AccessionIndex: TCD-SCSS-U.20121208.013
Accession Date: 8-Dec-2012
Accession By: Prof.J.G.Byrne
Object name: Circular Sliderules
Vintage: c.19xx
Synopsis: Sliderules.

Description:
Text …

Accession Index	Location	Vintage	Object and Identification
TCD-SCSS-U.20121208.013.01		c.19xx	<***Mfgr?***> <***model?***> sliderule. S/N: <***???***>
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TCD-SCSS-U.20121208.013.04		c.198x	
TCD-SCSS-U.20121208.013.05		c.198x	
TCD-SCSS-U.20121208.013.06		c.19xx	
TCD-SCSS-U.20121208.013.07		c.198x	
TCD-SCSS-U.20121208.013.08		c.198x	
TCD-SCSS-U.20121208.013.09		c.198x	
TCD-SCSS-U.20121208.013.10		c.19xx	
TCD-SCSS-U.20121208.013.11		c.198x	
TCD-SCSS-U.20121208.013.12		c.198x	
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TCD-SCSS-U.20121208.013.14		c.198x	
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TCD-SCSS-U.20121208.013.19		c.198x	

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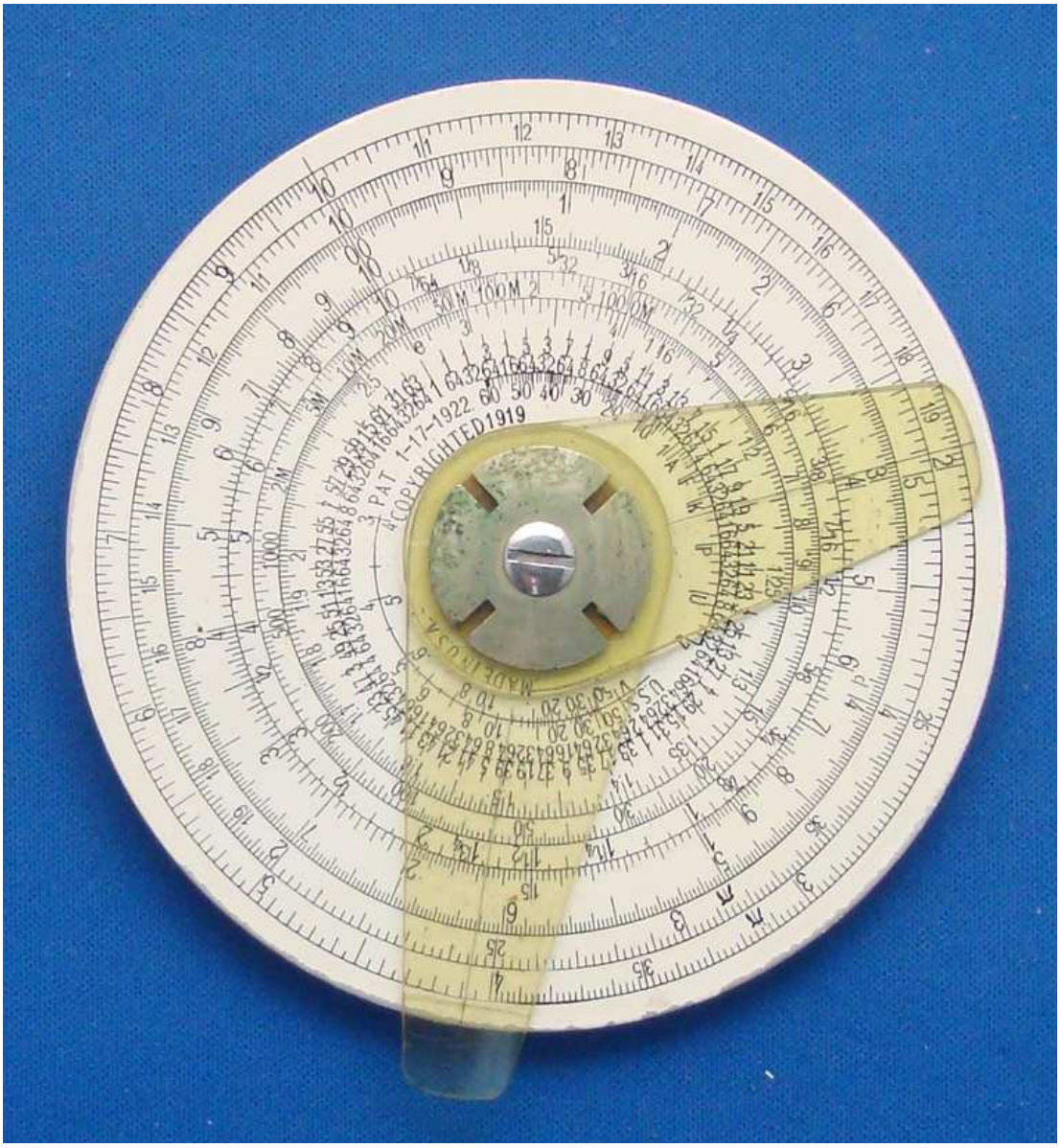
References:

1. Authors, *Title*, Publication, Publisher, Date.
2. Authors, *Title*, Publication, Publisher, Date.
3. Authors, *Title*, Publication, Publisher, Date.



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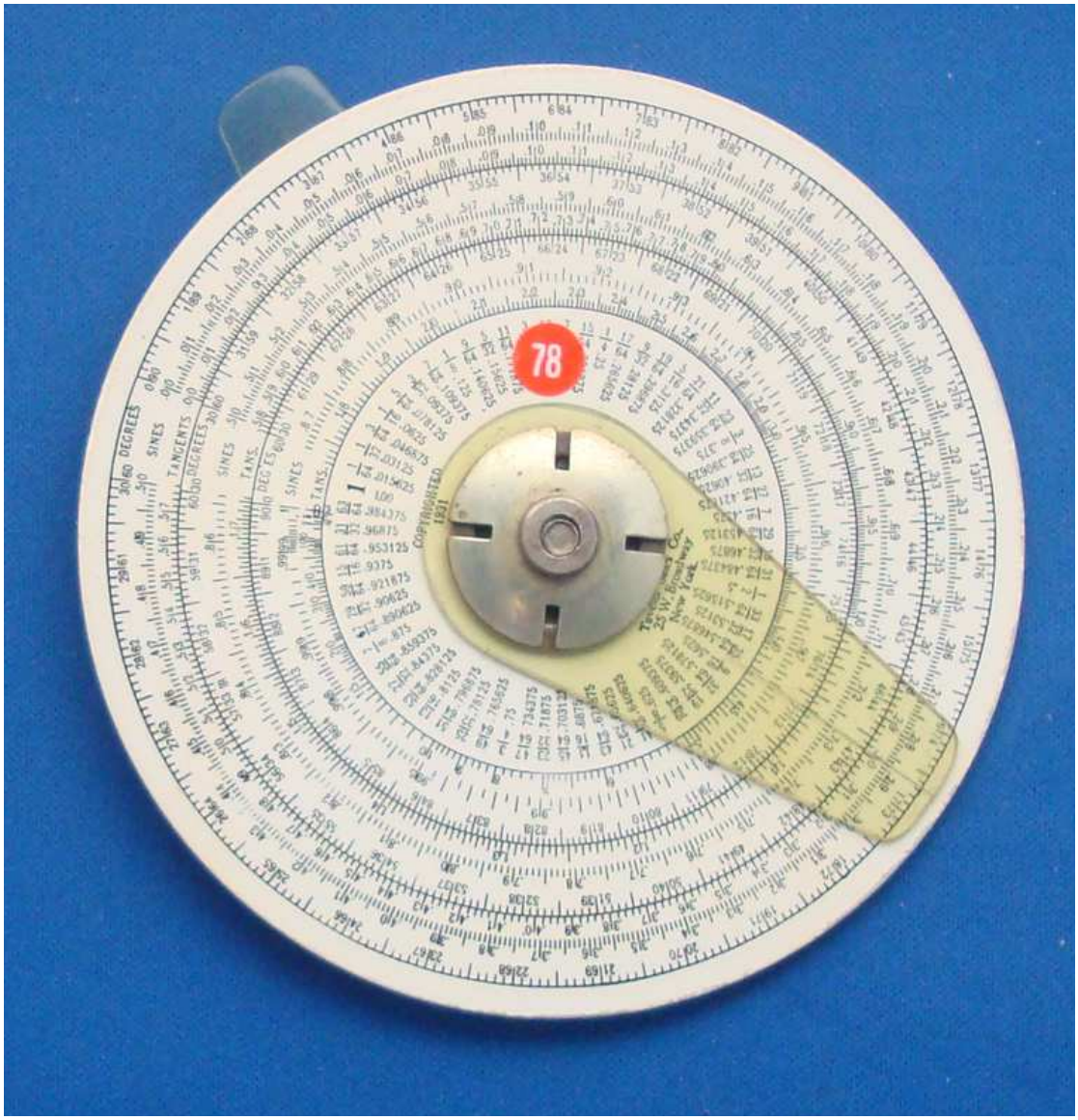

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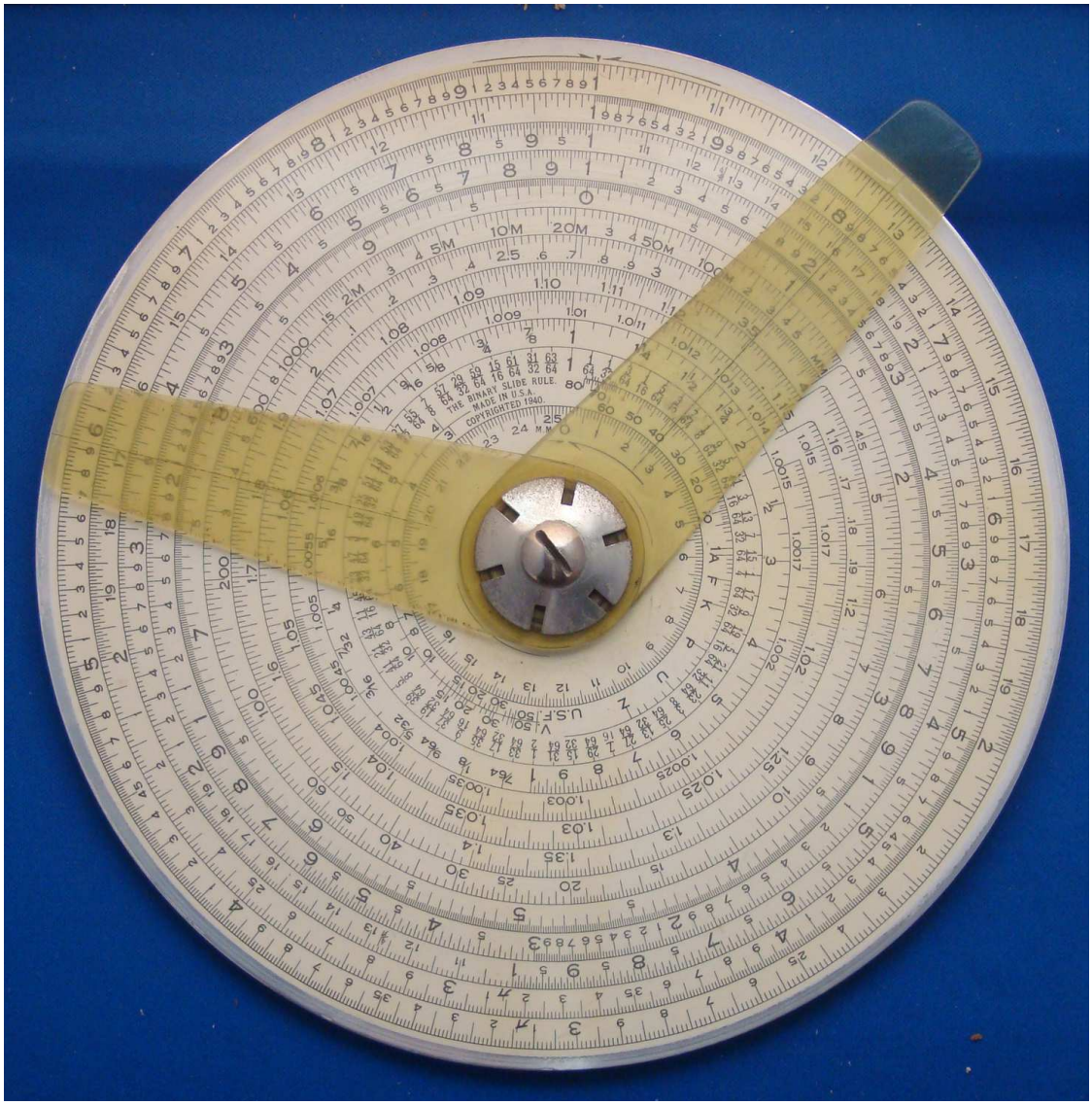

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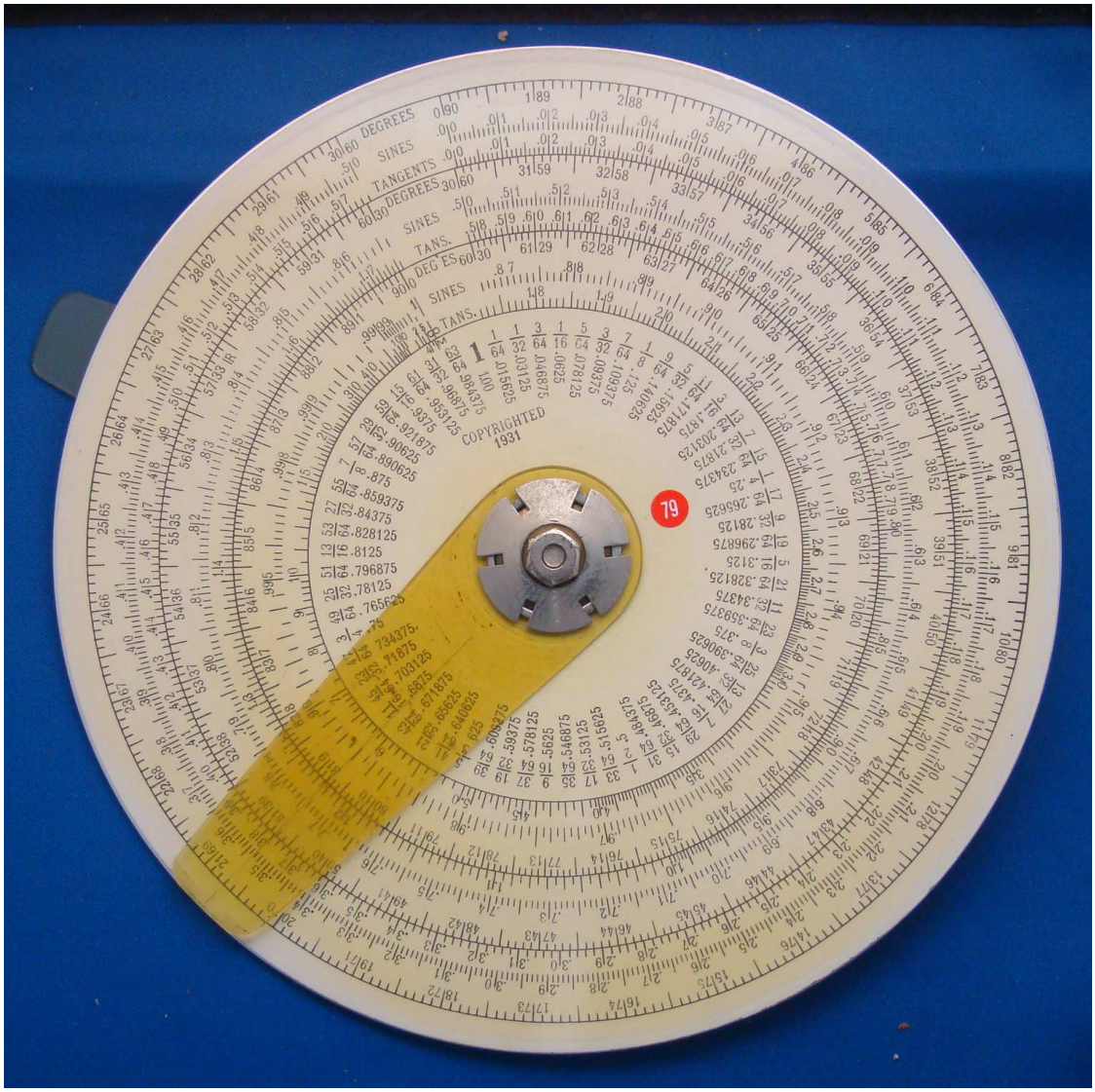

Figure 5: TCD-SCSS-U.20121208.013-fig05

Figure 6: TCD-SCSS-U.20121208.013-fig06
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Charles Bruning Company Inc."

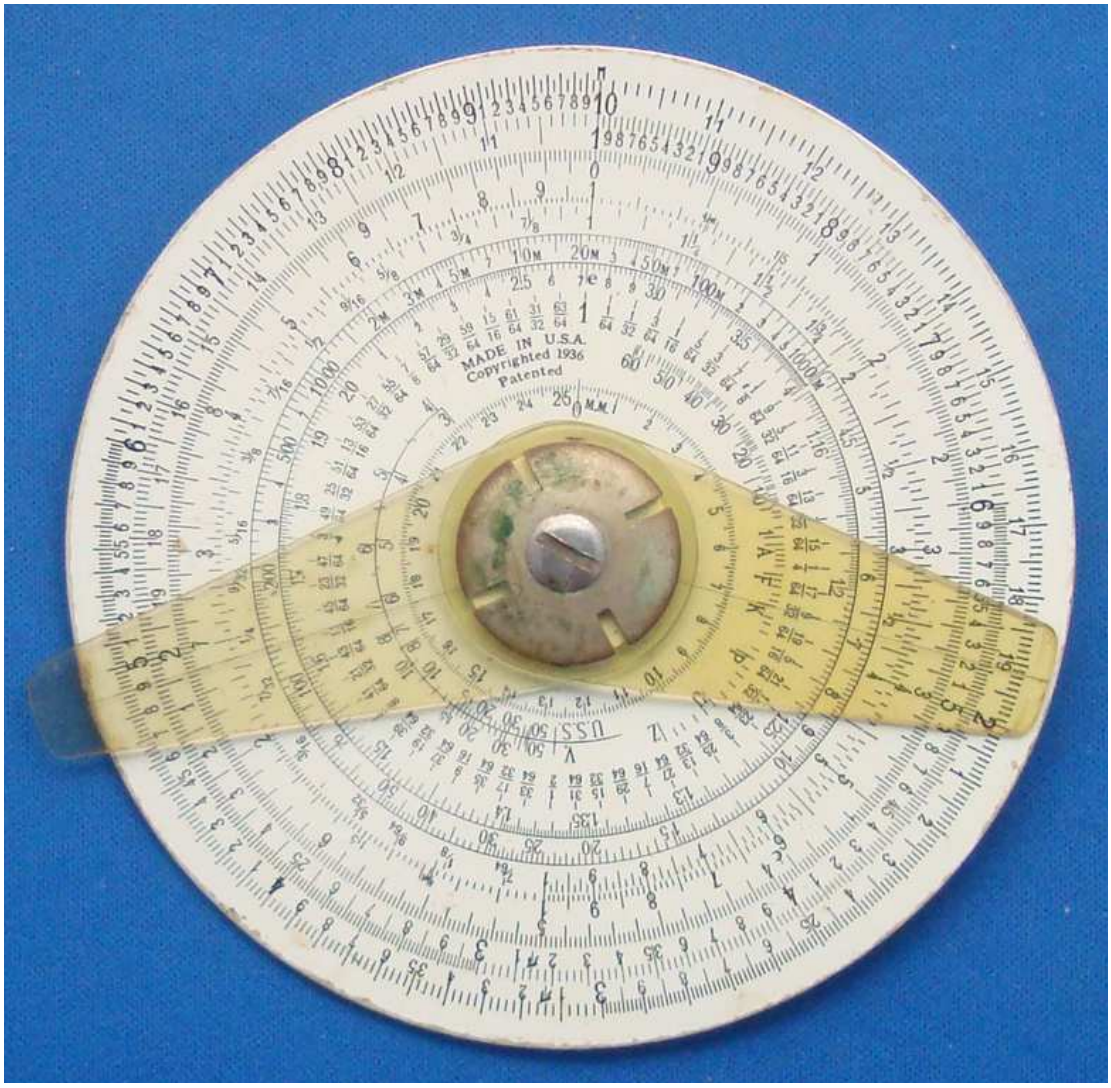


Figure 7: TCD-SCSS-U.20121208.013-fig07

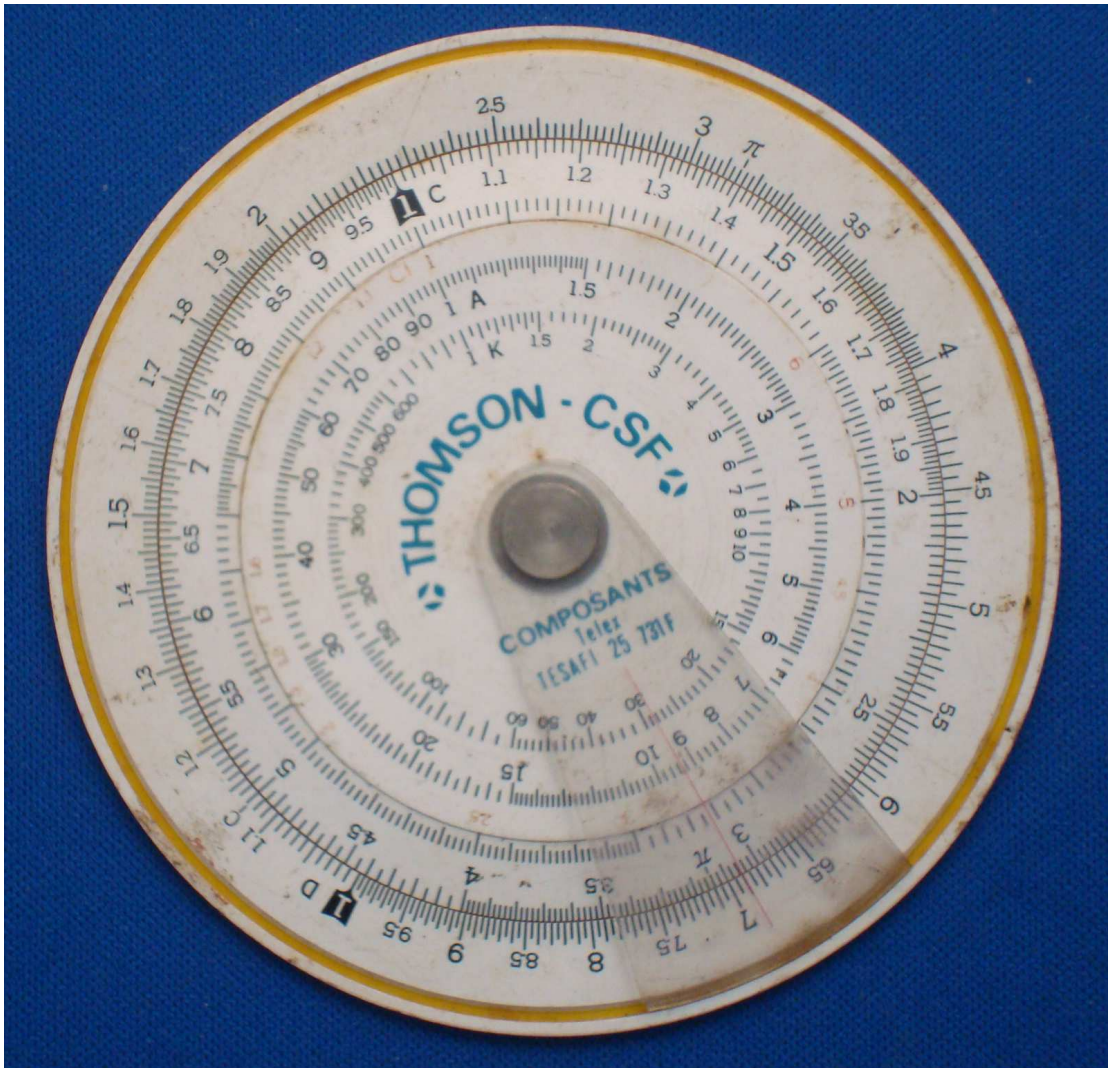
Figure 8: TCD-SCSS-U.20121208.013-fig08

Figure 9: TCD-SCSS-U.20121208.013-fig09

Figure 10: TCD-SCSS-U.20121208.013-fig10

Figure 11: TCD-SCSS-U.20121208.013-fig11

Figure 12: TCD-SCSS-U.20121208.013-fig12



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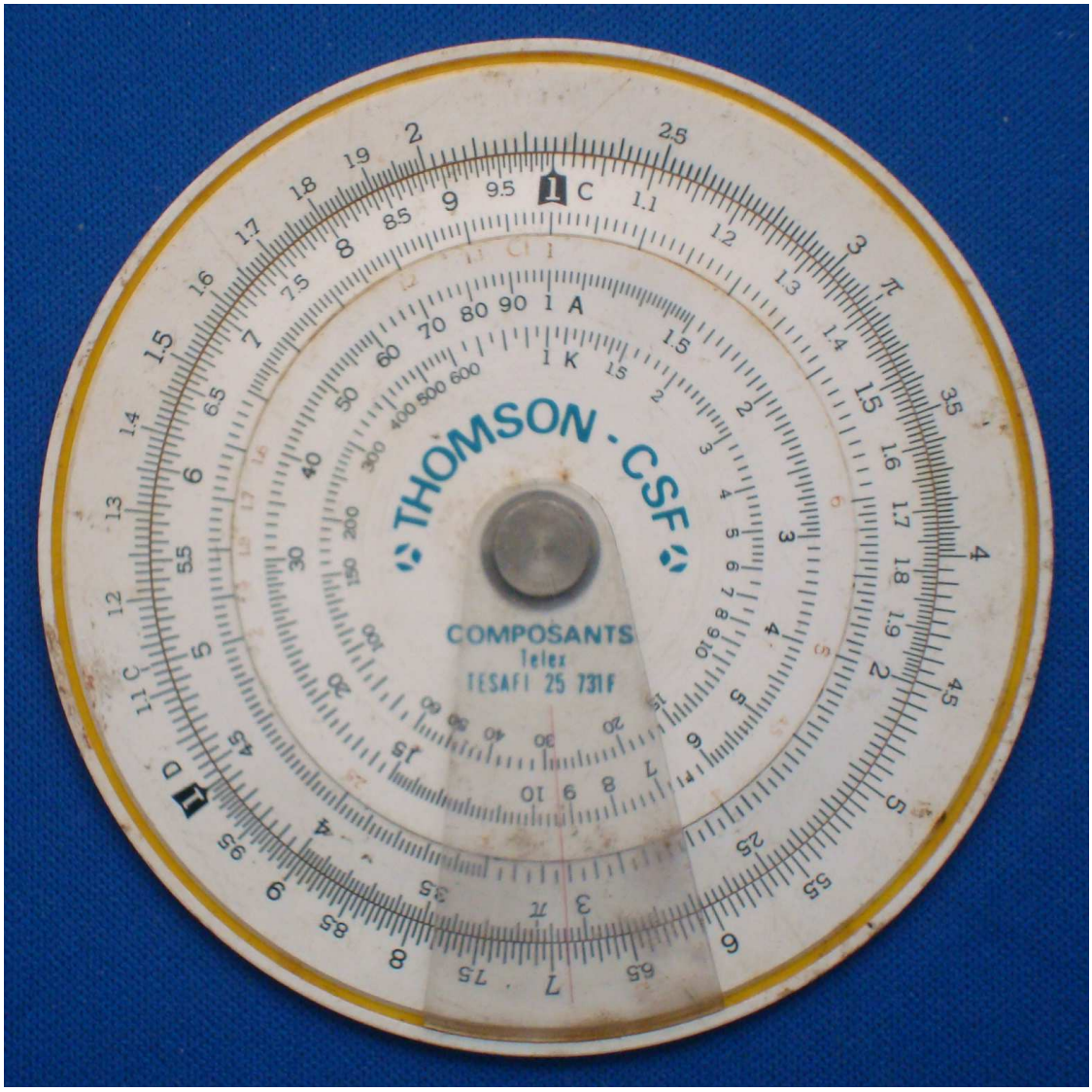

