D = n\lambda - \lambda + i'n - i'$$
$$= n(\lambda + i') - (\lambda + i')$$
$$= (n-1)(\lambda + i')$$

$D_1 = (n-1) P_1$

$D_2 = (n'-1) P_2$



$D = D_1 - D_2 = (n-1) P_1 - (n'-1) P_2$

$D = (n-1) P_1 - (\alpha + \beta n + \gamma n^2) P_2 \qquad n' = \alpha + \beta n + \gamma n^2$

$\frac{dD}{dn} = P_1 - (\beta + 2\gamma n) P_2$

$P_1 = (\beta + 2\gamma n) P_2$

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crown flint

$$D = (n-1)P_1 - (n'-1)P_2$$

$$\frac{dD}{dn} = P_1 - \frac{dn'}{dn}P_2 = 0$$

$$P_1 = \frac{dn'}{dn}P_2$$

$$P_2 = \frac{dn}{dn'}P_1$$

$$dn = n_F - n_B$$
$$dn' = n'_F - n'_B$$

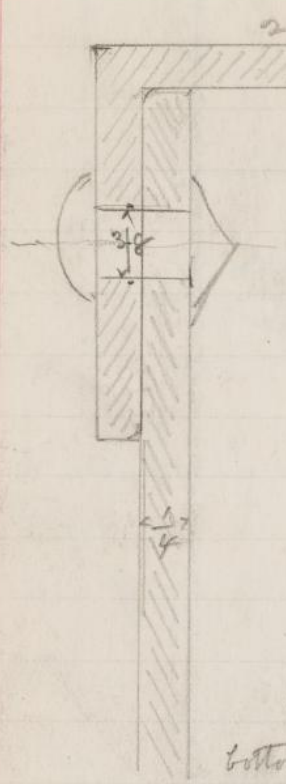
$$P_2 = \frac{n_F - n_B}{n'_F - n'_B} \cdot P_1$$

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$17\frac{1}{2}$
12
6
204
210

Comp. p. 176.



$4 \times 3.8 \times \frac{7}{32} \times 210 \times .28$ lbs $=$
$= 196$ lbs

28	=	1.447
.28	=	9.447
3.8	=	0.580
210	=	2.322
		3.796
32	=	1.505
		2.291

18 / 2 / 16

1.42
16
85 2
142
227 2
1.6
24.3 inches

length of diagonal

16) 210 (13 diagonal braces on bottom
16
50
48
2
11
22

bottom = $\frac{11}{22} \times \frac{3}{8} \times \frac{1}{4} \times 24.3 \times .07 =$

33	=	1.519
24.3	=	1.386
.07	=	8.845
lbs		1.750

bottom 56.2 lbs

47
52
48
147

sides = $\frac{2}{2} \times \frac{13}{26} \times \frac{5}{4} \times \frac{3}{16} \times \frac{8}{4} \times 24.3 \times .07 =$

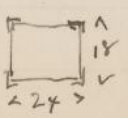
13	=	1.114
15	=	1.176
24.3	=	1.386
.07	=	8.845
		2.521
4		0.602
	=	1.919

sides = 83.0 lbs

Angles 196.

Total Wt = 335 lbs

2 Pivot channels	=	22	Wood
2 Pivot-Bearings	=	10	429
Rivets	=	12	105
2 braces ⊠ cross	=	16	534
		395 lbs	
add		10	against
		405	



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Bending Moment = $105^{-} \times 600^{\#} = 63000$

$\frac{63000}{18} = 3500^{\#}$

$3.8 \times \frac{7}{32} = 0.832$ sq in

Rivet = $\frac{3}{8} \times \frac{7}{32} = \frac{21}{256} = 0.082$

0.750 sq in at Rivet hole

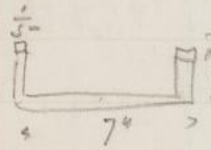
$\frac{3500}{0.750} = 4670$ lbs per sq in

0.832 = 0,580 + 0,845 + 1.425 + 1.505 + 9.920

0.0821 = 1.322 + 2.408 + 8.914

4670 = 3,544 + 9,875 + 3,669

2 channels for Pivot



$36 \times 11 \times \frac{1}{5} \times .28 = 22,2^{\#}$

36 / 5 | 396 / 79,2

1,899 + 9,447 + 1,346

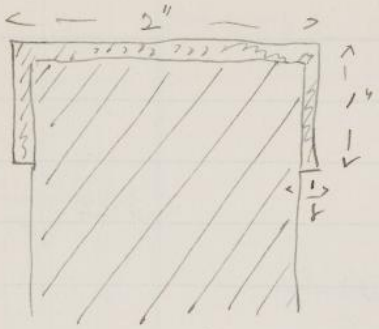
Wt of pivot - 405

" Tube 350

2 | 755

378 lbs at each end of Wt from frame of kite

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$2\frac{7}{8} + \frac{7}{8} + \frac{1}{8} = 3\frac{3}{4} = \frac{15}{4}$

$17\frac{1}{2}' = \frac{105}{2\cancel{10}} \times \frac{15}{\cancel{4}} \times \frac{1}{\cancel{4}} \times .28 = 27.5$ lbs

~~110.0~~

55.0

56.

111 lbs

Diagonals

105 = 2.021

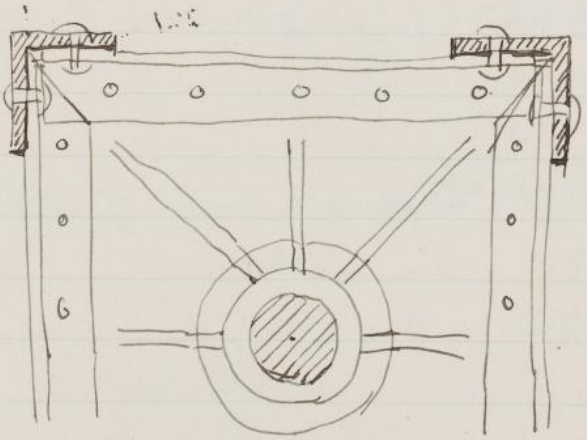
1.05 0.021

2.042

4 = 0.602

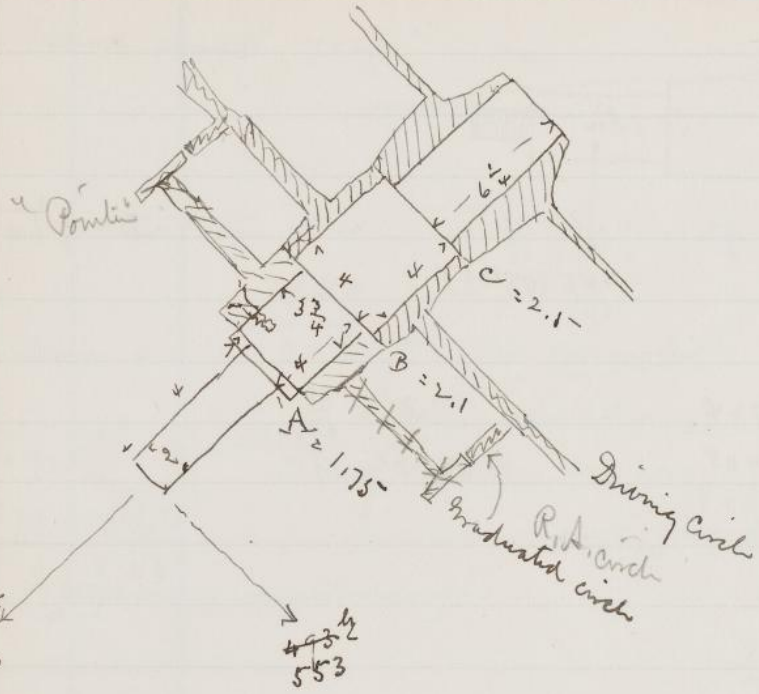
= 1.440

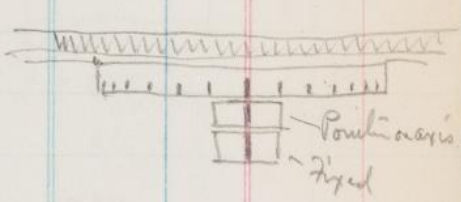
101 if of wood



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$D = \frac{1}{\delta}\sqrt[3]{M}$ p. 177

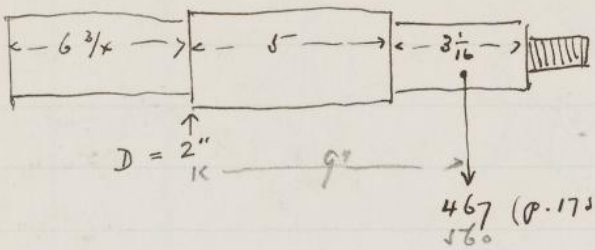
At A $M = 5\frac{5}{8} \times 4 = 22\frac{1}{2}$ $\sqrt[3]{22\frac{1}{2}} = 13\frac{1}{4}$ $\frac{13.25}{8} = 1.75 = d$

At B $M = 5\frac{3}{8} \times 8 = 44$ $\sqrt[3]{44} = 16\frac{1}{2}$ $\frac{16.5}{8} = 2.06$

At C $M = 5\frac{3}{4} \times 12 = 66$ $\sqrt[3]{66} = 19$ $\frac{19}{8} = 2.40$

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1897phae.proj..539H



$D = \frac{1}{8}\sqrt[3]{M}$

$\frac{467}{3736} = 3.5724$ $\quad D^3 = \frac{M}{\sqrt{20}}$

$8\,|\,\frac{15.\sqrt{2}}{2}$ $\quad 1.1908$ $\quad \sqrt{20}\,D^3 = M$

$M = \sqrt{40}$

$2\,|\,3.7024$

$8\,|\,17.1$ $\quad 1.2341$

2.2

$2.75 - 0.439_3$

1.317

$5\sqrt{2} \quad 2.709$

4.026

$8 = 0.903$

3.123

(As made $2\frac{3}{4}$d) $1330 =$

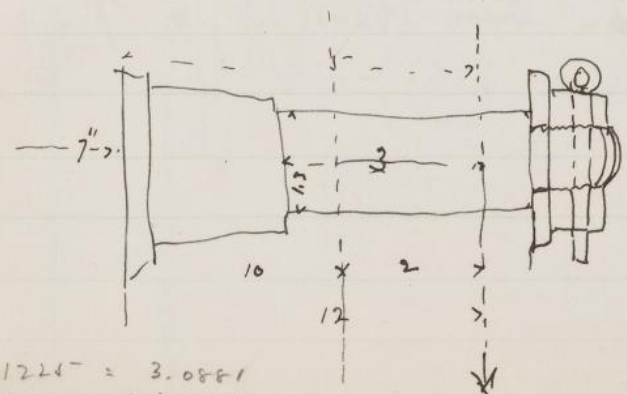
$\frac{64}{5\sqrt{2}}$

Junior $\qquad$ Cast Iron $\qquad$ $S = \frac{20000}{6} = 3333$

ρ. 170 $\qquad M = \frac{S\pi D^3}{32} = \frac{3200 \times 3.14 \times D^3}{32} = 314\,D^3$

$D = \sqrt[3]{\frac{M}{314}} = \frac{1}{6.8}\sqrt[3]{M}$

l	D
3"	1.20
4	1.30
5	1.40
7	1.6



$M = 7'' \times 17.5^- = 122.5^- = 3.0881$

$6.8\,|\,10.70 - (1.0294$

6.8

390 $\quad 1.6$

$M = 175 \times 3 = 525$

$\sqrt[3]{M} = 8.07$

$6.8\,|\,8.07\,(1.2$

$\frac{68}{127}$

$\frac{175}{4}$

700

$6.8\,|\,8.84\,(1.3$

$\frac{65}{208}$

204

175

8

$6.8\,|\,87.5\,(1.$

$\frac{68}{19}$

$6.8\,|\,9.56\,(1.4$

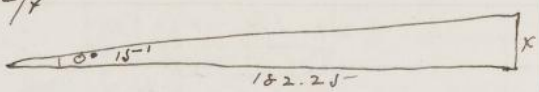
$\frac{65}{276}$

27^2

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1897phae_proj_5394

Focal length 182.25"



$x = 182.25 \tan 0° 15' = 2.2607$

7.6398

$.7953 = 9.9005$

$\frac{.7953}{2}$

Image of Moon = 1.6906 inches in diameter

$M = \frac{S\pi D^3}{32} = \frac{S D^3}{10}$ | $S = \frac{10M}{D^3}$

$D^3 = \frac{10M}{S}$ $D = \sqrt[3]{\frac{10M}{S}}$

for $S = 10000$ $D = \frac{1}{10}\sqrt[3]{M}$, p. 170

$M = 6417$ $D = 2.795 = 0.439$

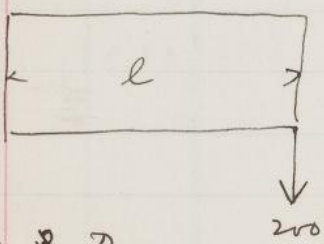
$6417 = 4.807$ 1.317

$S = 3100 = 3.490$

713 =
6417 =
6 | 18.6
2.3

3.8071
1.27

Iranian - continued



$D = \sqrt[3]{M}$
6.8

200
3
600

6.8 | 8.71 (1.28
6 8
191
136
55-50
4

200
4
800

6.8 | 9.28 (1.37
68
248
204
440

200
5
1000

6.8 | 10.00 (1.47
68
320
272
480

l	D
3	1.28 in
4	1.37
5	1.47

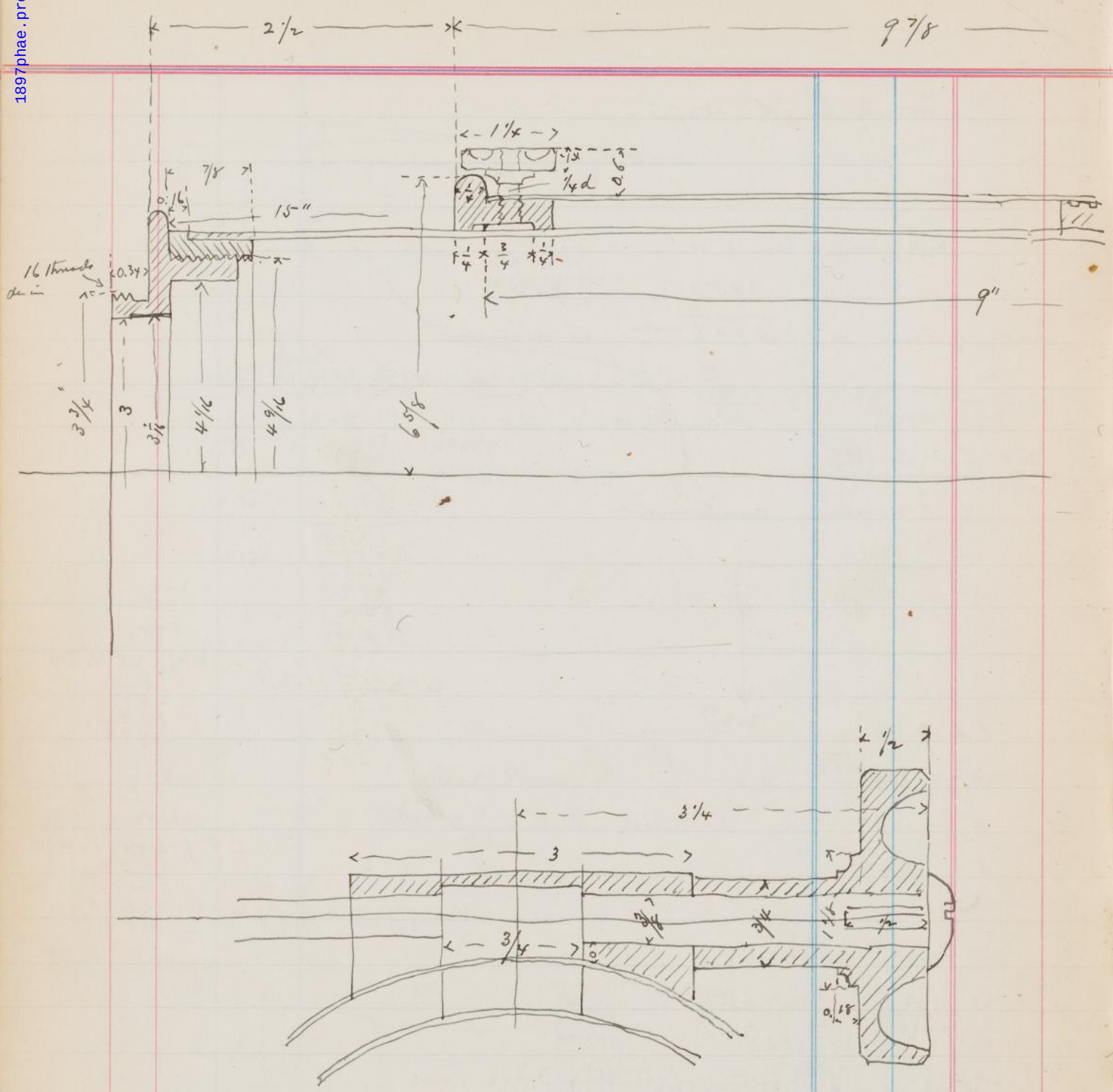
$\frac{5}{10000}$ lbs $= \frac{1}{20} = .05$ lbs per sq in

$\frac{5}{8}$" d = $\frac{1}{2}$" d at bottom of threads

0.196 area
4000
784.000

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Tail Piece for 16" Equatorial

