
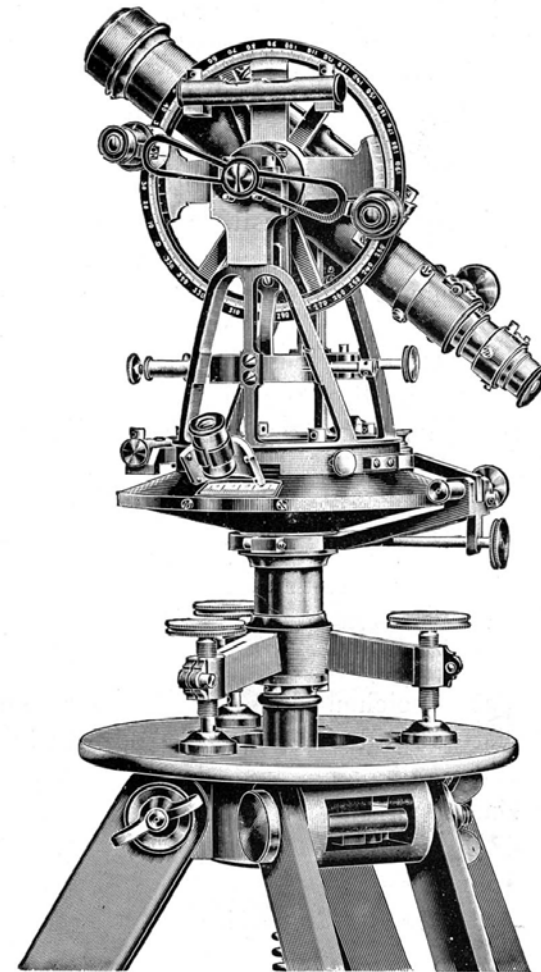
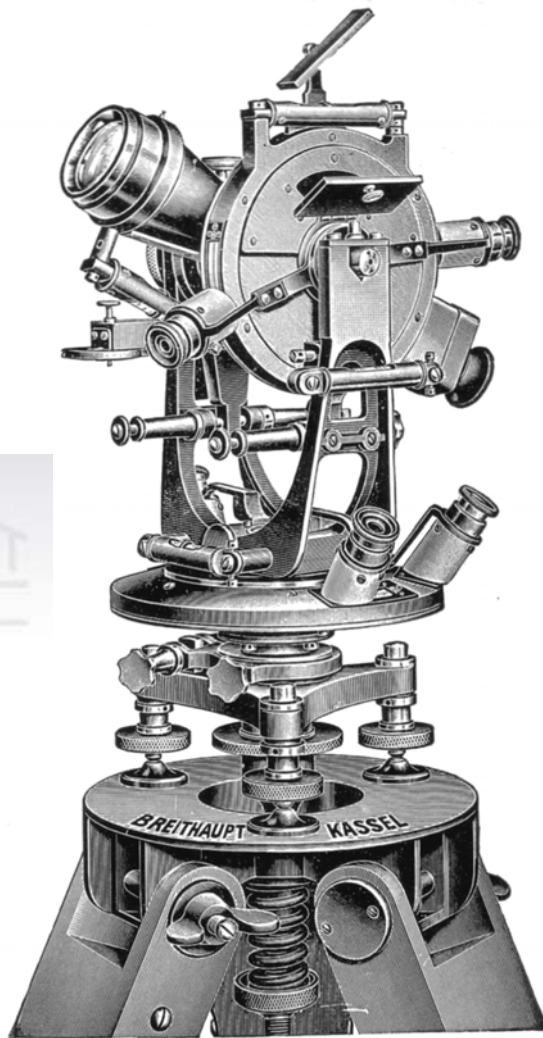


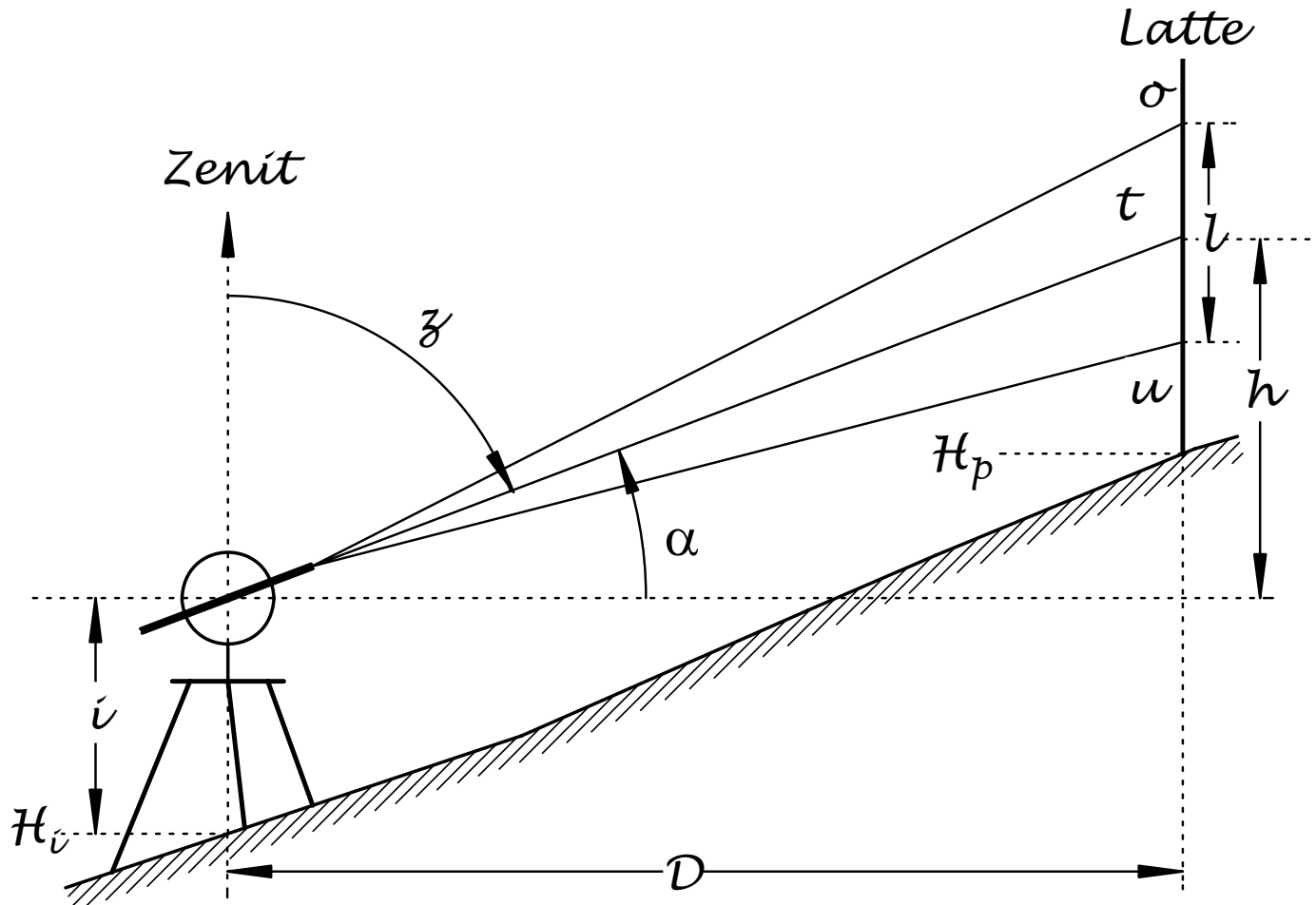


# Historische geodätische Rechenhilfsmittel bei der Tachymetrie -Ein Überblick-

- 
- Einleitung
  - Grafische Rechenhilfsmittel
  - Tabellarische Rechenhilfsmittel
  - Mechanische Rechenhilfsmittel
  - Tachymetrische Aufnahmen
  - Logarithmische Rechenmaschinen
  - Tachymetrie gestern und heute



# Tachymetrische Instrumente (1910/20)



# Messprinzip



$$D = G \cdot \cos^2 \alpha$$

Horizontaldistanz

$$h = G \cdot \sin \alpha \cdot \cos \alpha = G \cdot \frac{1}{2} \sin(2\alpha)$$