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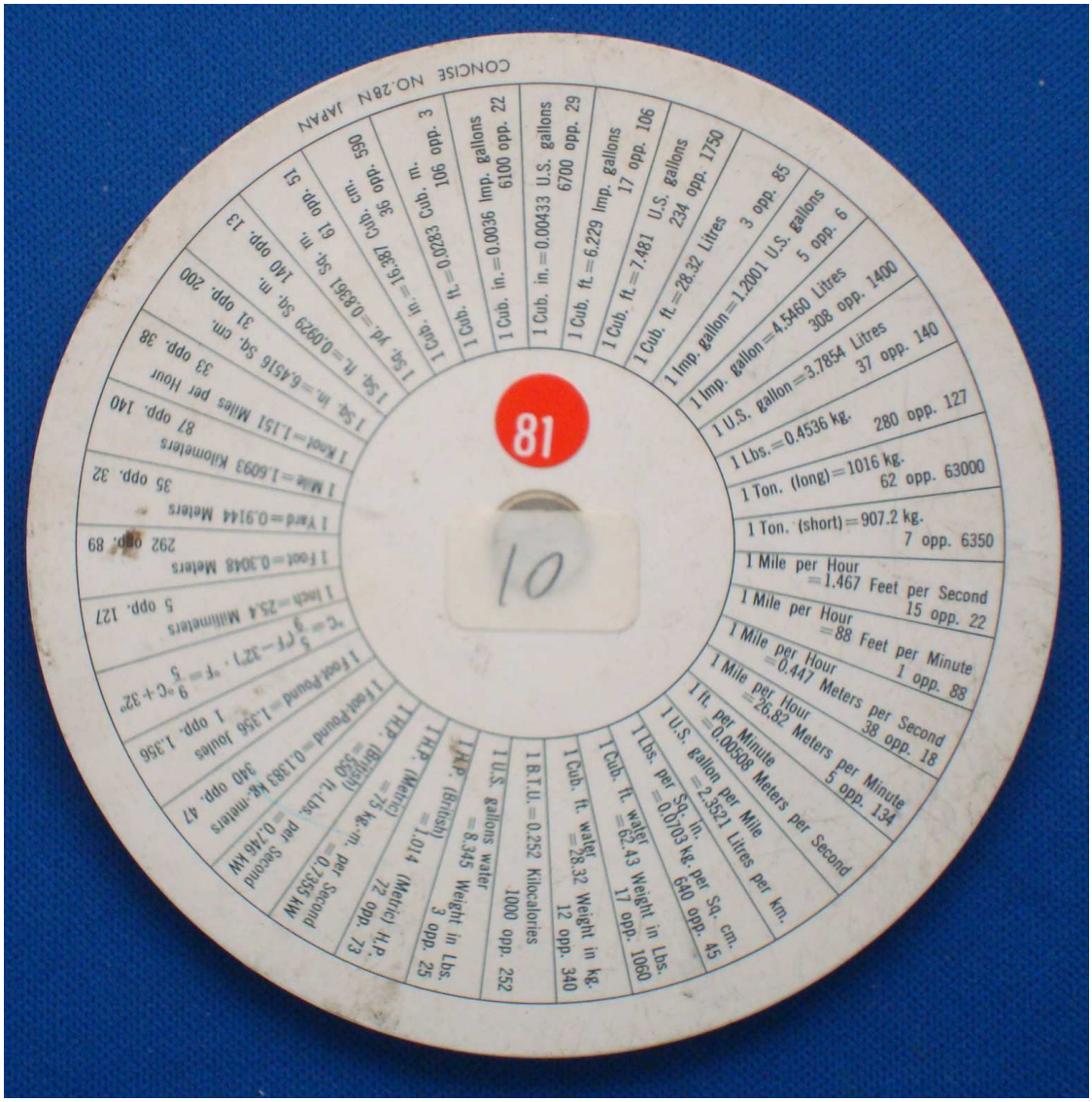

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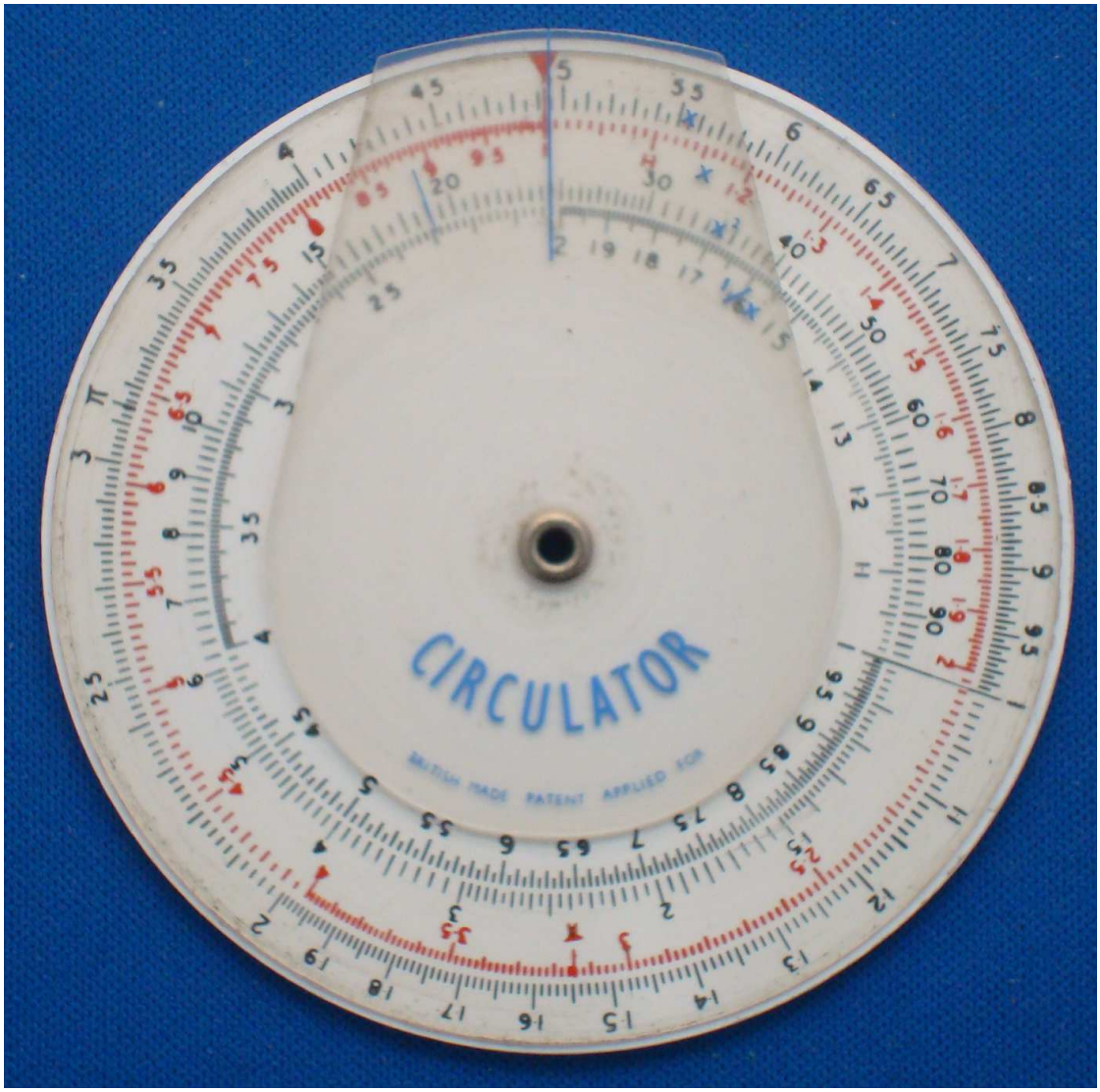

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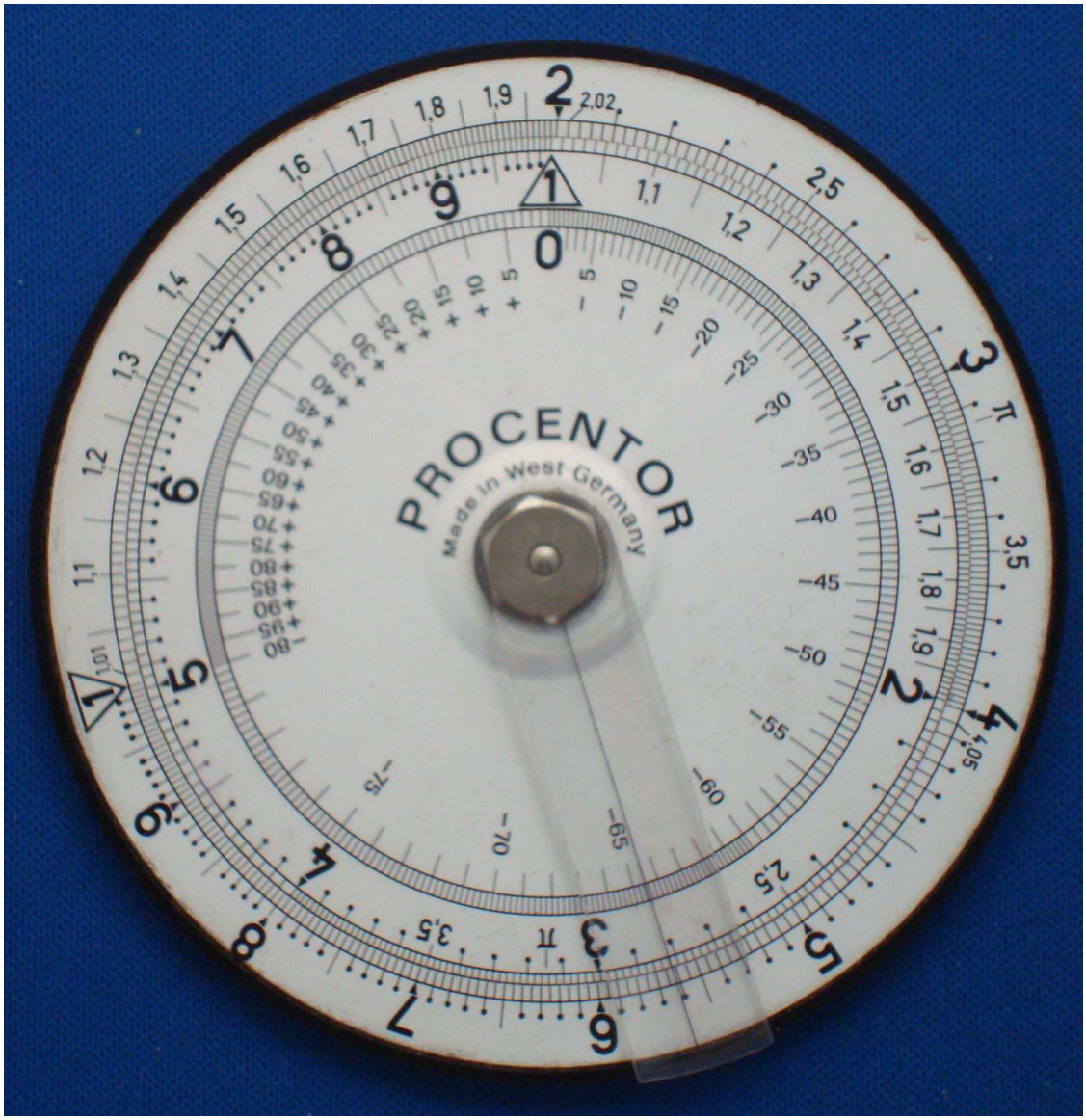

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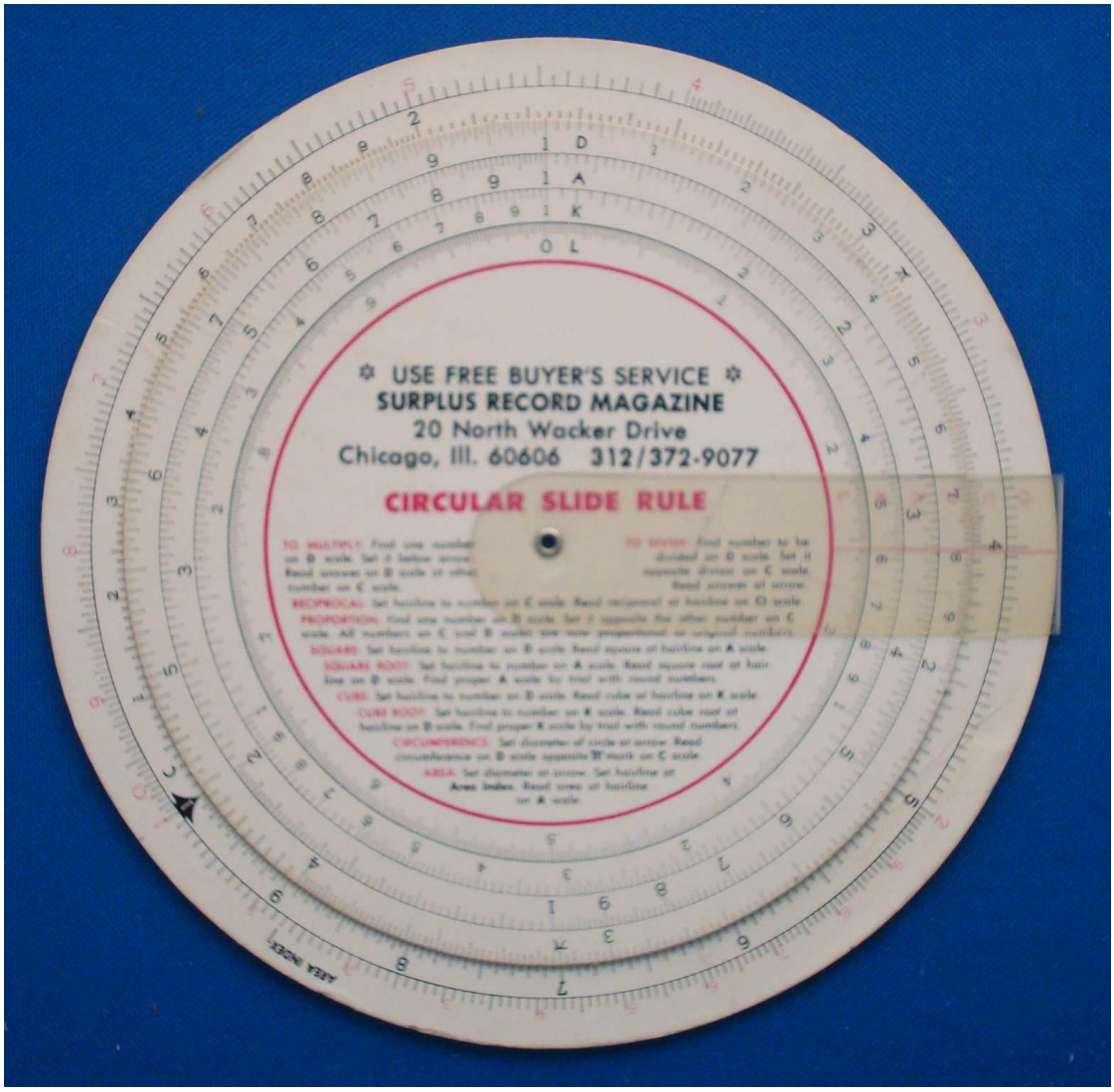

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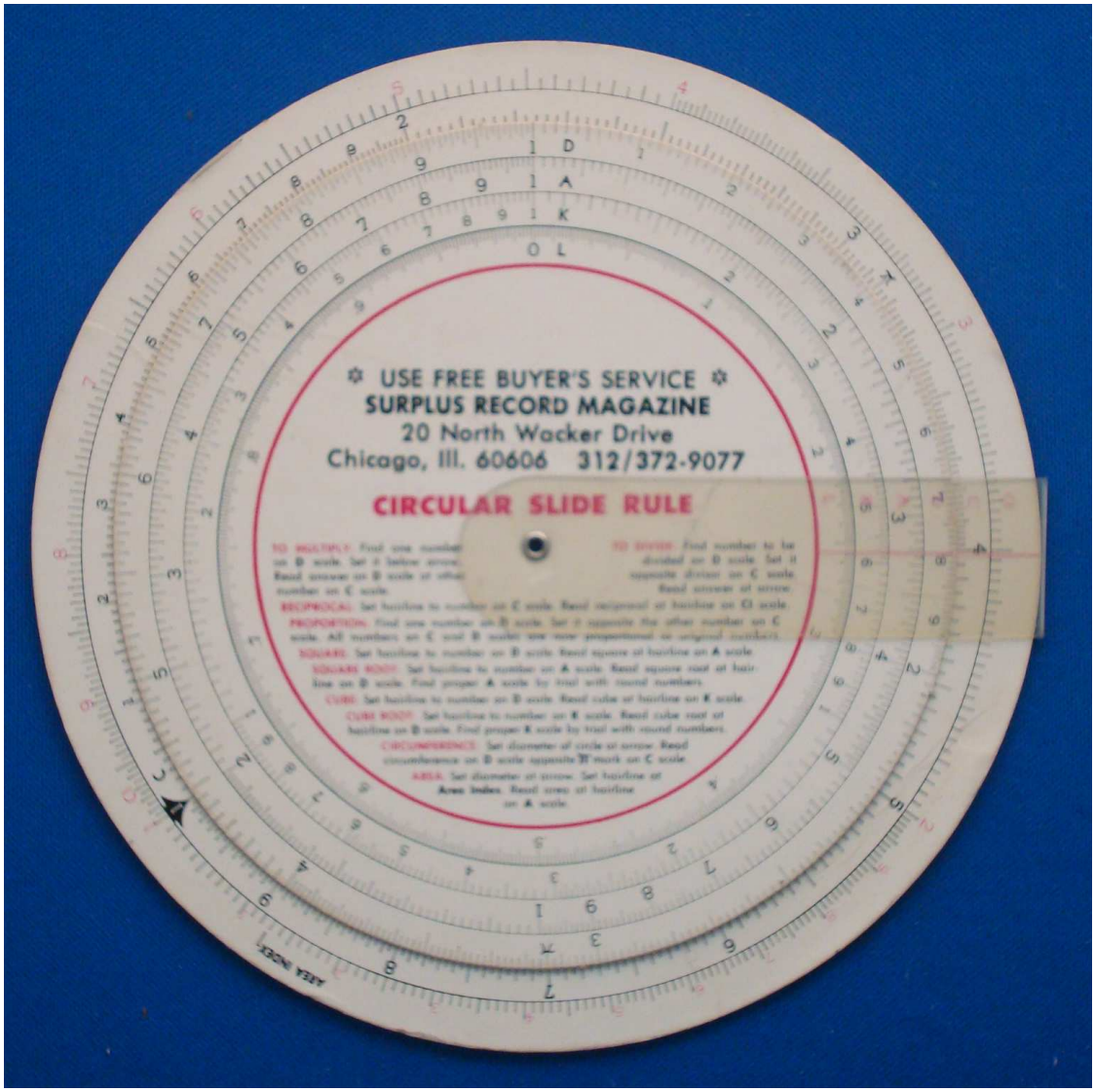

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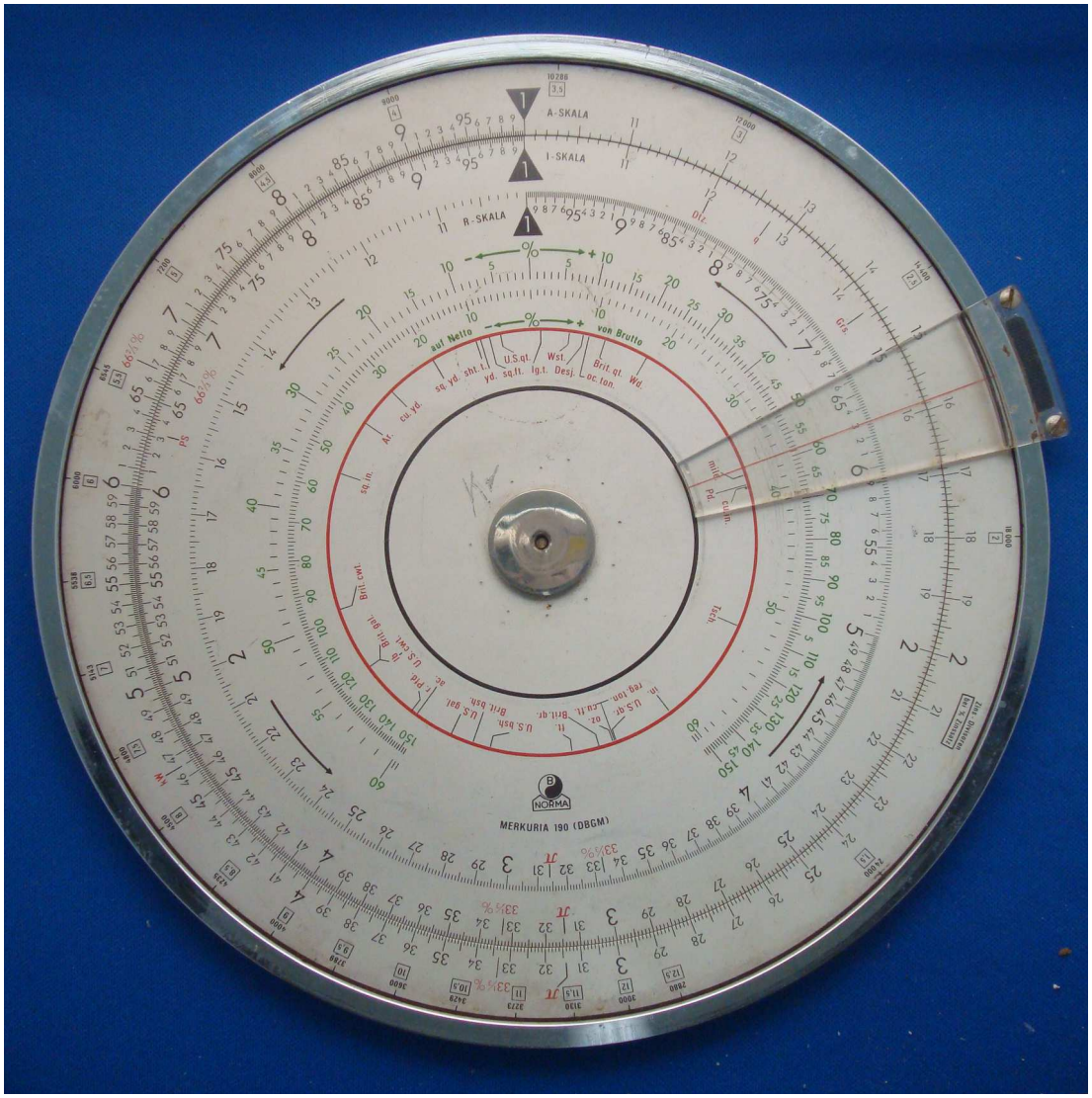