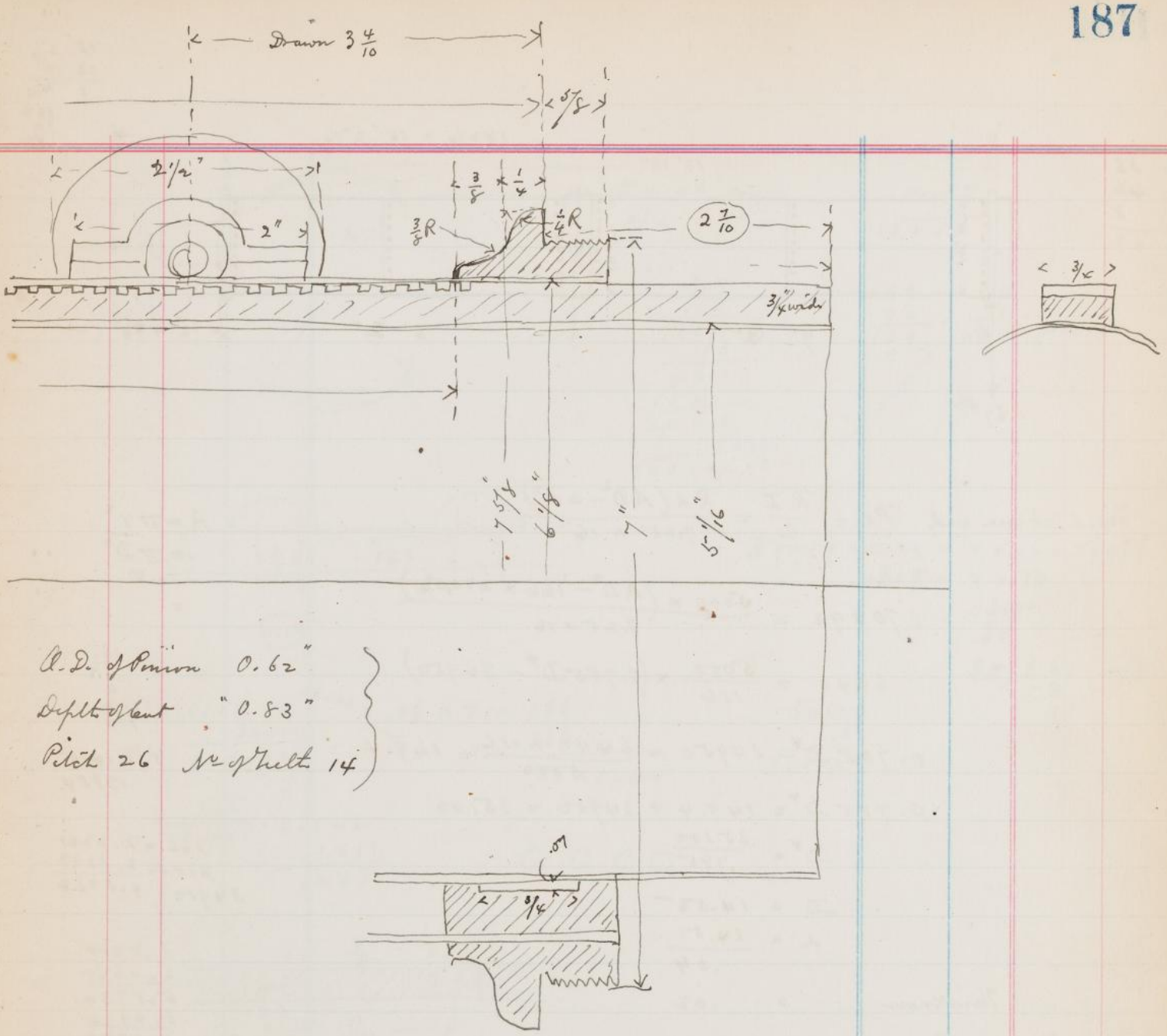
Blown blank blown temp

Blue Print sent to B.P.H

March 27th 1908

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O. D. of Pinion 0.62"
Depth of Cent " 0.83"
Pitch 26 No of Teeth 14

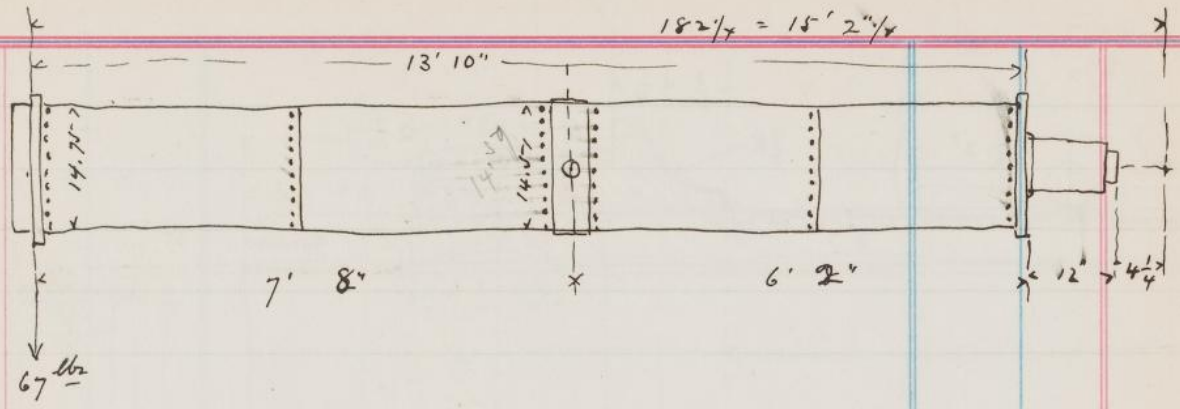
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15' 2 1/4"
13 10
1 4 1/4
16 1/4
12
4 1/4

182 1/4" = 15' 2 1/4"

13 46 8 / 67



Fixed at one end $Pl = \frac{RI}{C} = \frac{R \times (AD^2 - ad^2)}{7.25 \times 16}$

$70 \times 92 = \frac{5000 \times (AD^2 - 166 \times 210.5)}{7.25 \times 16}$

$6440 = \frac{5000}{116} \times (0.785 D^4 - 34950)$

$0.785 D^4 - 34950 = \frac{6440 \times 116}{5000} = 149.4$

$0.785 D^4 = 149.4 + 34950 = 35100$

$D^4 = \frac{35100}{.785}$

$D = 14.58$

$d = 14.51$

.04

Thickness = .02

$A = \pi r^2 = \frac{\pi D^2}{4} =$

16 1/4
4
11 2
116

4) 3.1415
.7854

166 = 2.2201
210.5 = 2.3233
34950 4.5434

3.8089
2.0645
5.8734
3.6990
2.1744

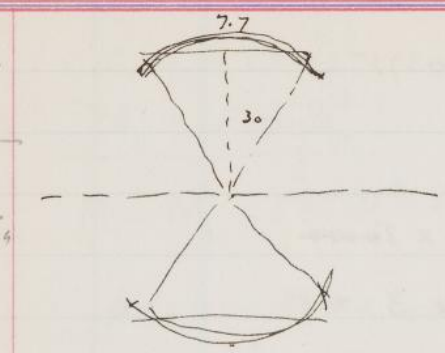
149.4
34950
35100. = 4.5453
.785 = 9.8949
4) 4.6504
14.58 = 1.1626

46 Sheet metal = 1/16" thick = .0625"

1/20 " " = 3/80 " = .0375

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$14.50 = 46$ " circ

$\frac{1}{6} = 7.7$"

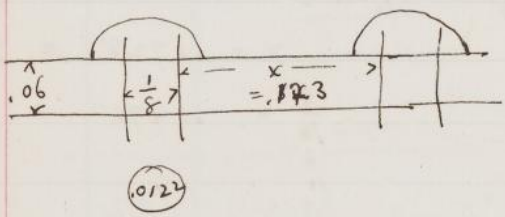
$7.7 \times .02 = .154$ sq in

$13 \times 462 \times 154 \times 2002 \times 5000 = 100100000$

$14.50 \times 9 = 130.50$

$67 \times 92 \times 134 \times 3$

$70 \times 92 = 6440$ ft. lbs



(.0122)

$3 \times .0123 = x \times .06 \times 5$

$.0369 = x \times .30$

$x = \frac{.0369}{.30}$

$30 \overline{)3.69} (.123$

$\frac{5\ 4}{75}$

$.0122 \times 30000 \times 366.0000$

$50000 \times .06 \times x = 366$

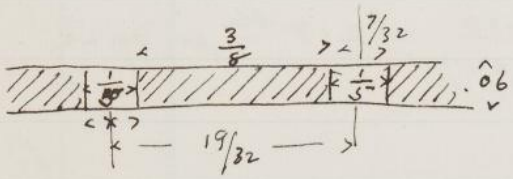
$x = \frac{366}{.06 \times 50000}$

$50000 \times .06 \times 300000$

$\frac{366}{3000} = 0.122$

$.125$

$.247$



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

$r^2 = \frac{1}{4} x^2$

πr^2

$\frac{\pi x^2}{4} = .785 x^2$

$\frac{3}{8} \times .06 \times 50000 = .785 x^2 \times 30000$

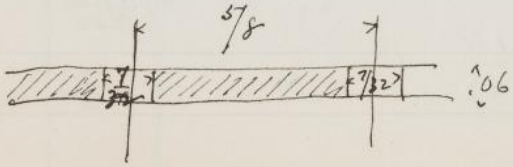
$x^2 = \frac{\frac{3}{8} \times .06 \times 50000}{.785 \times 30000} = \frac{3 \times .02 \times 5}{8 \times .785} = \frac{.30}{6.280}$

9.4771 9.4771

0.7980 0.7980

7.9801 8.6791

8.9900 9.3395



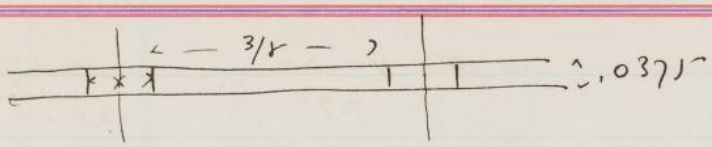
$7/32 = .2185$

$3/4 = .375$

$.593$

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$\frac{3}{8} \times .0375 \times 8000 = 0.785 x^2 \times 3000$

$3 \times .0375 \times 8 = 0.785 x^2 \times 3 \times 8$

$x^2 = \frac{3 \times .0375 \times 8}{.785 \times 24} = \frac{.0375}{1.256}$ $\quad .157 \quad 8$

8.5740
0.0990
8.4750

$x = .1728 = 9.2375$

$\frac{3}{16} = .1875$

$\frac{6}{16}$

$.0276 \times 3000 = \frac{3}{8} \times .0375 \times 8000$ $\quad .0235$ $\quad .0047$

Side Planks.

p.160 $R = \frac{3Pl}{2bd^2} = \frac{3 \times 100 \times 210}{2 \times 2 \times 17 \times 17} = 218$ lbs per sq in

17
17
119
17
289

289) 63000 (218
578
520
289
2310
2312

Wt

$2 \times 17 \times 70 \times \frac{1}{16} = 200$ lbs
$\frac{175}{375}$ lbs
on each plank

6) 1190
200

2) 350
175

$\frac{3 \times 94 \times 210}{2 \times 2 \times 17 \times 17}$

282
210
2820
564
289) 59220 (205
578
1420

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check on page 188.

$M_1 = 500 D_1^3$

$M_2 = 500 D_2^3$

$M_1 - M_2 = 500 D_1^3 - 500 D_2^3$

$6440 = 500 \times 14.51^3 - 500 D_2^3$

$500 D_2^3 = 15215\overline{60}$

$D_2 = 14.49$

.02

.01 Thiele.

$D_1 = 14.51 = 1.1617$ (3)

3.4851

500 = 2.6990

$M_1 = 1528000 = 6.1841$

6440

$15215\overline{60} = 6.1823$

2.6990

3.4833

14.49 1.1611

---

p 170.

$M = \frac{SI}{C} = \frac{SAD^2}{16C} = \frac{S\pi D^4}{16 \times 4 \times \frac{1}{2} D} = \frac{S\pi D^3}{32} = \frac{SD^3}{10}$

$A = \pi r^2 = \pi \frac{D^2}{4}$

$M = \frac{SD^3}{10} = 500 D^3$ when $S = 5000$,

$\frac{3.14}{32} = \frac{1}{10}$

14.51
.121⁻
14.385

.0625⁻
121⁻

$D_2 = 14.381 = 1.1578$ (3)

3.4734

500 = 1.6990

$1487300 = 6.1724$

1528000

1487300

$M_3 = M_1 - M_2 =$ 40700

13600 out for work hole.

27100

92
70
6440

$\frac{5}{8} = .625$

$\frac{7}{32} = \frac{219}{.625)\,.4060\,(.65}$

3750

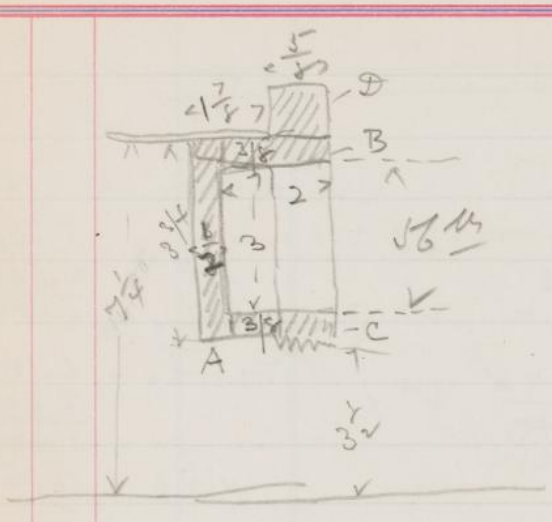
3100

3125

67
40
2680

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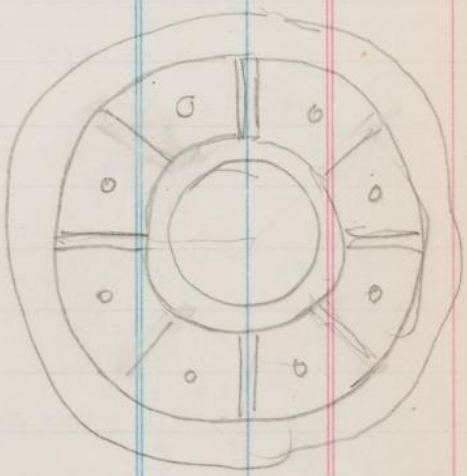
$7\frac{1}{4}$
$3\frac{1}{2}$
$3\frac{3}{4}$

		Area
$13\frac{3}{4}d$	=	148.5
$3\frac{7}{8}r = 7\frac{3}{4}d$	=	47.0
		101.5
		2
		203.0
		.28
		1624
		406
Removable	=	56.84 lbs
Fixed	—	36.0
		92.8 lbs

70 lbs Total Wt.

		Area	
$14\frac{1}{2}$	=	165.1	
7	=	38.5	
		126.6	
		63.3 cu in	63.3 = A
$14\frac{1}{2}$	=	165.1	
$13\frac{3}{4}$	=	148.5	
		16.6	
		2	
		33.2	33.2 = B
$7\frac{3}{4}$	=	47.2	
7	−	38.5	
		8.7	
		2	
		17.4	17.4 = C
$15\frac{1}{2}$	=	188.7	
$14\frac{1}{2}$	=	165.1	
		23.6	
8		118.0	
		14.8	14.8 = D

	14.8
	128.7
	.28
	1029 6
	257 4
	36.036 lbs



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Dew Cap
Cl. Ring
Ring

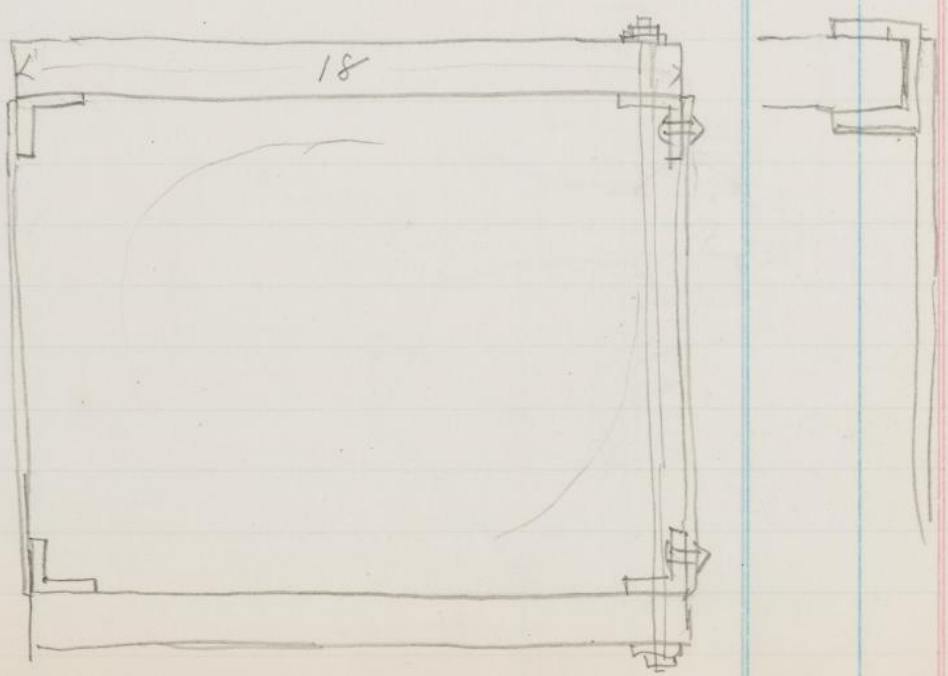
13
46
8
5
72 lbs

92"
74"

92
144
648
74) 6624 (89½ lbs
592
704
666
380

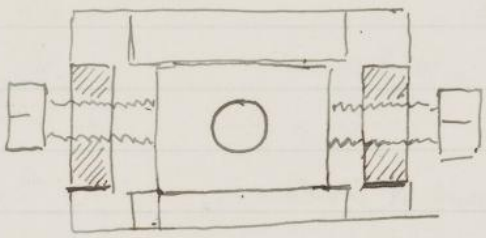
Wt at eye end to balance = 90 lbs
less eye end = 12
78
less Trunion = 12
66

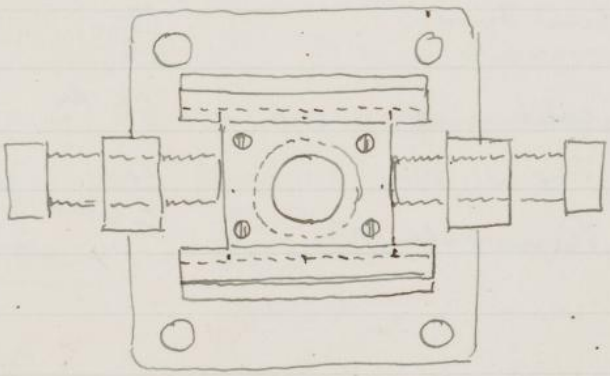
Weight of casting at eye end = 66 lbs
Fixed Wt, = 40
Removable Wt = 26