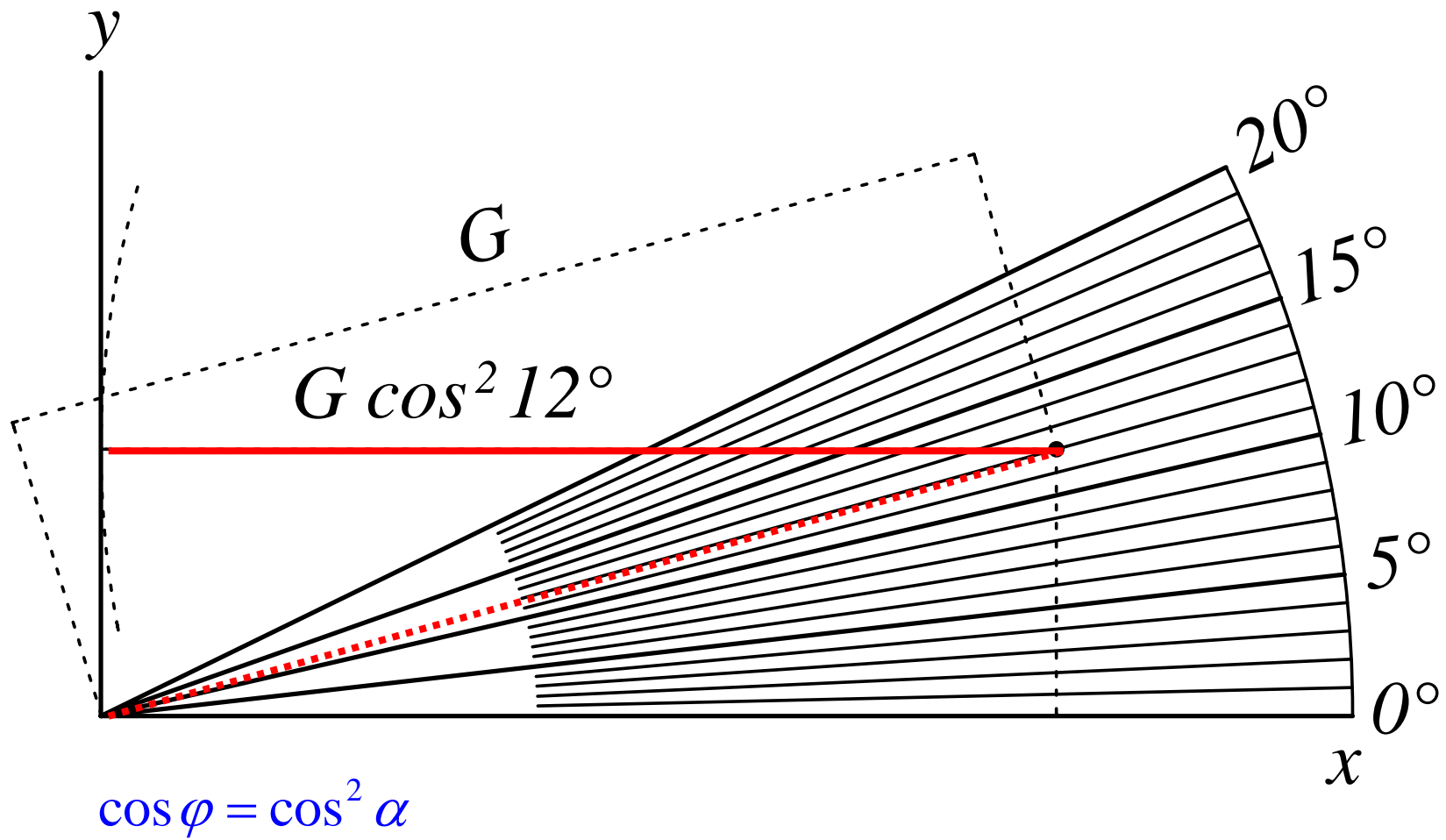
Höhenunterschied

$$G = k \cdot l \quad \text{oder} \quad G = c + k \cdot l$$

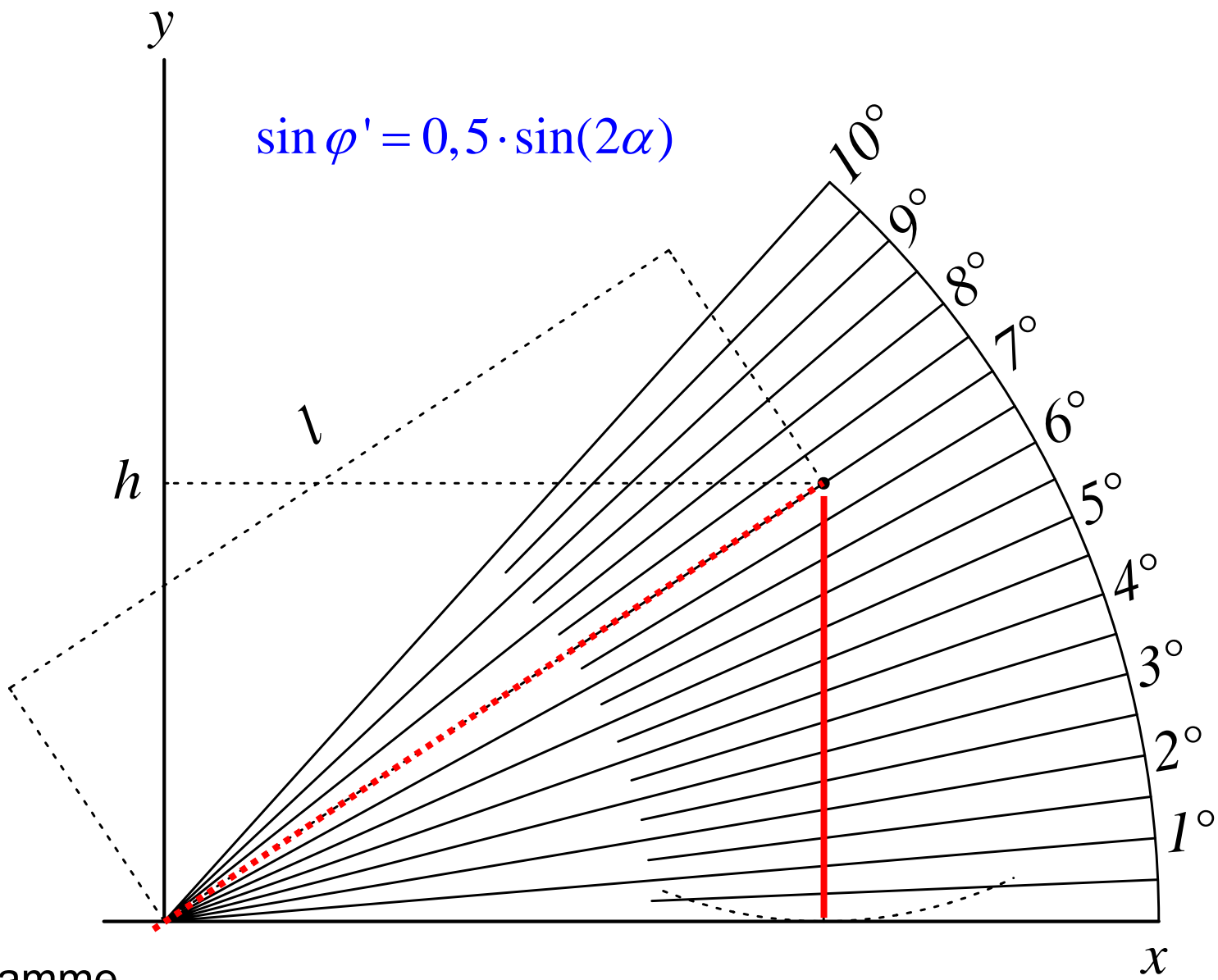
Fernrohrkonstanten

$$H_p = H_i + i - t + h$$

Höhe



$$\cos \varphi = \cos^2 \alpha$$

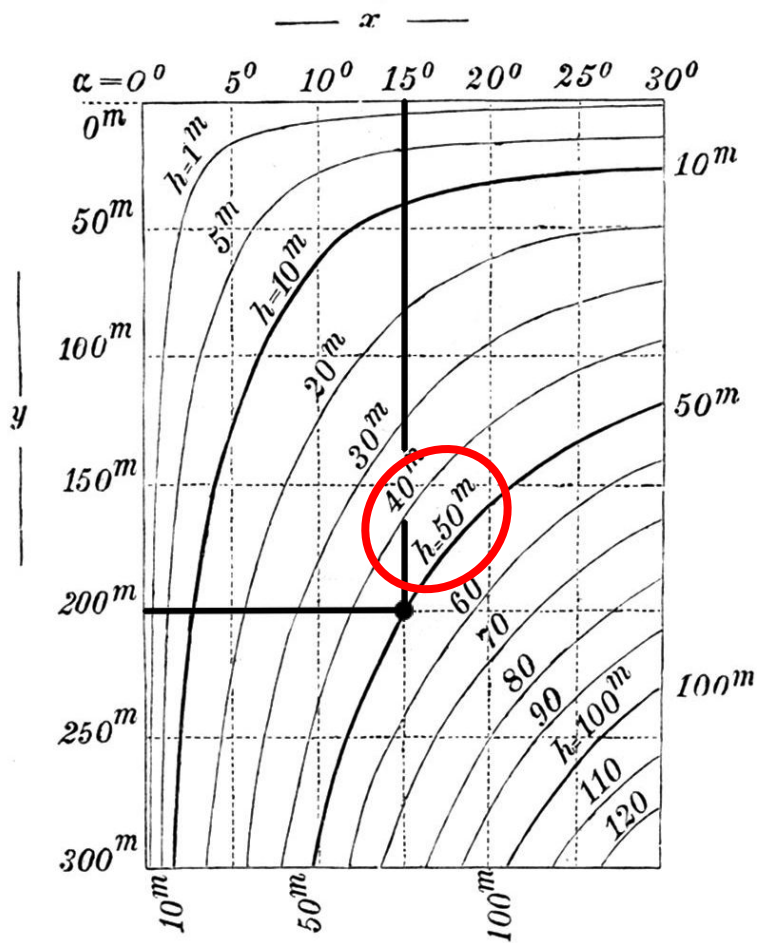


Nomogramme

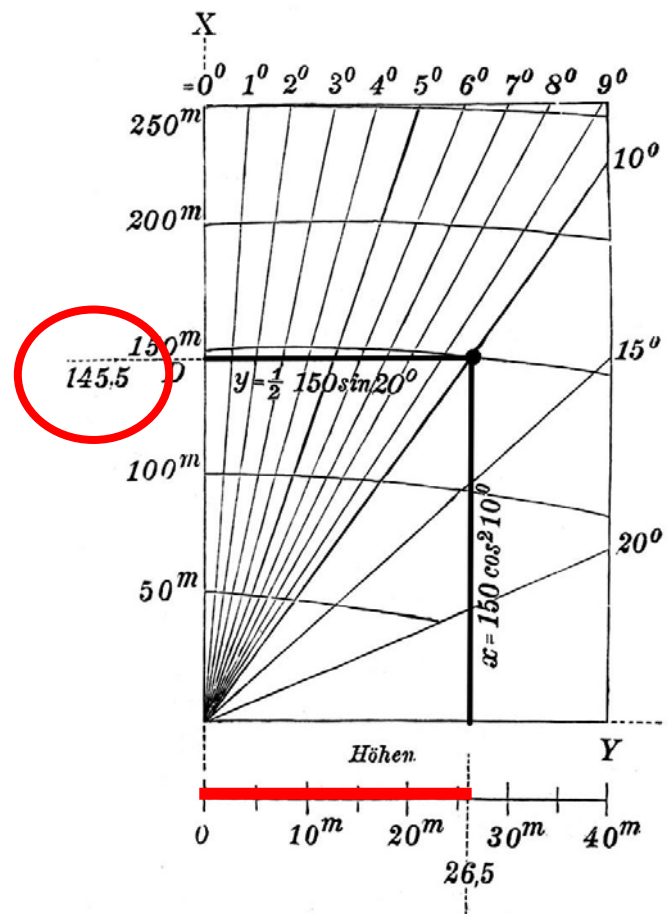


$\Delta h$

D,  $\Delta h$



Vogler (~1877)



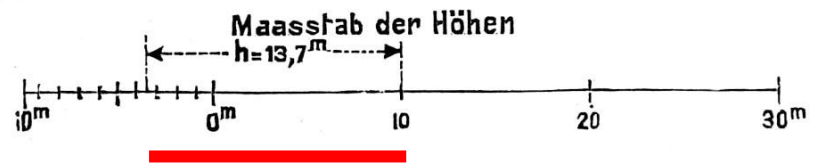
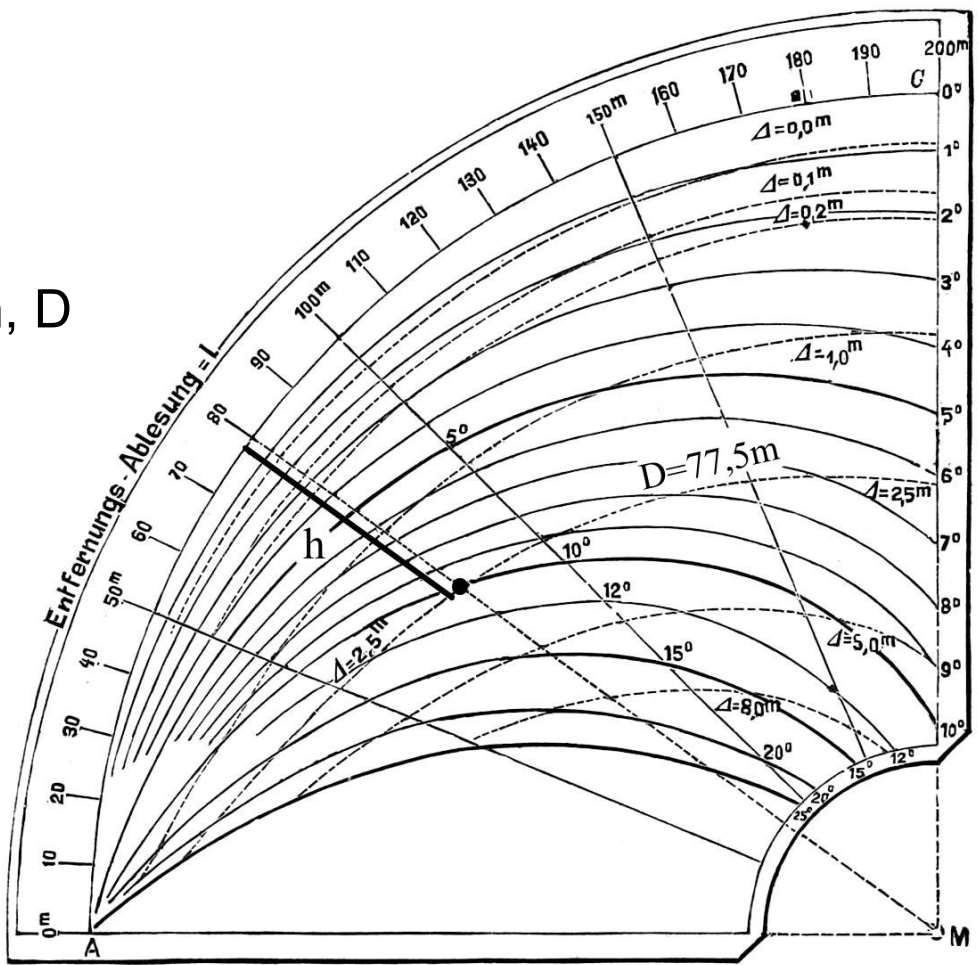
Teischinger (~1884)