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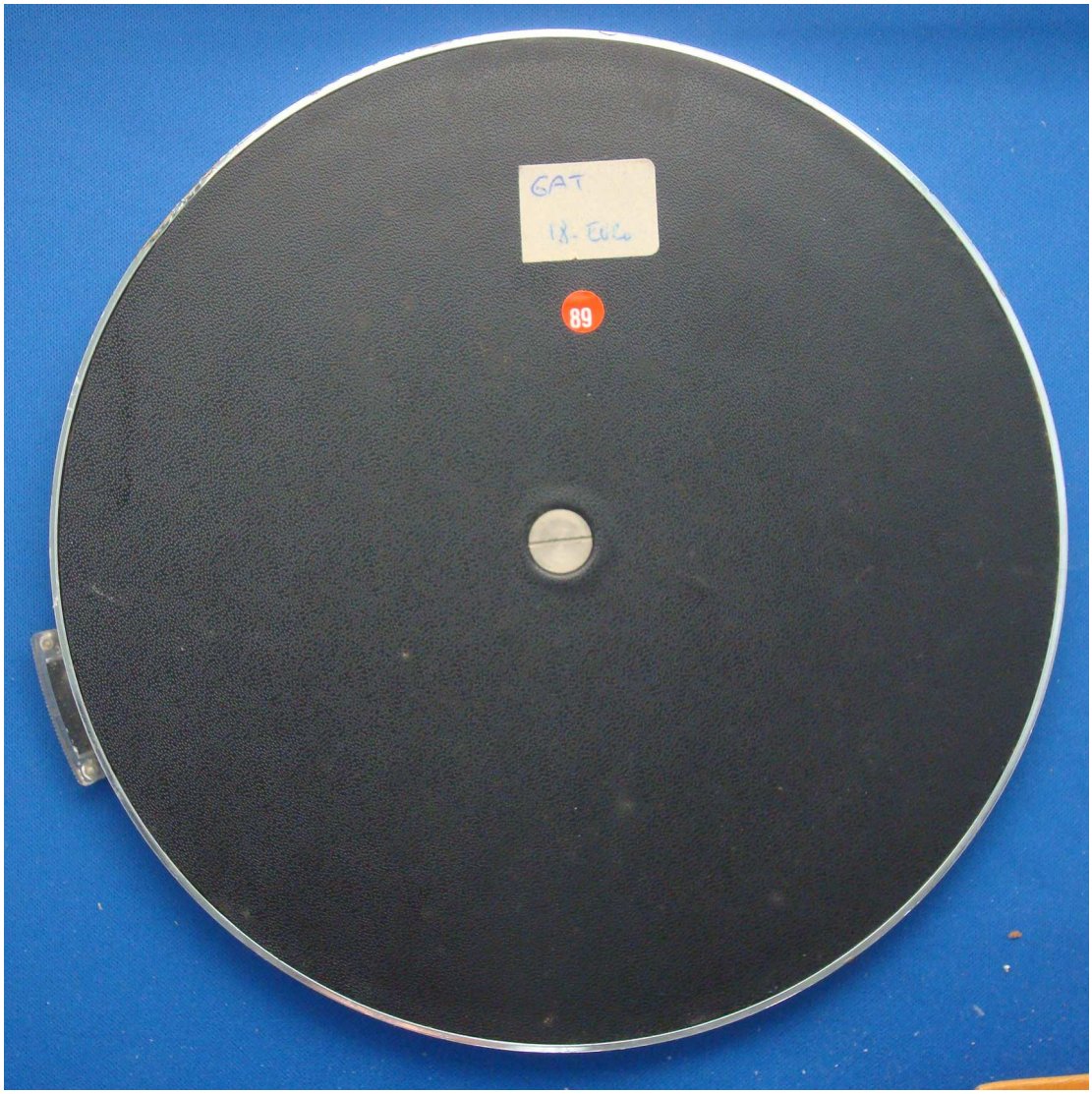

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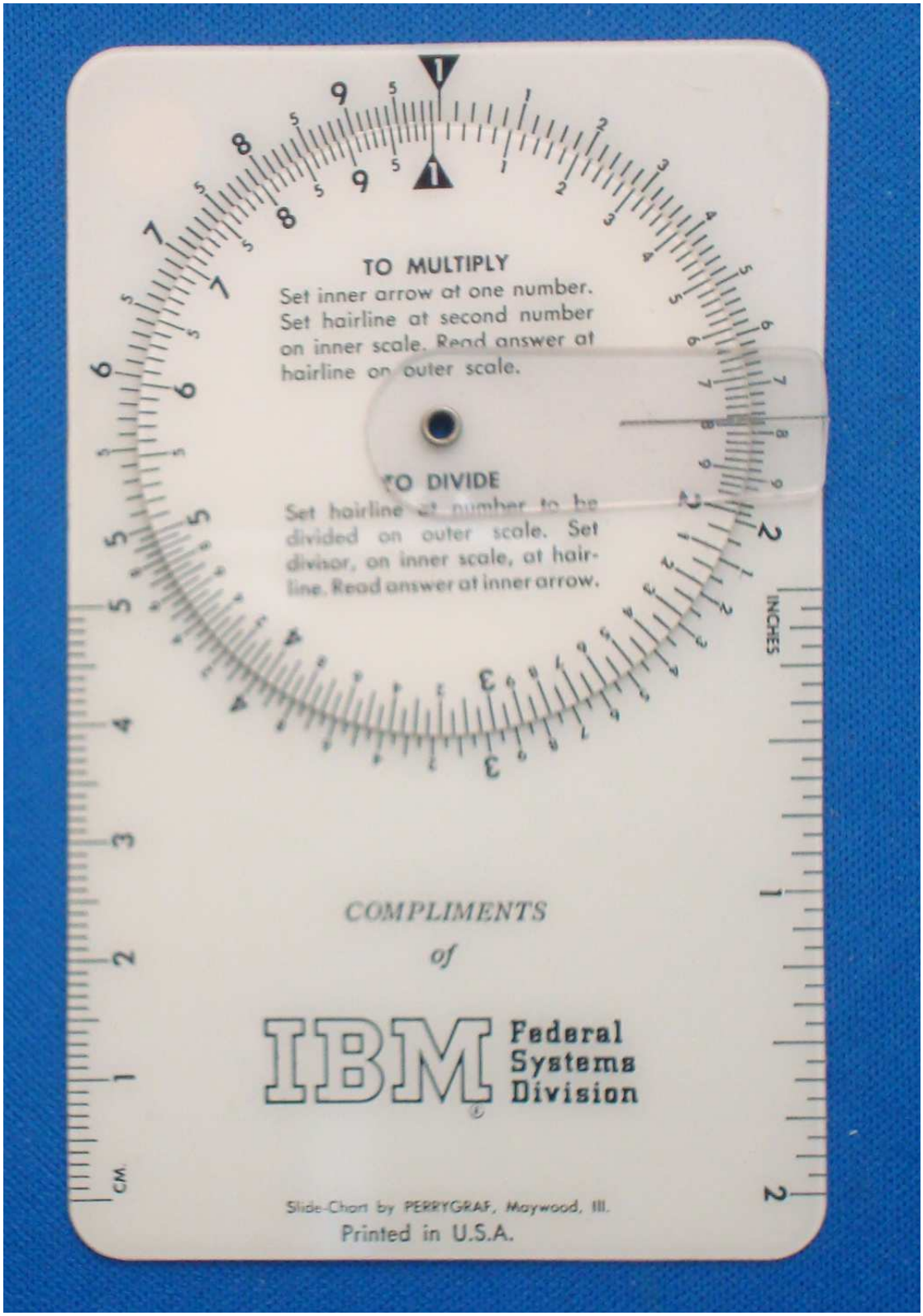

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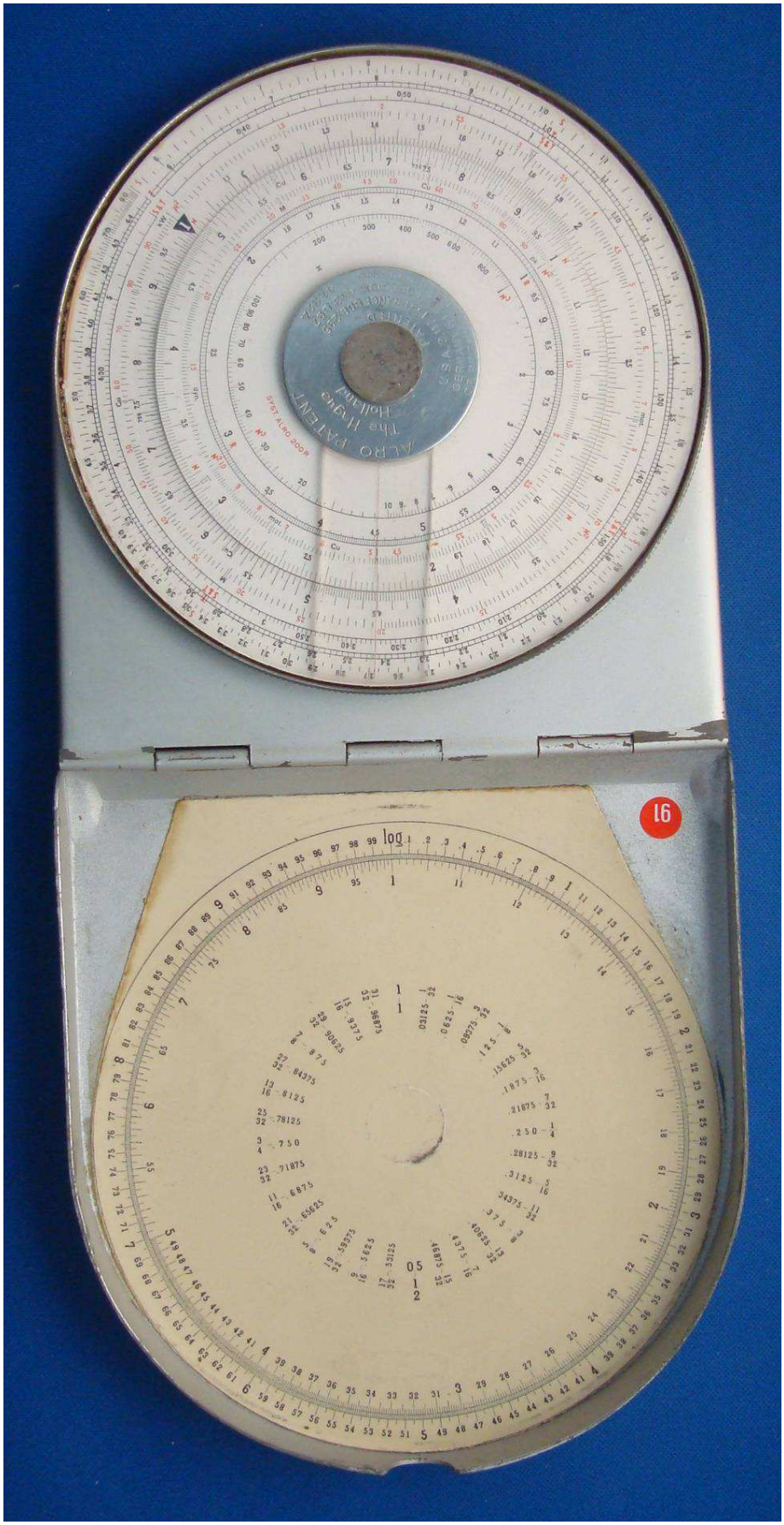

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Figure 26: TCD-SCSS-U.20121208.013-fig26

Figure 27: TCD-SCSS-U.20121208.013-fig27

Figure 28: TCD-SCSS-U.20121208.013-fig28

Figure 29: TCD-SCSS-U.20121208.013-fig29
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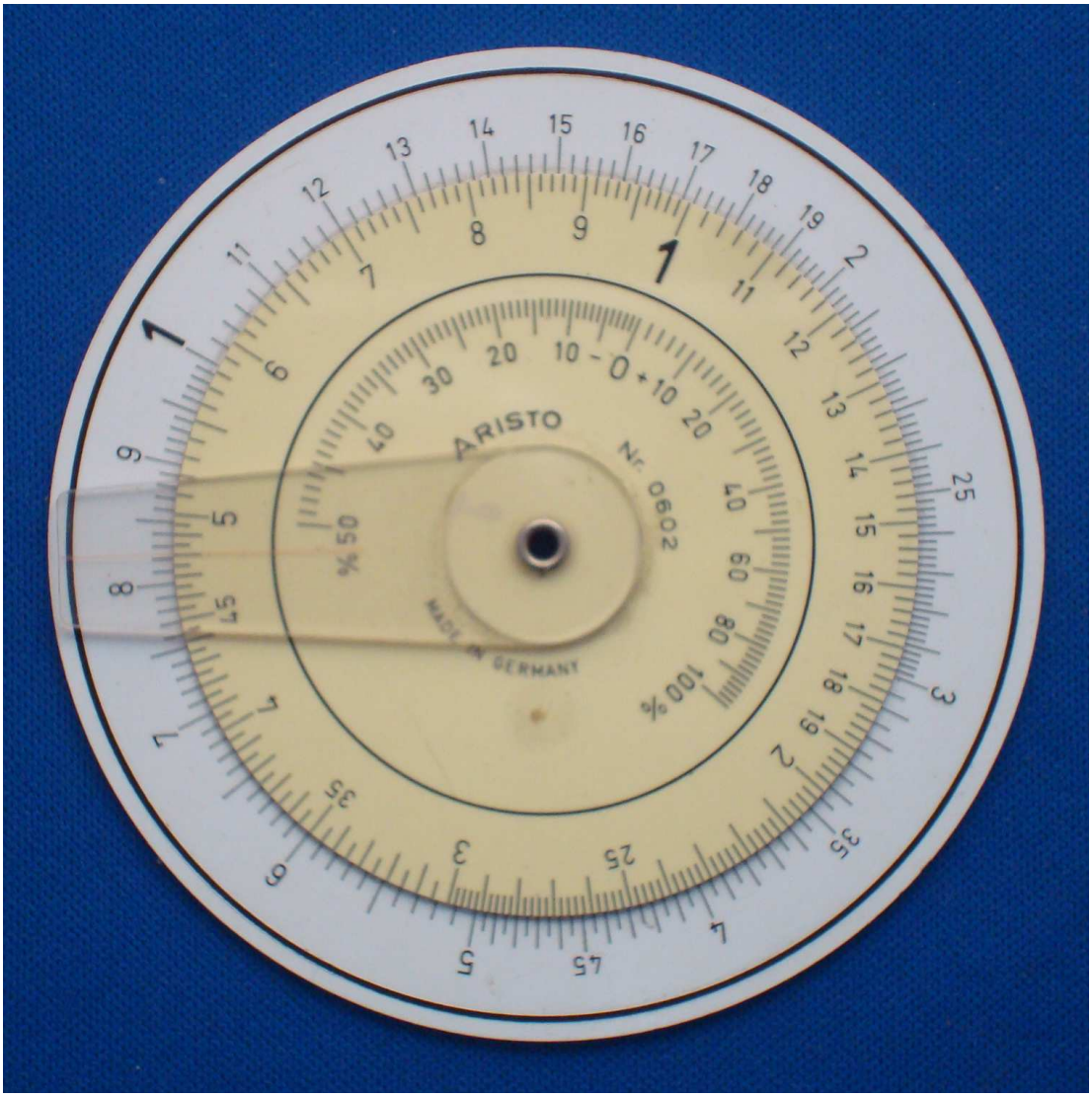

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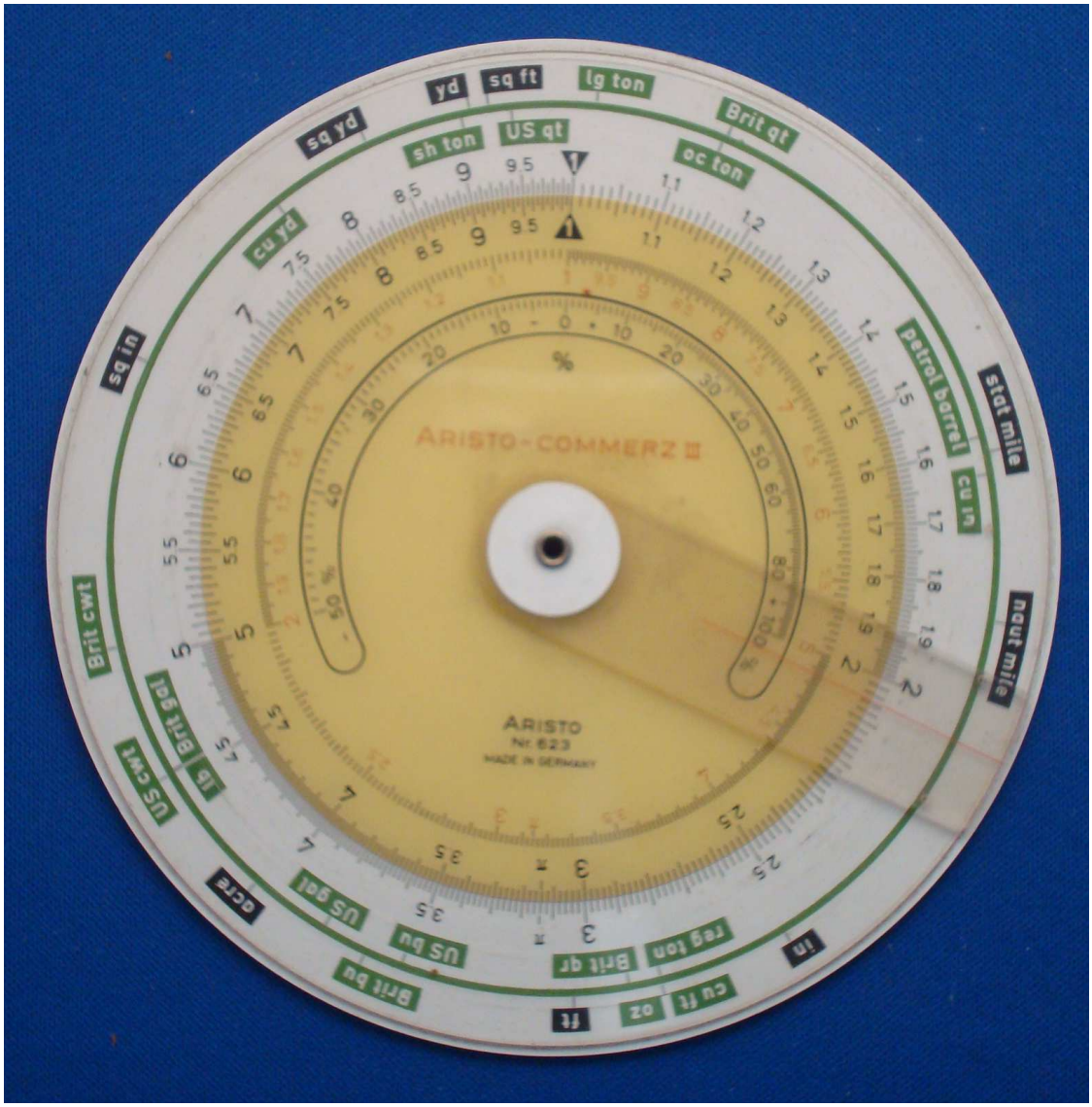


Figure 32: TCD-SCSS-U.20121208.013-fig32

Figure 33: TCD-SCSS-U.20121208.013-fig33

MODE D'EMPLOI

ARISTO COMMERZ III 623

Fig. 1

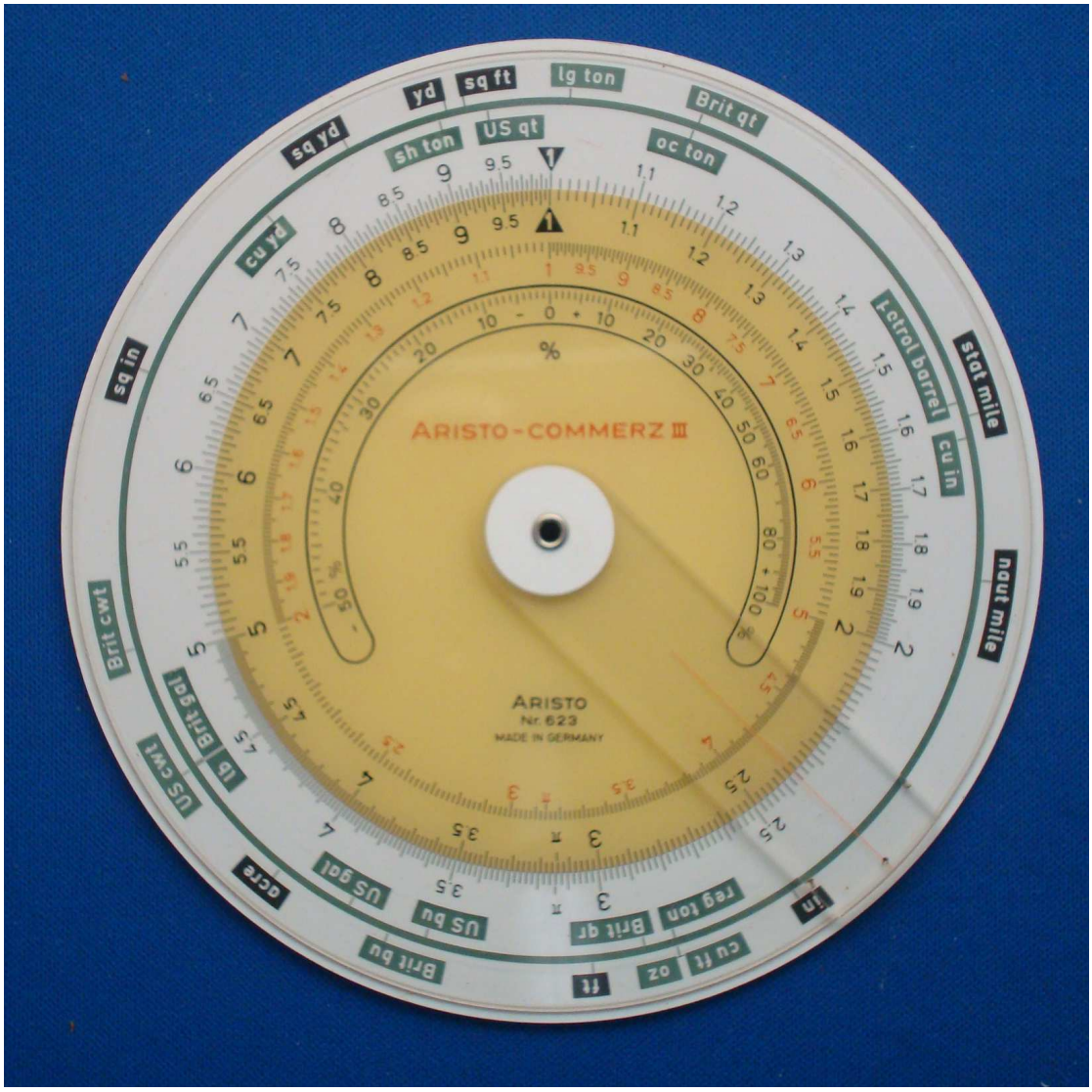
1. Les échelles

Le computeur circulaire ARISTO 623 comporte les échelles suivantes (de l'extérieur vers l'intérieur):

Repères pour la conversion des poids et mesures anglo-américaines en poids et mesures du système métrique	sur l'anneau extérieur fixe
Echelle de base	
Echelle de base	sur le disque mobile jaune
Echelle des inverses	
Echelle des pourcentages	