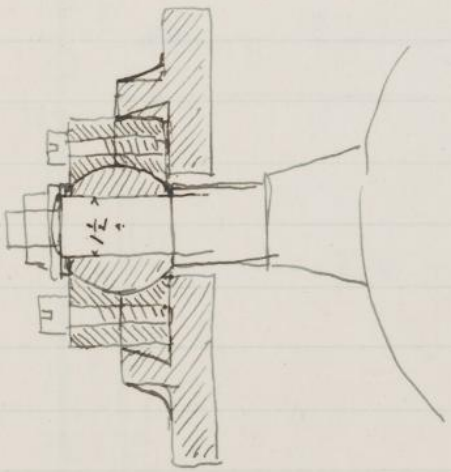


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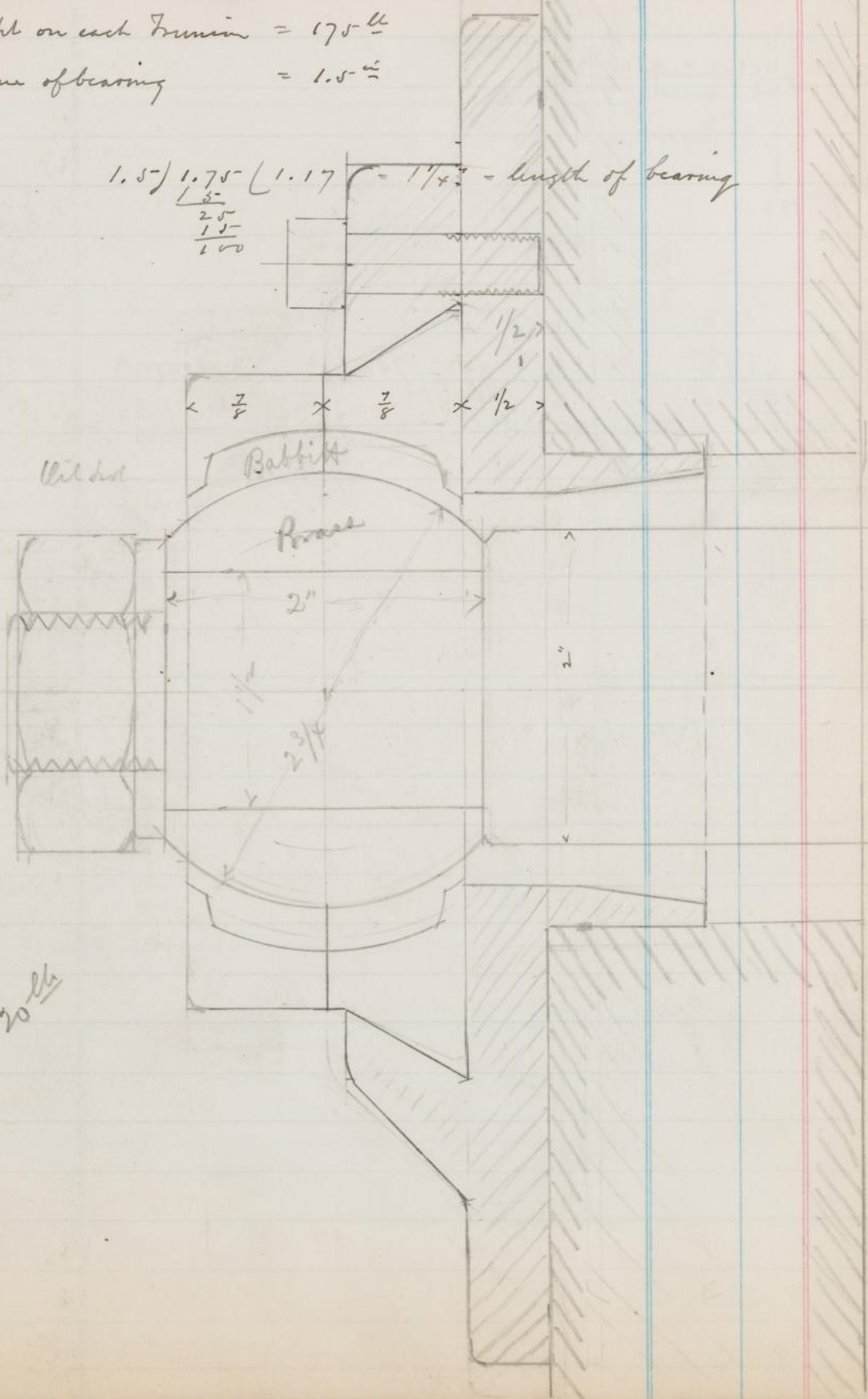
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Weight on each Journal = 175 lbs

Diam of bearing = 1.5 ins

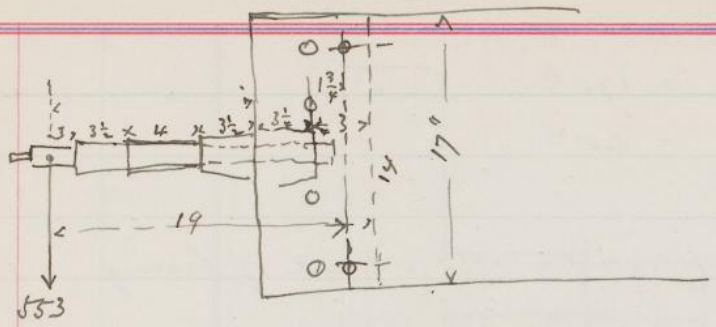
1.5 / 1.75 / 1.17 = 1 1/4" = length of bearing

1.5
25
15
100



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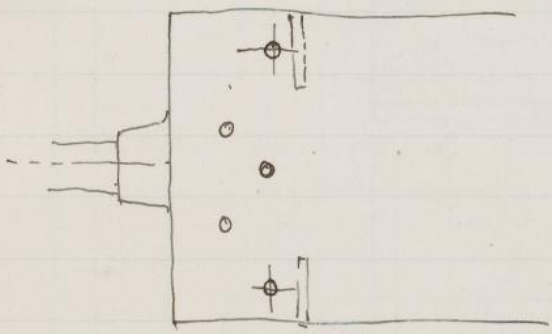
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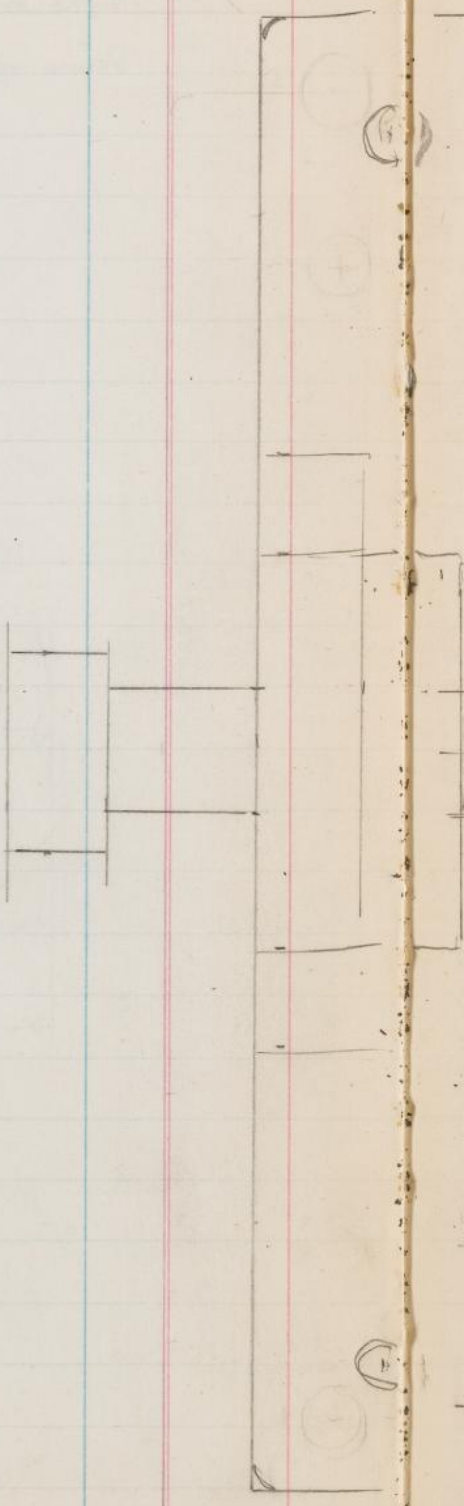


$$M = \sqrt{\sqrt{53}\cdot 19\cdot 4977}\cdot\sqrt{\sqrt{53}}\cdot 10\sqrt{07}$$

$14 \overline{)10\sqrt{07}(\sqrt{70}}$ — 98 — 70 — 70

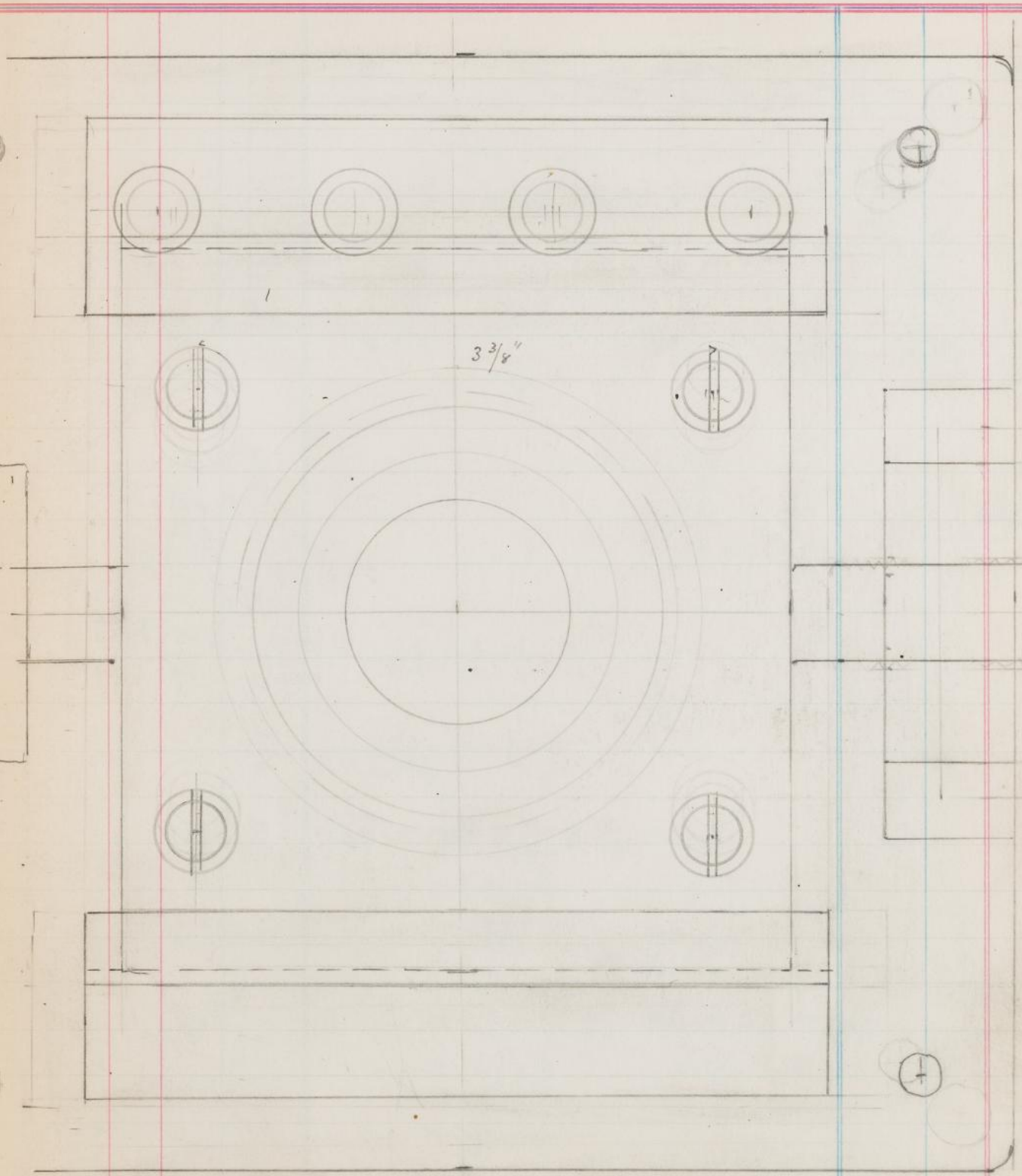
$\frac{\sqrt{70}}{2} = 37\sqrt{\frac{1}{4}}$





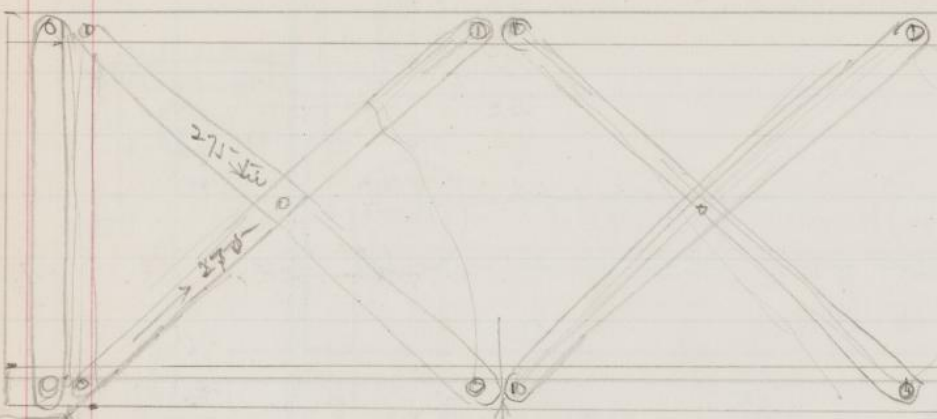
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$\frac{3}{16}d = .0376$

15000

1880000

376

564.0000

$\frac{1}{4}d = .049$ cu in.

15000

245000

49

735000

$\frac{5}{16}d = .077$ cu in.

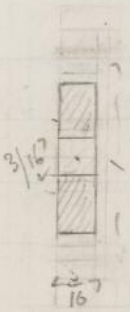
15000

385000

77

1155.0000

2 | 625
313

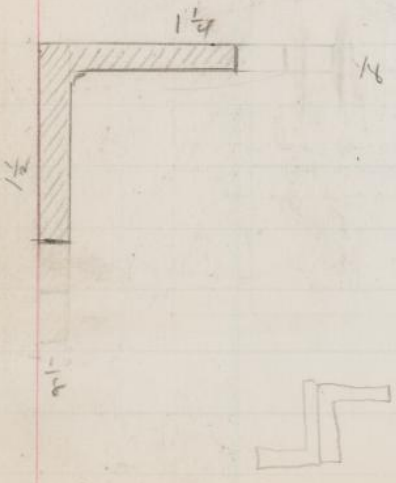


~~$\frac{5}{16} \times \frac{1}{4} = \frac{25}{64} = \frac{3}{8}$ cu in.~~

$\frac{3}{7} \times \frac{3}{8} \times \frac{3}{4} = \frac{27}{256} = \frac{1}{11}$

$\frac{3}{16} \times 1 \times 15000 = 2800$ lbs

16) 45(2.8
32
130
128



1.50
1.37
8) 2.87
.36

$\frac{3}{16} \times \frac{7}{8} \times 15000 =$

15000
21
1.5000

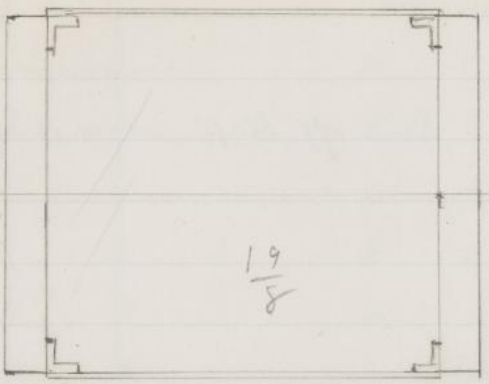
128) 315000 (2400
256
590

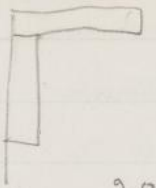
$\frac{3}{16} \times \frac{3}{4} \times 15000 =$

9
64) 1350.00 (21.00
128
70

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$1\frac{1}{4} + 1\frac{1}{8} \sim 2\frac{3}{8}$

$\frac{1}{8} \times 2\frac{3}{8} \times 160 \times 19 \times .28 =$

$\frac{19}{8} \times 45 \times .28 = 21^{lb}$

25
46 lb
4
50 lb

Seating weight

19.-
75-
.28
600
150
21,00

9 lb
10 ft

108
324
5400

$M = \frac{324}{37800}$ in lbs

$\frac{37800}{24} = \frac{1890 \text{ lb}}{1575} = .125$

18 ft
14
12
28
14
168
8

18
12
36
15
216

.28
90
25.20

$\frac{3}{4} \times 1 \times 60 \times \frac{1}{8} \times .28 = 25$

$1\frac{7}{8} = \frac{15}{8} \times \frac{1}{8} = \frac{15}{64} = \frac{1}{4}$

$90 \times 180 \times \frac{1}{40} \times \frac{1}{3} = 45^{lb}$

$\frac{45}{90}$

Seating weight 50 lb
Shaft Tin roofing 90
Solder bolts &c 10
150 lb

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St Andrews Golf Club, Mt. Hope -

Oct. 26 '97

	Morning		Afternoon			
1	6		6			Drive off bluff - abt 175 ft. high -
2	10		7			
3	8		8			
4	3		3			
5	5		6			
6	5		6			
7	7		5			
8	6		5			
9	5	53	3	49		
10	6		6			Drive over ledge of rocks
11	4		5			
12	4		6			Drive through notch
13	10		7			Longest link
14	6		9			Drive over apple orchard
15	6		7		7	Drive west from club house
16	6		5		6	
17	8		4			
18	6	56	6	53		
		111		104		

With Mr. Leuthe and Mr. Groth

Tribune Nov. 3, 97

SANDS IS ST. ANDREWS' CHAMPION.

The annual golf championship of the St. Andrews Club was decided yesterday on the club's links, at Mount Hope. The tournament was a thirty-six-hole medal-play affair, the conditions providing that the one returning the lowest score should be declared club champion for the ensuing year. The prize offered was the John Reid medal, one of the oldest golfing trophies in this country. It was won by W. H. Sands, with a total score of 179. This is Sands's third victory in these competitions, and he thus receives the medal to keep. Some of the leading scores follow:

	First round.	Second round.	Total.
W. H. Sands	93	86	179
G. E. Armstrong	91	90	181
R. H. Robertson	97	86	183
James Brown	90	94	184
S. D. Bowers	92	96	188
A. L. Livermore	96	93	189
H. W. Taft	105	91	196
W. T. Gray	100	96	196
D. G. Henderson	99	98	197
J. A. Wright	103	95	198
H. Holibrook, jr.	99	102	201
R. L. Cuthbert	102	99	201
E. Masten	105	97	202
T. L. Manson, jr.	97	106	203
J. B. Upham	107	97	204
J. Q. A. Johnson	107	98	205

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Springfield, Country Club -

Oct. 23rd 97

Handicap Tournament.