# Nomogramme





$\Delta h, D$

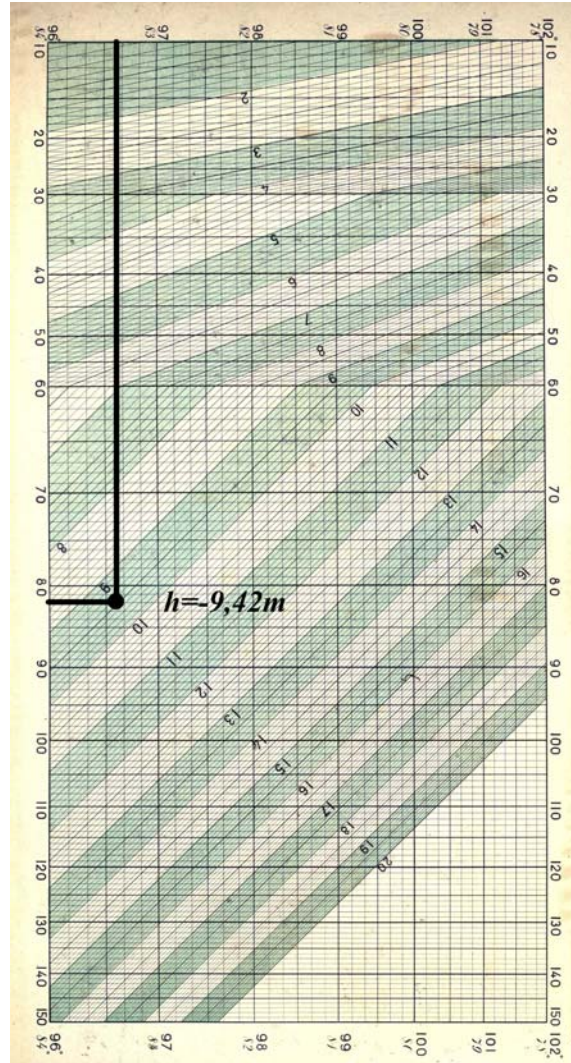
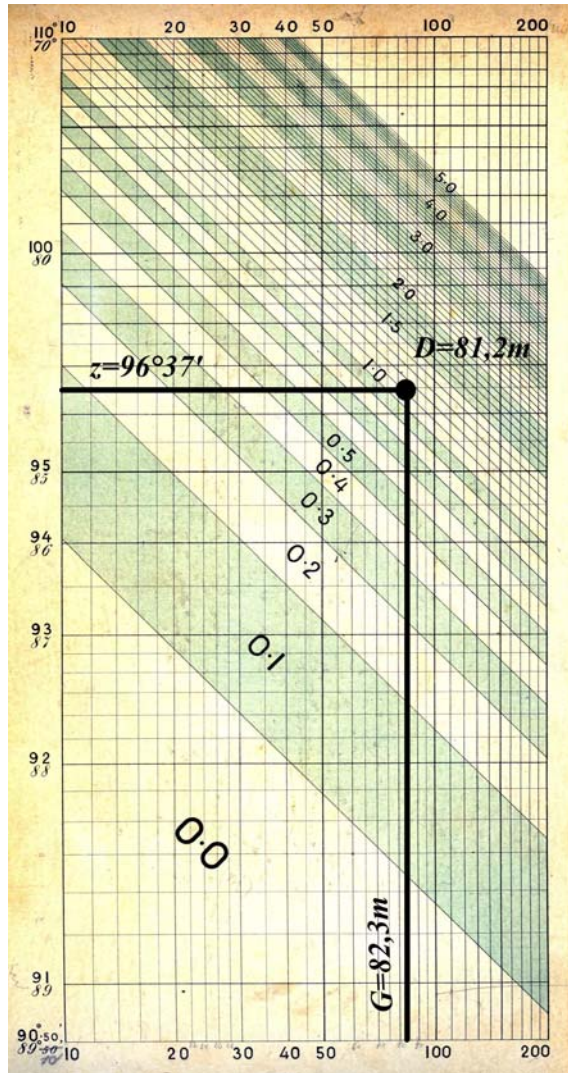


Puller (~1890)

# Nomogramme

D

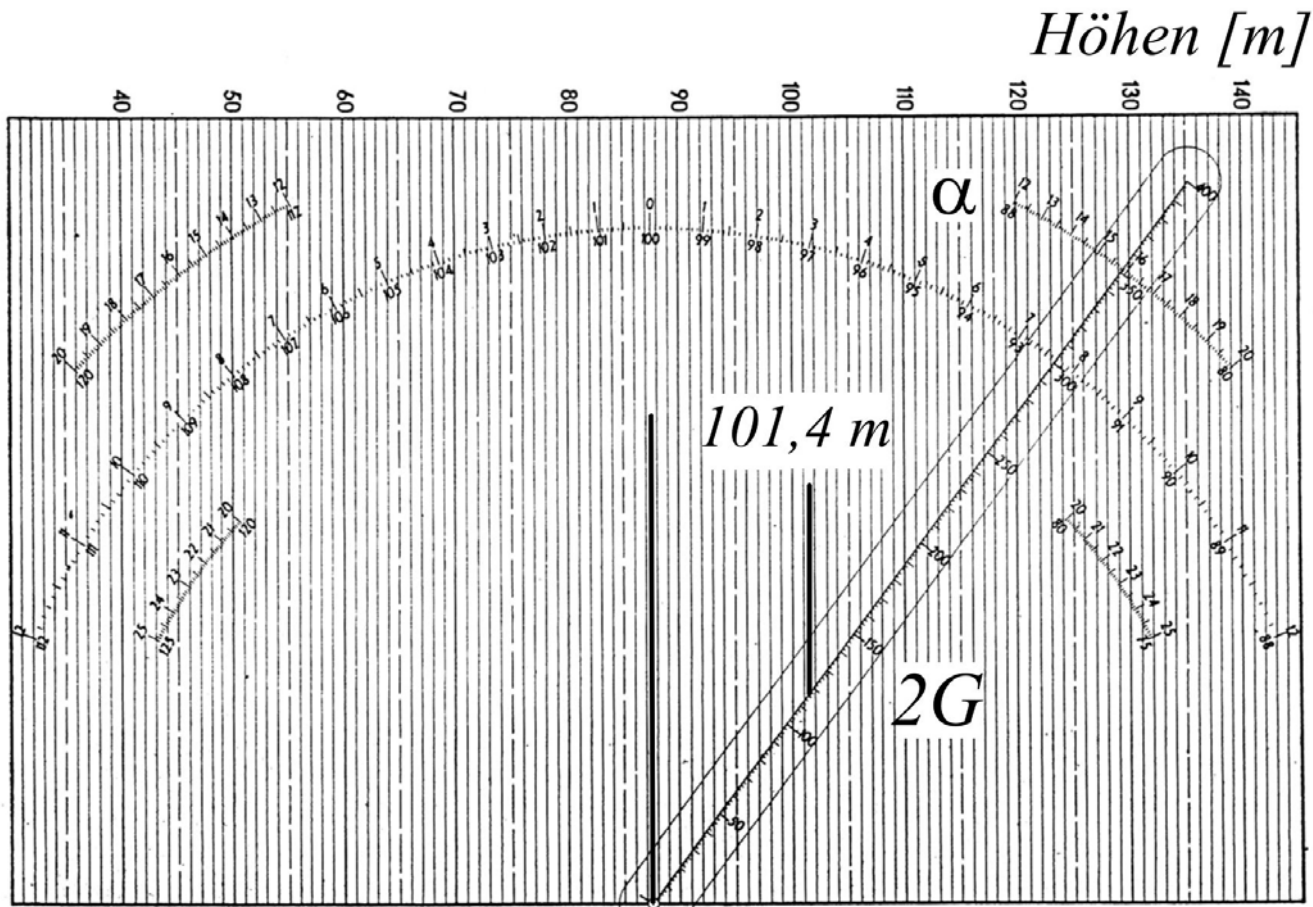
$\Delta h$



Wenner (~1905)

# Nomogramme

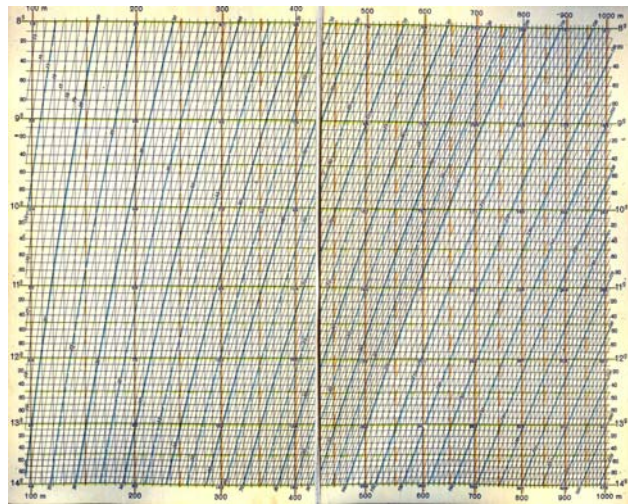




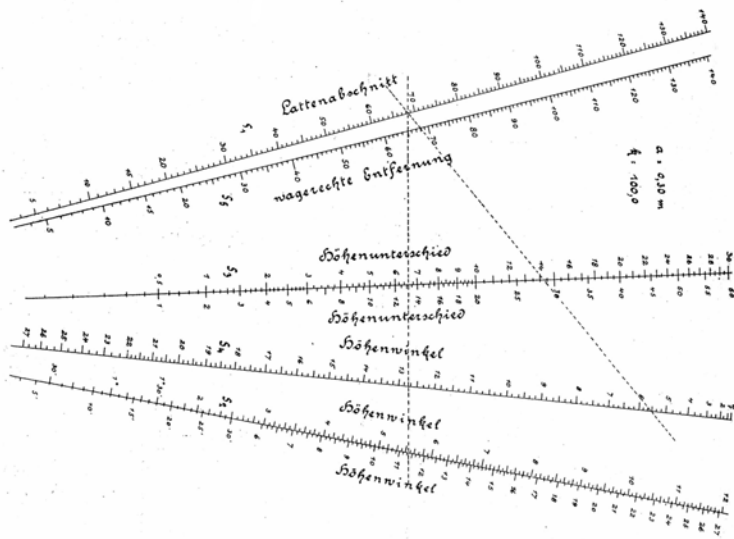
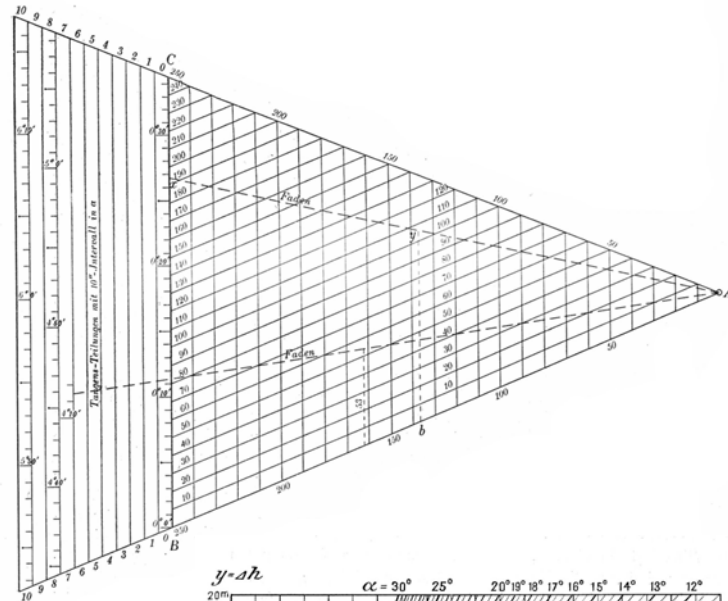
$\alpha = 15,87 \text{ gon}$   
 $G = 58 \text{ m}$