Figure 34: TCD-SCSS-U.20121208.013-fig34
"Aristo Commerz III [623]"

Figure 35: TCD-SCSS-U.20121208.013-fig35



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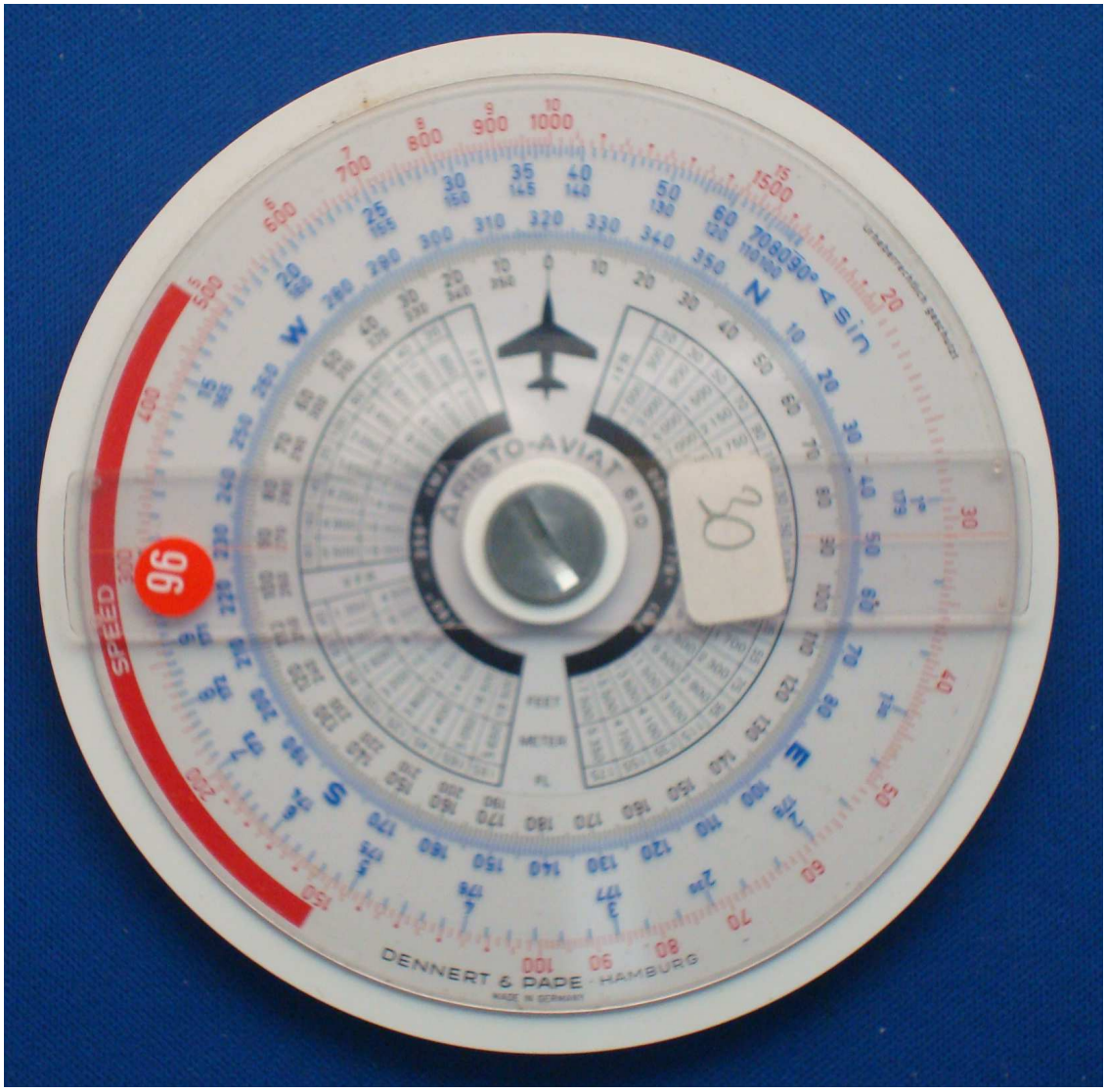

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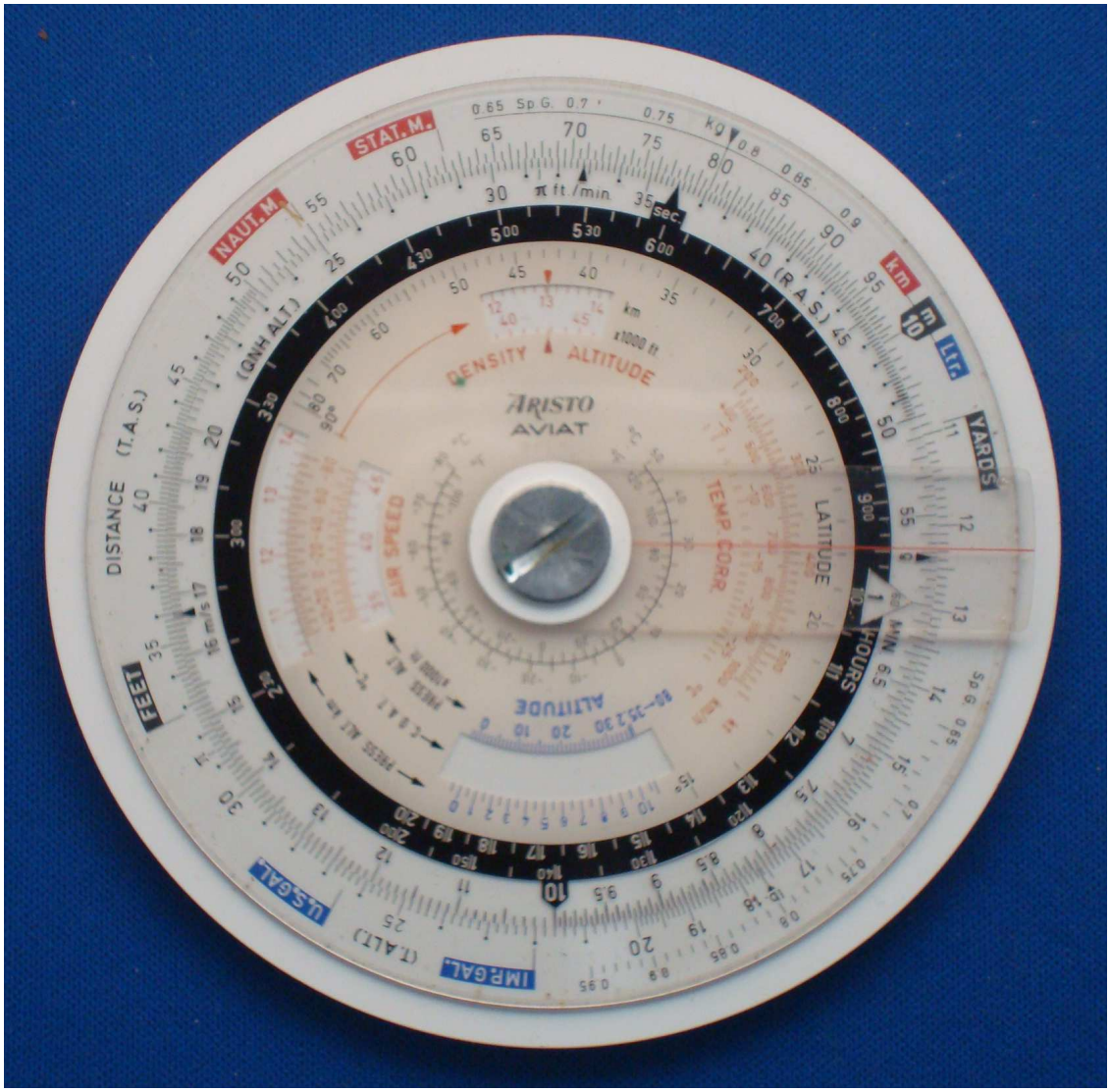

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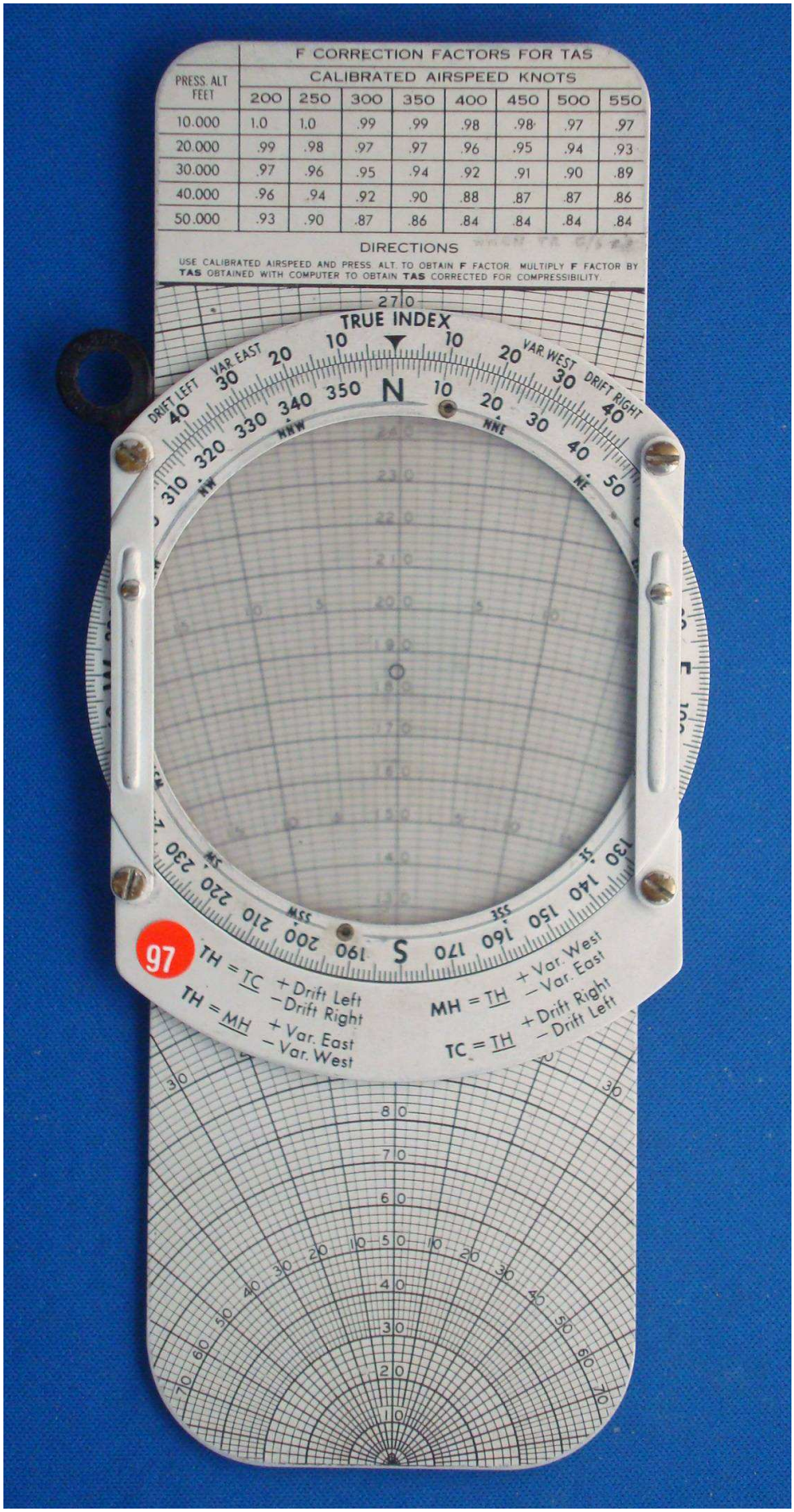

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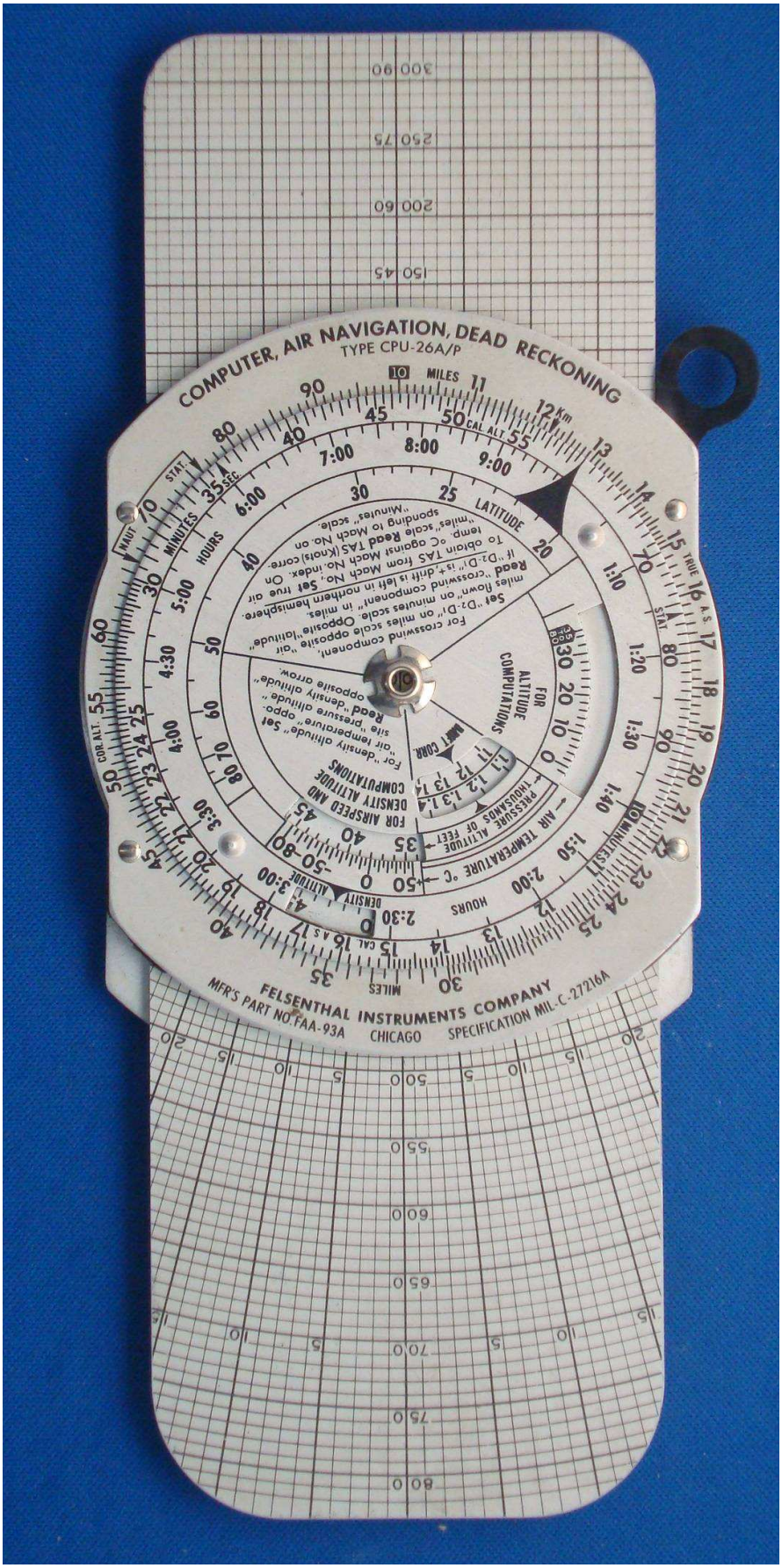

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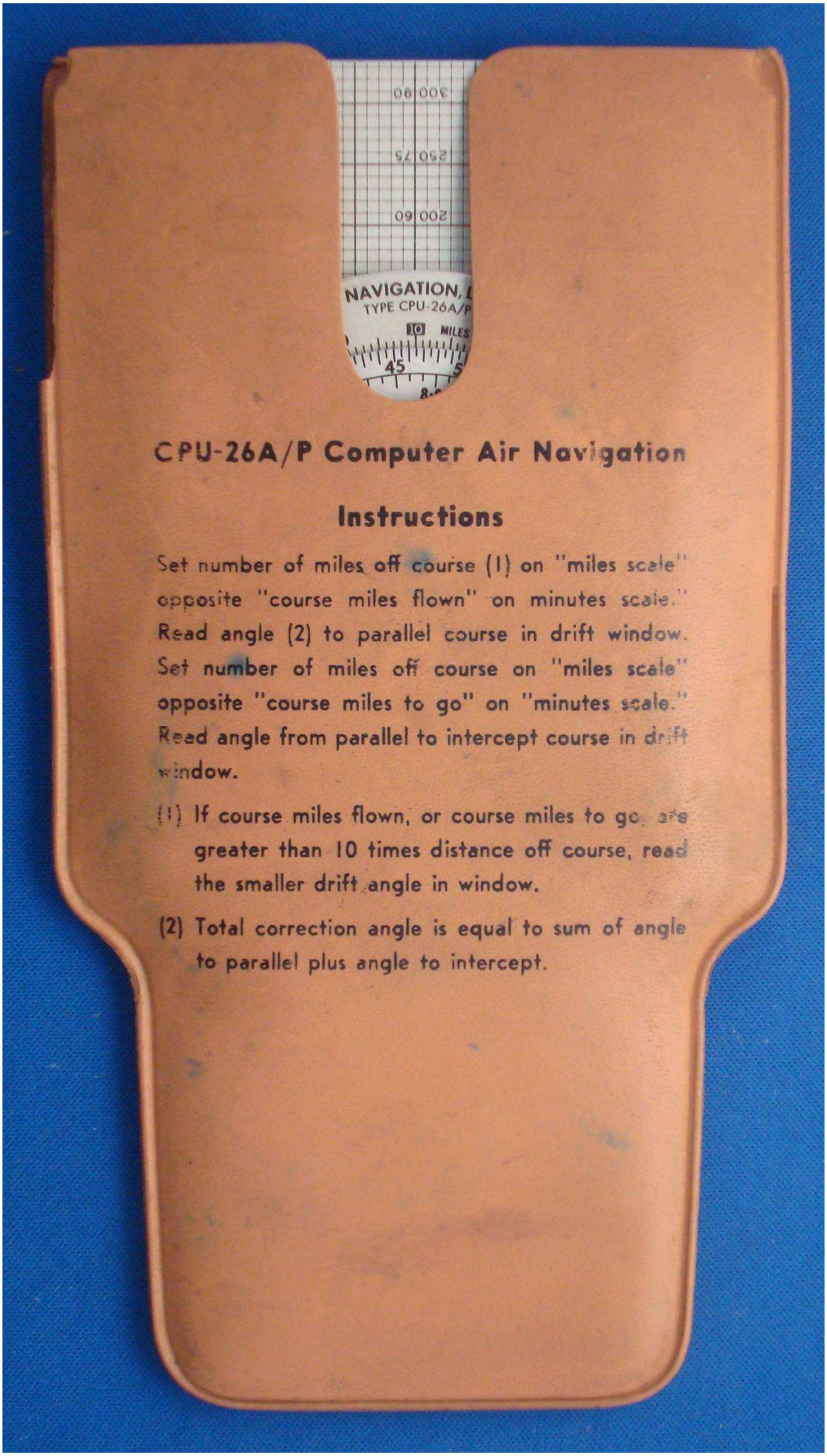

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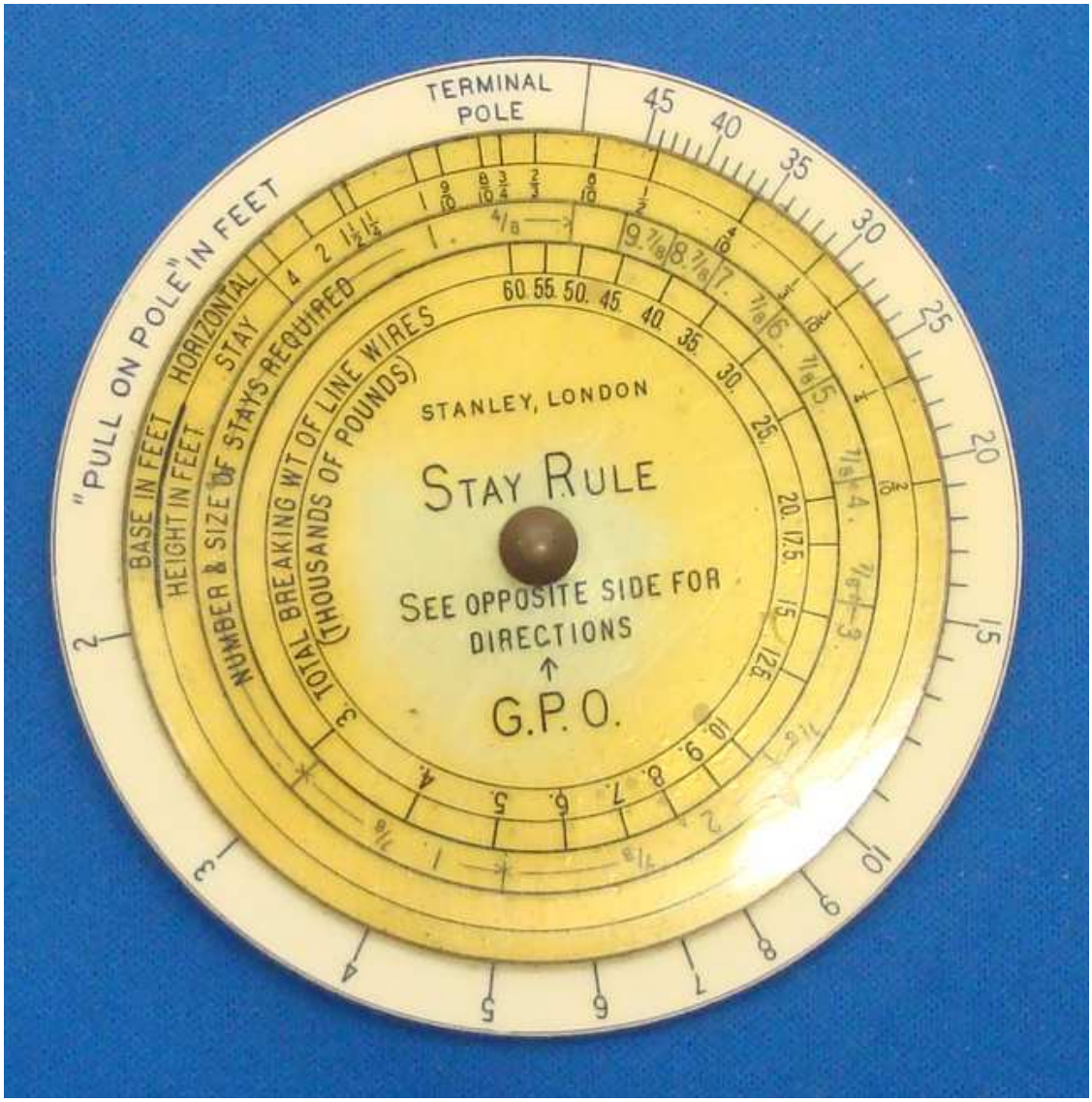

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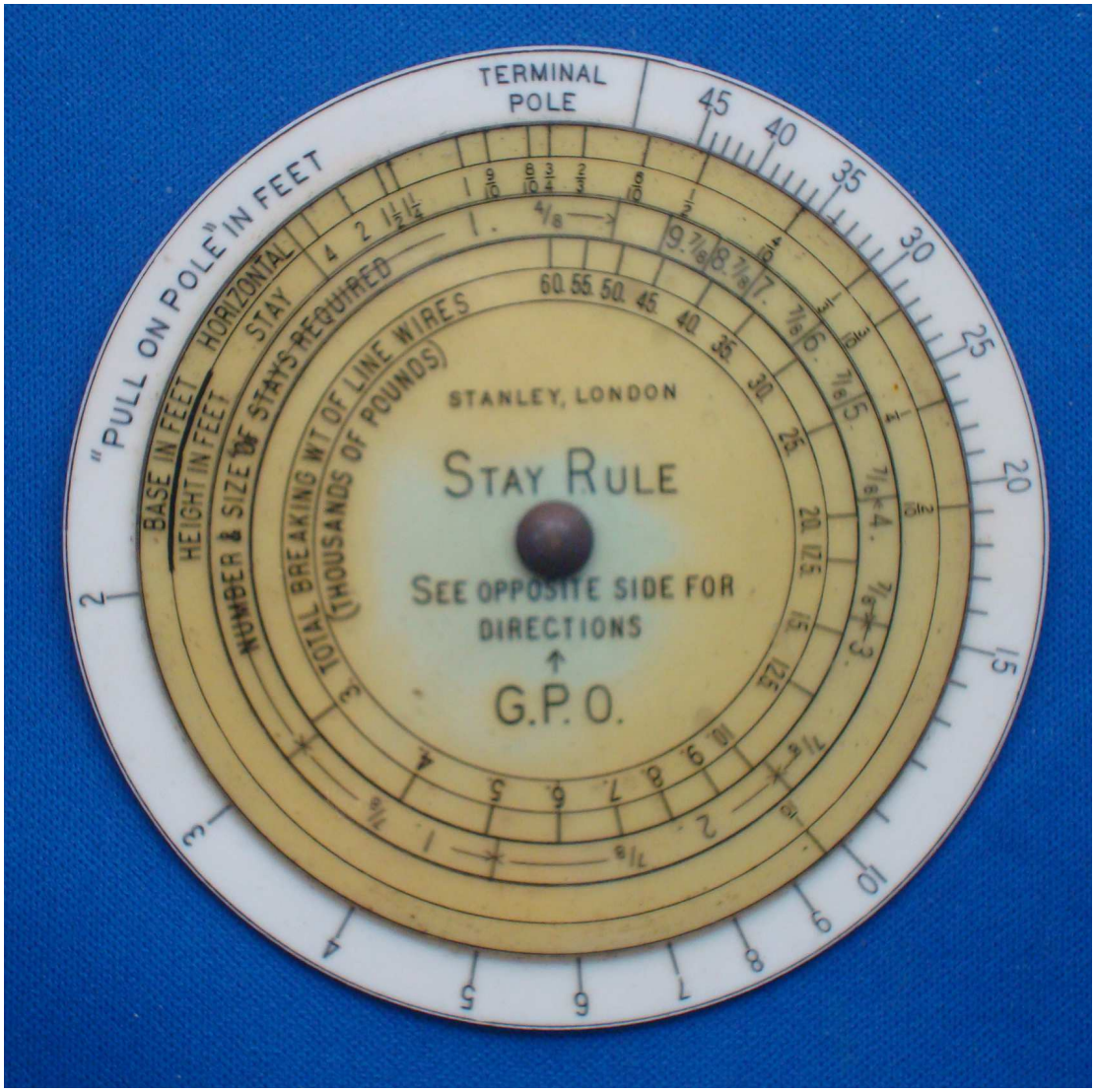