	Handicap	Tournament.	
1	8	6	
2	5-	7	
3	6	6	
4	4	3	
5-	5-	8	
6	9	7	
7	8	9	
8	6	9	
9	4	3	
	53-	58	
	Total	113	
	Handicap	8	
	Net.	105-	

Nov. 6th - Match - ~~Handicap Tournament~~,

	H.	C.		H.	C.
1	5-	6		5-	6
2	4 (1 stroke inside)	6		6	7
3	6	5-		6	7
4	4	4		4	4
5-	4	5- lost		4	5-
6	5-	6		7	8
7	9 (1 stroke overplus)	12		Conceded	8
8	7	9		10	10
9	4	5-		4	6
	48	58		57	61
	six up			five up	

Howard 11 up.

Op. Mr. Calhoun.

Opponent, Mr. Temple Chapman.

SPRINGFIELD WINS AT GOLF.

Hartford Club Defeated 16 to 11—Country Club Grounds to be Closed.

The Springfield Country club defeated the Hartford golf club yesterday afternoon in an 18-hole match play on the Country club's links in West Springfield. This is the second play the Springfield club has taken from Hartford, a match in that city about a month ago resulting 6—5 in favor of Springfield. The game yesterday practically closed the season at the Country club. A part of the grounds will be closed at once, so that the links may be improved for another season. The grounds will be smoothed over, and several of the greens enlarged. Yesterday's score:—

Springfield.		Hartford.	
Smith	8	Sterling	0
Parlett	1	Cutter	0
Chapin	5	Bunce	0
Calhoun	0	Howard	11
Stebbins	2	Prentiss	0
Total	16	Total	11

Springfield Republican Nov. 7.

Said R. H. Leutler to C.R.H. "You levened the whole lump".

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Good Games –

Nov. 5th 97. Dec. 18th 97

	C. P. H.	J. C. Sterling	C. P. H.	R. W. Cutler
1	6	5	5	8
2	4	5	5	4
3	5	4	4	4
4	6	7	7	6
5	4	5	6	5
6	4	6	4	4
7	6	5	5	6
8	4	4	4	4
9	4	4	4	4
	43	45	44	45
10	5	6	5	6
11	6	5	7	5
12	7	6	6	5
13	5	6	8	6
14	5	9	7	8
15	6	5	4	5
16	7 L.-b.	5	5	4
17	5	4	4	5
18	6	6	6	7
	52	52	52	51
	95	97	96	96

Holes - Sterling 1 up.

Holes - Tie.

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Record Broken held by F.R.C. 89.

Dec. 11th 97

C.P.H.	S.W. Prentice
4	6
3	8
4	3
6	10
4	7
5–	6
6	5–
5–	5–
6	6
43	56
4	4
4	6
5–	7
6	6
7	6
3	6
7 Drove into trench. 1 Stroke lost (ball in water)	5–
3	4
5–	5–
44	49
87	105–

May 7th 1898

C.P. Howard now holds the

Gillett cup
Silver Dish
Silver Scratch Medal
Record Mug Score 97

May 20th lost Silver Dish to F.R. Cooley

May 28th lost Record Mug to Mr. Schwartz Score 93

Nov 12th lost Gillett cup to Alec Bunce Score 89 – see p. 23

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Providence vrs. Manchester. May 14th 1898.

	L. P. H.	Capt. Smith.	
1	. 4	6	
2	9	5 .	
3	6	4 .	
4	. 6	---	The Pines
5	. 5	---	" Ravine
6	. 5	---	
7	5	5	
8	. 5	6	
9	. 5	---	
	50	---	Howard 4 up

2nd Round

1	5	4 .	
2	5	5	
3	5	5	
4	6	6	
5	. 6	8	Howard dormie 4
6	5	4 .	
7	5	4 .	
8	7	4 .	
9	6	5 .	
	50	45	All even

Result of match, Providence, 7 up.

Manchester Team

Wallie Cheney

Will "

Tone "

Mr. Pulsifer

R. W. Leutter

L. P. Howard

Mr. Smith is Providence's 4th best player. { has made course in 40

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Norfolk, Conn. October, 1898.

		⌜J. J. Naine⌝				Manning	C. Stevens
yds	Hole	13th	17	24	25	27	27
277	1	6	5	5	6	7	6
234	2	4	5	5	6	8	7
253	3	7	5	6	7	6	7
216	4	6	4	5	4	4	5
232	5	6	4	5	7	6	7
183	6	4	4	4	4	4	4
240	7	5	5	4	5	5	5
165	8	5	4	4	4	6	4
282	9	7	5	6	6	5	5
		50	41	44	47	57	57

The record for the links is 37 by Mr. Mallock, professional.
Mr. F. R. Cooley's lowest is 42

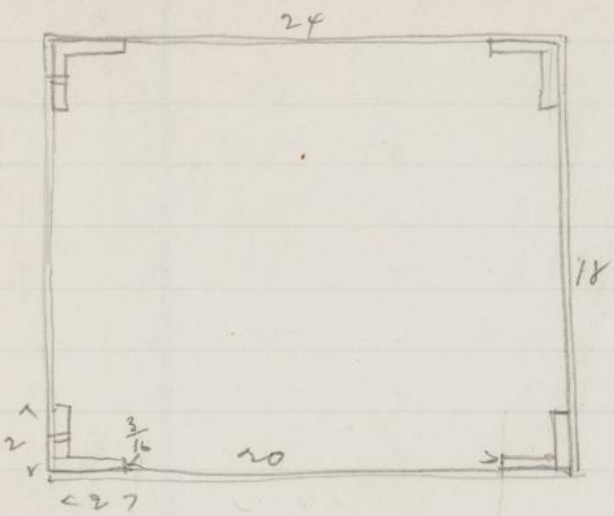
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Side Plates 400 lbs
Top & bottom 150
550



18 × 12 = 216 + 36 = 252 lineal
14 × 12 = 168

$1\frac{13}{16}$  $3\frac{13}{16} \times \frac{3}{16} \times 218'' \times 4 \times .28$

$\frac{61}{16} \times \frac{3}{16} \times \frac{109}{218} \times 4 \times .\overset{.07}{28} = 175^{\#}$

48
13
61

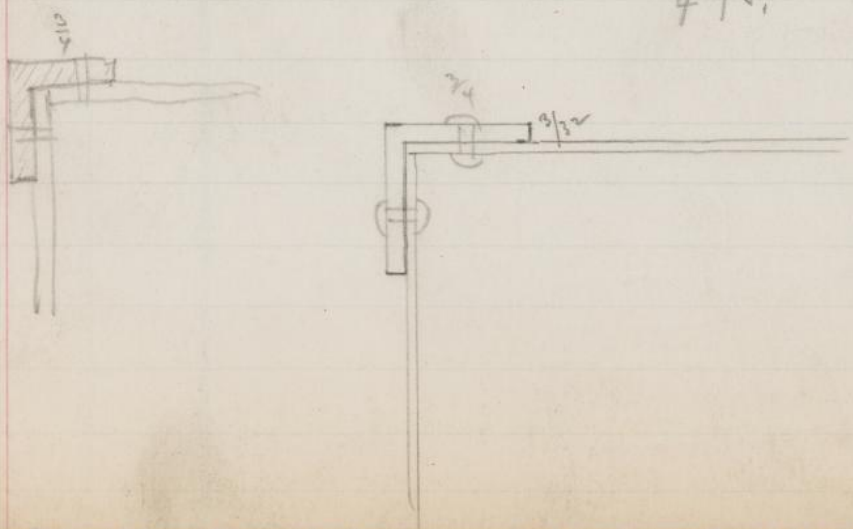
183 = 2.263
109 = 2.637
07 = 8.845
3.145
.8 = 0.903
175 = 2.242

Sides $36 \times 218 \times .04 \times .28 =$ ——— $88^{\#}$
Top & bottom $24 \times 170 \times .04 \times .28 =$ ——— 45.6
308.6
44
23.
475

36 = 1.556
218 = 2.339
.04 = 8.602
.28 = 9.447
1.944

24 = 1.380
170 = 2.230
8.049
1.659

.06 thick add
.06 "



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$1\frac{13}{32} \times \frac{3}{32} \times 218 \times 4 \times .28 =$

$\frac{45}{32} \times \frac{3}{32} \times 218 \times 4 \times .28 = 32.2$ lbs

25-6

Sides .08 thick 176.

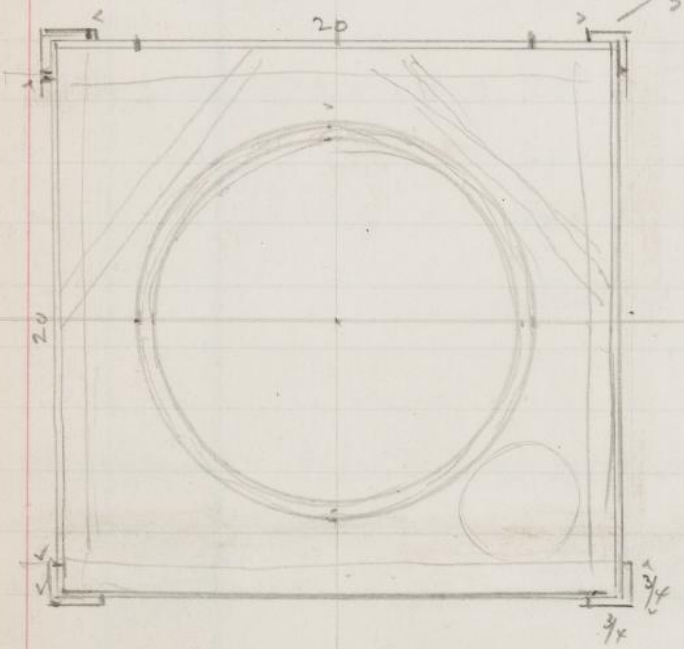
Top + bottom .08 " 91.

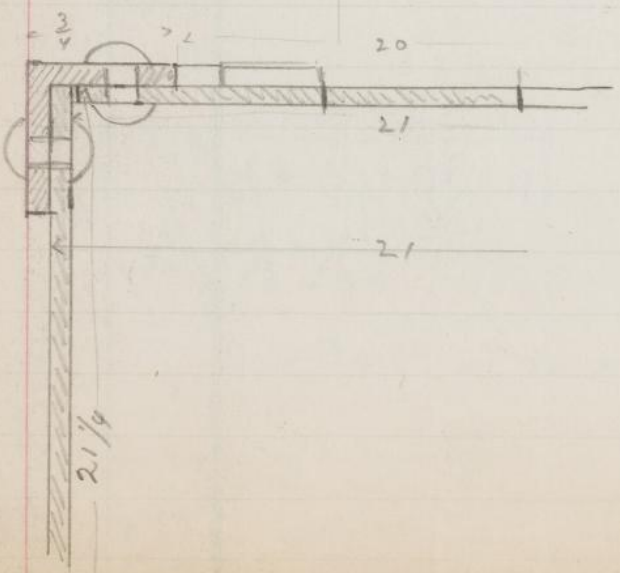
299

45 = 1.65-3
65-4 = 2.815
.28 = 9.447
3.915-
218 = 2.408
= 1.5-07 = 32.2

32 | 3.00 (0.09
288

Angles 33½





33.

Sides, $42\frac{1}{2} \times 218 \times .09 \times .28 = 232.$

Top, Bottom } $21 \times 170 \times 09 \times .28 = 90.$

35-5

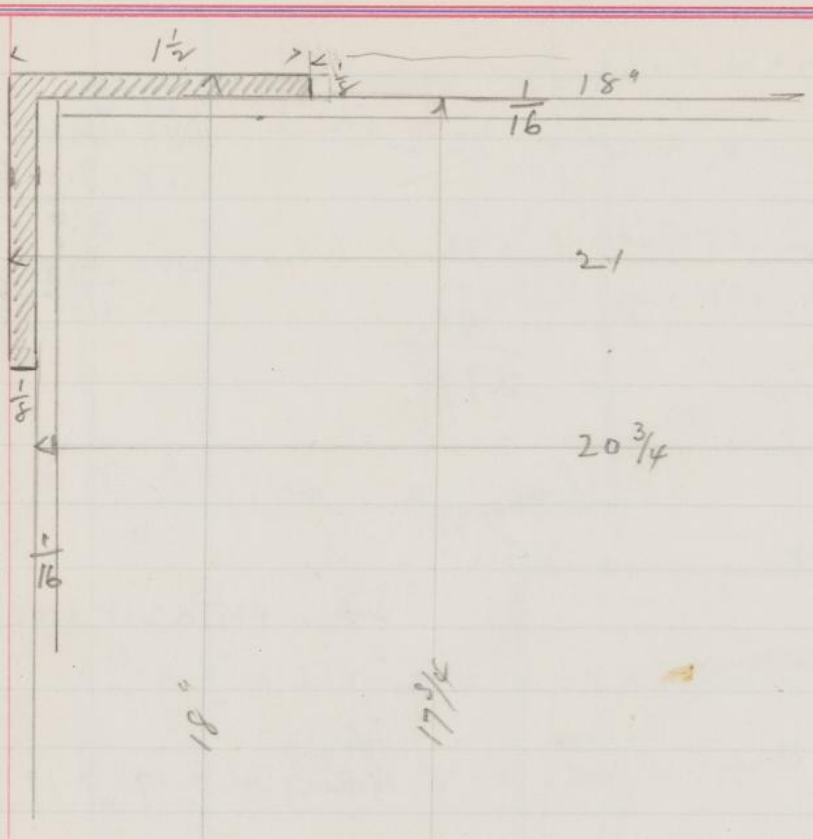
42.5 = 1.628
218 = 2.339
.025-2 = 8.401
232 2.368

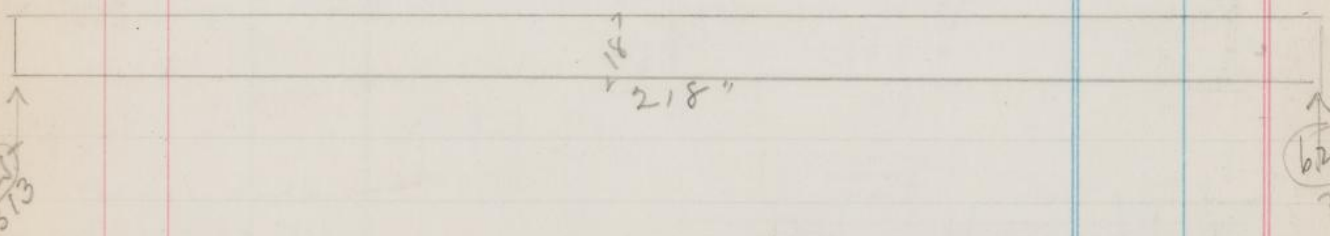
21 = 1.322
170 = 2.230
.0252 = 8.401
1.95-3

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Axle 900
Tube 350
Total 1250





625 / 313

625 / 313

7 Ribs

$20\frac{1}{2}$
$20\frac{1}{2}$
$17\frac{1}{2}$
$17\frac{1}{2}$
76"

$1\frac{29}{32} \times \frac{3}{32}$

$\frac{61}{32} \times \frac{3}{32} = \frac{183}{1024}$

$\frac{72}{32}$
64
96
1024

$\frac{7}{32}$" $\times \frac{183}{1024} \times .28 = 13.9$ lbs

2.726
2.263
9.447
4.486
3.010
1.426

13.9

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1897phae.proj.--539H

Side Planks
Top & bottom

400 - Wood
150 "
550



Angles $2\frac{7}{8} \times \frac{1}{8} \times 218 \times 4 \times .28$

$\frac{23}{8} \times \frac{1}{8} \times 218 \times 4 \times .28 = 88^{lbs}$

23	1.362
54.5	1.736
.07	8.845
87.7	1.943

Sides $17.75 \times 2 \times 218 \times 0.9 \times .28 = 196$

17.75	1.249
438	2.642
.0252	8.401
	2.292

Top & Bot. $20.75 \times 170 \times .9 \times .28 = 89$

373 lbs

20.75	1.317
170	2.230
	8.401
	1.948

№16 = 1/16 = .625

98
44
142

142 out
231
Ribs - 14
245

Bending Moment = $\frac{313 \times 218}{17} = 4020^{lbs}$

313

2.496	
2.338	
4.834	4 / 68200
1.230	24 / 170 50 (710
3.604	168
	25

$R = \frac{3Pl}{2bd^2}$

$\frac{4020}{1600} = \frac{1}{4}$

$\frac{23}{8} \times \frac{1}{8} = \frac{23}{64} = \frac{1}{3}$

1/16

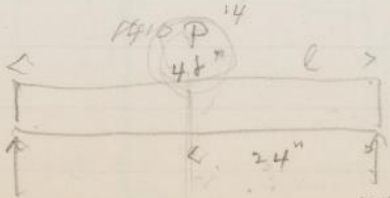
$17\frac{3}{4}$

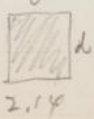
$R = \frac{3 \times 625 \times 218}{2 \times \frac{1}{16} \times 17\frac{3}{4} \times 17\frac{3}{4}}$

$= 10400$

17.75	1.249
2	
2.498	
8	0.903
1.595	

3	0.477
625	2.796
218	2.339
	5.612
	1.595
10400	4.017





$2b^3R = 3Pl$

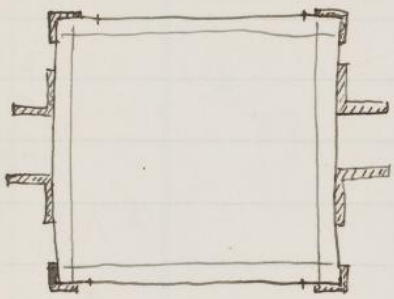
$b^3 = \frac{3Pl}{2R}$

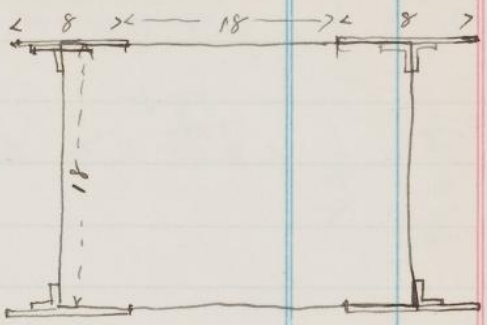
3	0.477
1420	3.152
48	1.681
	5.310
20000 =	4.301
	1.009