Standpunkthöhe 87,5 m

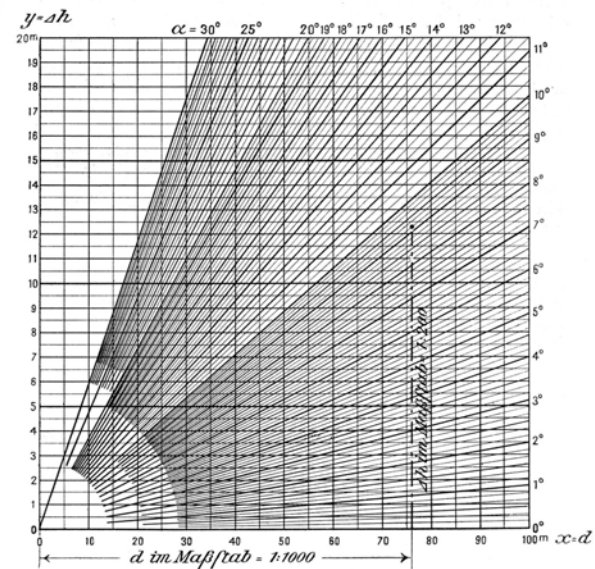
Trutwin (~1953)



Masstab 1 : 3.



Figur 2



# Nomogramme

250 ( $\frac{1}{2} \sin 2\alpha$ )

$\alpha$	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	250 $\cos^2\alpha$		
0'	0.00	4.36	8.72	13.07	17.40	21.71	25.99	30.24	34.45	38.63			
1'	0.07	4.44	8.79	13.14	17.47	21.78	26.06	30.31	34.52	38.70			
2'	0.15	4.51	8.86	13.21	17.54	21.85	26.13	30.38	34.59	38.77			
3'	0.22	4.58	8.94	13.28	17.61	21.92	26.20	30.45	34.66	38.83			
4'	0.29	4.65	9.01	13.36	17.68	21.99	26.27	30.52	34.73	38.90			
5'	0.36	4.73	9.08	13.43	17.76	22.06	26.34	30.59	34.80	38.97	0°	250.0	
6'	0.44	4.80	9.16	13.50	17.83	22.14	26.42	30.66	34.87	39.04	0° 30'	250.0	
7'	0.51	4.87	9.23	13.57	17.91	22.21	26.49	30.73	34.94	39.11	1°	249.9	
8'	0.58	4.94	9.30	13.64	17.97	22.28	26.56	30.80	35.01	39.18	1° 30'	249.8	
9'	0.65	5.02	9.37	13.72	18.04	22.35	26.63	30.88	35.08	39.25			
10'	0.73	5.09	9.44	13.79	18.12	22.42	26.70	30.95	35.15	39.32	2°	249.7	
11'	0.80	5.16	9.52	13.86	18.19	22.49	26.77	31.02	35.22	39.39	2° 30'	249.5	
12'	0.87	5.23	9.59	13.93	18.26	22.56	26.84	31.09	35.29	39.46			
13'	0.95	5.31	9.66	14.01	18.33	22.64	26.91	31.16	35.36	39.53			
14'	1.02	5.38	9.73	14.08	18.40	22.71	26.98	31.23	35.43	39.59	3°	249.3	
15'	1.09	5.45	9.81	14.15	18.48	22.78	27.06	31.30	35.50	39.66	3° 30'	249.1	
16'	1.16	5.53	9.88	14.22	18.55	22.85	27.13	31.37	35.57	39.73			
17'	1.24	5.60	9.95	14.29	18.62	22.92	27.20	31.44	35.64	39.80	4°	248.8	
18'	1.31	5.67	10.02	14.37	18.69	22.99	27.27	31.51	35.71	39.87	4° 30'	248.5	
19'	1.38	5.74	10.10	14.44	18.76	23.07	27.34	31.58	35.78	39.94			
20'	1.45	5.82	10.17	14.51	18.84	23.14	27.41	31.65	35.85	40.01	5°	248.1	
21'	1.53	5.89	10.24	14.58	18.91	23.21	27.48	31.72	35.92	40.08	5° 20'	247.8	
22'	1.60	5.96	10.31	14.66	18.98	23.28	27.55	31.79	35.99	40.15	5° 40'	247.6	
23'	1.67	6.03	10.39	14.73	19.05	23.35	27.62	31.86	36.06	40.21			
24'	1.74	6.11	10.46	14.80	19.12	23.42	27.69	31.93	36.13	40.28			
25'	$G = 250 \text{ m}, \alpha = 5^\circ 20'$  $D = 247,8 \text{ m}, h = 23,14 \text{ m}$												
26'													
27'													
28'													
29'													
30'													
31'													
32'													
33'													
34'													
35'	2.02	6.31	11.20	15.08	19.19	23.51	27.76	32.00	36.20	40.35	6°	247.3	
36'	2.02	6.31	11.20	15.08	19.19	23.51	27.76	32.00	36.20	40.35	6° 20'	247.0	
37'	2.09	6.38	11.27	15.15	19.26	23.58	27.83	32.07	36.27	40.42	6° 40'	246.6	
38'	2.16	6.45	11.34	15.22	19.33	23.65	27.90	32.14	36.34	40.49	7°	246.3	
39'	2.24	6.52	11.41	15.29	19.40	23.72	27.97	32.21	36.41	40.56	7° 20'	245.9	
40'	2.31	6.59	11.48	15.36	19.47	23.79	28.04	32.28	36.48	40.63	7° 40'	245.6	
41'	2.38	6.66	11.55	15.43	19.54	23.86	28.11	32.35	36.55	40.70			
42'	2.45	6.73	11.62	15.50	19.61	23.93	28.18	32.42	36.62	40.77	8°	245.2	
43'	2.52	6.80	11.69	15.57	19.68	24.00	28.25	32.49	36.69	40.84	8° 20'	244.7	
44'	2.59	6.87	11.76	15.64	19.75	24.07	28.32	32.56	36.76	40.91	8° 40'	244.3	
45'	2.66	6.94	11.83	15.71	19.82	24.14	28.39	32.63	36.83	40.98			
46'	2.73	7.01	11.90	15.78	19.89	24.21	28.46	32.70	36.90	41.05	9°	243.9	
47'	2.80	7.08	11.97	15.85	19.96	24.28	28.53	32.77	36.97	41.12	9° 20'	243.4	
48'	2.87	7.15	12.04	15.92	20.03	24.35	28.60	32.84	37.04	41.19	9° 40'	243.0	
49'	2.94	7.22	12.11	15.99	20.10	24.42	28.67	32.91	37.11	41.26			
50'	3.01	7.29	12.18	16.06	20.17	24.49	28.74	32.98	37.18	41.33			
40'	2.91	7.27	11.62	15.96	20.27	24.56	28.83	33.05	37.24	41.38	10°	242.5	
41'	2.98	7.34	11.69	16.03	20.34	24.64	28.90	33.12	37.31	41.45			
42'	3.05	7.41	11.76	16.10	20.42	24.71	28.96	33.19	37.38	41.52			
43'	3.13	7.49	11.84	16.17	20.49	24.78	29.04	33.26	37.45	41.59			

1. Auflage 1880  
Vorlage 1939

Tafel nach Jordan



400 g

z	$\alpha$ z	100 cos <sup>2</sup> α	d	50 sin 2 α	d	z	$\alpha$ z	100 cos <sup>2</sup> α	d	50 sin 2 α	d
100 00	0 0	100.00	0	00.00	16	95 00	5 0	99.38	2	7.82	16
99 90	100 10	100.00	0	0.16	15	94 90	105 10	99.36	3	7.98	15
80	20	100.00	0	0.31	16	80	20	99.33	2	8.13	16
70	30	100.00	0	0.47	16	70	30	99.31	3	8.29	15
60	40	100.00	1	0.63	16	60	40	99.28	2	8.44	16
50	50	99.99	0	0.79	15	50	50	99.26	3	8.60	15
40	60	99.99	0	0.94	16	40	60	99.23	3	8.75	16
30	70	99.99	1	1.10	16	30	70	99.20	3	8.91	15
20	80	99.98	0	1.26	15	20	80	99.17	3	9.06	15
10	90	99.98	0	1.41	16	10	90	99.14	3	9.21	16
0	1 0	99.98	1	1.57	16	0	6 0	99.11	3	9.37	15
98 90	101 10	99.97	1	1.73	15	93 90	106 10	99.08	3	9.52	16
80	20	99.96	1	1.88	15	80	20	99.05	3	9.68	16
70	30	99.94	1	2.03	16	70	30	99.02	4	9.83	15
60	40	99.91	1	2.17	16	60	40	98.99	3	9.98	16
50	50	99.87	1	2.31	16	50	50	98.95	4	10.13	15
40	60	99.82	1	2.44	16	40	60	98.91	4	10.28	16
30	70	99.77	1	2.57	15	30	70	98.87	3	10.43	15
20	80	99.71	1	2.69	16	20	80	98.83	3	10.58	16
10	90	99.65	1	2.81	16	10	90	98.79	3	10.73	16
0	100 0	99.58	1	2.92	16	0	100 0	98.75	3	10.88	16
97 90	102 10	99.51	1	3.03	15	92 90	107 10	98.71	3	11.06	15
80	20	99.44	1	3.14	16	80	20	98.67	3	11.21	16
70	30	99.37	1	3.25	16	70	30	98.63	5	11.37	15
60	40	99.30	1	3.36	15	60	40	98.59	3	11.52	15
50	50	99.23	2	3.47	16	50	50	98.55	4	11.67	15
40	60	99.16	1	3.58	16	40	60	98.51	4	11.82	16
30	70	99.09	1	3.69	15	30	70	98.47	3	11.98	15
20	80	99.02	1	3.80	16	20	80	98.43	3	12.13	16