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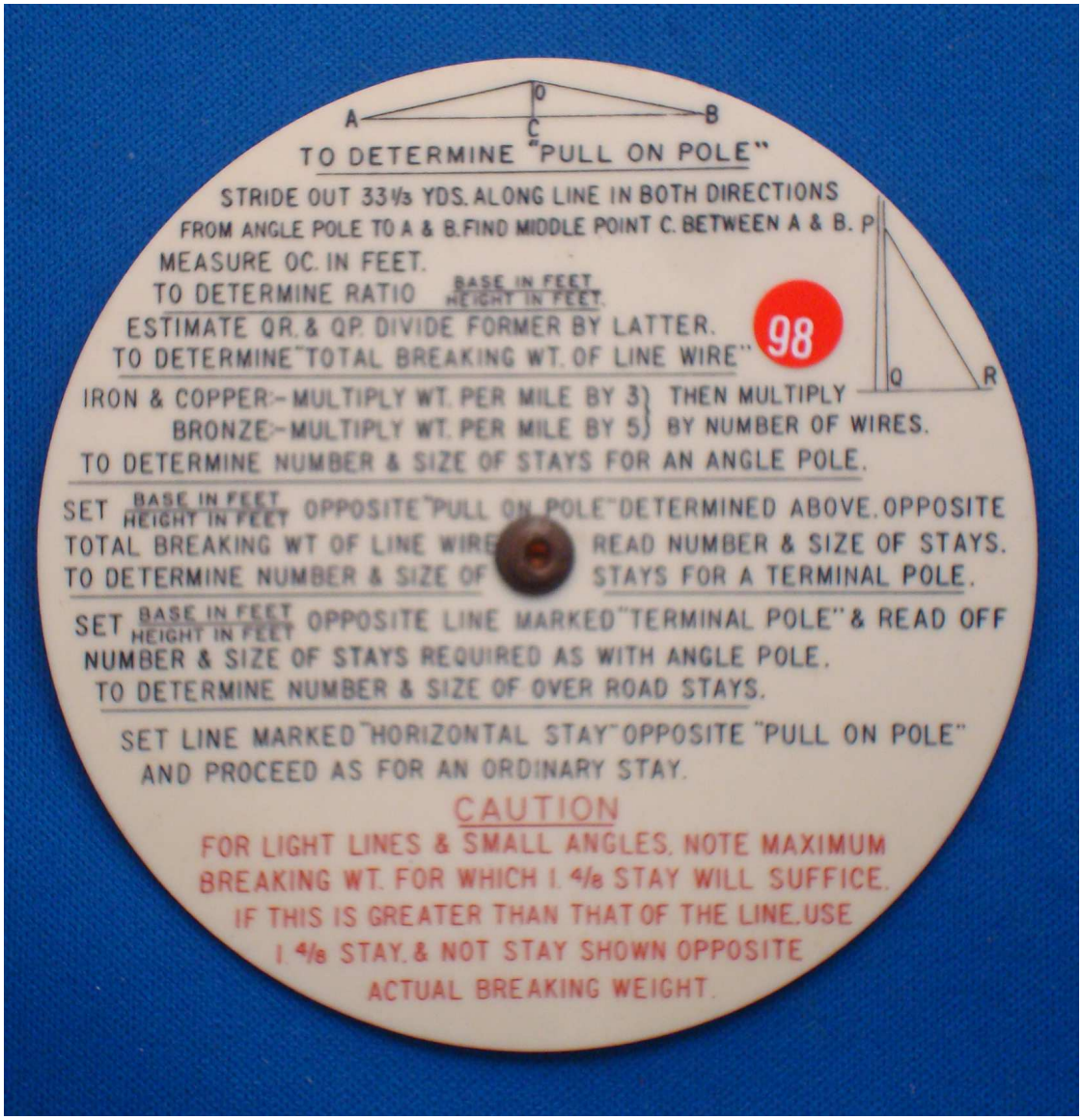

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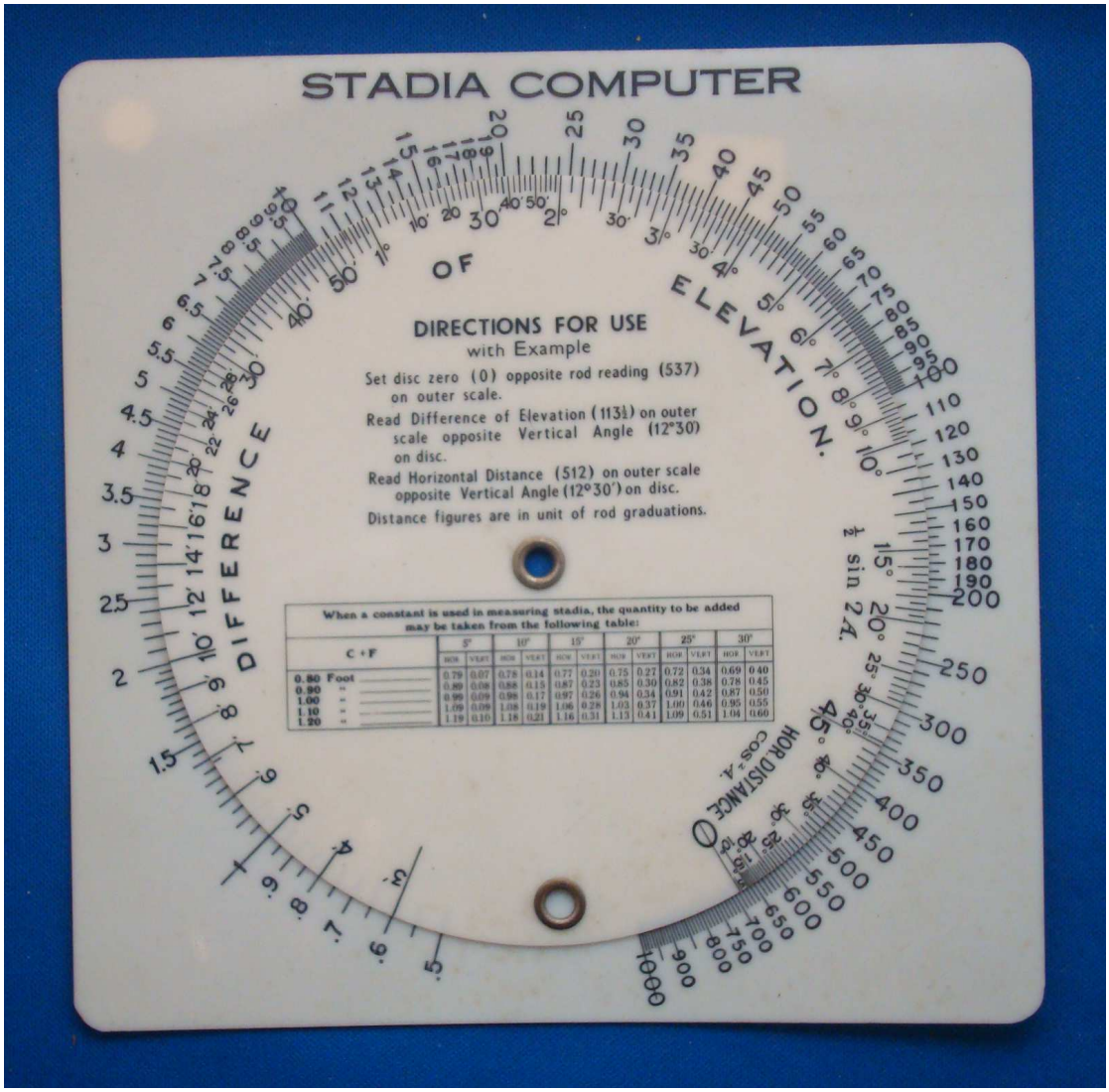

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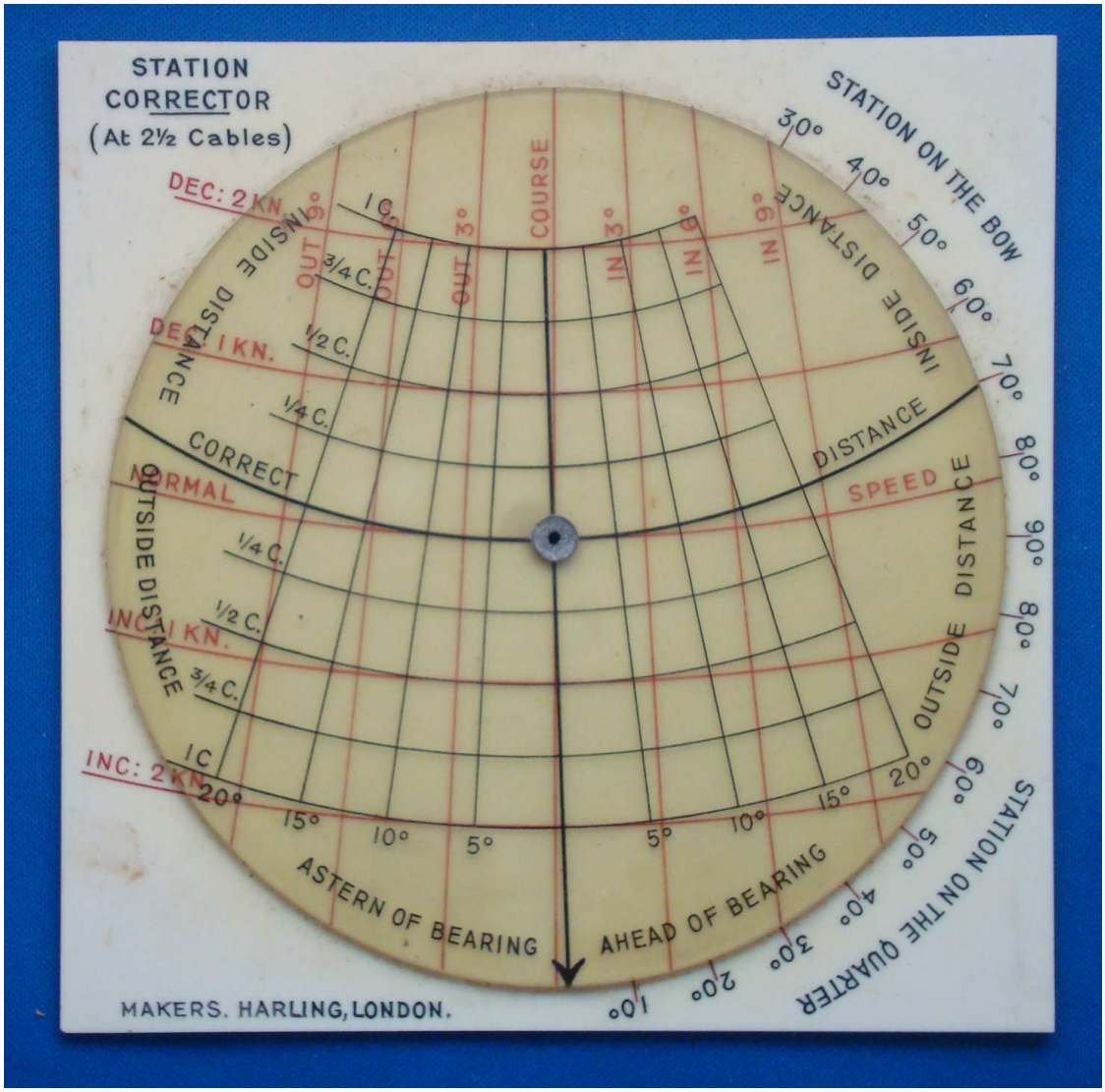

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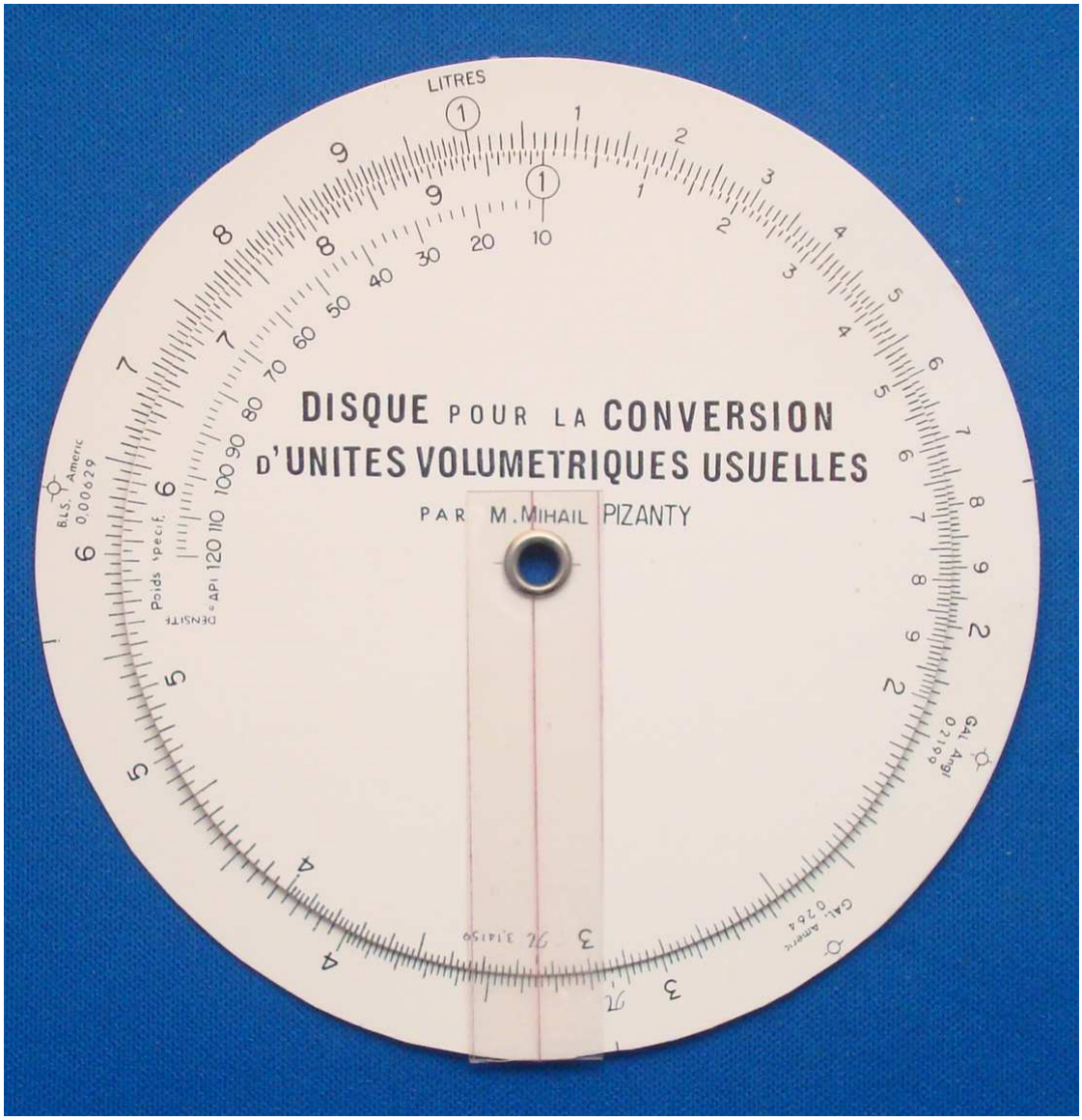

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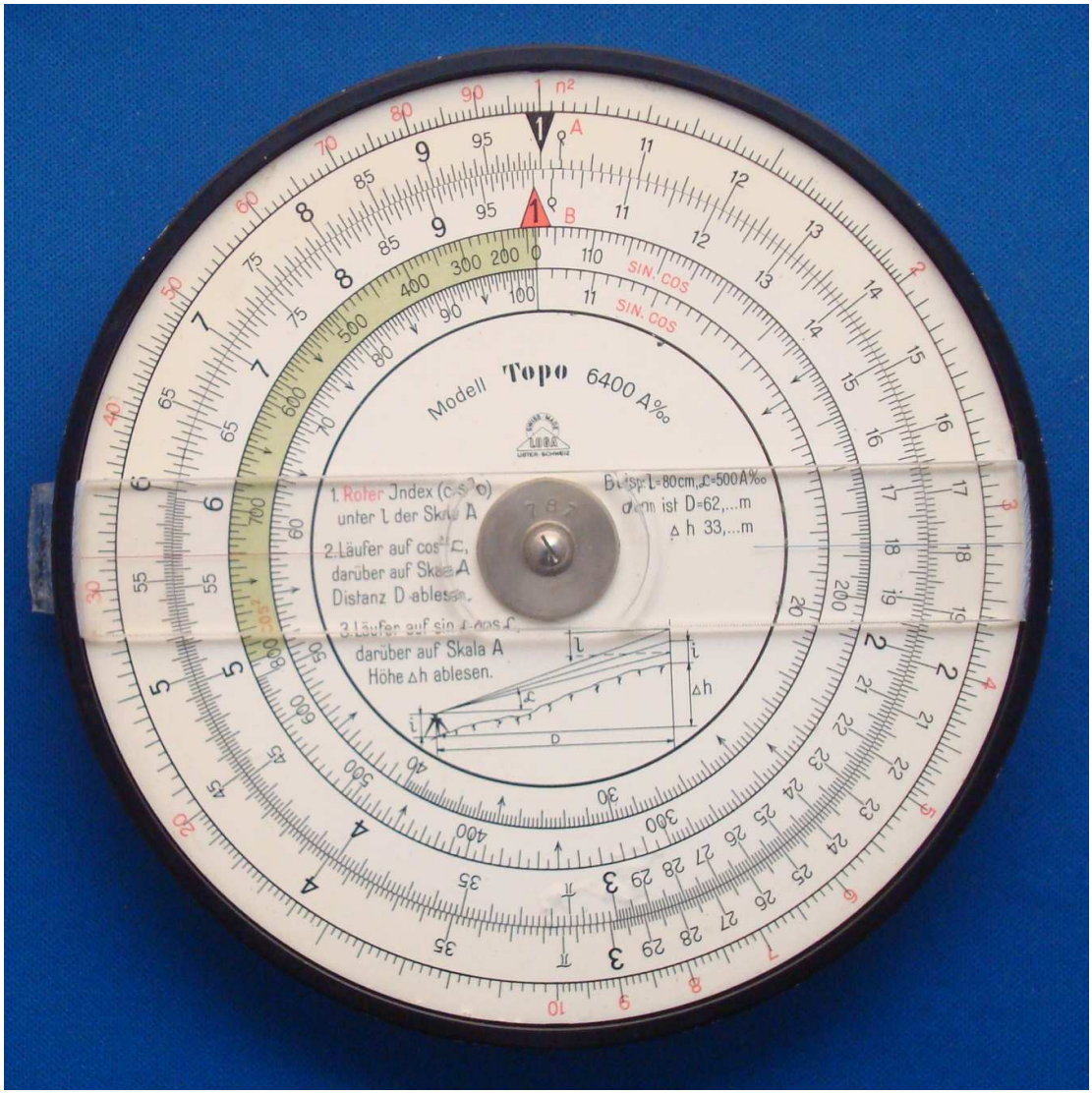
Figure 51: TCD-SCSS-U.20121208.013-fig51

Figure 52: TCD-SCSS-U.20121208.013-fig52



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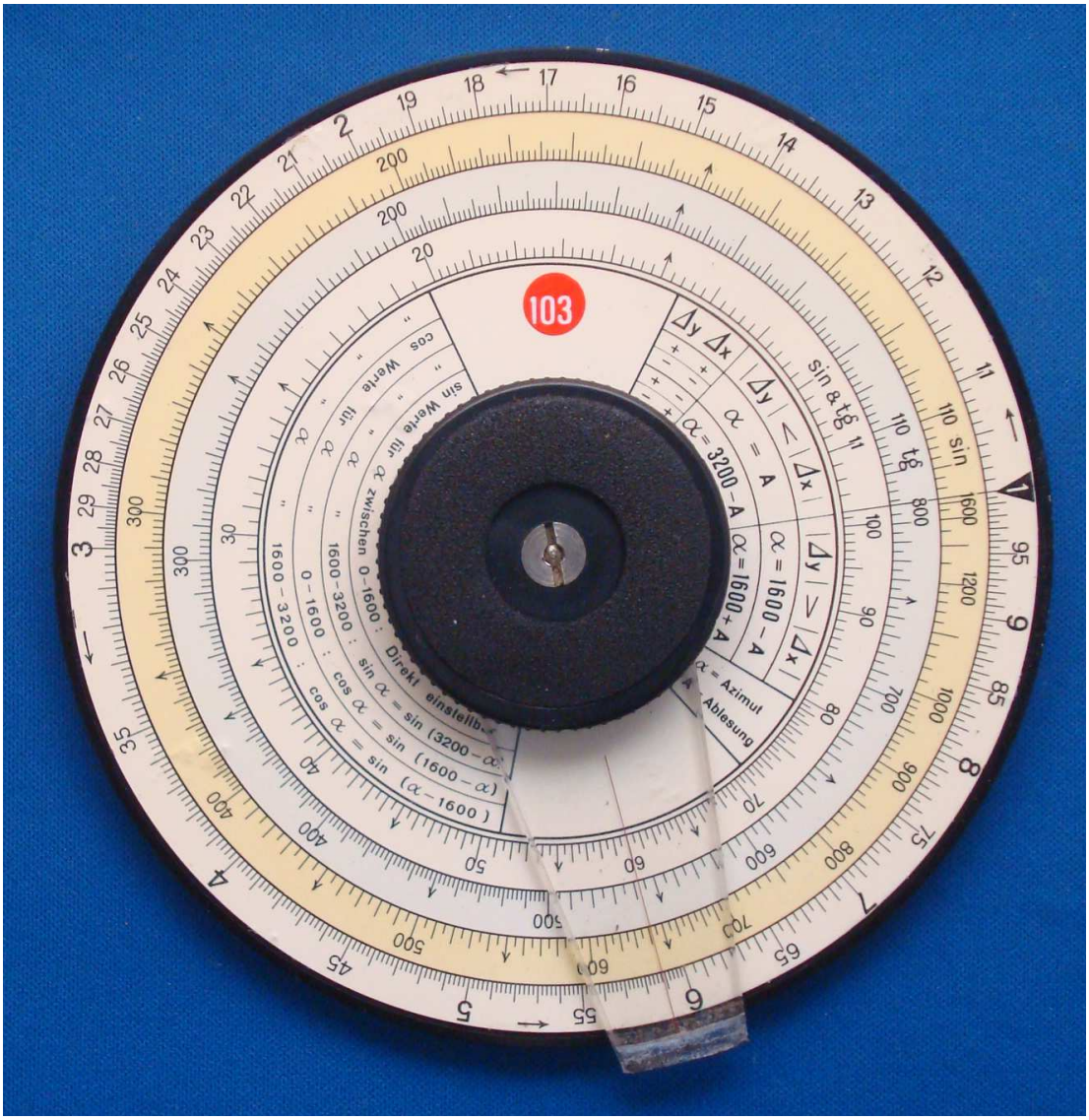