2.14 0.336

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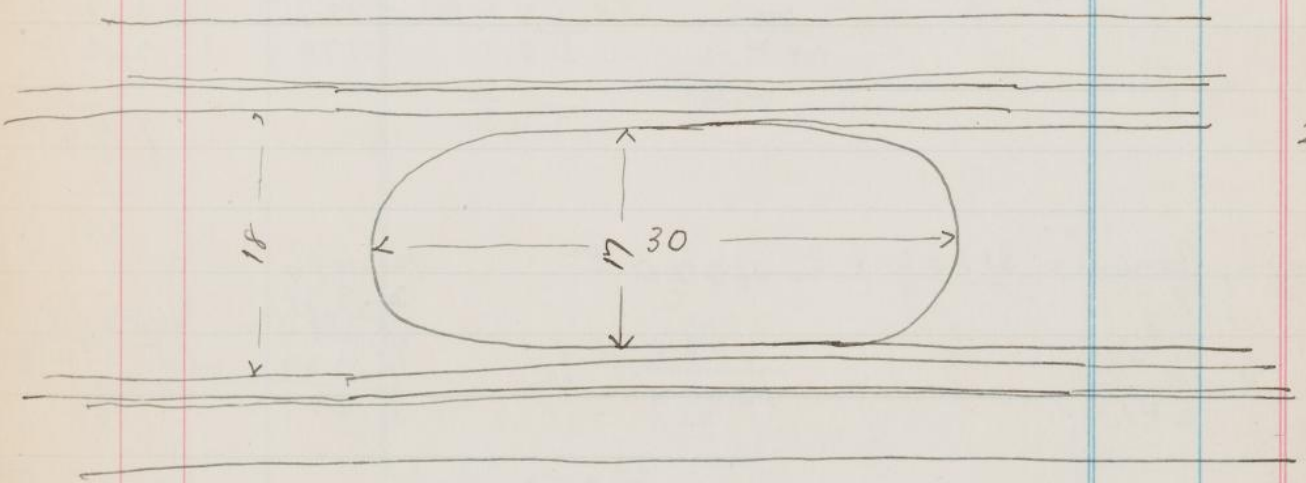




Total bending moment = $625^{lbs} \times \overset{\div}{\cancel{218}}{}^{109} = \cancel{136400}\ 68200^{\div lbs}$

$= 625 \times \overset{120}{\cancel{240}} = 75000.$

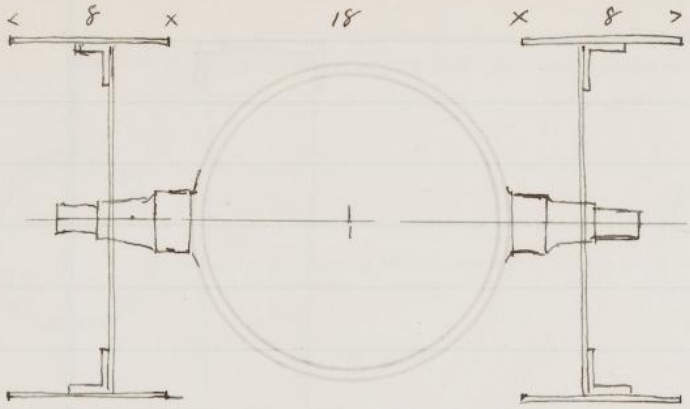
625
120
75000

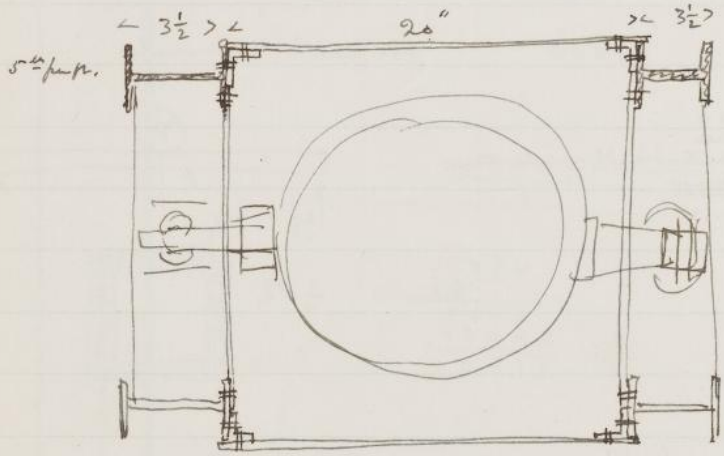


2.3
12
27.6

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4 | 68200 / 17050

$M = \frac{1}{4} Pl = \frac{RI}{c}$

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

R = stress per sq in of extreme fibre

$17050 = \frac{12000 \times I}{\frac{1}{2} d}$

$8525\, d = 12000\, I$

$9999\, d = 12000\, I$

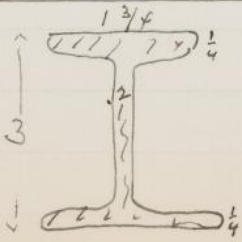
$d = \frac{4}{3} I$

$I = \frac{3}{4} d$

4" I Beam. $I = 4.6$ Weight = 6½ per ft.

$M = \frac{RI}{c} = \frac{12000}{7} \times 4.6 = 27600$ Kent p. 274

$I = \frac{A h^2}{6.66} = 2$



1.4 × 12 × .28 = 5½ lbs per ft.

$\frac{7}{4} \times \frac{1}{2} \times 2 = .9$

$.2 \times \frac{5}{2} = .5$

$A = 1.4$

$h^2 = 9$

6.66) 12.60 (2

12 / 1.4 / 48 / 12 / 16.8

16.8 / .28 / 1344 / 336 / 4.704

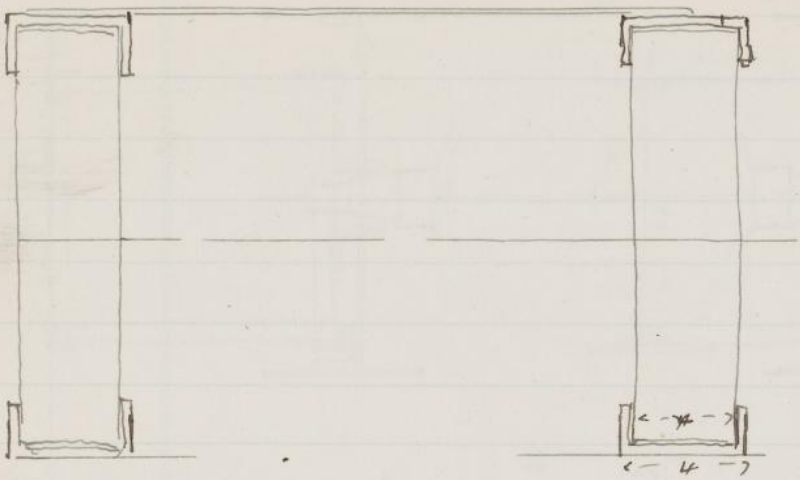
$\frac{12000 \times 2}{1\frac{1}{2} = \frac{3}{2}}$

$\frac{4000}{12000 \times 2 \times 2}$

16000.

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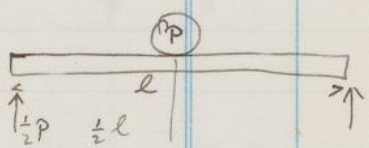
Bending Moment = 75000 in lbs.

19000 " " for each channel

15" (I) $M = \frac{RI}{c} = \frac{4800}{2.5} \times 12.4 = 59520$

$.4$

12.4
4800
99200
496
59520



4800
6½
2400
28800
31200

$\frac{1}{4}Pl$

15" [$\frac{4800}{2.5} \times 6.5 = 31200$

4800
8½
2400
14400
16800

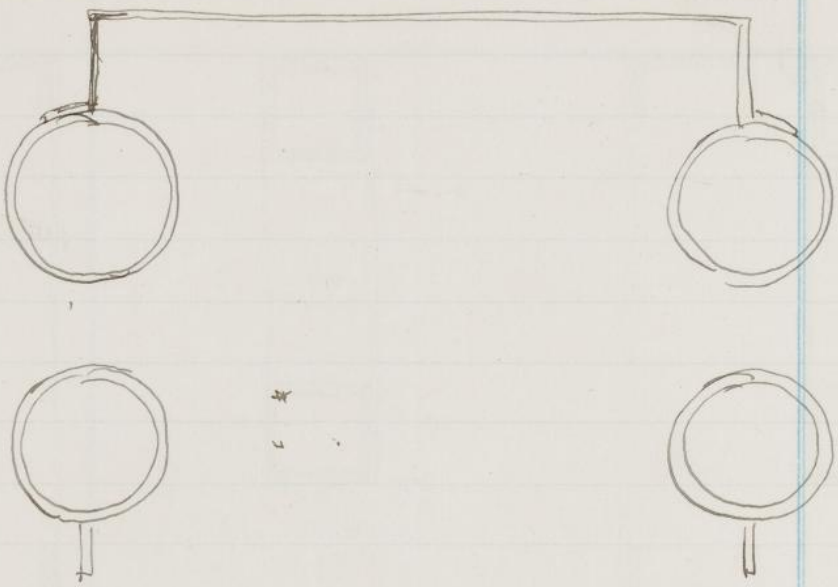
4" [light 5# per ft. $\frac{4800}{2.5} \times 3.5 = 16800$

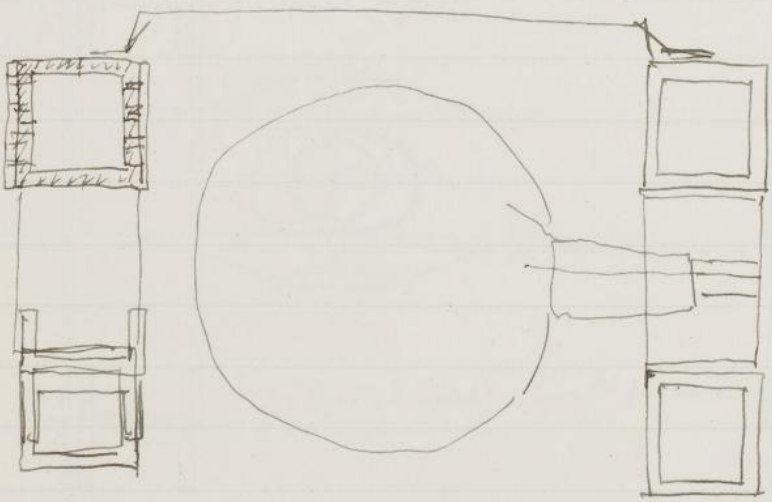
4800
4.8
38400
192
230400

4" [heavy 8 1/4 # per ft = 23040

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1897phae..proj..539H

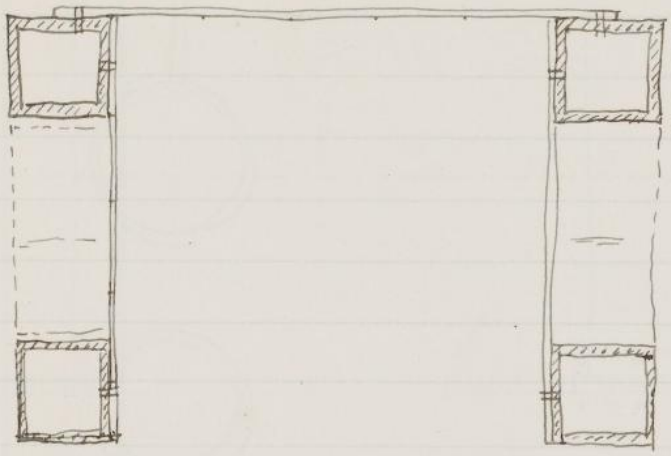


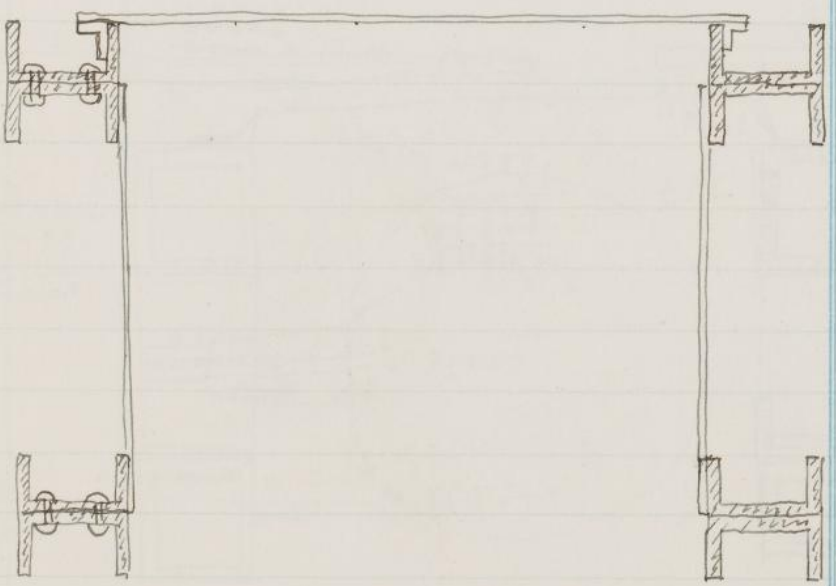




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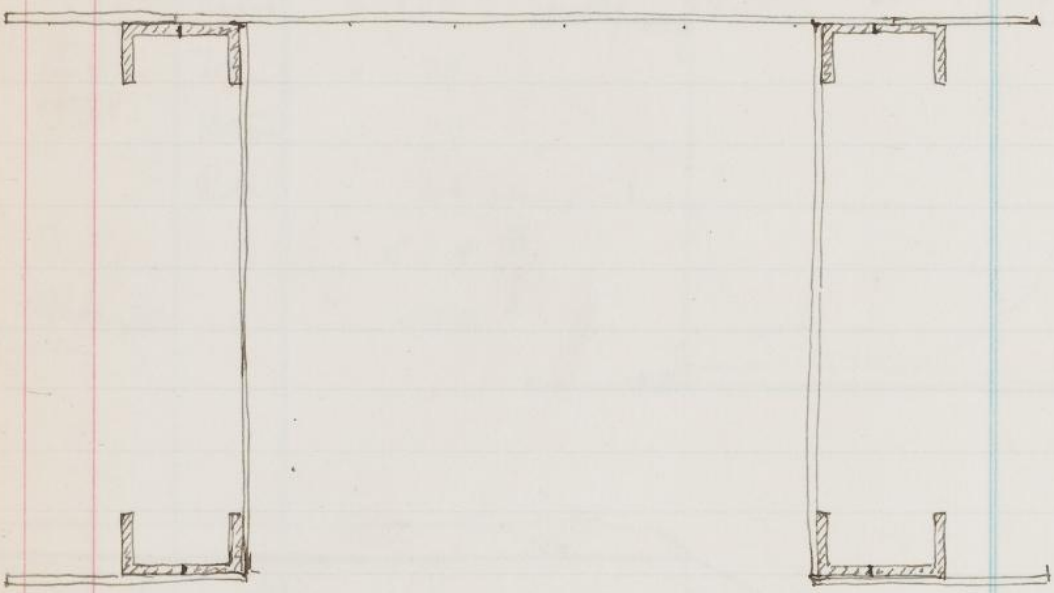


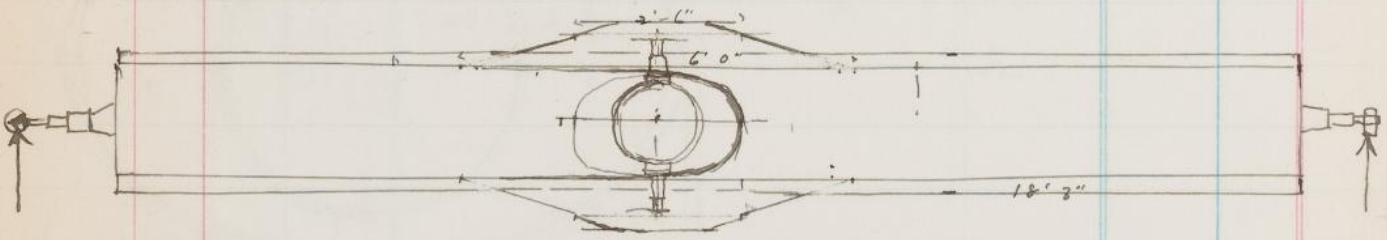


4" I Beams.