$l = 0,874, z = 94,50 \text{ gon}$   
 $D = 0,874 \times 99,26 = 86,75 \text{ m}$   
 $h = 0,874 \times 8,60 = 7,52 \text{ m}$

Tafel nach Prokes (~1938)

x100 x10



3  
G. cos<sup>2</sup> α

3  
G. sin α cos α

α	1	2	3	4	5	6	7	8	9
3,00	0,99773	1,99556	2,99334	3,99112	4,98890	5,98667	6,98445	7,98222	8,98000
02	75	550	325	100	88	65	42	20	8,9797
04	72	544	316	088	86	63	40	18	95
06	69	538	307	076	84	61	38	15	92
08	66	532	298	064	83	60	36	13	89
10	63	526	289	052	81	58	34	10	87
12	60	520	280	040	80	56	32	08	84
14	57	514	271	028	78	54	30	06	81
16	54	508	262	016	77	52	28	03	79
18	51	502	253	3,99004	75	51	26	7,9801	76
20	48	496	244	3,98992	74	49	24	7,9798	73
22	44	488	232	976	72	46	21	95	70
24	41	482	223	964	70	45	19	93	67
26	38	476	214	952	69	43	17	90	64
28	35	470	205	940	67	41	14	88	61
30	32	464	196	928	66	39	12	86	59
32	28	456	184	912	64	37	10	82	55
34	25	450	175	900	62	35	07	80	52
36	22	444	166	888	60	33	05	78	49
38	18	436	156	876	58	31	03	76	46
40	15	430	146	864	56	29	01	74	43
42	12	424	136	852	54	27	00	72	40
44	08	416	126	840	52	25	00	70	37
46	05	410	116	828	50	23	00	68	34
48	0,99701	402	106	816	48	21	00	66	31
50	0,99598	396	96	804	46	19	00	64	28
52	95	390	86	792	44	17	00	62	25
54	91	382	76	780	42	15	00	60	22
56	88	376	66	768	40	13	00	58	19
58	84	368	56	756	38	11	00	56	16
60	81	362	46	744	36	09	00	54	13
62	77	354	36	732	34	07	00	52	10
64	73	346	26	720	32	05	00	50	07
66	70	340	16	708	30	03	00	48	04
68	66	332	06	696	28	01	00	46	01
70	63	326	00	684	26	00	00	44	00
72	59	318	977	672	24	95	61	27	03
74	55	310	965	660	22	93	58	24	89
76	52	304	956	648	20	91	56	22	87

α	1	2	3	4	5	6	7	8	9
3,00	0,04705	0,09410	0,14115	0,18820	0,23525	0,28230	0,32935	0,37640	0,42345
02	737	474	211	0,18948	368	842	316	790	263
04	768	536	304	0,19072	384	861	338	814	291
06	799	598	397	196	399	879	359	830	319
08	831	662	493	324	415	899	382	865	349
10	862	724	586	448	431	917	403	890	376
12	893	786	679	572	446	936	425	914	404
14	924	848	772	696	462	954	447	939	432
16	956	912	868	824	478	974	469	965	460
18	0,04987	0,09974	0,14961	0,19948	493	0,2992	491	0,3990	488
20	0,05018	0,10036	0,15054	0,20072	509	0,3011	513	0,4014	516
22	049	098	147	196	524	029	534	030	544
24	081	162	243	324	540	049	557	065	573
26	112	224	336	448	556	067	578	090	601
28	143	286	429	572	571	086	600	114	629
30	174	348	522	696	587	104	622	139	657
32	206	412	618	824	603	124	644	165	685
34	237	474	711	0,20948	618	142	666	190	713
36	268	536	804	634	161	161	688	214	741
38	299	598	897	649	179	179	709	239	769
40	330	662	993	665	199	199	732	265	798
42	361	724	1086	681	217	217	753	290	826
44	392	786	1179	696	236	236	775	314	854
46	423	848	1272	712	254	254	797	339	882
48	454	912	1365	727	273	273	819	364	909
50	485	974	1458	743	292	292	841	390	938
52	516	1036	1551	759	311	311	863	414	966
54	547	1098	1644	774	329	329	884	439	0,4094
56	578	1160	1737	790	348	348	906	464	0,5022
58	609	1222	1830	806	367	367	928	490	051
60	640	1284	1923	822	386	386	950	514	079
62	671	1346	2016	837	404	404	972	539	107
64	702	1408	2109	852	423	0,3993	564	564	134
66	733	1470	2202	868	442	0,4015	589	589	162
68	764	1532	2295	884	461	028	614	614	191
70	795	1594	2388	899	479	059	639	639	219
72	826	1656	2481	915	498	081	664	664	247
74	857	1718	2574	930	517	103	689	689	275
76	888	1780	2667	946	535	124	714	714	303

$G = 125 \text{ m}, \alpha = 3,30 \text{ gon}$   
 $100 \dots = 99,732 \qquad 5,174$   
 $20 \dots = 19,946 \qquad 1,035$   
 $5 \dots = 4,987 \qquad 0,259$   


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 $D = 124,665 \text{ m} \quad h = 6,468 \text{ m}$



Tafel nach Jadanza-Hammer (~1909)

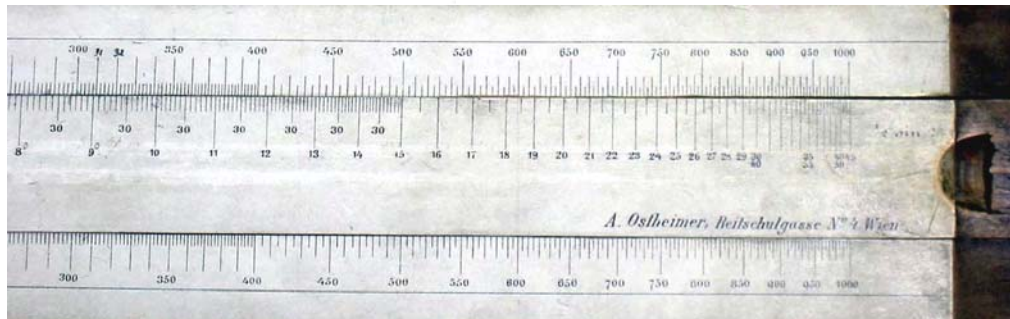
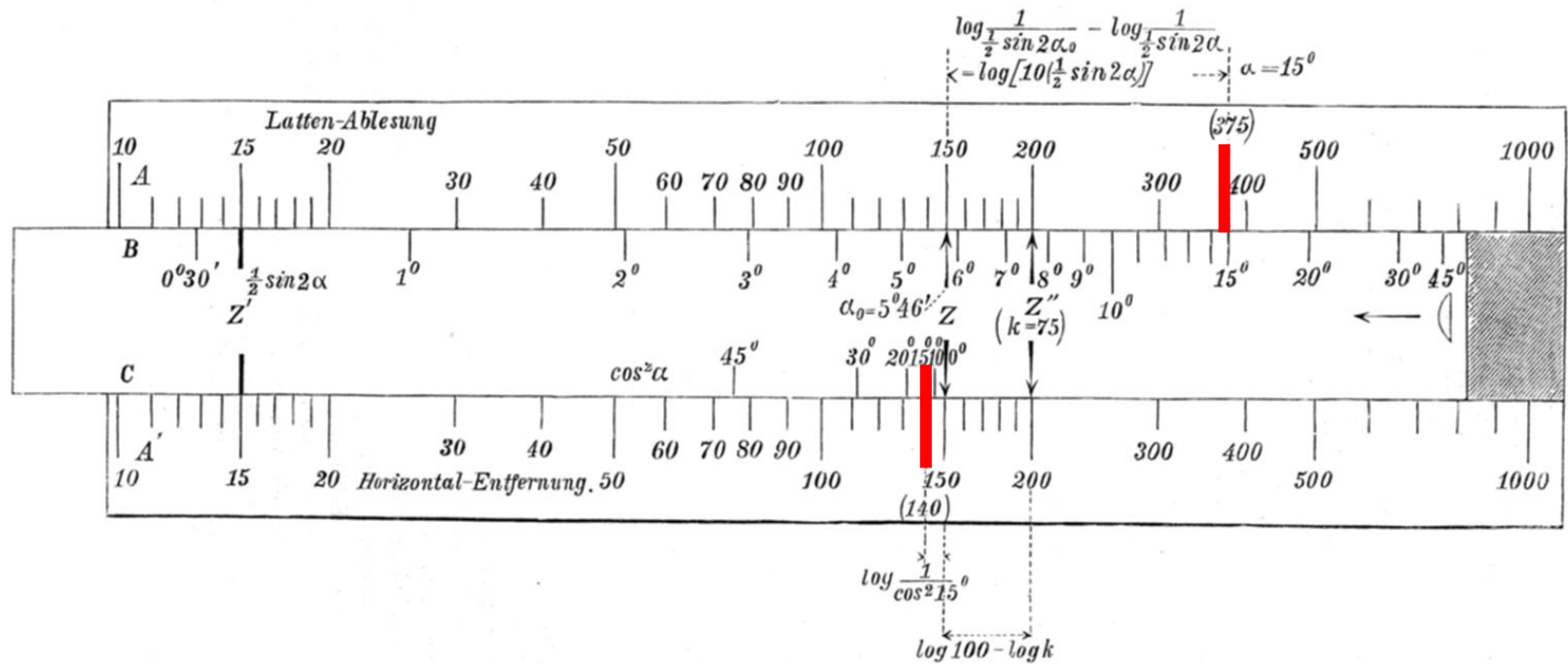


A				$z = 100^{\circ} \dots 95^{\circ}$				$z = 95^{\circ} \dots 90^{\circ}$						
z	S	d	H d	$\beta$	z	S	d	H d	$\beta$					
100,0	100,00		0,00	0,0	95,0	99,38		7,82	5,0			16		
99,9	100,00	0	0,16	16	94,9	99,36	2	7,98	16	1 <sup>c</sup>	2			
8	100,00	0	0,31	15	8	99,33	3	8,13	15	2	3			
7	100,00	0	0,47	16	7	99,31	2	8,29	16	3	5			
6	100,00	0	0,63	16	6	99,28	3	8,44	15	4	6			
5	99,99	1	0,79	16	5	99,26	2	8,60	16	5	8			
4	99,99	0	0,94	15	4	99,23	3	8,75	15	6	10			
3	99,99	0	1,10	16	3	99,20	3	8,91	15	7	11			
2	99,98	1	1,26	16	2	99,17	3	9,06	15	8	13			
1	99,98	0	1,41	15	1	99,14	3	9,21	15	5,9	14			
	99,98	0	1,57	16		99,11	3	9,37	16					
99,0	99,98		1,73	16	94,0	99,08	3	9,52	15	6,0				
98,9	99,97	1	1,88	15	93,9	99,05	3	9,68	16	1				
8	99,96	0	2,04	16	8	99,02	3	9,83	15	2				
7	99,96	0			7					3				
6	99,95	1								4			15	
5	99,94	1								5				
4	99,94	1								6				
3	99,93	1								7				
2	99,92	1								8				
1	99,91	1								9				
	99,90	1								10				
98,0	99,90									11				
97,9	99,89	1								12				
8	99,88	1								13				
7	99,87	1	3,61	16	3	98,69	4	11,37	16	6,9	4	6	8	9
6	99,86	1	3,77	16	4	98,65	4	11,52	15	7,0	1	2	3	4
5	99,85	1	3,92	15	5	98,62	3	11,67	15	1	3	4	5	6
4	99,83	2	4,08	16	6	98,58	4	11,82	15	2	4	5	6	7
3	99,82	1	4,24	16	7	98,54	4	11,98	16	3	5	6	7	8
2	99,81	1	4,39	15	8	98,51	3	12,13	15	4	6	7	8	9
1	99,79	2	4,55	16	2,9	98,47	4	12,28	15	5	7	8	9	10
	99,78	1	4,71	16		98,43	4	12,43	15	6	8	9	10	11
97,0	99,78		4,86	16	3,0	92,0	98,43	12,43	8,0	7	8	9	10	11
96,9	99,76	2	5,02	16	1	91,9	98,39	12,59	16	1	2	3	4	5
8	99,75	1	5,17	15	2	8	98,35	12,74	15	2	3	4	5	6
7	99,73	2	5,33	16	3	7	98,31	12,89	15	3	4	5	6	7
6	99,72	1	5,49	16	4	6	98,27	13,04	15	4	5	6	7	8
5	99,70	2	5,64	15	5	5	98,23	13,19	15	5	6	7	8	9
4	99,68	2	5,80	16	6	4	98,19	13,35	16	6	7	8	9	10
3	99,66	2	5,95	15	7	3	98,14	13,50	15	7	8	9	10	11
2	99,64	1	6,11	16	8	2	98,10	13,65	15	8	9	10	11	12
1	99,63	2			3,9	1	98,06	13,80	15	8,9	10	11	12	13
96,0	99,61		6,27	16	4,0	91,0	98,01	13,95	15	9,0	11	12	13	14