Figure 54: TCD-SCSS-U.20121208.013-fig54

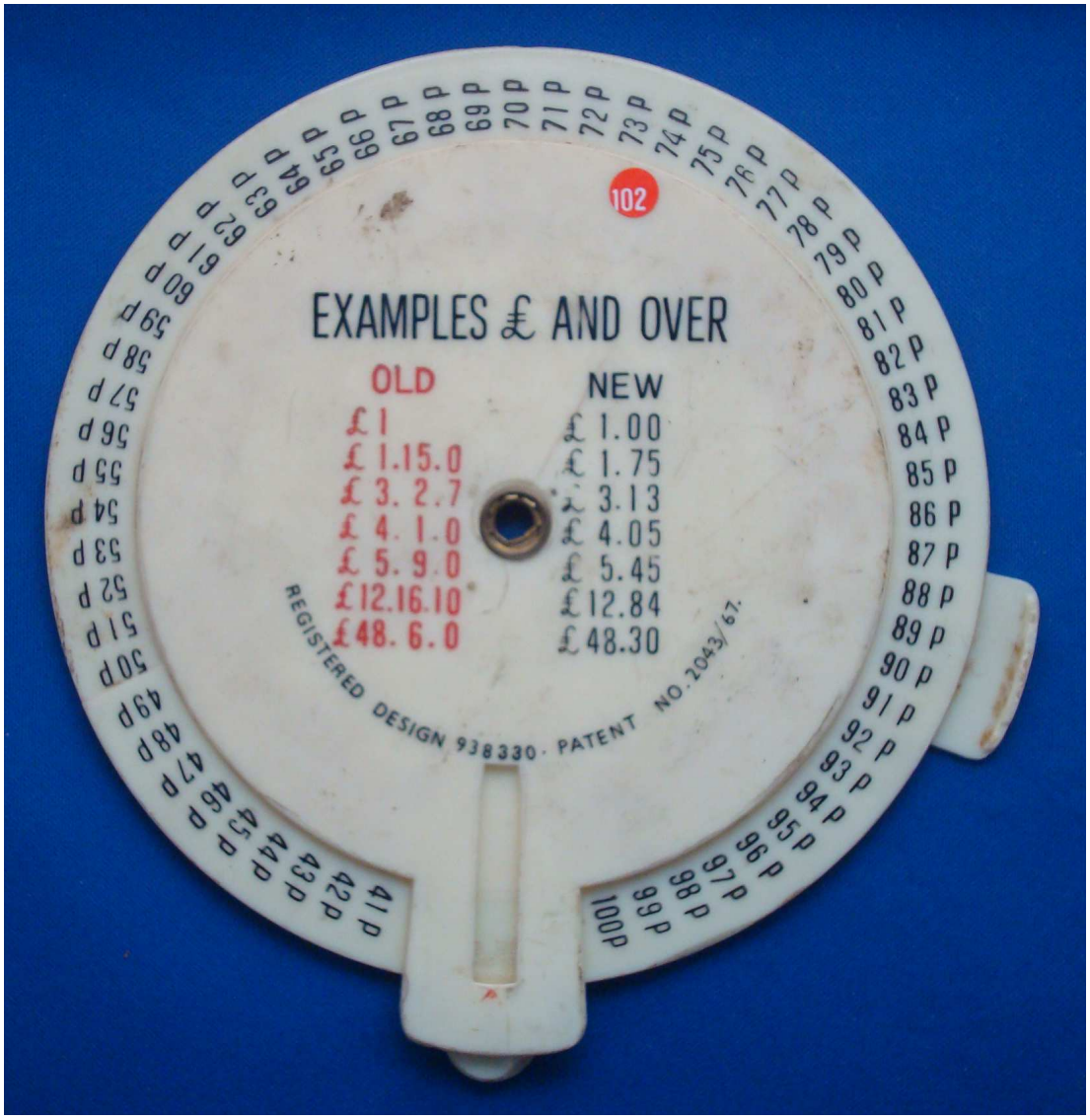


Figure 55: TCD-SCSS-U.20121208.013-fig55

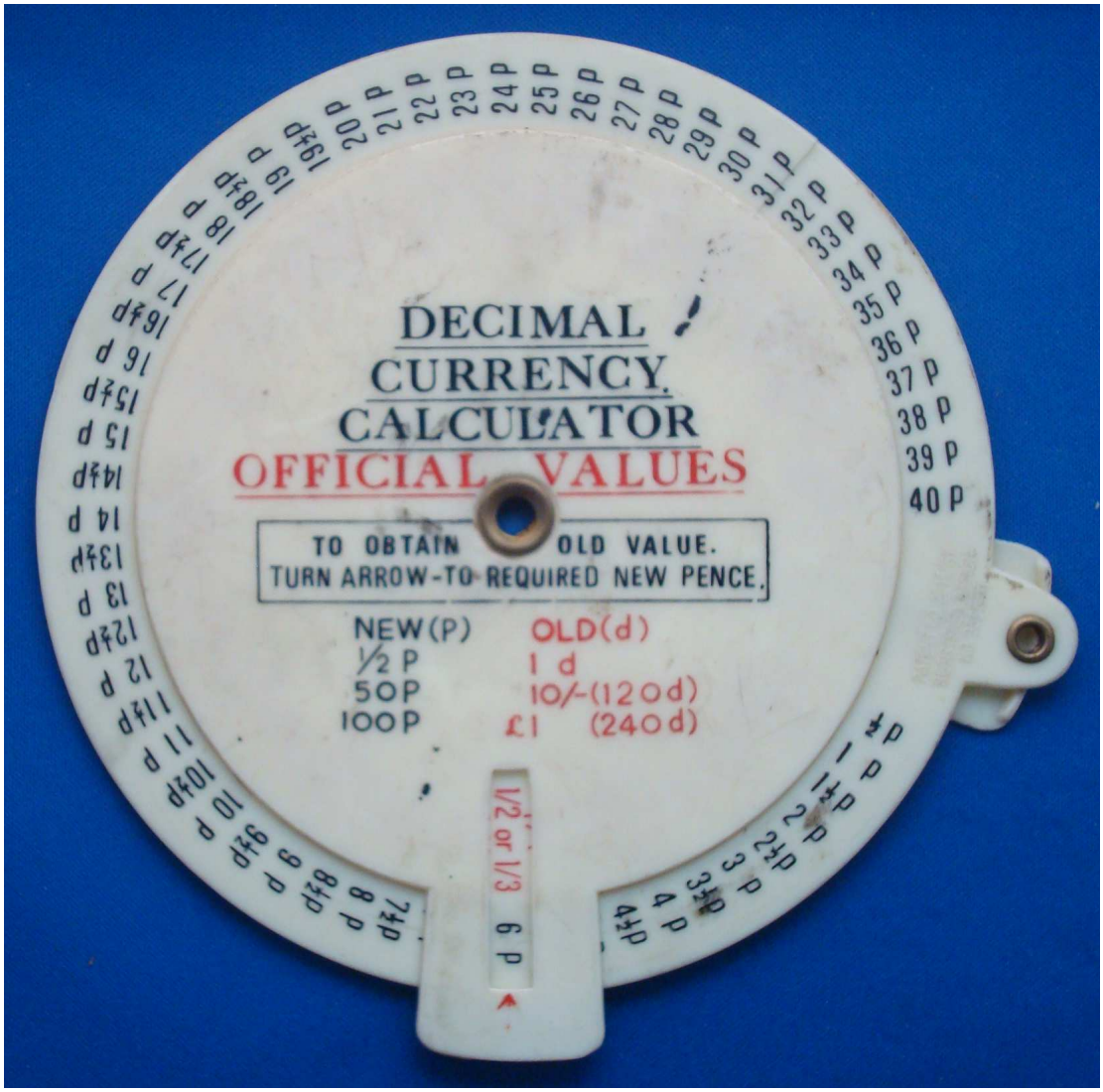


Figure 56: TCD-SCSS-U.20121208.013-fig56

Figure 57: TCD-SCSS-U.20121208.013-fig57

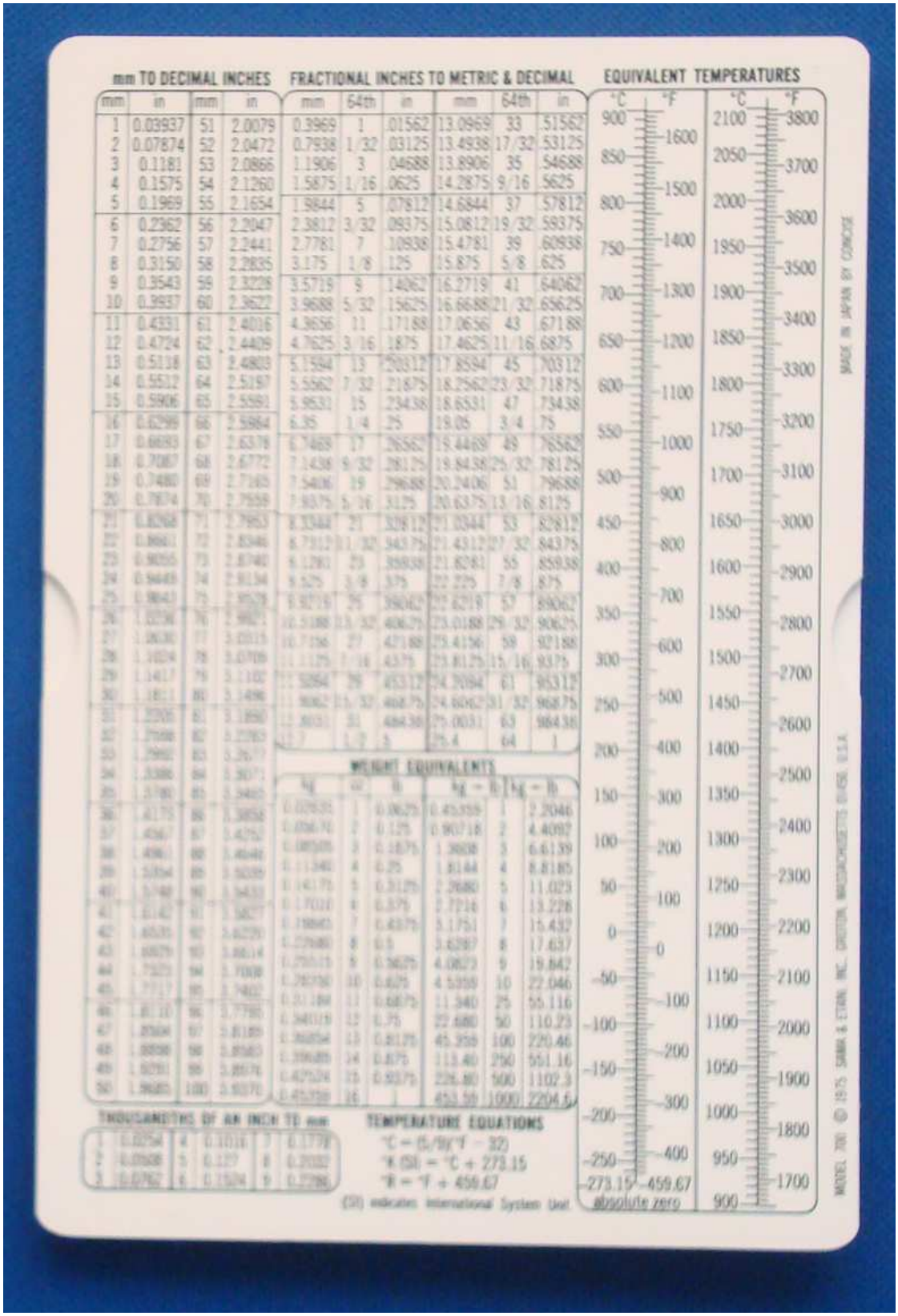
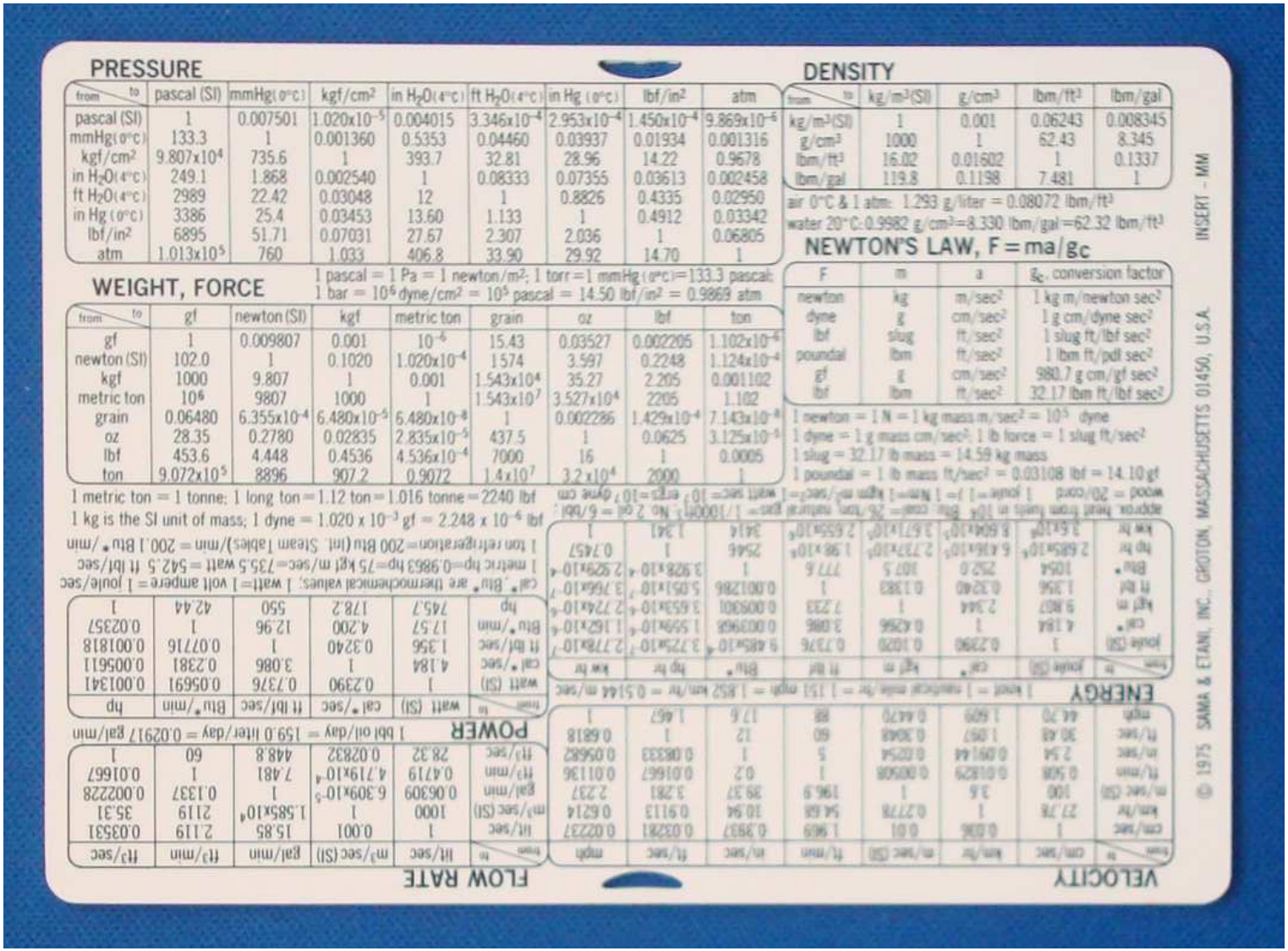


Figure 58: TCD-SCSS-U.20121208.013-fig58



PRESSURE

from \ to	pascal (SI)	mmHg (0°C)	kgf/cm²	in H_2O (4°C)	ft H_2O (4°C)	in Hg (0°C)	lbf/in²	atm
pascal (SI)	1	0.007501	1.020×10^{-5}	0.004015	3.346×10^{-4}	2.953×10^{-4}	1.450×10^{-4}	9.869×10^{-6}
mmHg (0°C)	133.3	1	0.001360	0.5353	0.04460	0.03937	0.01934	0.001316
kgf/cm²	9.807×10^{4}	735.6	1	393.7	32.81	28.96	14.22	0.9678
in H_2O (4°C)	249.1	1.868	0.002540	1	0.08333	0.07355	0.03613	0.002458
ft H_2O (4°C)	2989	22.42	0.03048	12	1	0.8826	0.4335	0.02950
in Hg (0°C)	3386	25.4	0.03453	13.60	1.133	1	0.4912	0.03342
lbf/in²	6895	51.71	0.07031	27.67	2.307	2.036	1	0.06805
atm	1.013×10^{5}	760	1.033	406.8	33.90	29.92	14.70	1

1 pascal = 1 Pa = 1 newton/m²; 1 torr = 1 mmHg (0°C) = 133.3 pascal;
1 bar = 10^6 dyne/cm² = 10^5 pascal = 14.50 lbf/in² = 0.9869 atm

DENSITY

from \ to	kg/m³ (SI)	g/cm³	lbm/ft³	lbm/gal
kg/m³ (SI)	1	0.001	0.06243	0.008345
g/cm³	1000	1	62.43	8.345
lbm/ft³	16.02	0.01602	1	0.1337
lbm/gal	119.8	0.1198	7.481	1

air 0°C & 1 atm: 1.293 g/liter = 0.08072 lbm/ft³
water 20°C: 0.9982 g/cm³ = 8.330 lbm/gal = 62.32 lbm/ft³

NEWTON'S LAW, $F = ma/g_c$

F	m	a	g_c, conversion factor
newton	kg	m/sec²	1 kg m/newton sec²
dyne	g	cm/sec²	1 g cm/dyne sec²
lbf	slug	ft/sec²	1 slug ft/lbf sec²
poundal	lbm	ft/sec²	1 lbm ft/pdl sec²
gf	g	cm/sec²	980.7 g cm/gf sec²
lbf	lbm	ft/sec²	32.17 lbm ft/lbf sec²

1 newton = 1 N = 1 kg mass m/sec² = 10^5 dyne
1 dyne = 1 g mass cm/sec²; 1 lb force = 1 slug ft/sec²
1 slug = 32.17 lb mass = 14.59 kg mass
1 poundal = 1 lb mass ft/sec² = 0.03108 lbf = 14.10 gf

WEIGHT, FORCE

from \ to	gf	newton (SI)	kgf	metric ton	grain	oz	lbf	ton
gf	1	0.009807	0.001	10^{-6}	15.43	0.03527	0.002205	1.102×10^{-6}
newton (SI)	102.0	1	0.1020	1.020×10^{-4}	1574	3.597	0.2248	1.124×10^{-4}
kgf	1000	9.807	1	0.001	1.543×10^{4}	35.27	2.205	0.001102
metric ton	10^{6}	9807	1000	1	1.543×10^{7}	3.527×10^{4}	2205	1.102
grain	0.06480	6.355×10^{-4}	6.480×10^{-5}	6.480×10^{-8}	1	0.002286	1.429×10^{-4}	7.143×10^{-8}
oz	28.35	0.2780	0.02835	2.835×10^{-5}	437.5	1	0.0625	3.125×10^{-5}
lbf	453.6	4.448	0.4536	4.536×10^{-4}	7000	16	1	0.0005
ton	9.072×10^{5}	8896	907.2	0.9072	1.4×10^{7}	3.2×10^{4}	2000	1

1 metric ton = 1 tonne; 1 long ton = 1.12 ton = 1.016 tonne = 2240 lbf
1 kg is the SI unit of mass; 1 dyne = 1.020×10^{-3} gf = 2.248×10^{-6} lbf

VELOCITY

from \ to	cm/sec	km/hr	m/sec (SI)	ft/min	m/sec	ft/sec	mph
cm/sec	1	0.036	0.01	1.969	0.3937	0.03281	0.02237
km/hr	27.78	1	0.2778	54.68	10.94	0.9113	0.6214
m/sec (SI)	100	3.6	1	196.9	39.37	3.281	2.237
ft/min	0.508	0.01829	0.00508	1	0.2	0.01667	0.01136
m/sec	2.54	0.09144	0.0254	5	1	0.08333	0.05682
ft/sec	30.48	1.097	0.3048	60	12	1	0.6818
mph	44.70	1.609	0.4470	88	17.6	1.467	1

ENERGY

1 kwatt = 1 kilowatt mile/hr = 1.341 mph = 1.852 km/hr = 0.5144 m/sec

from \ to	joule (SI)	cal*	kgf m	ft lbf	Btu*	hp hr	kw hr
joule (SI)	1	0.2390	0.1020	0.7376	9.485×10^{-4}	3.725×10^{-7}	2.778×10^{-7}
cal*	4.184	1	0.4269	3.088	0.003968	1.559×10^{-6}	1.162×10^{-6}
kgf m	9.807	2.344	1	7.233	0.009301	3.653×10^{-6}	2.724×10^{-6}
ft lbf	1.356	0.3240	0.1383	1	0.001286	5.051×10^{-7}	3.766×10^{-7}
Btu*	1054	252.0	107.5	777.6	1	3.928×10^{-4}	2.929×10^{-4}
hp hr	2.685×10^{6}	6.416×10^{5}	2.737×10^{5}	1.98×10^{6}	2546	1	0.7457
kw hr	3.6×10^{6}	8.604×10^{5}	3.671×10^{5}	2.655×10^{6}	3414	1.341	1

approx. heat from fuels in 10^4 Btu/cord = 26 ton natural gas = 1/1000th No. 2 oil = 6/bbl;
wood = 20/cord 1 joule = 1 Nm = 1 kgm m²/sec² = 1 watt sec = 10^7 ergs = 10^7 dyne cm

FLOW RATE

from \ to	ft³/sec	m³/sec (SI)	gal/min	ft³/min
ft³/sec	1	0.001	15.85	2.119
m³/sec (SI)	1000	1	1.585×10^{4}	2119
gal/min	0.06309	6.309×10^{-5}	1	0.1337
ft³/min	0.4719	4.719×10^{-4}	7.481	1
ft³/sec	28.32	0.02832	448.8	60

POWER

1 bbl oil/day = 159.0 liter/day = 0.02917 gal/min

from \ to	watt (SI)	cal*/sec	ft lbf/sec	Btu*/min	hp
watt (SI)	1	0.2390	0.7376	0.05691	0.001341
cal*/sec	4.184	1	3.086	0.2381	0.005611
ft lbf/sec	1.356	0.3240	1	0.07716	0.001818
Btu*/min	17.57	4.200	12.96	1	0.02357
hp	745.7	178.2	550	42.44	1

cal*, Btu* are thermochemical values; 1 watt = 1 volt ampere = 1 joule/sec
1 metric hp = 0.9863 hp = 75 kgf m/sec = 735.5 watt = 542.5 ft lbf/sec
1 ton refrigeration = 200 Btu (int. Steam Tables)/min = 200.1 Btu*/min

INSERT - MM

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Figure 59: TCD-SCSS-U.20121208.013-fig59

LENGTH

from \ to	cm	decimeter	m (SI)	dekameter	hectometer	km	in	ft	yd	mile
cm	1	0.1	0.01	0.001	10^{-4}	10^{-5}	0.3937	0.03281	0.01094	6.214×10^{-6}
decimeter	10	1	0.1	0.01	0.001	10^{-4}	3.937	0.3281	0.1094	6.214×10^{-5}
m (SI)	100	10	1	0.1	0.01	0.001	39.37	3.281	1.094	6.214×10^{-4}
dekameter	1000	100	10	1	0.1	0.01	393.7	32.81	10.94	0.006214
hectometer	10^4	1000	100	10	1	0.1	3937	328.1	109.4	0.06214
km	10^5	10^4	1000	100	10	1	3.937×10^4	3281	1094	0.6214
in	2.54	0.254	0.0254	0.00254	2.54×10^{-4}	2.54×10^{-5}	1	0.08333	0.02778	1.578×10^{-5}
ft	30.48	3.048	0.3048	0.03048	0.003048	3.048×10^{-4}	12	1	0.3333	1.894×10^{-4}
yd	91.44	9.144	0.9144	0.09144	0.009144	9.144×10^{-4}	36	3	1	5.682×10^{-4}
mile	1.609×10^5	1.609×10^4	1609	160.9	16.09	1.609	6.336×10^4	5280	1760	1

1 angstrom = 1 Å = 10^{-10}m; 1 micron = 1 μm = 10^{-6}m; 1 mil = 0.001 in; 1 pica = 12 point = 0.4218 cm = 0.1660 in;
1 nautical mile = 1.852 km = 6076 ft = 1.151 mile; 1 light year = 5.879×10^{12} mile = 9.461×10^{12} km