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l = 20' 3"

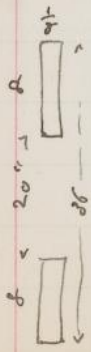
$P = \frac{2}{3} \cdot \frac{R\,b\,d^2}{l}$

P = load at middle = 600 lbs for each side
l = length in inches

$\frac{2}{3} \cdot \frac{4500 \times \frac{1}{8} \times 36 \times 18}{243} = 5400$ lbs

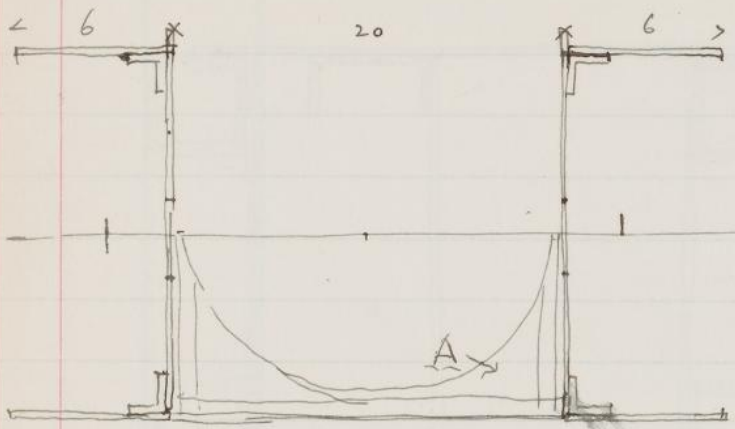
$\frac{2}{3} \cdot \frac{4500 \times \frac{1}{8} \times 36 \times 25}{243} = 1700$

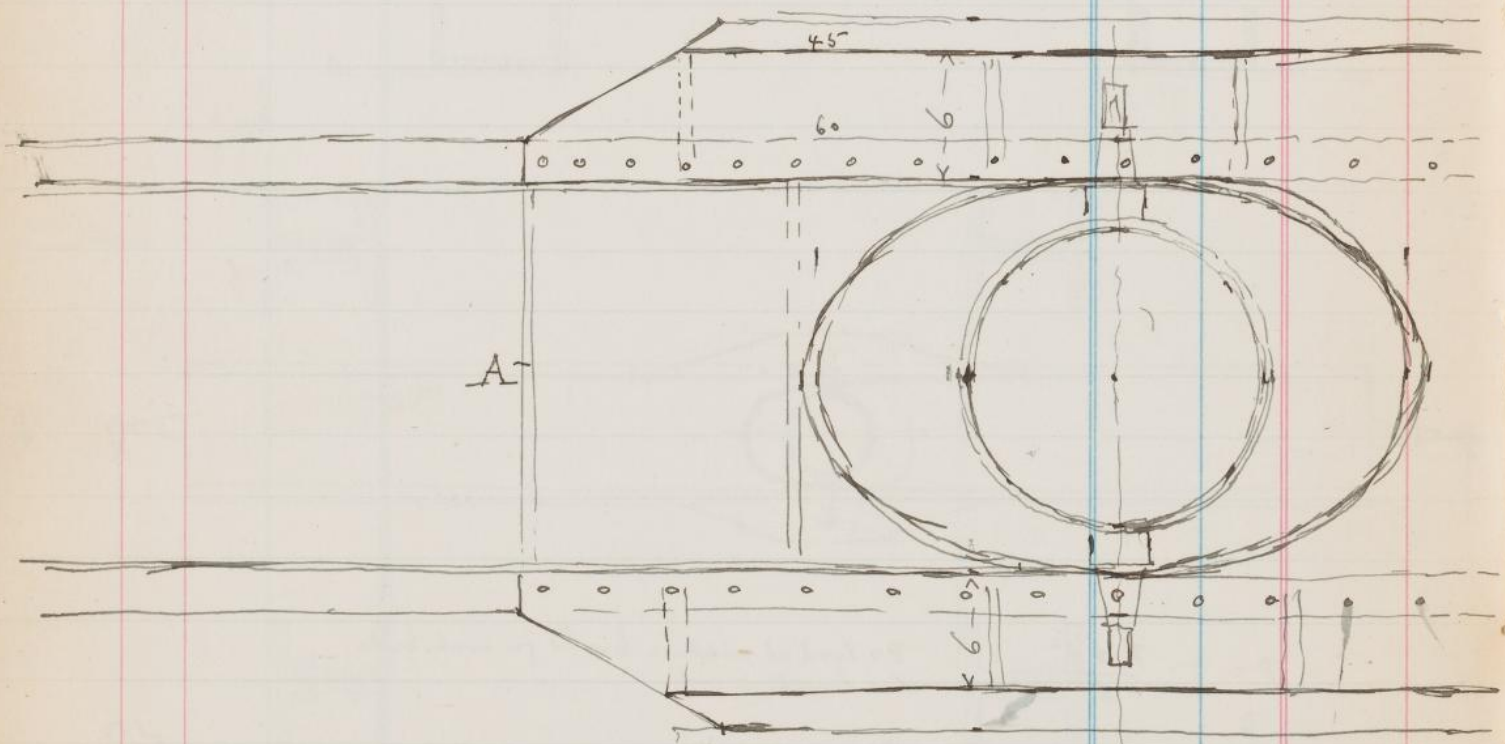
$3700 = P$



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$$\frac{\cancel{2} \times \cancel{10000}^{333} \times 1 \times \cancel{33}^{\cancel{4}} \times \cancel{33}^{11}}{\cancel{8} \times \cancel{240}^{\cancel{60}\,30} \times \cancel{8}} = 3663$$

1700

1963

qp

2 [3/16] = 175 lbs p 208

Sides = 176 p. 209 .08 thick

Top = 79

Bottom = 79

Ribs = 25

534 lbs

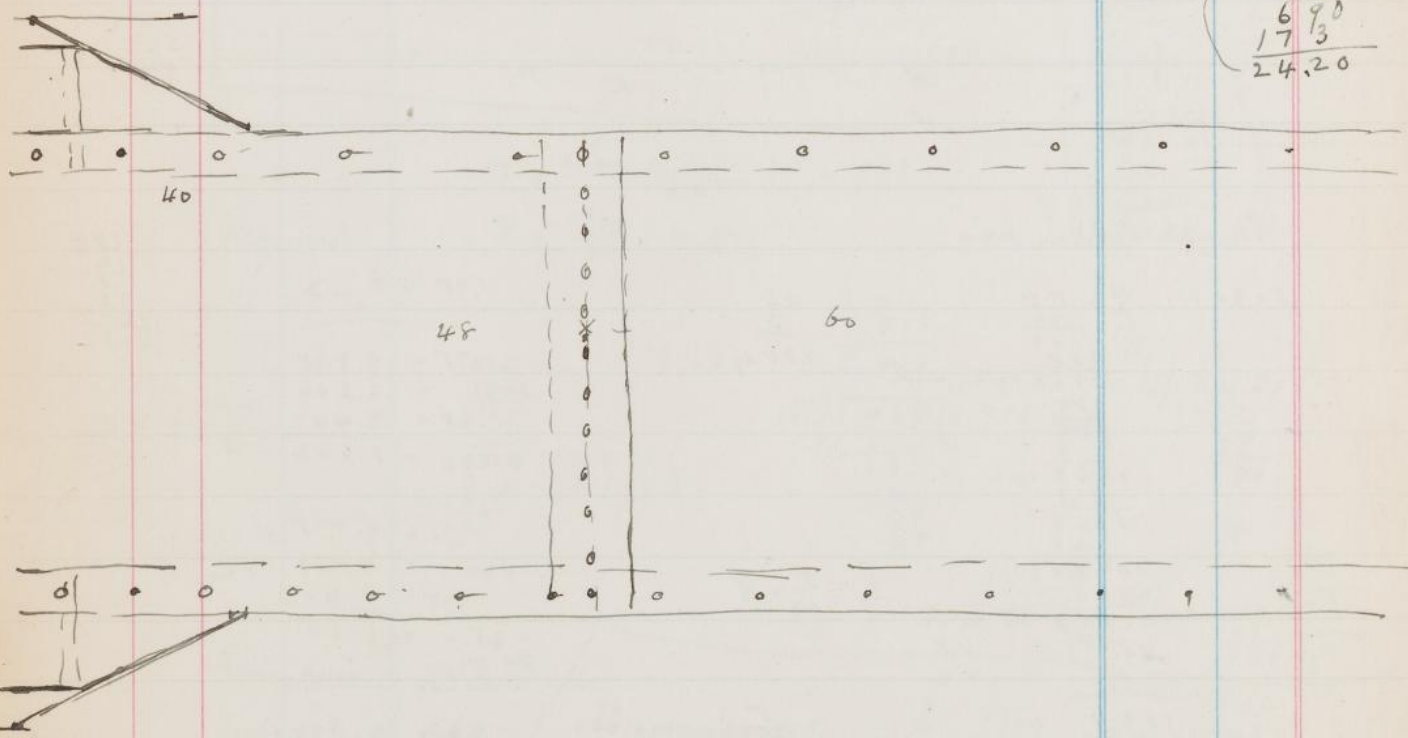
534

Side Planks, Top & Bottom

6 / 53 / 330

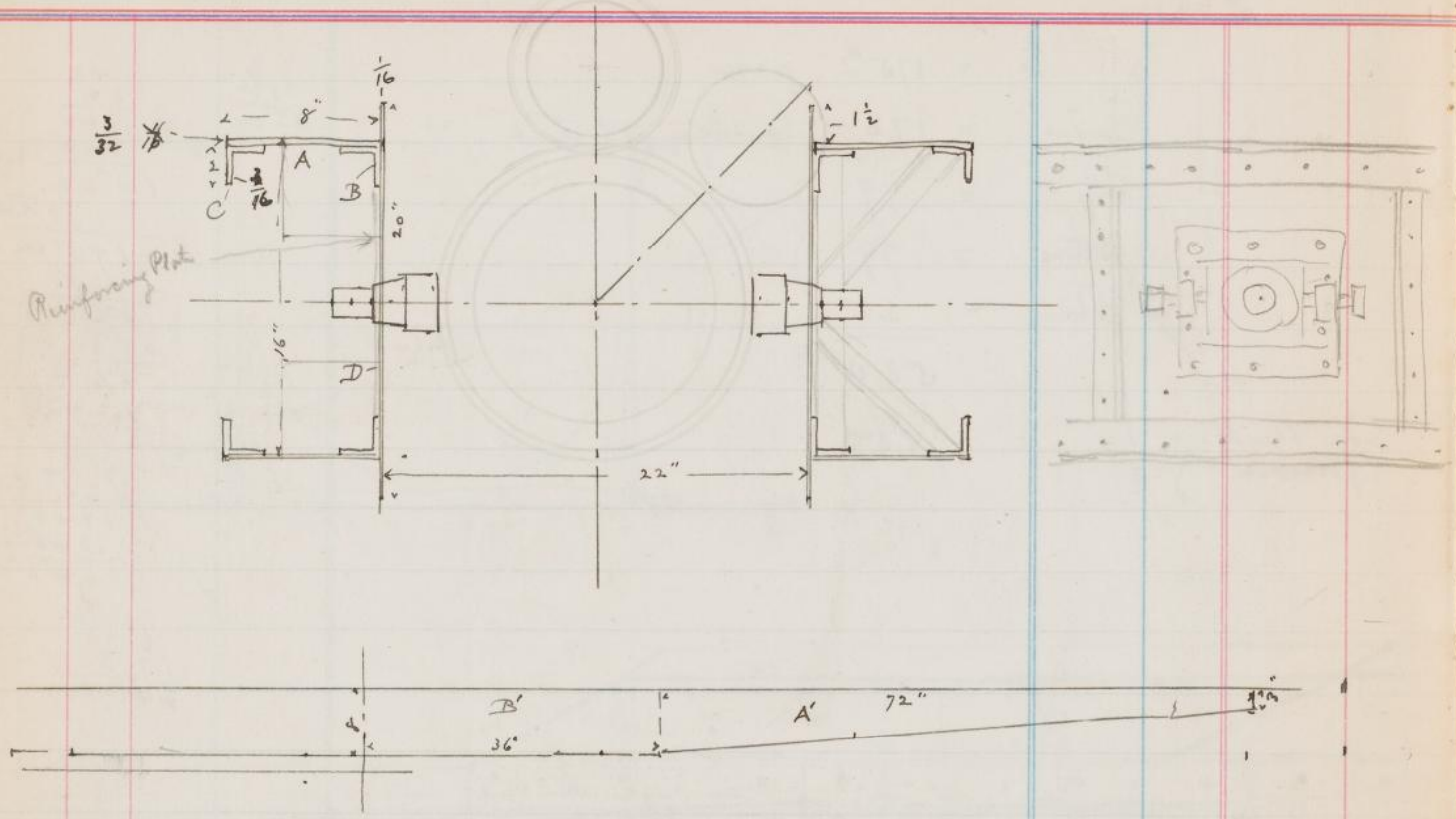
40 / 24 / 960 / 800 / 1560 — 1/8 thick / 195 cu in / .28 / 1560 / 390 / 54.60 / 24.2 / 79

60 / 24 / 1440 / .06 thick / 86.40 cu in / .28 / 690 / 173 / 24.20



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Weight of Polar Axis.

8 + 3 = 11 $\frac{11}{2}$ = 5.5

72
110
385
396.0 sq in. = A

288
684
2
1368 sq in
.1
136.8
.28
10944
2736
38.304 lbs in A
45.9 " B
25.2 " C
109.4
4
437.6 — D
152.
589.6 lbs

200 — end —
60 " Rivets —
40 Trunnion Rivets
890.
46. cover
936 lbs
14 — Rivets
950

Polar axis weight —

36
8
288 sq in = B'

.75 sq in = in B

.75 = 9.875
219. = 2.340
.28 = 9.447
45.9 = 1.662 — B.

.75 = 9.875
120 = 2.079 — C
.28 = 9.447
25.2 = 1.401

$\frac{5}{24} \times \frac{1}{16} \times 219 \times .07 \times .28 =$

209 = 2.340
.35 = 9.544 — D
76.3
2
152
1.884

$\frac{3}{24} \times 220 \times \frac{1}{32} \times .07 \times .28$

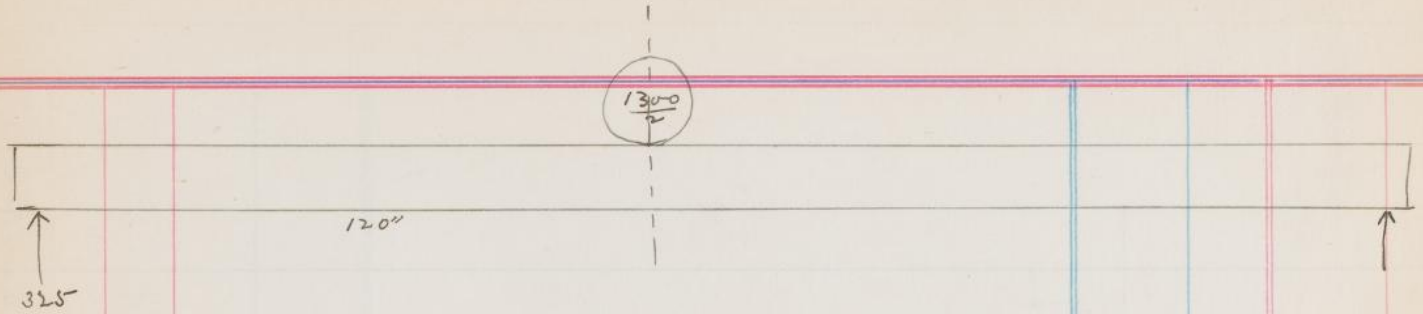
660
.07
46,20.

24 wide
220 long
$\frac{1}{32}$ thick
} Cover.

18 1/4
12
3
36
15
219

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Binding at centre = 325 × 120 = 39000 in lbs = $\frac{RI}{C}$

$M = (19500) = \frac{6000 \times 27.4}{2}$ 164,400.0

$P = \frac{80}{20} \times 1.56 \times 8 = 998$

Required $P = \frac{1300}{4} = 325$

$D = \frac{1}{7}\sqrt[3]{M.}$

175 / 350 / 525 / 1 / 2625 — 7 / 13.8 / 2 — 3.4191 / 1.1397

2.0 / 1.813 / 3.813 — 16 / 11.439 (0.715 cy. in

16 / 13.0 (.813 — 128 / 20 / 16 / 40 — 13/16

16 / 15.00 (.9375 — 144 / 60 / 48 / 120

$\frac{3}{4} \times \frac{3}{32} = \frac{3}{4}$

Polar axis = 950 lbs

Tube = 350

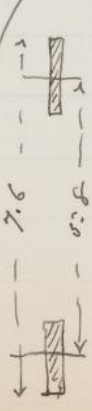
Total 1300

$\frac{1}{4}PL = \frac{RI}{C} = \frac{R\,b\,h^3}{12 \cdot \frac{1}{2}h} = \frac{2R\,b\,h^2}{12}$

$P = \frac{2}{3}\frac{R\,b\,d^2}{D}$

$M = \frac{R\,b\,h^2}{6}$

7.6 / 4. / 11.6 / 5.8



$\frac{3}{16} \times 1300 \times 12000 \times 7.8 = 11{,}700$

$\frac{13}{16} \times \frac{3}{16} \times 12000 \times 2.9 = 10{,}600$

$\frac{1}{2} \times 2000 \times \frac{3}{32} \times 5.8 \times 5.8 = 6{,}300$

Moment of Resistance = 28600

39 = 1.591 = 1.972 — 0.462 — 4.025

5.8 = 0.763 — 1.526 — 3.778 — 5.304

6000 = 32 = 1.801 — 6300 = 3.779

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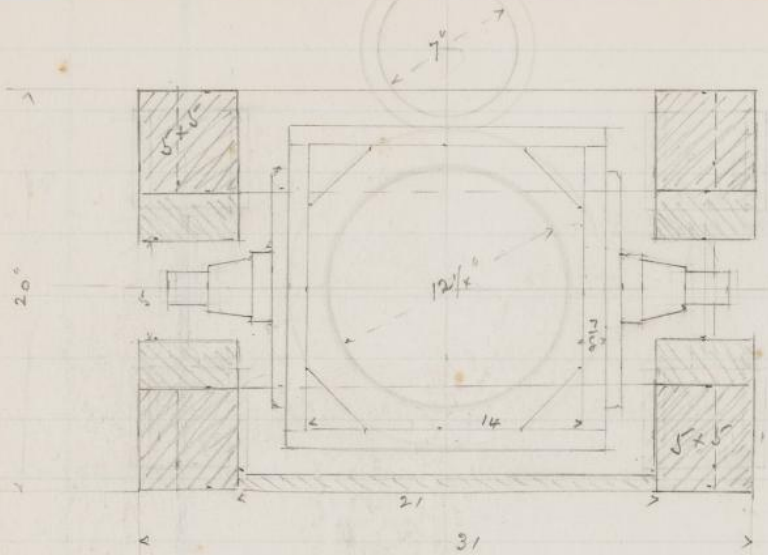
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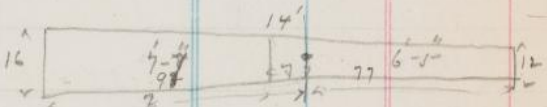
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260 ℔ on bearing (each)

$64 \times 42 \times \frac{1}{44} =$

64
42
128
256
2688
244



Large End

$\frac{31}{2} \times 91 \times 2 \times \frac{1}{44} = 64$ ℔

$13\frac{1}{2} \times 7 \times 2 \times \frac{1}{44} = 47.3$

$M_1 = 64 \times 46 = 2944$

$M_2 = 47.3 \times 38 = 1797$

Weight of Polar Axis –

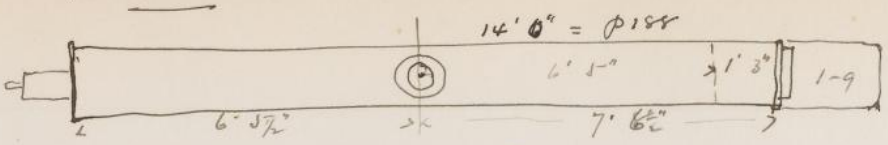
25" × 4 = 100 sq in –

$\frac{100}{2} \times 218 \times \frac{1}{50} = 436$ ℔	
$21 \times \frac{3}{4} \times \frac{200}{50} \times \frac{1}{50} =$	63
$\frac{5}{2} \times \frac{3}{4} \times \frac{5}{4} \times 48 \times \frac{1}{50} \times \frac{4}{4} =$	48
Trunnion Bearings	40
Ends + Pivots	260
Levers	46
Bolts	25
918 ℔	= Wt of Axis
520 "	= Wt of Tube
1438	
	360

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Wood Tube



$1'' \times 16 \times 2 = 32$ sq in
$1 \times 14 \times 2 = 28$ sq in
$3 \times 3 \times 2 = 18$ sq in
$78 \times 168 \times \frac{1}{144} = \frac{262}{300}$ lbs

Object Glass	46
Ring cast iron	10
Dew cap	13
Top End	5
	74

Steel Tube
See p 164 & 188

Weight at lower end to counterpoise
Diaphragms 2 lbs + 3 = 5
Trunnions = 50
5 5 1 5

Wood Tube overhang

96	
28	

5 7 0

$P_1 = \frac{2}{3} \times \frac{100 \times 2 \times 14 \times 14}{15} =$

$P = 1740$

1 cubic foot = 62½ lbs

1.796	
1728 =	3.237
	= 8.5 5 8
.0361 lbs per sq in	= 1/27.4
27.4	= 1.442

1.146
2
2.292
2.602
4.894
45 = 1.653
1740 = 3.241

Ash Centre
2 2 5
3 5
4 8
4 0
2 5
2 0
1 0
5 2 0
9 2 8 total

Eq wt at Centre

$\frac{78 \times 15}{10} = 23.4$

6 | 163.8
28.