$l = 0,125 \text{ m}, z = 96,7 \text{ gon}$   
 $D = 0,125 \times 99,73 = 124,66 \text{ m}$   
 $h = 0,125 \times 5,17 = 6,46 \text{ m}$

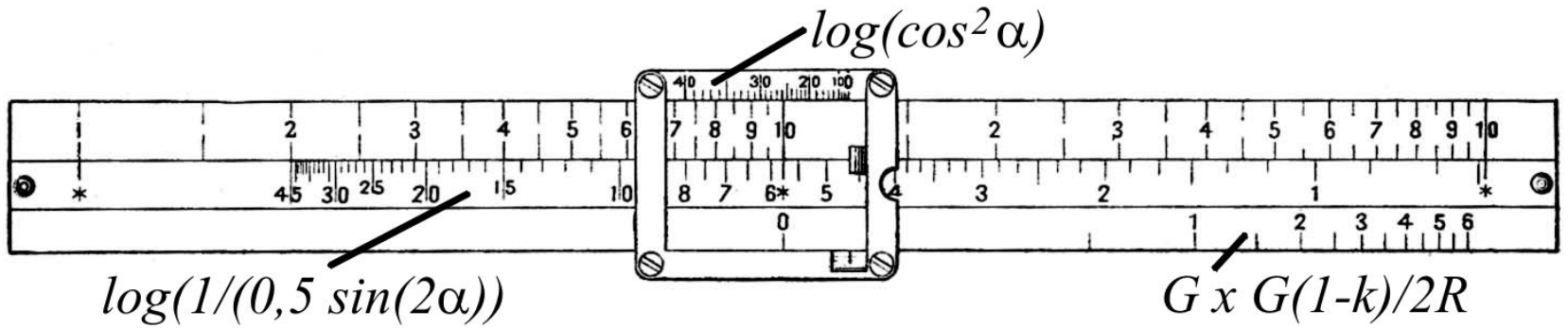
Tafel nach Zeiss ( ~1960)





Jordan, 1893

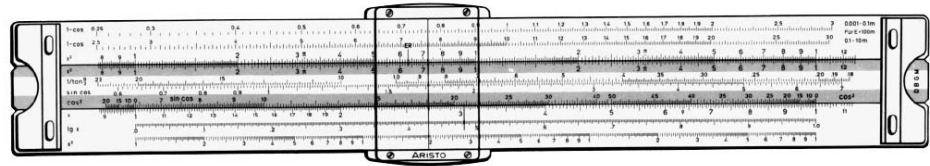
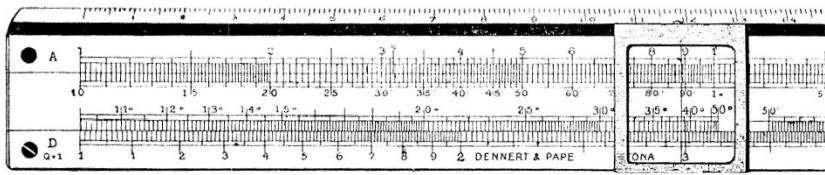
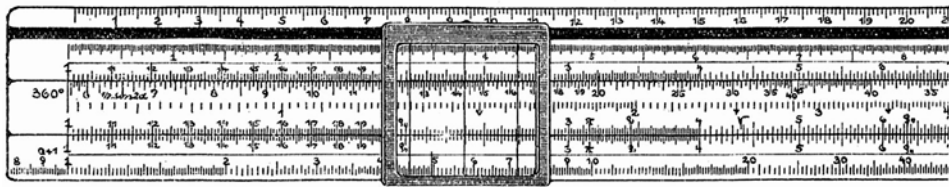
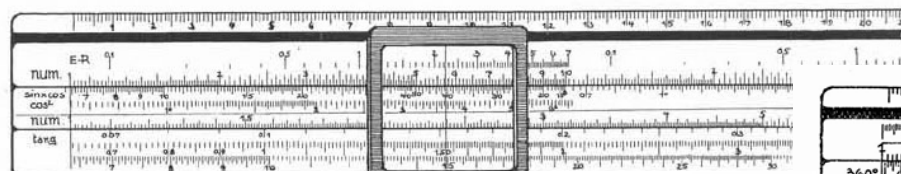
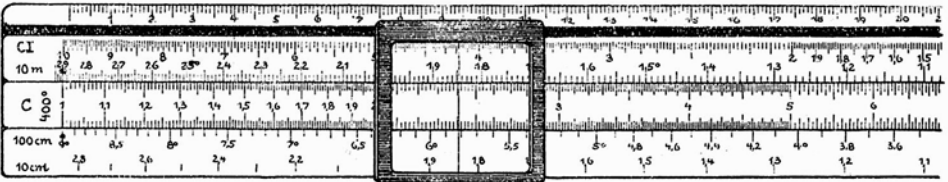
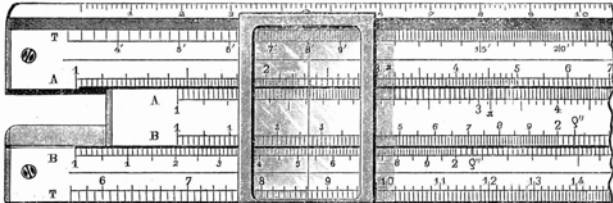
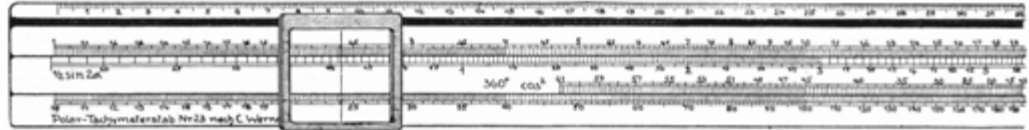
# Rechenschieber



[http://www.history-of-geodesy-ch./virt\\_-museum.htm](http://www.history-of-geodesy-ch./virt_-museum.htm)

Eschmann, Wild, Kern

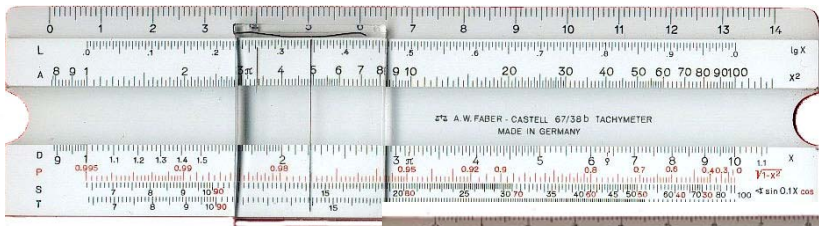
Rechenschieber



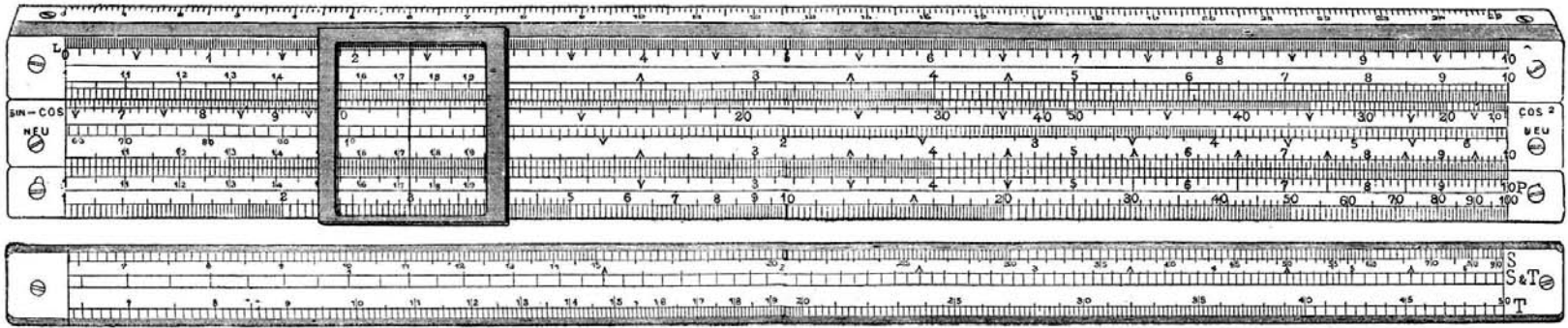
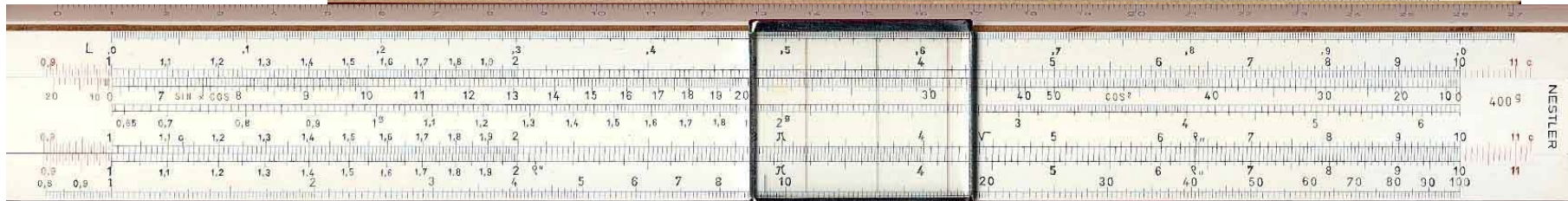
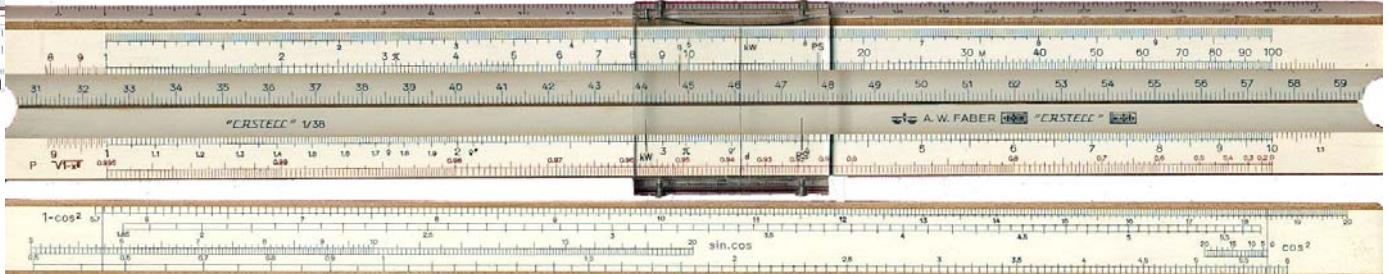
DuP Aristo Geodät