AREA

from \ to	cm^2	m^2 (SI)	are	hectare	km^2	in^2	ft^2	yd^2	acre	$mile^2$
cm^2	1	10^{-4}	10^{-6}	10^{-8}	10^{-10}	0.1550	0.001076	1.196×10^{-4}	2.471×10^{-8}	3.861×10^{-11}
m^2 (SI)	10^4	1	0.01	10^{-4}	10^{-6}	1550	10.76	1.196	2.471×10^{-4}	3.861×10^{-7}
are	10^6	100	1	0.01	10^{-4}	1.550×10^5	1076	119.6	0.02471	3.861×10^{-5}
hectare	10^8	10^4	100	1	0.01	1.550×10^7	1.076×10^5	1.196×10^4	2.471	0.003861
km^2	10^{10}	10^6	10^4	100	1	1.550×10^9	1.076×10^7	1.196×10^6	247.1	0.3861
in^2	6.452	6.452×10^{-4}	6.452×10^{-6}	6.452×10^{-8}	6.452×10^{-10}	1	0.006944	7.716×10^{-4}	1.594×10^{-7}	2.491×10^{-10}
ft^2	929.0	0.09290	9.290×10^{-4}	9.290×10^{-6}	9.290×10^{-8}	144	1	0.1111	2.296×10^{-5}	3.587×10^{-8}
yd^2	8361	0.8361	0.08361	8.361×10^{-5}	8.361×10^{-7}	1296	9	1	2.066×10^{-4}	3.228×10^{-7}
acre	4.047×10^7	4047	40.47	0.4047	0.004047	6.273×10^6	4.356×10^4	4840	1	0.001562
$mile^2$	2.590×10^{10}	2.590×10^6	2.590×10^4	259.0	2.590	4.014×10^9	2.788×10^7	3.098×10^6	640	1

1 mm^2 = 0.01 cm^2 = $10^{-6}m^2$ = 0.001550 in^2; 1 are = 1 dekameter^2; 1 circular mil = 5.067×10^{-10} m^2 = 7.854×10^{-7} in^2

VOLUME

from \ to	cm^3	liter	dekaliter	hectoliter	m^3 (SI)	in^3	ft^3	yd^3	fl oz	fl qt	gal	gal (U.K.)	bbl (oil)
cm^3	1	0.001	10^{-4}	10^{-5}	10^{-6}	0.06102	3.531×10^{-5}	1.308×10^{-6}	0.03381	0.001057	2.642×10^{-4}	2.200×10^{-4}	6.290×10^{-6}
liter	1000	1	0.1	0.01	0.001	61.02	0.03531	0.001308	33.81	1.057	0.2642	0.2200	0.006290
dekaliter	10^4	10	1	0.1	0.01	610.2	0.3531	0.01308	338.1	10.57	2.642	2.200	0.06290
hectoliter	10^5	100	10	1	0.1	6102	3.531	0.1308	3381	105.7	26.42	22.00	0.6290
m^3 (SI)	10^6	1000	100	10	1	6.102×10^4	35.31	1.308	3.381×10^4	1057	264.2	220.0	6.290
in^3	16.39	0.01639	0.001639	1.639×10^{-4}	1.639×10^{-5}	1	5.787×10^{-4}	2.143×10^{-5}	0.5541	0.01732	0.004329	0.003605	1.031×10^{-4}
ft^3	2.832$\times10^4$	28.32	2.832	0.2832	0.02832	1728	1	0.03704	957.5	29.92	7.481	6.229	0.1781
yd^3	7.646×10^5	764.6	76.46	7.646	0.7646	4.666×10^4	27	1	2.585×10^4	807.9	202.0	168.2	4.809
fl oz	29.57	0.02957	0.002957	2.957×10^{-4}	2.957×10^{-5}	1.805	0.001044	3.868×10^{-5}	1	0.03125	0.007812	0.006505	1.860×10^{-4}
fl qt	946.4	0.9464	0.09464	0.009464	9.464×10^{-4}	57.75	0.03342	0.001238	32	1	0.25	0.2082	0.005952
gal	3785	3.785	0.3785	0.03785	0.003785	231	0.1337	0.004951	128	4	1	0.8327	0.02381
gal (U.K.)	4546	4.546	0.4546	0.04546	0.004546	277.4	0.1605	0.005946	153.7	4.804	1.201	1	0.02859
bbl (oil)	1.590×10^5	159.0	15.90	1.590	0.1590	9702	5.615	0.2079	5376	168	42	34.97	1

1 m^3 = 1 stere = 1 kiloliter
1 liter = 1 cubic decimeter = 1 dm^3
1 deciliter = 1 dl = 0.1 liter
1 bbl (liq) = 31.5 gallon = 0.1192 m^3
1 cord = 128 ft^3 = 3.625 m^3
1 fl. pint = 1/2 fl quart = 2 cup
1 cup = 8 fl oz = 16 tablespoon
1 tbsp = 3 tsp = 1/2 fl oz = 14.79 ml
1 dry qt = 1.164 fl qt = 1.101 liter
1 bu = 32 dry qt = 0.3524 hectoliter
1 bu/acre=0.8708 hectoliter/hectare

PREFIX VALUES

value	prefix	symbol
10^{12}	tera	T
10^9	giga	G
10^6	mega	M
10^3	kilo	k
10^2	hecto	h
10	deka	da
10^{-1}	deci	d
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n
10^{-12}	pico	p
10^{-15}	femto	f
10^{-18}	atto	a

Figure 60: TCD-SCSS-U.20121208.013-fig60

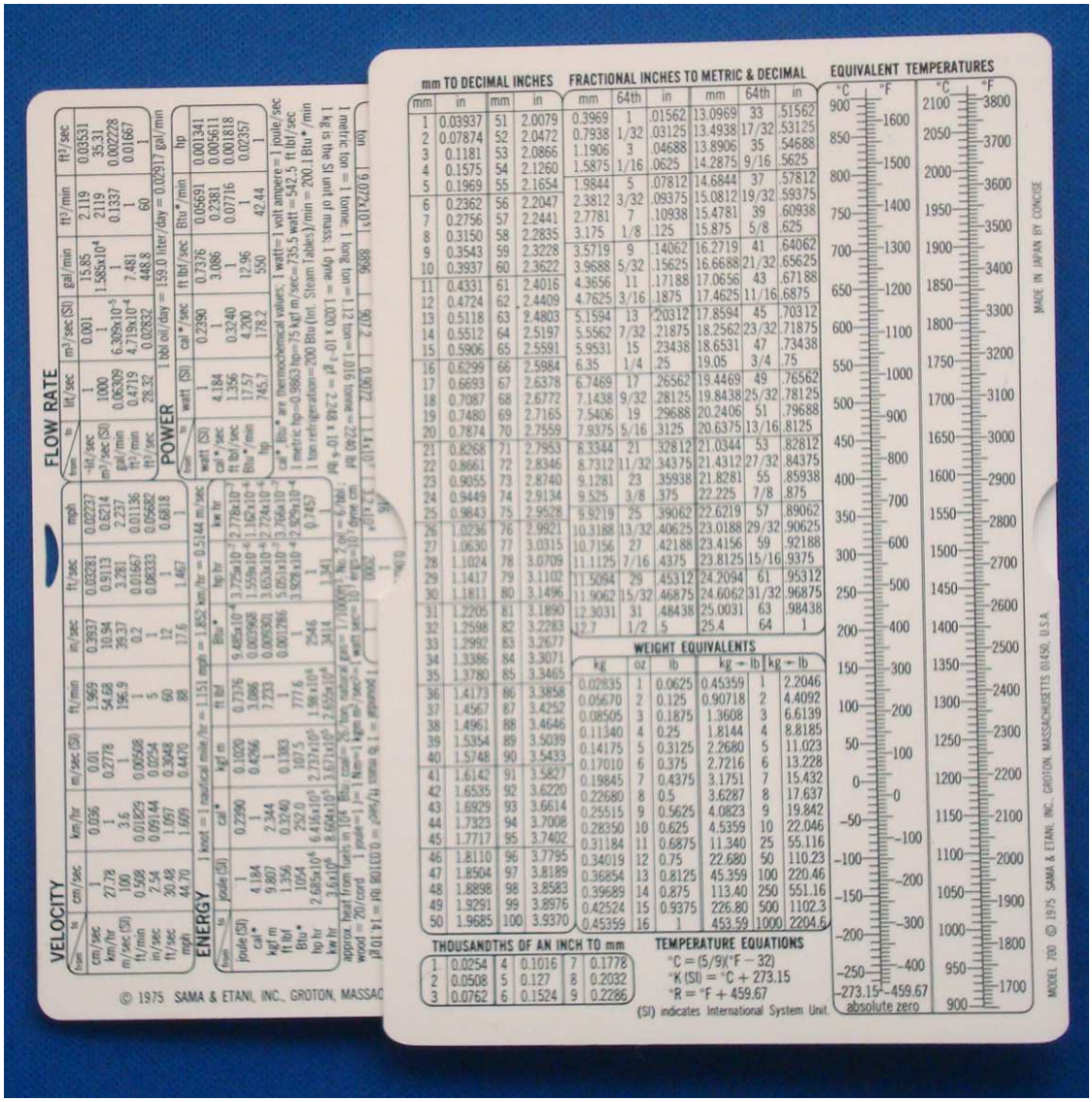


Figure 61: TCD-SCSS-U.20121208.013-fig61

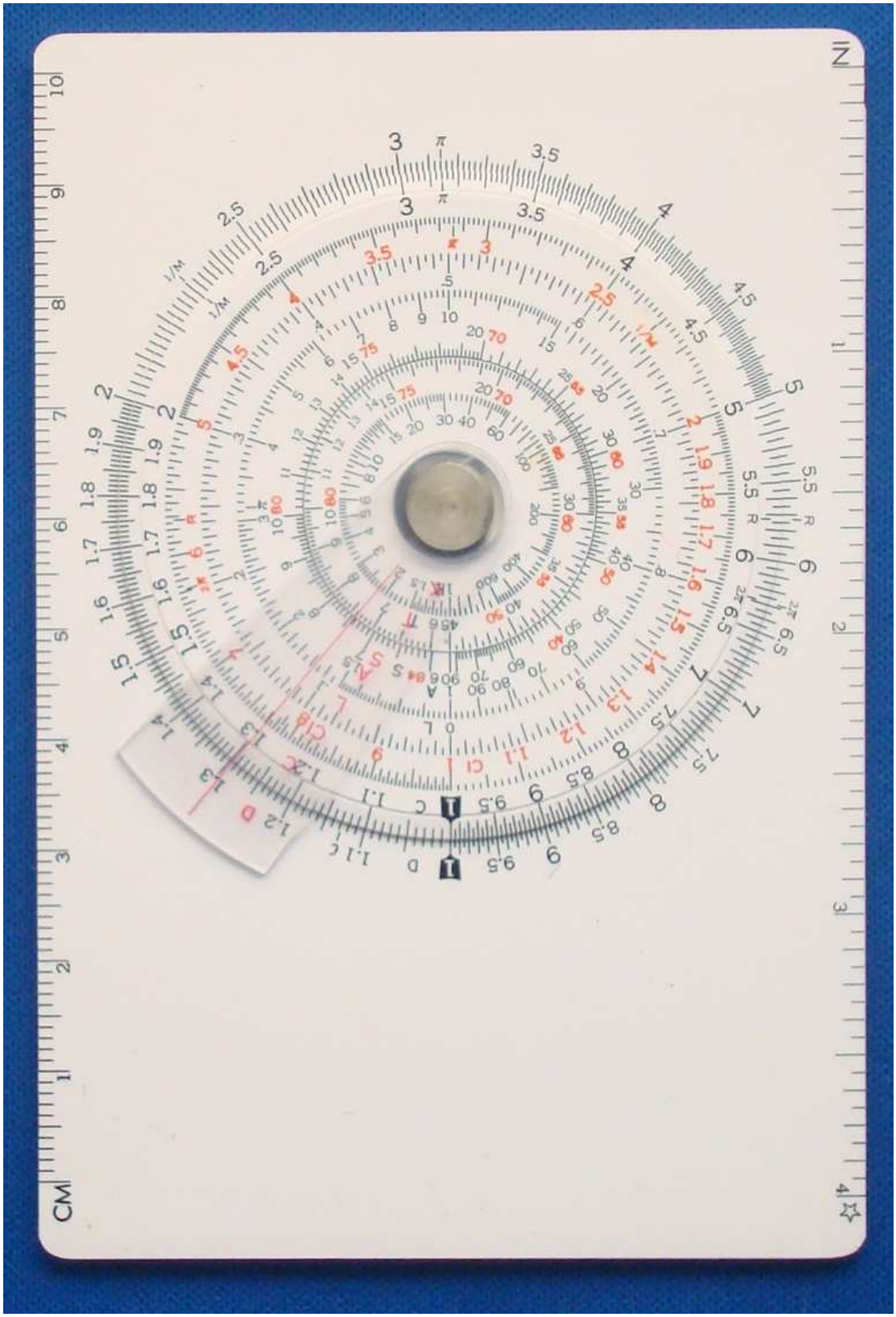


Figure 62: TCD-SCSS-U.20121208.013-fig62

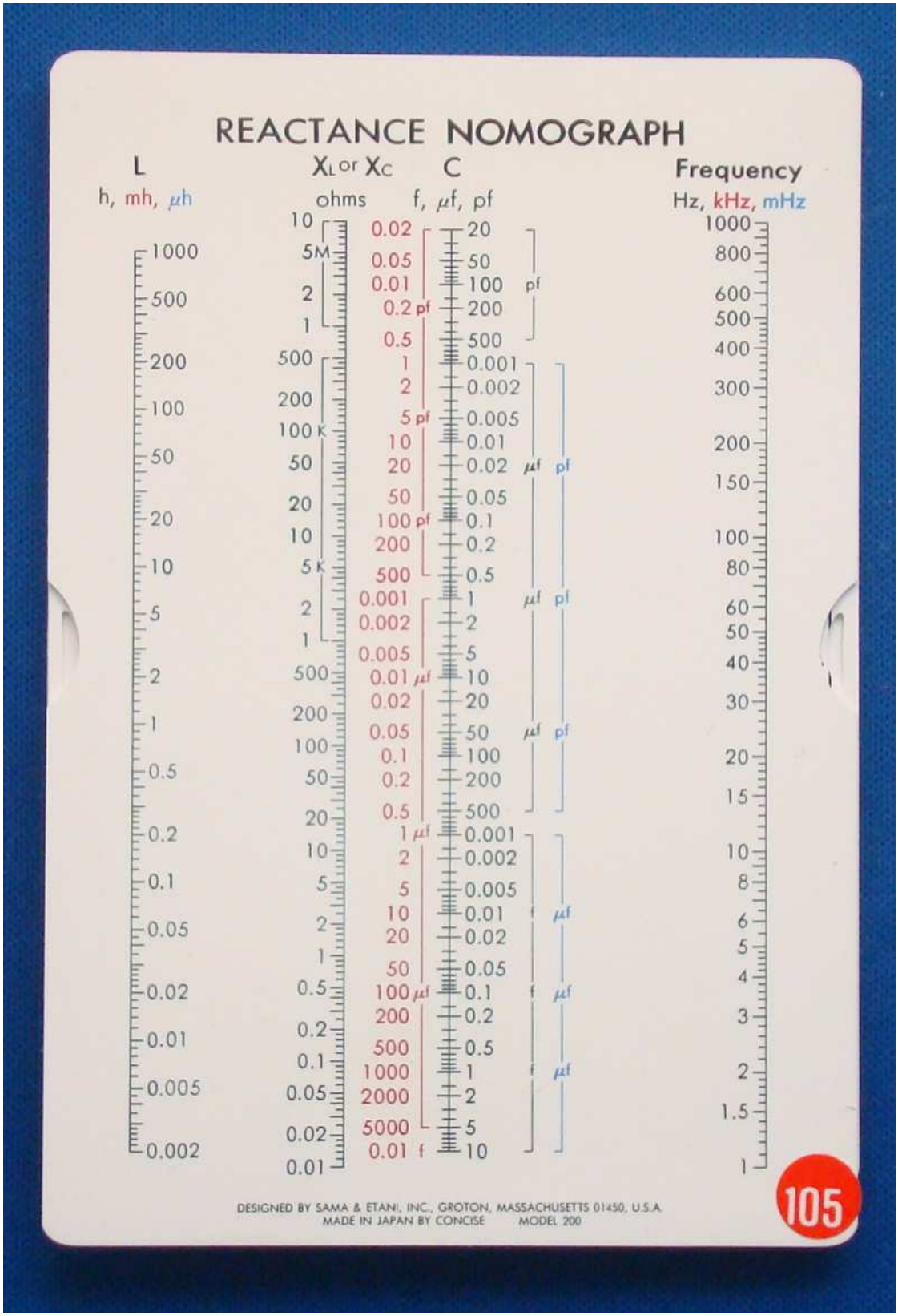
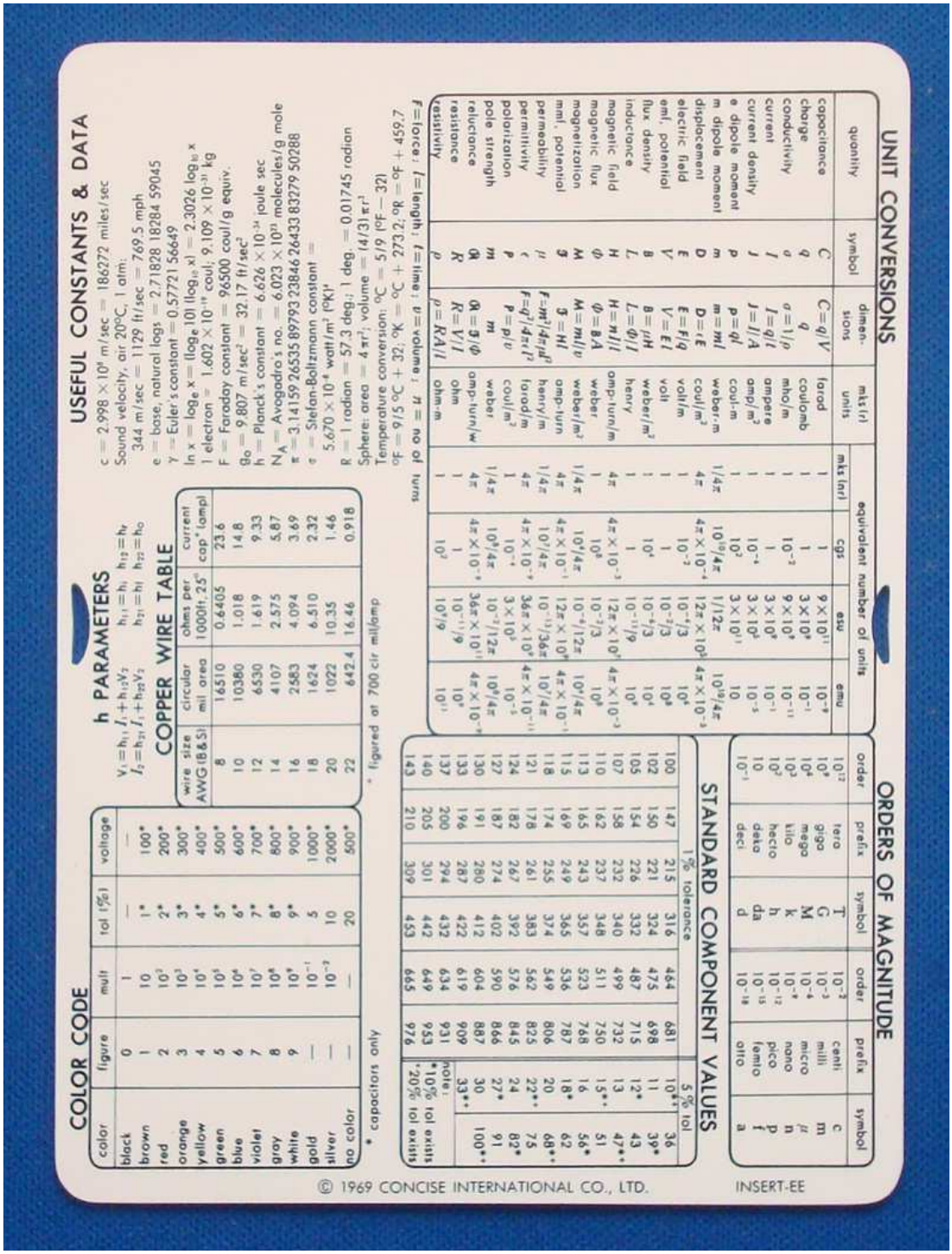


Figure 63: TCD-SCSS-U.20121208.013-fig63



UNIT CONVERSIONS

quantity	symbol	dimensions	mks (r) units	equivalent number of units: mks (nr)	cgs	esu	emu
capacitance	C	$C=q/V$	farad	1	1	9×10^{11}	10^{-9}
charge	q	q	coulomb	1	1	3×10^{9}	10^{-1}
conductivity	σ	$\sigma=1/\rho$	mho/m	1	10^{-2}	9×10^{9}	10^{-11}
current	I	$I=q/t$	ampere	1	1	3×10^{9}	10^{-1}
current density	J	$J=I/A$	amp/m^2	1	10^{-4}	3×10^{5}	10^{-5}
e dipole moment	p	$p=ql$	coul-m	1	10^{2}	3×10^{11}	10
m dipole moment	m	$m=ml$	weber-m	$1/4\pi$	$10^{10}/4\pi$	$1/12\pi$	$10^{10}/4\pi$
displacement	D	$D=\epsilon E$	coul/m^2	4π	$4\pi\times10^{-4}$	$12\pi\times10^{5}$	$4\pi\times10^{-3}$
electric field	E	$E=F/q$	volt/m	1	10^{-2}	$10^{-4}/3$	10^{4}
emf, potential	V	$V=El$	volt	1	1	$10^{-2}/3$	10^{8}
flux density	B	$B=\mu H$	weber/m^2	1	10^{4}	$10^{-6}/3$	10^{4}
inductance	L	$L=\Phi/I$	henry	1	1	$10^{-11}/9$	10^{9}
magnetic field	H	$H=nI/l$	amp-turn/m	4π	$4\pi\times10^{-3}$	$12\pi\times10^{7}$	$4\pi\times10^{-3}$
magnetic flux	Φ	$\Phi=BA$	weber	1	10^{8}	$10^{-2}/3$	10^{8}
magnetization	M	$M=ml/v$	weber/m^3	$1/4\pi$	$10^{4}/4\pi$	$10^{-6}/12\pi$	$10^{1}/4\pi$
mmf, potential	$\mathcal{F}$	$\mathcal{F}=nI$	amp-turn	4π	$4\pi\times10^{-1}$	$12\pi\times10^{8}$	$4\pi\times10^{-1}$
permeability	μ	$F=m^2/4\pi\mu d^2$	henry/m	$1/4\pi$	$10^{-7}/4\pi$	$10^{-11}/36\pi$	$10^{7}/4\pi$
permittivity	ϵ	$F=q^2/4\pi\epsilon l^2$	farad/m	4π	$4\pi\times10^{-9}$	$36\pi\times10^{9}$	$4\pi\times10^{-11}$
polarization	P	$P=pl/v$	coul/m^2	1	10^{-5}	3×10^{5}	10^{-5}
pole strength	m	m	weber	$1/4\pi$	$10^{8}/4\pi$	$10^{-7}/12\pi$	$10^{8}/4\pi$
reluctance	$\mathcal{R}$	$\mathcal{R}=\mathcal{F}/\Phi$	amp-turn/w	4π	$4\pi\times10^{-9}$	$36\pi\times10^{11}$	$4\pi\times10^{-9}$
resistance	R	$R=V/I$	ohm	1	1	$10^{-11}/9$	10^{9}
resistivity	ρ	$\rho=RA/l$	ohm-m	1	10^{7}	$10^{9}/9$	10^{11}

F=force; l=length; t=time; v=volume; n=no of turns

ORDERS OF MAGNITUDE

order	prefix	symbol	order	prefix	symbol
10^{12}	tera	T	10^{-2}	centi	c
10^{9}	giga	G	10^{-3}	milli	m
10^{6}	mega	M	10^{-6}	micro	μ
10^{3}	kilo	k	10^{-9}	nano	n
10^{2}	hecto	h	10^{-12}	pico	p
10	deka	da	10^{-15}	femto	f
10^{-1}	deci	d	10^{-18}	atto	a

STANDARD COMPONENT VALUES

1% tolerance								5% tol
100	147	215	316	464	681			10^{4}**
102	150	221	324	475	698			11
105	154	226	332	487	715			12*
107	158	232	340	499	732			13
110	162	237	348	511	750			15**
113	165	243	357	523	768			16
115	169	249	365	536	787			18*
118	174	255	374	549	806			20
121	178	261	383	562	825			22**
124	182	267	392	576	845			24
127	187	274	402	590	866			27*
130	191	280	412	604	887			30
133	196	287	422	619	909			33**
137	200	294	432	634	931			36
140	205	301	442	649	953			39*
143	210	309	453	665	976			43
								47**
								51
								56*
								62
								68**
								75
								82*
								91
								100**

note: *10% tol exists; **20% tol exists

COLOR CODE

color	figure	mult	tol (%)	voltage
black	0	1	—	—
brown	1	10	1*	100*
red	2	10^{2}	2*	200*
orange	3	10^{3}	3*	300*
yellow	4	10^{4}	4*	400*
green	5	10^{5}	5*	500*
blue	6	10^{6}	6*	600*
violet	7	10^{7}	7*	700*
gray	8	10^{8}	8*	800*
white	9	10^{9}	9*	900*
gold	—	10^{-1}	5	1000*
silver	—	10^{-2}	10	2000*
no color	—	—	20	500*

* capacitors only

h PARAMETERS

$V_1=h_{11}I_1+h_{12}V_2$ $\quad h_{11}=h_i$ $\quad h_{12}=h_r$

$I_2=h_{21}I_1+h_{22}V_2$ $\quad h_{21}=h_f$ $\quad h_{22}=h_o$

COPPER WIRE TABLE

wire size AWG (B&S)	circular mil area	ohms per 1000ft, 25°	current cap* (amp)
8	16510	0.6405	23.6
10	10380	1.018	14.8
12	6530	1.619	9.33
14	4107	2.575	5.87
16	2583	4.094	3.69
18	1624	6.510	2.32
20	1022	10.35	1.46
22	642.4	16.46	0.918

* figured at 700 cir mil/amp

USEFUL CONSTANTS & DATA

$c = 2.998\times10^{8}$ m/sec = 186272 miles/sec

Sound velocity, air 20°C, 1 atm:
344 m/sec = 1129 ft/sec = 769.5 mph

e = base, natural logs = 2.71828 18284 59045

γ = Euler's constant = 0.57721 56649

$\ln x = \log_e x = (\log_e 10)(\log_{10} x) = 2.3026 \log_{10} x$

1 electron = 1.602×10^{-19} coul; 9.109×10^{-31} kg

F = Faraday constant = 96500 coul/g equiv.