231 on each 5" beam - see p 159

78 = 1.892
168 = 2.225
44 = 1.643
50 = 1.699
308 = 2.489
262 = 2.418

13 16
13 16
39 96
4 | 169 16
42 256 sq in
3 121
126 100 sq in
2
40 | 200 sq in
5 lbs

6.2 | 74 (12.
62
120
96

Trunnions
144
3
7
4 | 108 30
27 27 lbs

6
4 | 96
24 lbs

24
5 1
2
102

Trunnions
12 × 12 = 144
.3
4 | 43.2
11 lbs
7
18 lbs
20
40

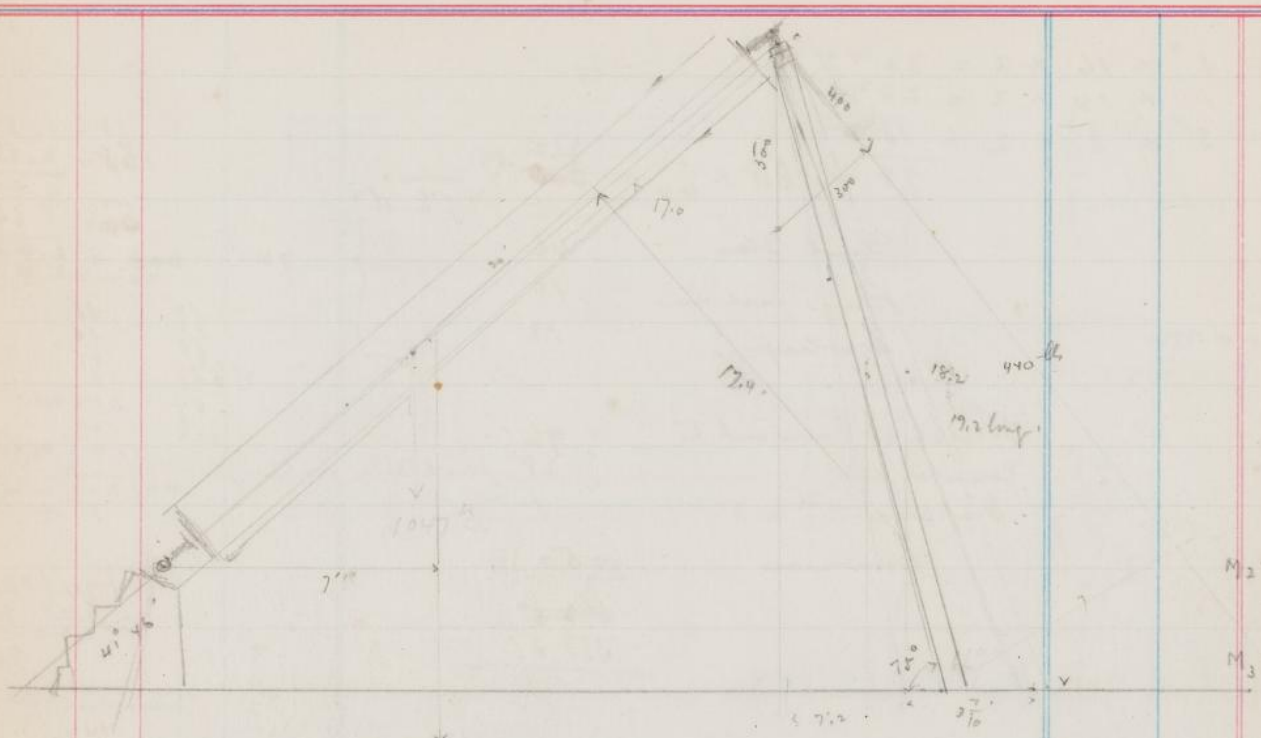
4½
4 | 27
7 lbs

$\frac{33}{1728} = \frac{1}{}$

33 | 1728 (52
165
78

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$\frac{20}{12} = 1.7$

4) $\frac{\sqrt{3}}{13\frac{2}{4}}$

4) $\frac{11.3}{3.4}$

$\frac{90}{75}$
$\frac{}{12}$

$\frac{440.}{2\frac{2}{4}}$
110
440
990

$M_2 = 990$

$M_3 = \frac{440}{7} = 20.80$

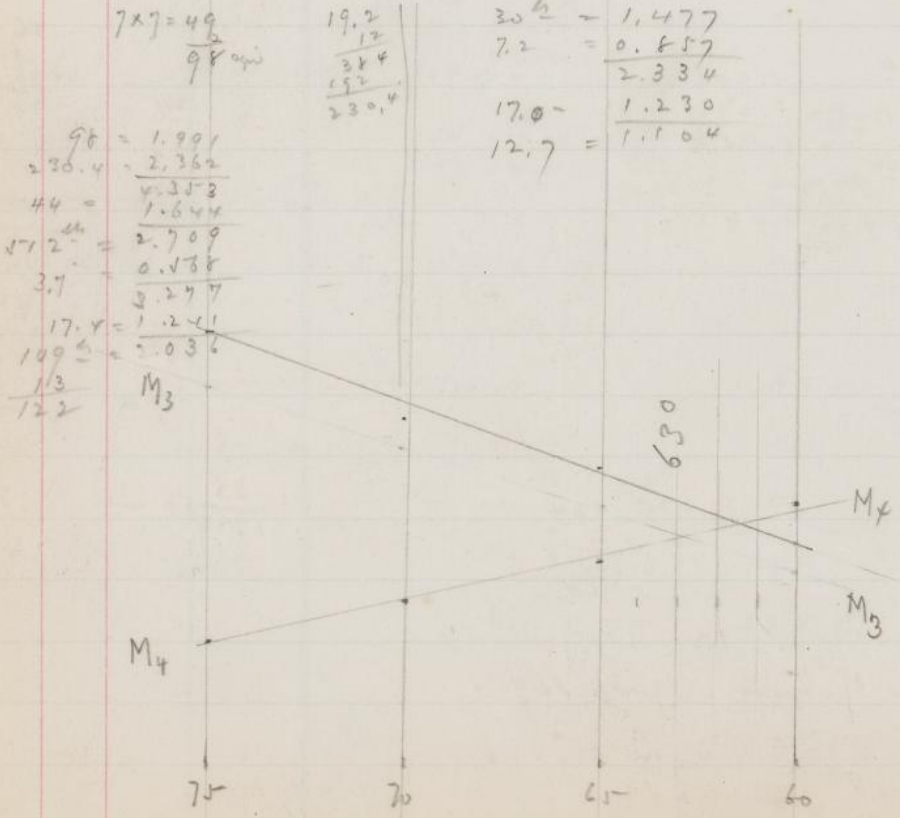
$7 \times 7 = 49$
98 agst

19.2
12
384
192
230.4

30	−	1,477
7.2	=	0.857
		2.334
17.0	−	1.230
12.7	=	1.104

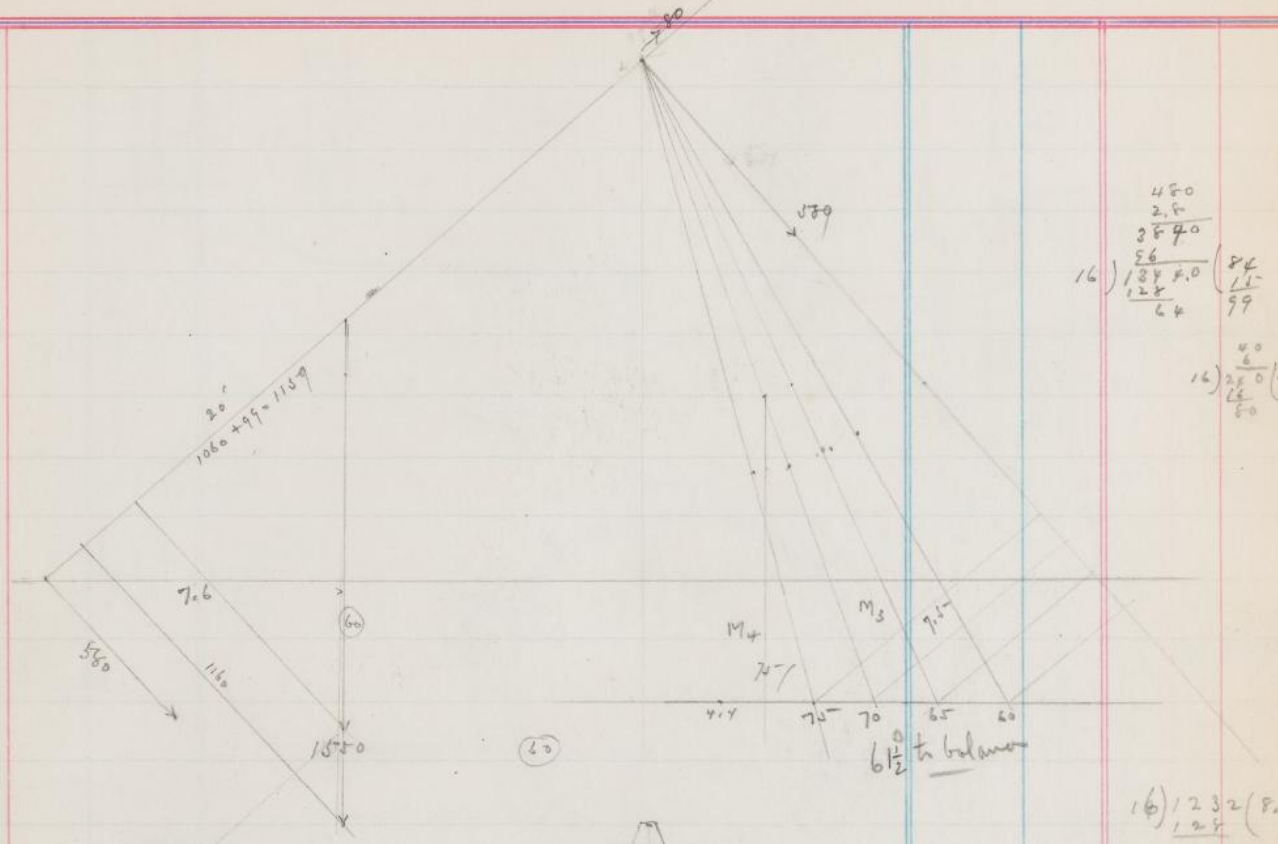
$\frac{1047}{366} = 7\frac{315}{366} = M_1$

98	=	1.991
230.4	−	2.362
		4.353
44	=	1.644
		2.709
12	=	0.738
3.7	=	3.277
17.4	=	1.241
109	=	2.036
13		
122		



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75°

$M_1 = 1550 \times 7.6 = 11780$

$M_2 = \frac{11780}{20} = 589$

$M_3 = 589 \times 7.5 = 4417$

$M_4 = 480 \times 2.2 = 1056 + 176 = 1232$

70°

$M_3 = 589 \times 6.3 = 3711$

$M_4 = 480 \times 3 = 1440 + 240 = 1680$

65°

$M_3 = 589 \times 5.1 = 3004$

$M_4 = 480 \times 3.7 = 1776 + 280 = 2056$

60°

$\times 3.8 = 2238$

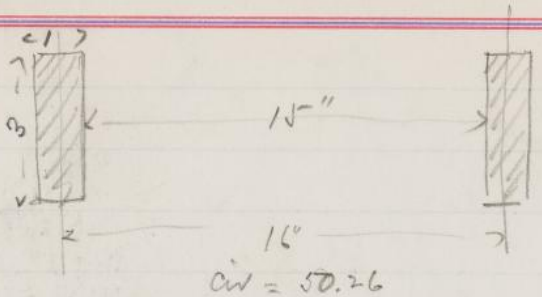
$480 \times 4.9 = 2352 + 392 = 2644$

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Weight to be used when O. G. is removed

46
13
59
60.



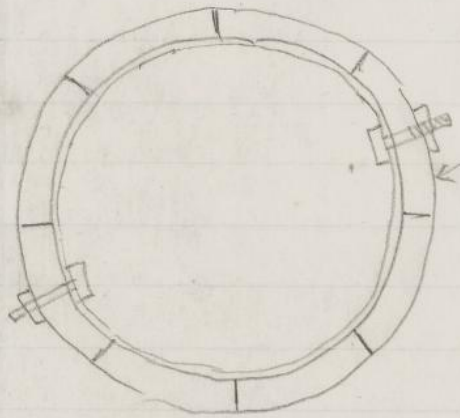
Cir = 50.26

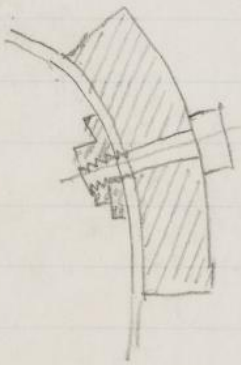
Lead weight.

.41 | 60.00 (147 cu in 50.3) 1500.0 (30 sq in section
41 1508.9
190
164
260

8 | 50.26
6.28

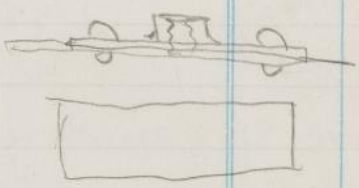
8 | 60
7½ lbs each







Inside Plate



Check

50¼ × 3 × .41 =

201/4 × 3 × .41 = 62 lbs

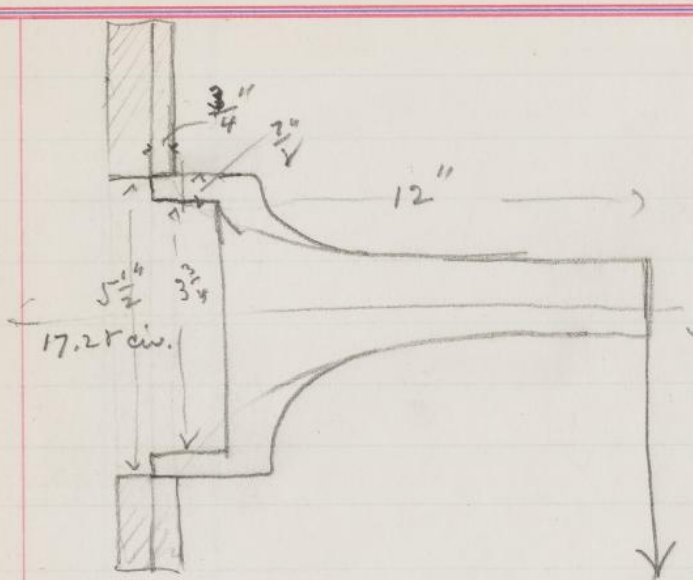
603
.41
603
2412
4 | 247.23
62 lbs

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17.2 × 3/4 = 12.96 sq in — 4.32 — 5 1/2 d = 23.76 — 12.96 — 10.80





713 lbs

713 / 12 = 59 6/12 in lbs = M.

S = fibre strain per sq in

y = arm.