# Rechenschieber

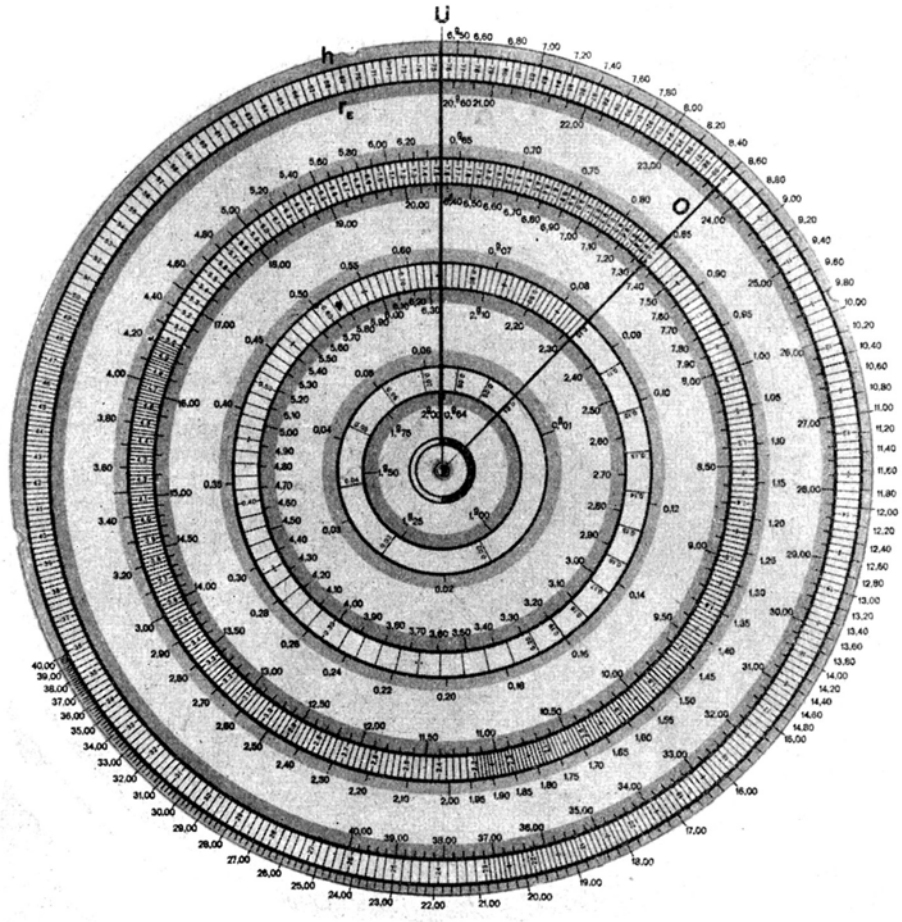




Faber Castell Tachymeterrechenschieber



Rechenschieber

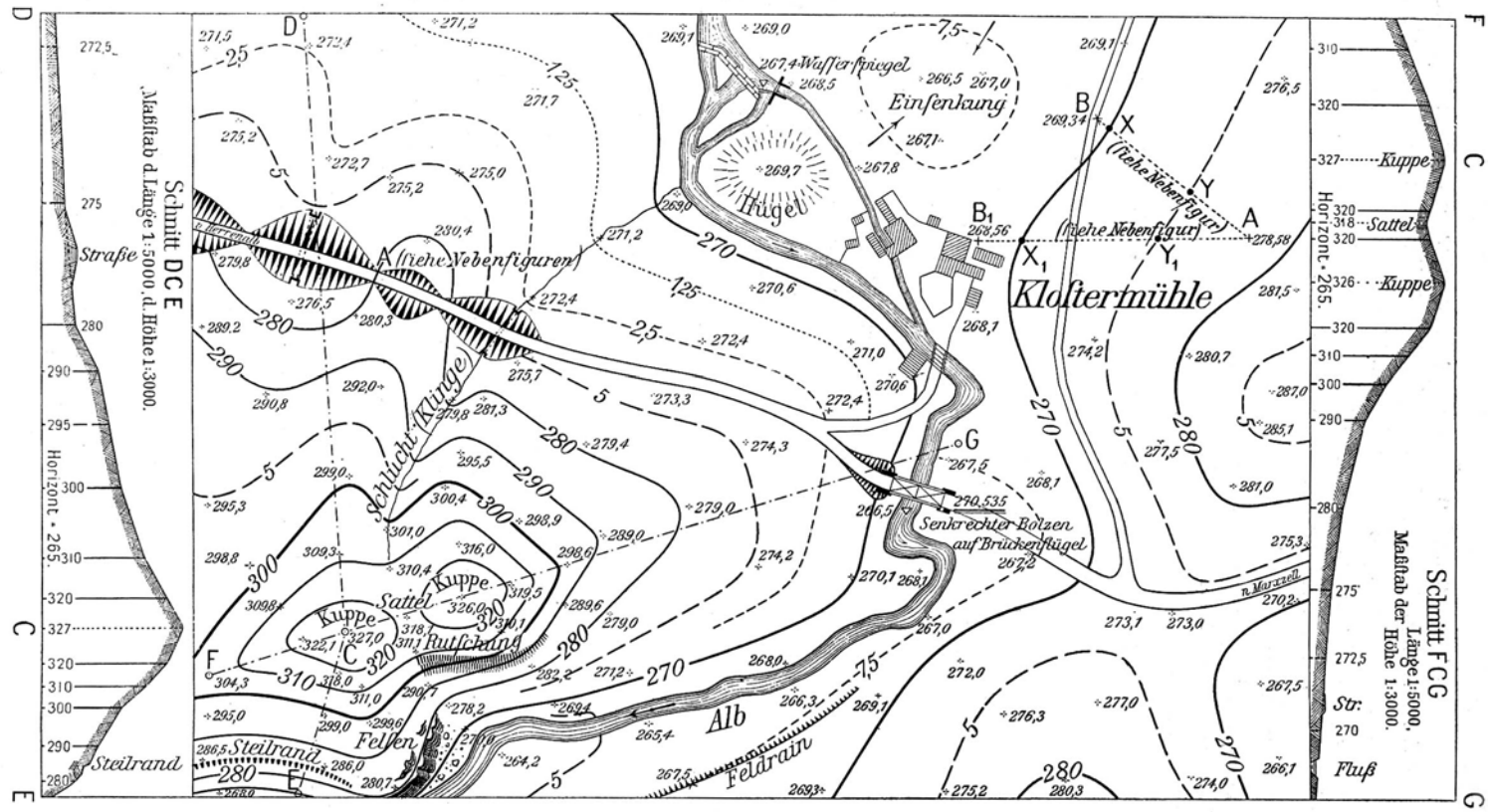


Tachymeterscheibe nach Mohr (~1954)

# Rechenschieber



# Darstellung einer Geländeform durch Höhenkurven



Maßstab 1:5000.

## Tachymetrische Aufnahmen

EXAMPLE OF 'ACHEOMETER OR STADIA SURVEY'

Fig. 184<sup>a</sup>

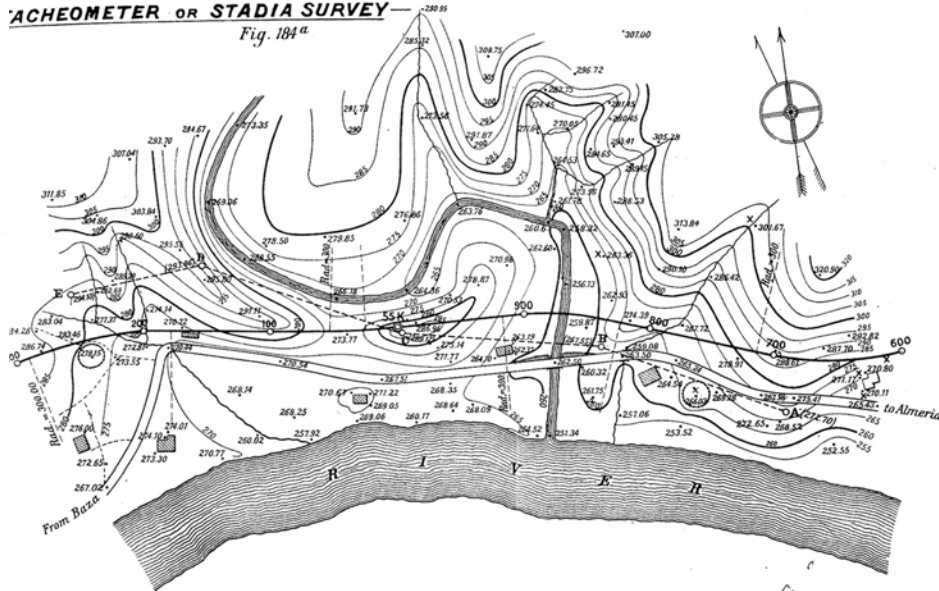
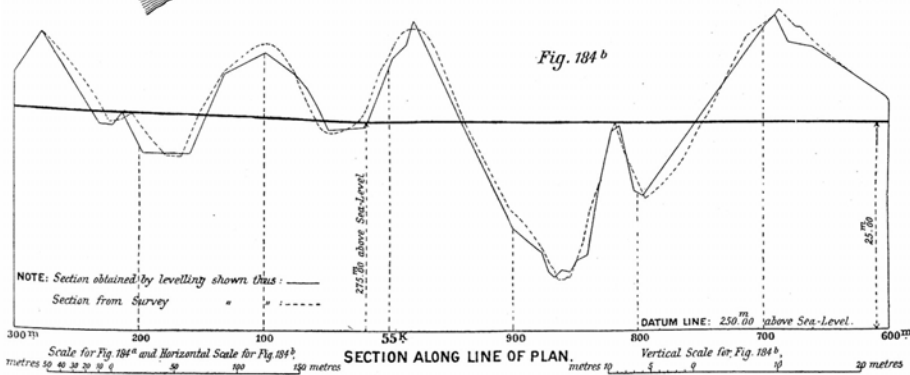