$\sqrt{(dx^2+dy^2)}$ δy = moment of resistance each such element

Fixed one end

$Pl = \frac{RI}{c}$

$8536 = \frac{R\,I}{11/4 = 2.75}$

$I = \frac{\pi(d^4 - d_1^4)}{64}$

5,5 = 0,7404 / 2.9616 = 915.4

3,75 = 0.5940 / 2.2960 = 197.7 / 717.7

3.141 = 2.8559 / 0.4920 / 3.3529

64 = 1.5062

35.21 = 1.5467 < I

$M_0 = \int_r^0 \sqrt{dx^2+dy^2}\cdot \delta y$

$M_0 = \int_r^0 \delta y \sqrt{\frac{y^2dy^2}{x^2} + dy^2}$

$M_0 = \int_r^{r_0} \delta y \sqrt{\frac{y^2dy^2}{r_2^2 - y^2}}$

$= \int_r^{r_0} \delta y \sqrt{\frac{y^2dy^2}{r^2-y^2}} = \int_r^{r_0} \delta y^2 \sqrt{\frac{dy^2}{r^2-y^2}}$

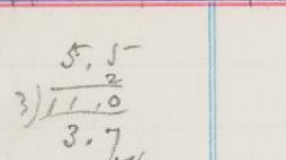
$\int_r^0 \delta y^2 \frac{dy}{\sqrt{r^2-y^2}}$

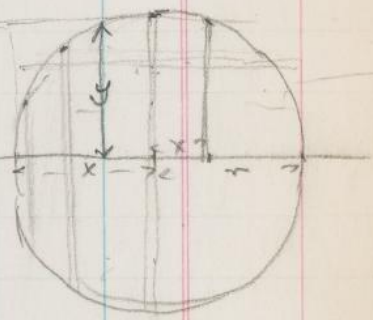
8536 = 2.9323

2.75 = 0.4393 / 4.3716

I = 1.5467 / 2.8249

R = 668





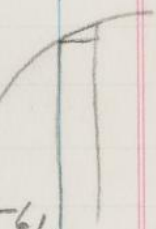
5,5 / 3 / 11.0 / 3.7

1 8 5 / 1 8 5 / 2 0 3.5 / 6 1 0.5 / 1 5 2.6

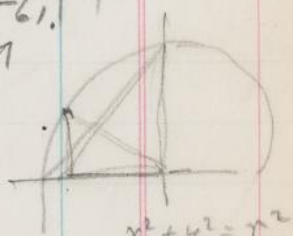
$8.536 = 3.7 \times 5\frac{1}{2} \times \frac{3}{4} \times R$

9.875 / 0.740 / 0.528 / 1.183 / 3.932

$R = 2.749 = 561.$



$dx^2 + dy^2 = ds^2$



$x^2 + y^2 = r^2$

$2x\,dx + 2y\,dy = 0$

$dx = \frac{y\,dy}{x}$

$\frac{dx}{dy} = \frac{y}{x}$

$x = \sqrt{r^2 - y^2}$

$dx = \frac{y\,dy}{\sqrt{r^2-y^2}}$

$dx^2 = \frac{y^2dy^2}{r_2 - y^2}$

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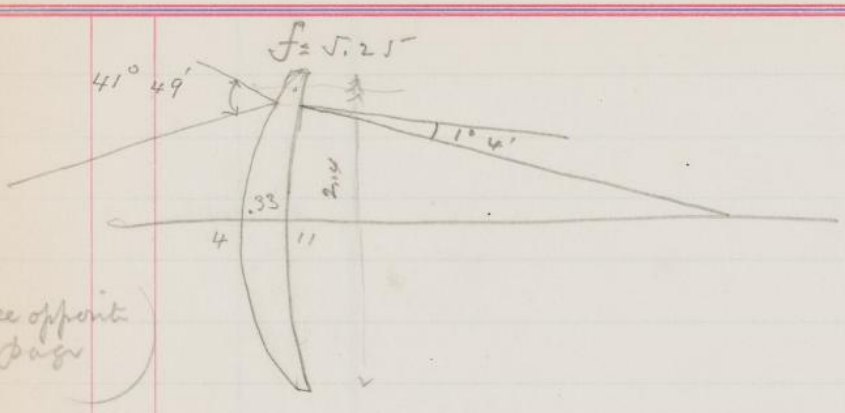
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Aim form of Eyepiece



Does not go through at angle of minimum deviation

See opposite page

$$\frac{1}{f} = (n-1)\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$$

$$\frac{1}{5.25} = 0.520\left(\frac{1}{r_1} - \frac{1}{\frac{11}{4}r_1}\right)$$

$$\left(\frac{1}{r_1} - \frac{\frac{4}{11}}{r_1}\right)$$

$$\left(\frac{\frac{7}{11}}{r_1}\right)$$

$$\frac{1}{5.25} = 0.520 \times \frac{\frac{7}{11}}{r_1}$$

$$r_1 = 5.25 \times 0.520 \times \frac{7}{11}$$

0.7202
9.7160
0.8451
1.2813
1.0414

$r_1 = 1.737 = 0.2399$

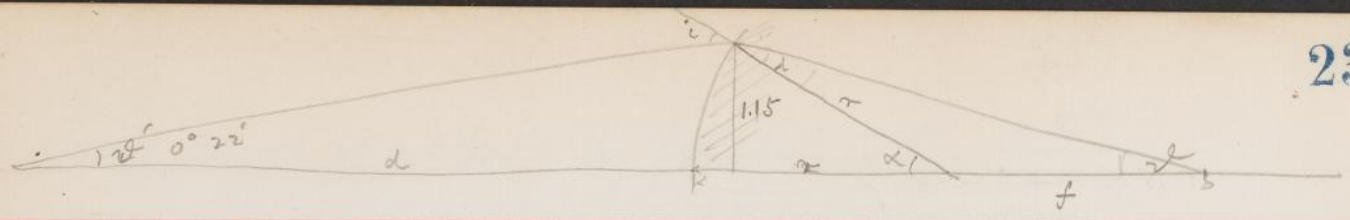
$r_2 = 4.777$

1.737
11
4 | 19.107
4.777

1737
1737
19.107
4.777

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$1.15 = 0.0607$ $\quad 0.0607$

$180. = 2,2553$ $\quad 1.737 = 0.2399$

$\alpha' = 0°\ 21'\ 58'' = \sin 7.8054$ $\quad \alpha = 41°\ 26'\ 50'' \sin 9,8298$

$41\ 26\ 50$

$i = 41\ 48\ 48 = \sin 9,8239$

$n = 1.520$ $\quad 0,1812$

$\lambda = 26°\ 1'\ 0'' = \sin 9.6421$

$\alpha = 41\ 26\ 50$ $\quad 0,2399$

$\alpha' = 15\ 25\ 50 = \sin 9.4250$ $\quad 9.8820$

$2,864 = 0.4570$

$s = 1.737$

$f_1 = 4.601$

$,33$

$\alpha_2 = 4.271$

$r_2 = 4.777$

$0,5506 = 9.7041$

$\alpha' = \sin 9.4250$

9.1291

$r = 4.777 = 0.6792$

$i = 1°\ 36'\ 53'' = \sin 8.4499$

$\alpha' = 15\ 25\ 50$ $\quad 0,1812$

$13\ 48\ 57$ $\quad 8.2681 = \sin\lambda$

$\lambda = 1\ 3\ 44$ $\quad 0.6792 = r$

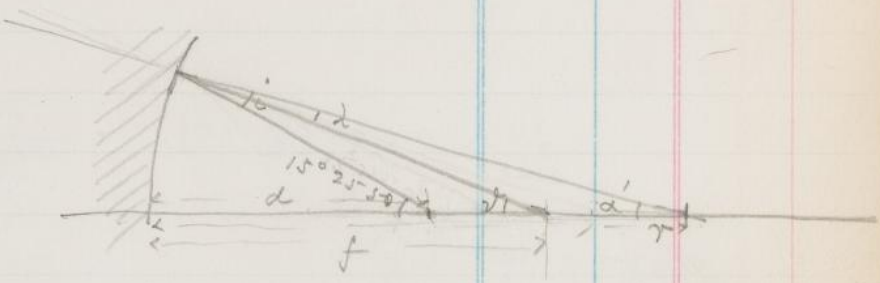
$\alpha = 14\ 52\ 41 = \sin$ $\quad 8.9473$

$r = 4.777$ $\quad 9.4091$

$,3450$ $\quad = 9.5378$

$f_2 = 4.432$

$\frac{\sin i}{\sin\lambda} = n \therefore \sin\lambda = \frac{\sin i}{n}$



$i = \alpha + \alpha'$

$\frac{f-r}{r} = \frac{\sin\lambda}{\sin\alpha}$

$f = \frac{r\sin\lambda}{\sin\alpha} + r$

$\frac{r-d}{r} = \frac{\sin i}{\sin\alpha}$

$\sin i = \frac{(r-d)\sin\alpha}{r}$

$\alpha' = \alpha - i$ $\quad \frac{\sin i}{\sin\lambda} = n$

$\alpha = \alpha' + \lambda$ $\quad \sin\lambda = \frac{\sin i}{n}$

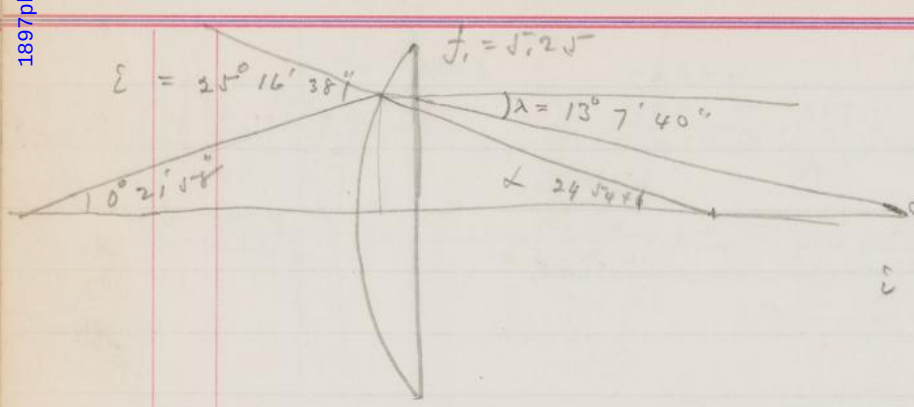
$\frac{r-f}{r} = \frac{\sin\lambda}{\sin\alpha}$

$r - f = \frac{r\sin\lambda}{\sin\alpha}$

$f = r - \frac{r\sin\lambda}{\sin\alpha}$

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$\alpha = 24° 54' 40''$ = sin = 9.6245
$10° 21' 58''$
$i = 25° 16' 38''$

1.15 = 0.0607
r_1 = 0.4362

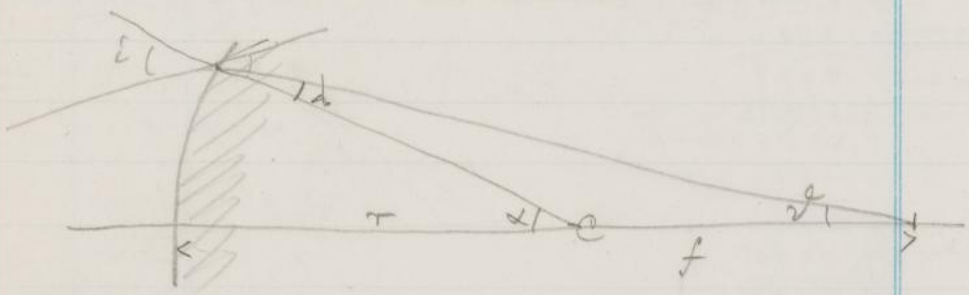
$$\frac{1}{5.25} = 0.520\left(\frac{1}{r_1} + 0\right)$$

$$\frac{1}{5.25} = \frac{0.520}{r_1}$$

$$r_1 = 5.25 \times 0.520$$

0.7202
9.7160
0.4362

$r_1 = 2.730$



$$\sin\lambda = -\frac{\sin i}{n}$$

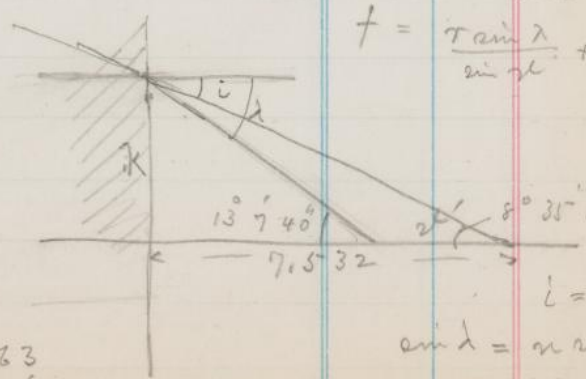
$i = 25° 16' 38''$ = sin 9.6304
n = 0.1815
$\lambda = 16° 19' 0''$ = sin 9.4486
$\alpha = 24\ 54\ 40$ r = 0.4362
$\nu = 8\ 35\ 40$ = sin 9.1745 = 0.8848
5.132 = 0.7103

$$\frac{f-r}{r} = \frac{\sin\lambda}{\sin\nu}$$

$$f - r = \frac{r\sin\lambda}{\sin\nu}$$

$$f = \frac{r\sin\lambda}{\sin\nu} + r$$

r = 2.730
f_1 = 7.862
.133
d_2 = 7.532



$i = \nu = 8° 35' 40''$ = sin 9.1745
0.1815
λ = 13 7 40 = sin 9.3563

$i = \nu$
$\sin\lambda = n\sin i$
$K = d\tan\nu$
$f = \frac{K}{\tan\lambda}$

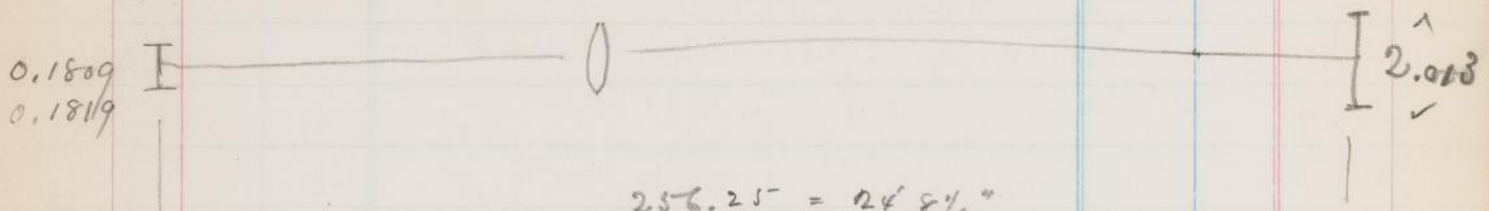
$d = 7.532$ = 0.8769
$\nu = 8° 35' 40''$ = tan 9.1794
13 7 40 0.0563

0.0563
9.3678
0.6885 = 4.881 = f_2

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Focal length of 2½ O.G. by formula - $f = \frac{dDA}{(d+D)^2}$



256.25" = 24' 8¼"

80 | 14.47
0.1809

$$f = \frac{dDA}{(d+D)^2}$$

d = 0.1809		=	9.25744
D = 2.0130		=	0.30384
2.1939 =	0.34122	A = 296.21' =	2.47166
	0.68244		2.03294
			0.68244
f = 22.418		=	1.35050

Repeated

d = 0.1819		=	9.25983
D = 2.0130		=	0.30384
2.1949 =	0.34141	A = 296.50 =	2.47202
	0.68282		2.03569
			0.68282
f = 22.536		=	1.35287

By transit of β Maw Majoris' = 22.549

$f = \frac{d \tan \phi}{\tan \phi'}$ $\tan \phi = k$ Repeated $D = 3.165$, $d = 0.28579$, $A = 296.50$ $f = 22.520$

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L. P. Howard — Alexander Bunce. challenge

Aug 23 1897.

	White H	White B	Aug 26. challenge H	Aug 26. challenge B	Aug 27 H	Aug 27 B
1	7	5 •	• 4	7	• 5	8
2	3	3	4	4	5	5
3	• 4	5	8	8	low ball 3 strikes 5	5 •
4	10	8 •	• 7	12	12	8 •
5	• 5	6	• 5	8	• 5	7
6	• 6	8	• 5	6	6	6
7	8	6 •	7	5 •	6	6
8	4	3 •	5	4 •	• 3	4
9	• 5	6	8	6 •	5	4 •
	52	50	53	60	52	53
Holiz	Tied		H 1 up		Tied	
	Red					
10	• 5	7	6	5 •	6	6
11	4	4	• 5	9	5	5
12	10	8 •	9	6 •	7	7
13	• 6	9	7	6 •	• 5	6
14	9	9	9	7 •	• 5	9
15	9	8 •	• 9	11	• 6	12
16	5	5	7	7	7	4 •
17	5	5	4	4	• 4	5
18	6	6	7	6 •	8	6 •
	59	61	63	61	53	60
Holiz	Tied		B 3 up		H 2 up	
	111	111	116	121	105	113

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b. P. H. Ed. Horker v. Challenge. -

Aug 25th

White	
5-	7
5-	6
4	4
10	10
8	9
6	6
7	6
5-	5-
5-	11
53-	64

Horrnd 3 up.

2nd round.

White	
5-	6
5-	4
4	6
11	8
9	11
7	6
5-	7
4	9
5-	6
53-	63

Horrnd 3 up.

b. P. H. A. Welch Challenge

Sept 10th

H.	W.
8	7
5-	6
3	4
10	7
5-	7
6	5-
6	6
5-	5-
5-	8
53-	53-

H = 1 up

6	6
6	5-
7	8
7	12
7	7
lost 7	7
5-	6
4	5-
6	lost 6
53	62

H = 3 up

108

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α Persei - 1.9 Mags
β " 2.3 "
ε " 3.0 "
δ " 3.1 "

Aug 8th 97 - Clyclonic 1000 -
Nov 13 98 " 1000 -

New Star in Perseus - Discovered Feb 21 by Anderson C.R.H. saw it at 11.25 p.m. Feb 22 in N. W. without knowing it was new. Moonlight prevented its identification by the smaller stars

Friday 22 About as bright as Capella - and same color, think it was a mere shade less bright - white. Thought it might be α Lyncis from appearance, but could not find small stars.

Saturday 23 Cloudy

Sunday 24 Look at it through telescope. color white, hardly perceptibly less white than Sirius & Rigel - Betelgeuse was deep orange in comparison - no bright lines - spectrum from Rigel to Antares. Slightly less brilliant than Capella

Mon 25 Less brilliant. (decidedly), about half way between Capella & Pole Star - did not look through tel,

Tues 26 Little less brilliant than last night. reddish color - rather more so than Aldebaran -

Wonderful bright line spectrum (prism held in hand) Red line brighter than blue (hydrogen) brilliant yellow line (helium?) 2 brilliant green lines violet line (hyd). each line had a dark shade towards violet - each line was very broad, bright lines + shading in violet 2 lines in orange between red + yellow) very plain but not nearly as much so as this.

Wed 27 Only about as bright as α Persei could hardly tell which was the brighter. Reddish Spectrum same as last night but not as brilliant + could not see any dark lines

Thurs. 28 Brighter. Distinctly brighter than α Persei, same as Castor Reddish. Spectrum as brilliant as on 26th much more so than last night Dark lines - Pleiades - many bright + dark lines - but not as brilliant as on 26th

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Fri. March 1. Decidedly fainter than α, about like Algol brighter than ε. Seen through broken clouds which stay nearly full Moon -

Saturday March 2. Brightness ½ Half way between α and β Persei - sky clear

Sunday " 3. Cloudy

Monday " 4. "

Tuesday " 5. "

Wednesday " 6. Clear. Much fainter than on 2nd inst - some risk as δ and γ Persei - shade brighter if either may - could not say positively that it was brighter. Spectrum same as on 28th ult. Red line seemed brighter in relation to others but could not be sure it really was brighter -

Thursday 7th 6.30pm. Brighter than β but not as bright as ε, considerably brighter than δ and γ - 9.00 - 9.30 Light at min -
Red ground stronger in proportion - very strong in focus of both telescopes - With prism - red line very strong - yellow fainter - Black line near yellow.

Cloudy every night until

Saturday 16th Half way between ν and σ²

Sunday 17th Cloudy

Monday 18th "Opaque" sky. Shade fainter than ν
Through telescope surrounded by strong ordinary rings -
Commences to look like ruby star
With prism red line very strong with dark shade towards violet -
green lines seemed relatively fainter -

Tuesday 19th Much fainter than last night could only just glimpse it while ν was plain as ever

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