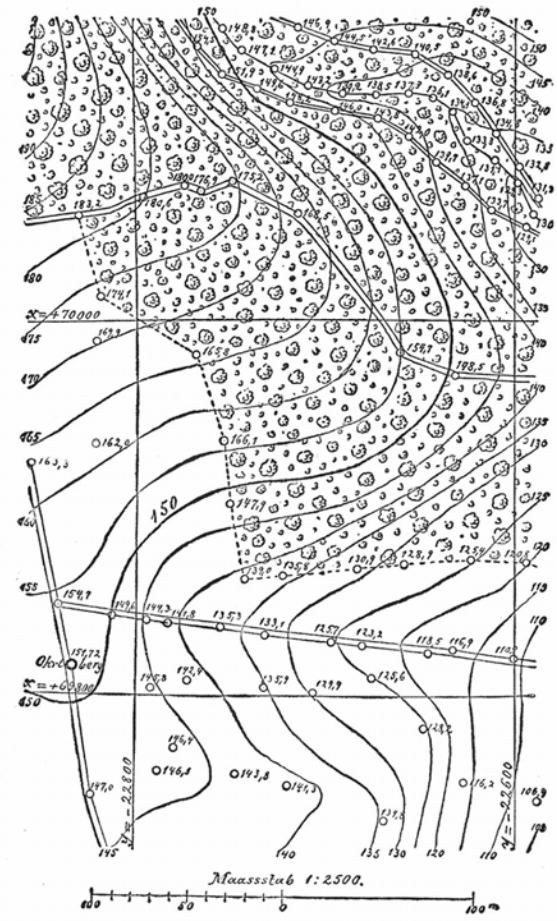
Fig. 184<sup>b</sup>

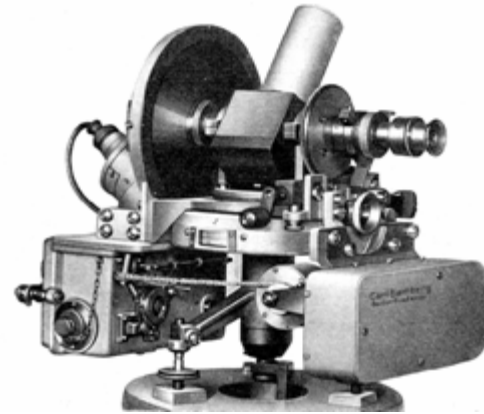
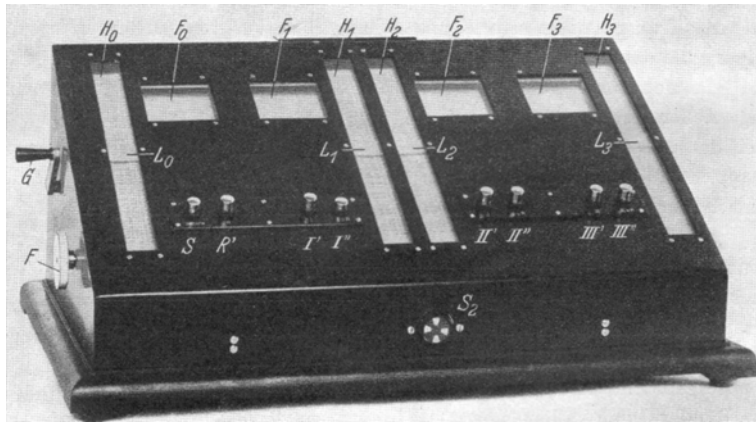


[To face p. 284.]

VII. Beispiel einer Tachymeter-Aufnahme.

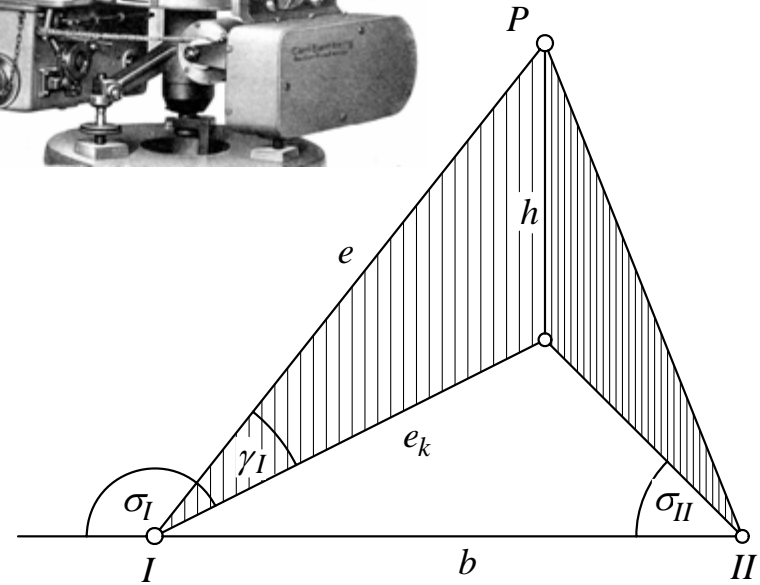
Fig. 8.





Logarithmische Rechenmaschine nach Fuß (~1933)  
(Askania Werke)

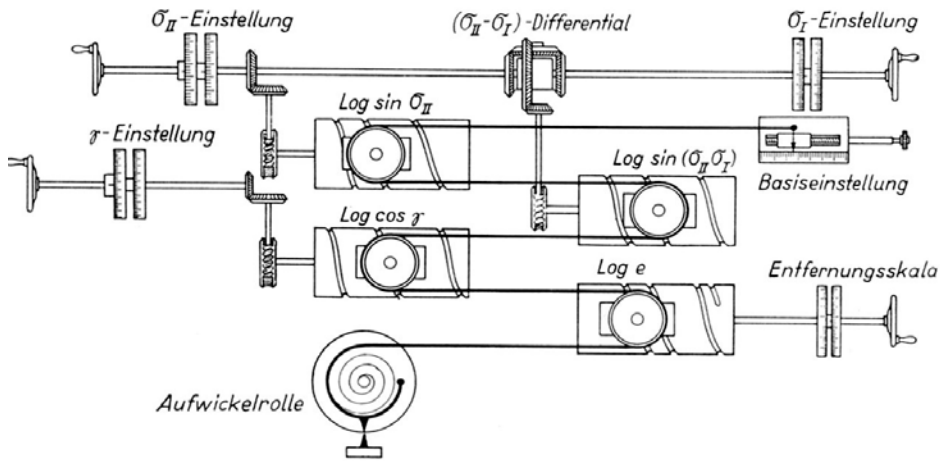
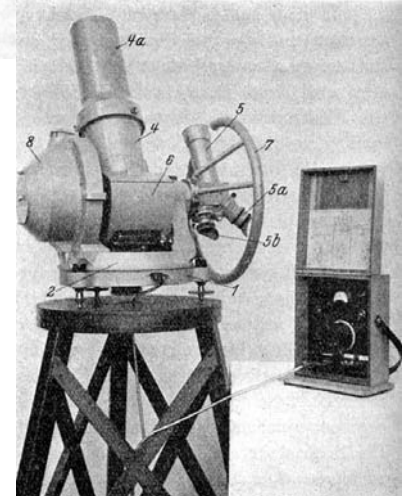
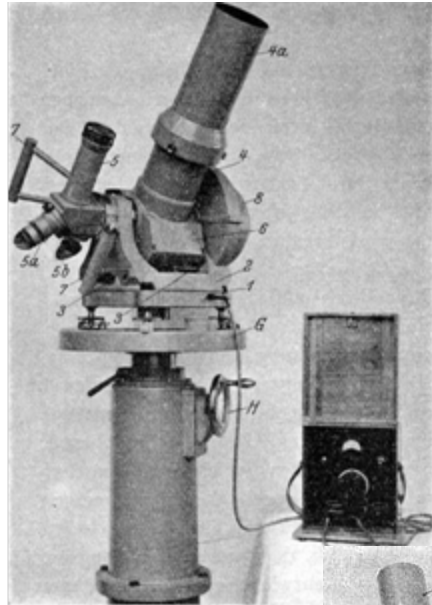
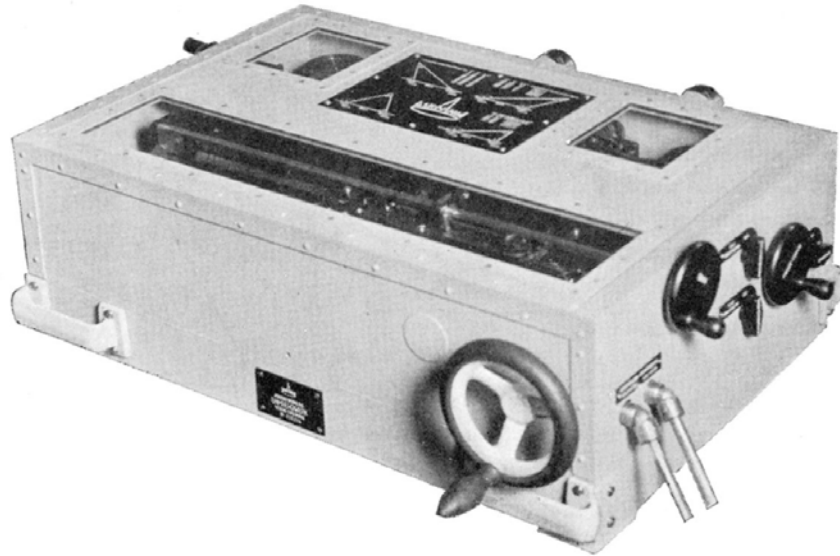
$$e = b \cdot \frac{\sin \sigma_{II}}{\sin(\sigma_{II} - \sigma_I)} \cdot \frac{1}{\cos \gamma_I}$$



$$\log e = \log b + \log \sin \sigma_{II} - \log \sin(\sigma_{II} - \sigma_I) - \log \cos \gamma_I$$

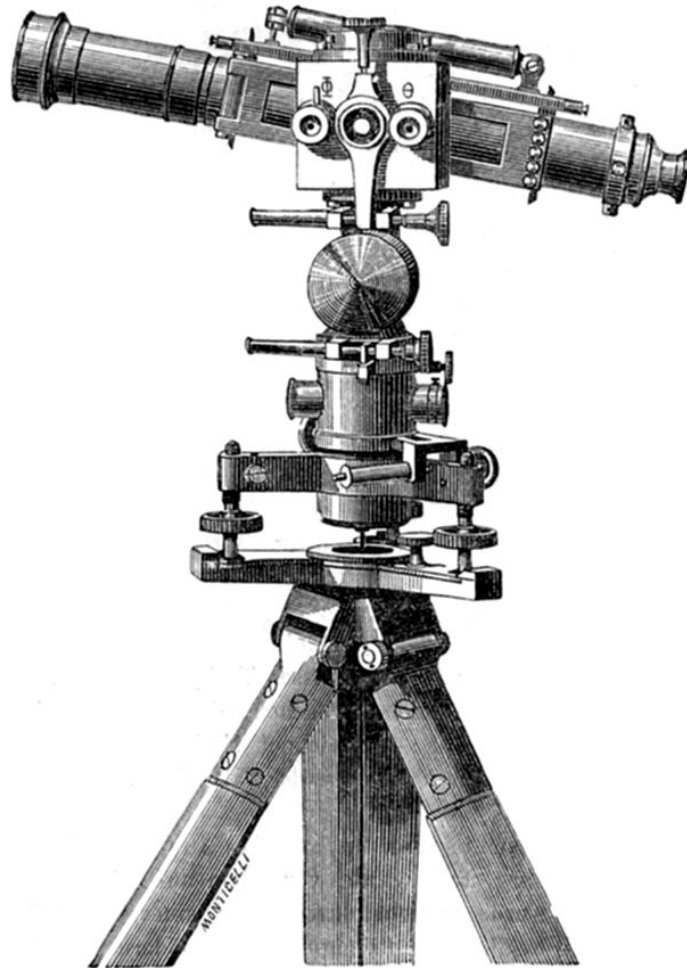


# Veithen Rechner (~1940)



## Logarithmische Rechenmaschinen

gestern



heute



# Tachymetrie gestern und heute