$g_0 = 9.807$ m/sec^2 = 32.17 ft/sec^2

h = Planck's constant = 6.626×10^{-34} joule sec

N_A = Avogadro's no. = 6.023×10^{23} molecules/g mole

$\pi = 3.14159\,26535\,89793\,23846\,26433\,83279\,50288$

σ = Stefan-Boltzmann constant =
5.670×10^{-8} watt/m^2 (°K)^4

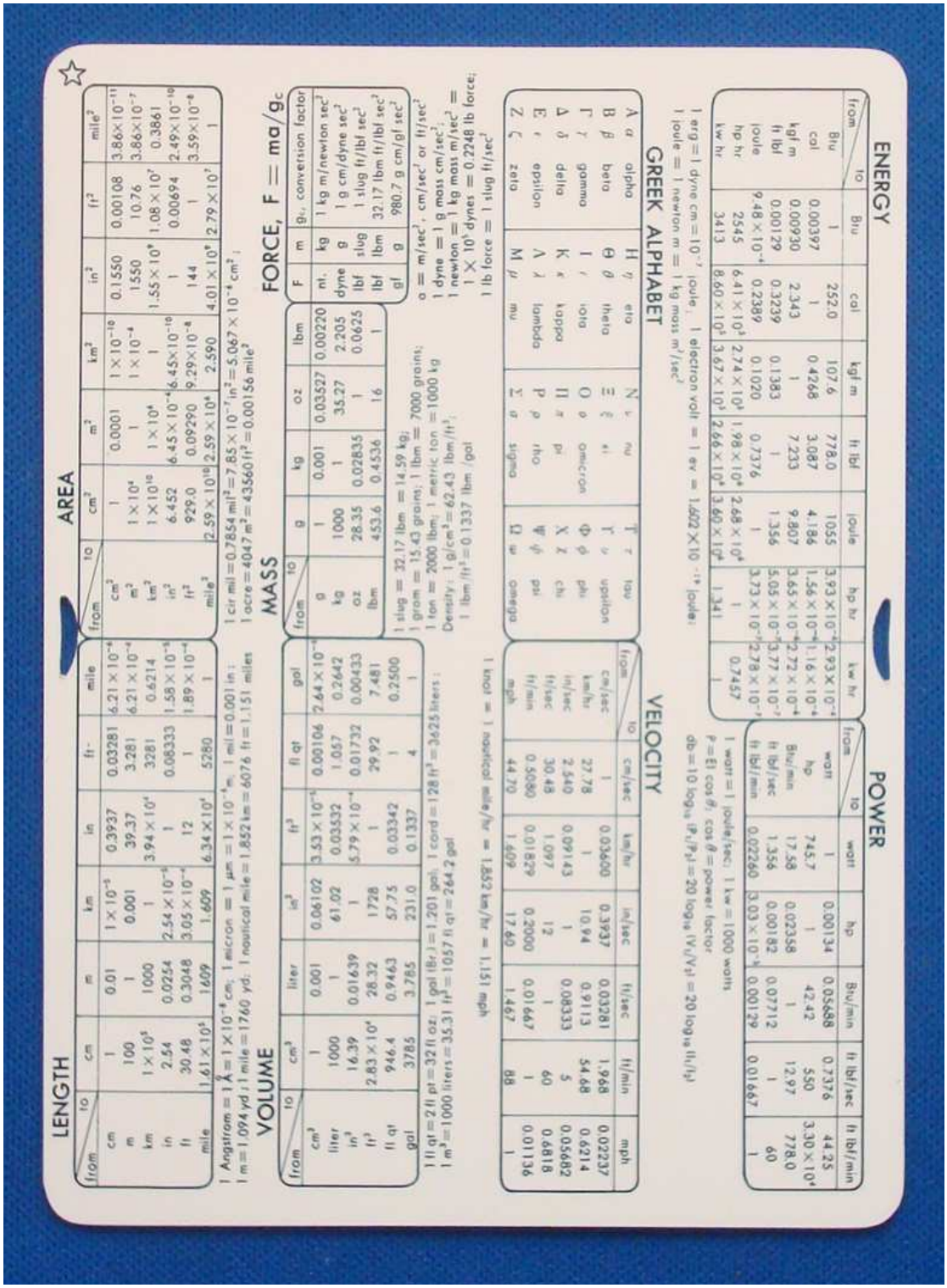
R = 1 radian = 57.3 deg.; 1 deg. = 0.01745 radian

Sphere: area = $4\pi r^2$; volume = $(4/3)\pi r^3$

Temperature conversion: °C = 5/9 (°F − 32)
°F = 9/5 °C + 32; °K = °C + 273.2; °R = °F + 459.7

INSERT-EE

Figure 64: TCD-SCSS-U.20121208.013-fig64



ENERGY

from \ to	Btu	cal	kgf m	ft lbf	joule	hp hr	kw hr
Btu	1	252.0	107.6	778.0	1055	3.93×10^{-4}	2.93×10^{-4}
cal	0.00397	1	0.4268	3.087	4.186	1.56×10^{-6}	1.16×10^{-6}
kgf m	0.00930	2.343	1	7.233	9.807	3.65×10^{-6}	2.72×10^{-6}
ft lbf	0.00129	0.3239	0.1383	1	1.356	5.05×10^{-7}	3.77×10^{-7}
joule	9.48×10^{-4}	0.2389	0.1020	0.7376	1	3.73×10^{-7}	2.78×10^{-7}
hp hr	2545	6.41×10^{3}	2.74×10^{5}	1.98×10^{6}	2.68×10^{6}	1	0.7457
kw hr	3413	8.60×10^{5}	3.67×10^{5}	2.66×10^{6}	3.60×10^{6}	1.341	1

1 erg = 1 dyne cm = 10^{-7} joule; 1 electron volt = 1 ev = 1.602×10^{-19} joules;
1 joule = 1 newton m = 1 kg mass m^2/sec^2

POWER

from \ to	watt	hp	Btu/min	ft lbf/sec	ft lbf/min
watt	1	0.0134	0.05688	0.7376	44.25
hp	745.7	1	42.42	550	3.30×10^{4}
Btu/min	17.58	0.0236	1	12.97	778.0
ft lbf/sec	1.356	0.0018	0.07712	1	60
ft lbf/min	0.02260	3.03×10^{-5}	0.00129	0.01667	1

1 watt = 1 joule/sec; 1 kw = 1000 watts
$P = EI\cos\theta$; $\cos\theta$ = power factor
$db = 10\log_{10}(P_1/P_2) = 20\log_{10}(V_1/V_2) = 20\log_{10}(I_1/I_2)$

LENGTH

from \ to	cm	m	km	in	ft	mile
cm	1	0.01	1×10^{-5}	0.3937	0.03281	6.21×10^{-6}
m	100	1	0.001	39.37	3.281	6.21×10^{-4}
km	1×10^{5}	1000	1	3.94×10^{4}	3281	0.6214
in	2.54	0.0254	2.54×10^{-5}	1	0.08333	1.58×10^{-5}
ft	30.48	0.3048	3.05×10^{-4}	12	1	1.89×10^{-4}
mile	1.61×10^{5}	1609	1.609	6.34×10^{4}	5280	1

1 Angstrom = 1 Å = 1×10^{-8} cm; 1 micron = 1 μm = 1×10^{-6} m; 1 mil = 0.001 in;
1 m = 1.094 yd; 1 mile = 1760 yd; 1 nautical mile = 1.852 km = 6076 ft = 1.151 miles

AREA

from \ to	cm^2	m^2	km^2	in^2	ft^2	$mile^2$
cm^2	1	0.0001	1×10^{-10}	0.1550	0.00108	3.86×10^{-11}
m^2	1×10^{4}	1	1×10^{-6}	1550	10.76	3.86×10^{-7}
km^2	1×10^{10}	1×10^{6}	1	1.55×10^{9}	1.08×10^{7}	0.3861
in^2	6.452	6.45×10^{-4}	6.45×10^{-10}	1	0.00694	2.49×10^{-10}
ft^2	929.0	0.09290	9.29×10^{-8}	144	1	3.59×10^{-8}
$mile^2$	2.59×10^{10}	2.59×10^{6}	2.590	4.01×10^{9}	2.79×10^{7}	1

1 cir mil = 0.7854 mil^2 = 7.85×10^{-7} in^2 = 5.067×10^{-4} cm^2;
1 acre = 4047 m^2 = 43560 ft^2 = 0.00156 $mile^2$

VOLUME

from \ to	cm^3	liter	in^3	ft^3	fl qt	gal
cm^3	1	0.001	0.06102	3.53×10^{-5}	0.00106	2.64×10^{-4}
liter	1000	1	61.02	0.03532	1.057	0.2642
in^3	16.39	0.01639	1	5.79×10^{-4}	0.01732	0.00433
ft^3	2.83×10^{4}	28.32	1728	1	29.92	7.481
fl qt	946.4	0.9463	57.75	0.03342	1	0.2500
gal	3785	3.785	231.0	0.1337	4	1

1 fl qt = 2 fl pt = 32 fl oz; 1 gal (Br.) = 1.201 gal; 1 cord = 128 ft^3 = 3625 liters;
1 m^3 = 1000 liters = 35.31 ft^3 = 1057 fl qt = 264.2 gal

MASS

from \ to	g	kg	oz	lbm
g	1	0.001	0.03527	0.00220
kg	1000	1	35.27	2.205
oz	28.35	0.02835	1	0.0625
lbm	453.6	0.4536	16	1

1 slug = 32.17 lbm = 14.59 kg;
1 grain = 15.43 grains; 1 lbm = 7000 grains;
1 ton = 2000 lbm; 1 metric ton = 1000 kg
Density: 1 g/cm^3 = 62.43 lbm/ft^3;
1 lbm/ft^3 = 0.1337 lbm/gal

FORCE, $F = ma/g_c$

	F	m	g_c, conversion factor
	nt.	kg	1 kg m/newton sec^2
	dyne	g	1 g cm/dyne sec^2
	lbf	slug	1 slug ft/lbf sec^2
	lbf	lbm	32.17 lbm ft/lbf sec^2
	gf	g	980.7 g cm/gf sec^2

a = m/sec^2; cm/sec^2 or ft/sec^2
1 dyne = 1 g mass cm/sec^2;
1 newton = 1 kg mass m/sec^2 = 1×10^5 dynes = 0.2248 lb force;
1 lb force = 1 slug ft/sec^2

GREEK ALPHABET

Α α	alpha	Η η	eta	Ν ν	nu	Τ τ	tau
Β β	beta	Θ θ	theta	Ξ ξ	xi	Υ υ	upsilon
Γ γ	gamma	Ι ι	iota	Ο ο	omicron	Φ φ	phi
Δ δ	delta	Κ κ	kappa	Π π	pi	Χ χ	chi
Ε ε	epsilon	Λ λ	lambda	Ρ ρ	rho	Ψ ψ	psi
Ζ ζ	zeta	Μ μ	mu	Σ σ	sigma	Ω ω	omega

VELOCITY

from \ to	cm/sec	km/hr	in/sec	ft/sec	ft/min	mph
cm/sec	1	0.03600	0.3937	0.03281	1.968	0.02237
km/hr	27.78	1	10.94	0.9113	54.68	0.6214
in/sec	2.540	0.09143	1	0.08333	5	0.05682
ft/sec	30.48	1.097	12	1	60	0.6818
ft/min	0.5080	0.01829	0.2000	0.01667	1	0.01136
mph	44.70	1.609	17.60	1.467	88	1

1 knot = 1 nautical mile/hr = 1.852 km/hr = 1.151 mph

Figure 65: TCD-SCSS-U.20121208.013-fig65

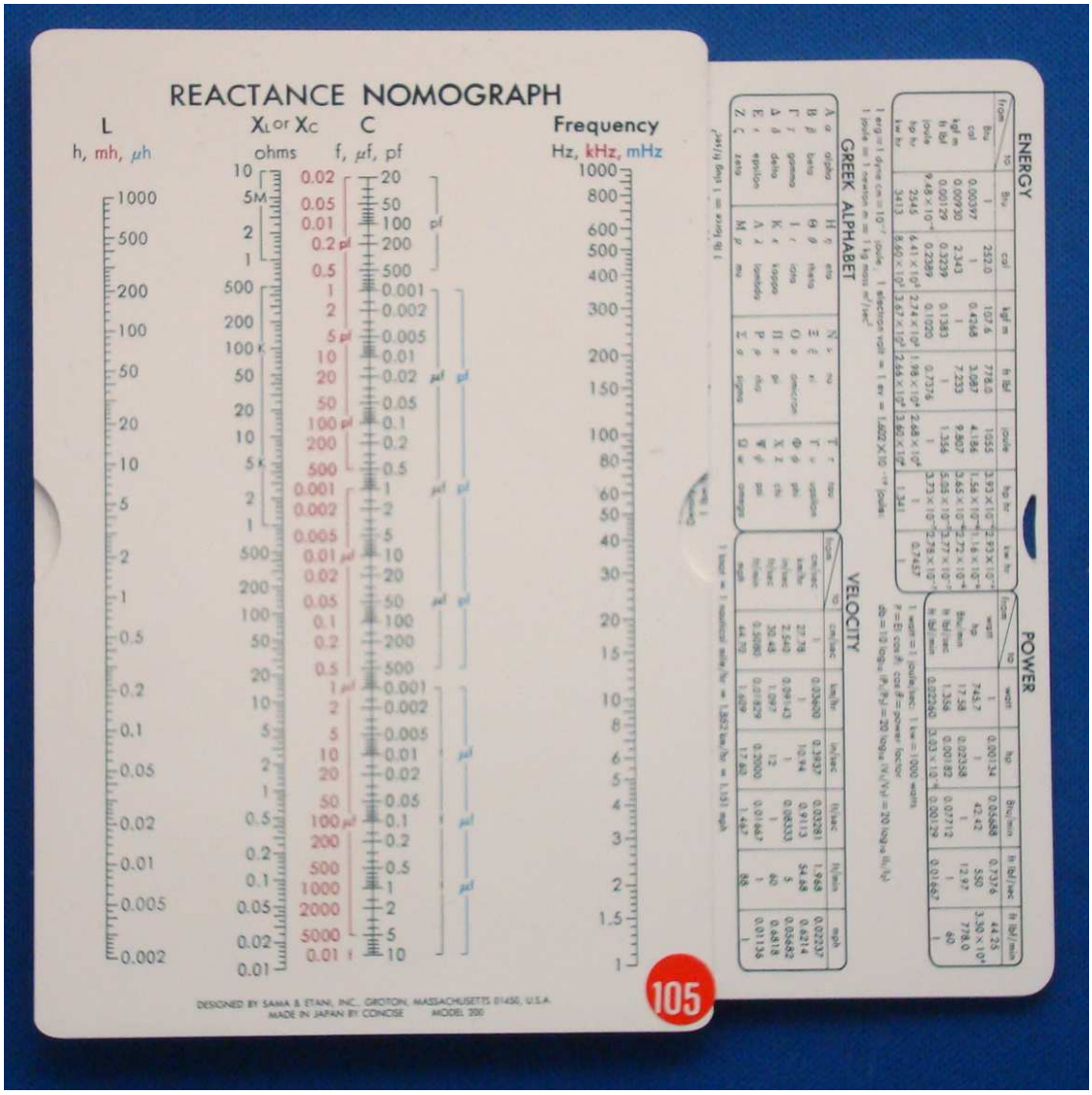


Figure 66: TCD-SCSS-U.20121208.013-fig66

Figure 67: TCD-SCSS-U.20121208.013-fig67

Figure 68: TCD-SCSS-U.20121208.013-fig68

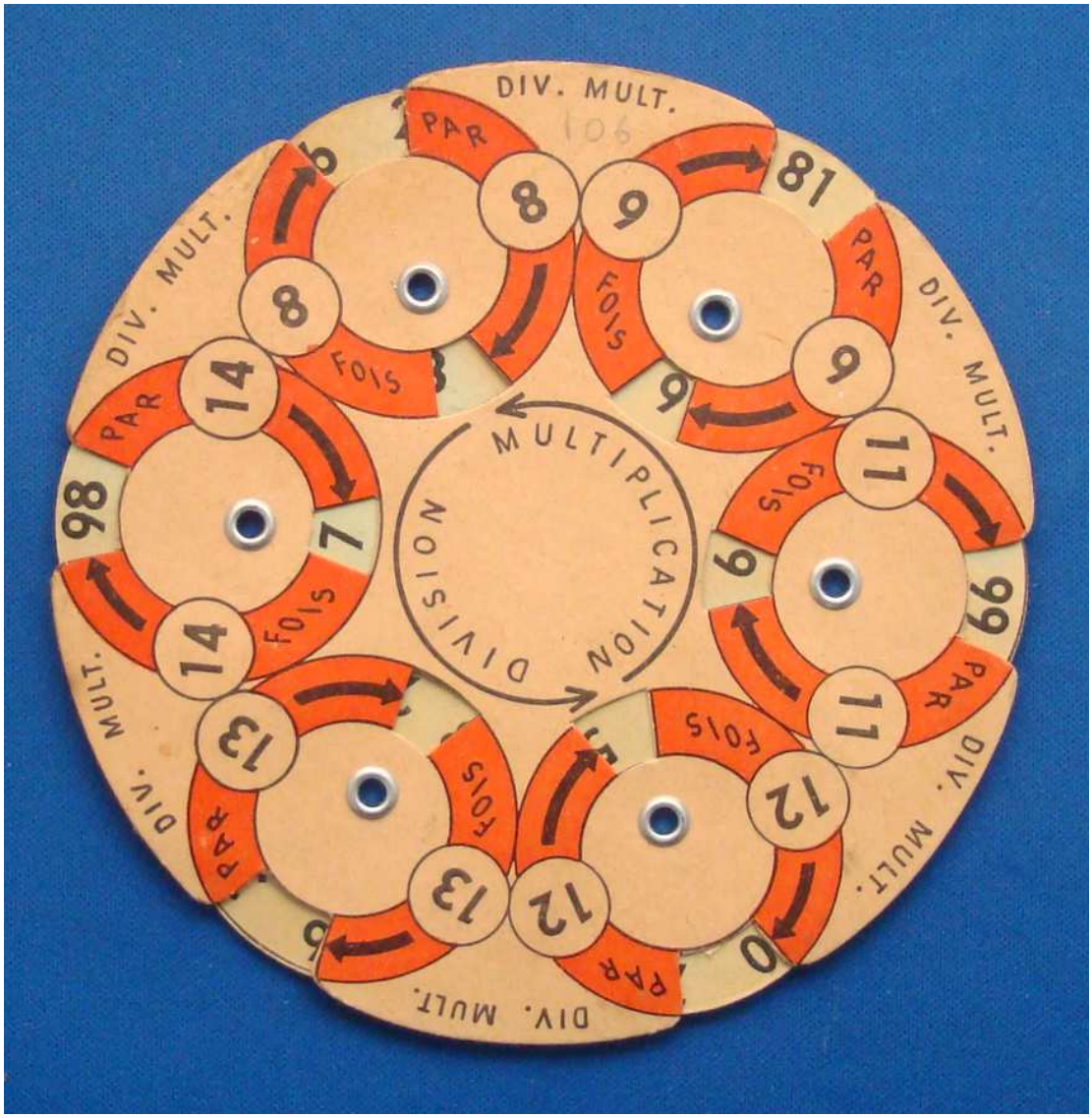


Figure 69: TCD-SCSS-U.20121208.013-fig69

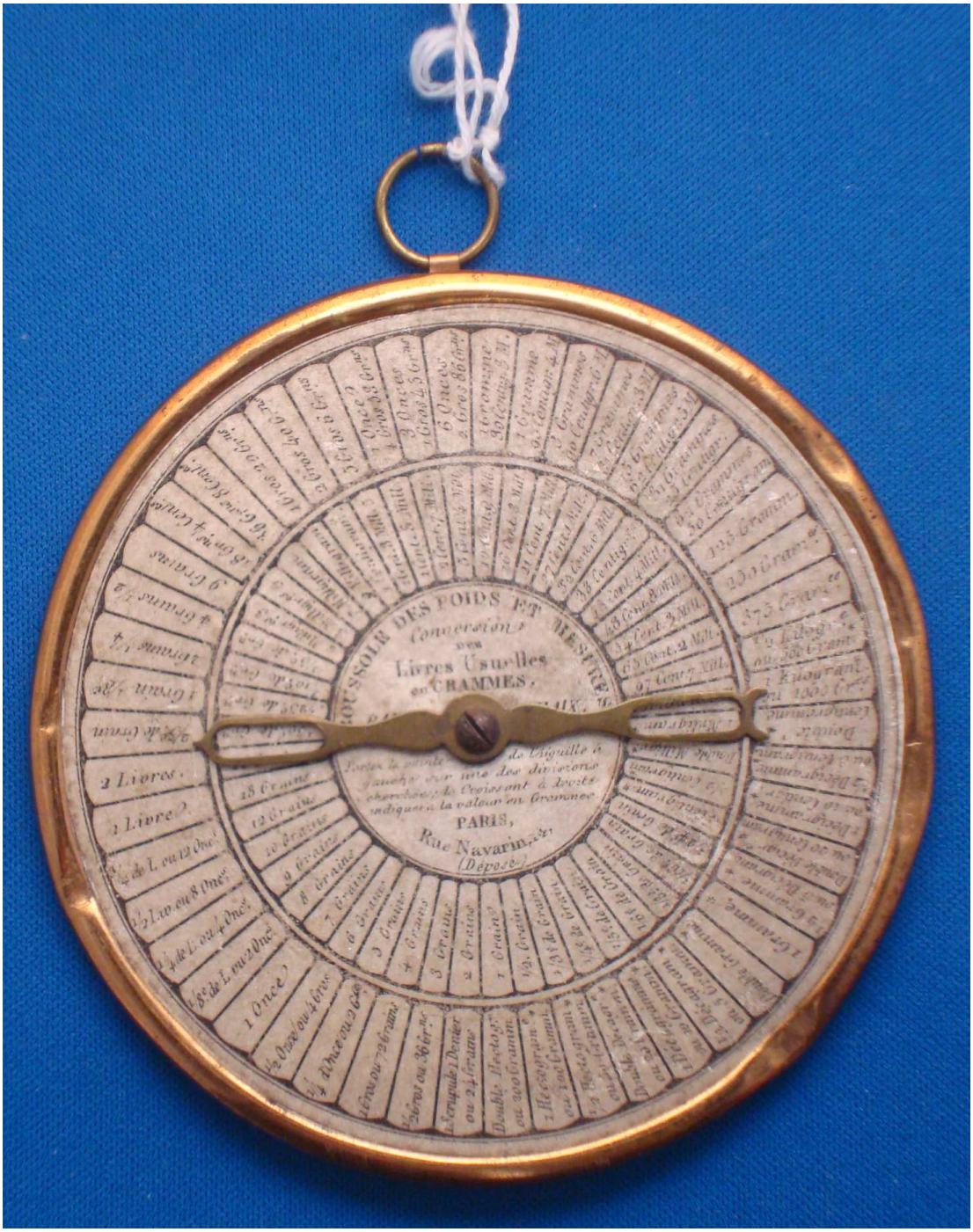


Figure 70: TCD-SCSS-U.20121208.013-fig70

Figure 71: TCD-SCSS-U.20121208.013-fig71

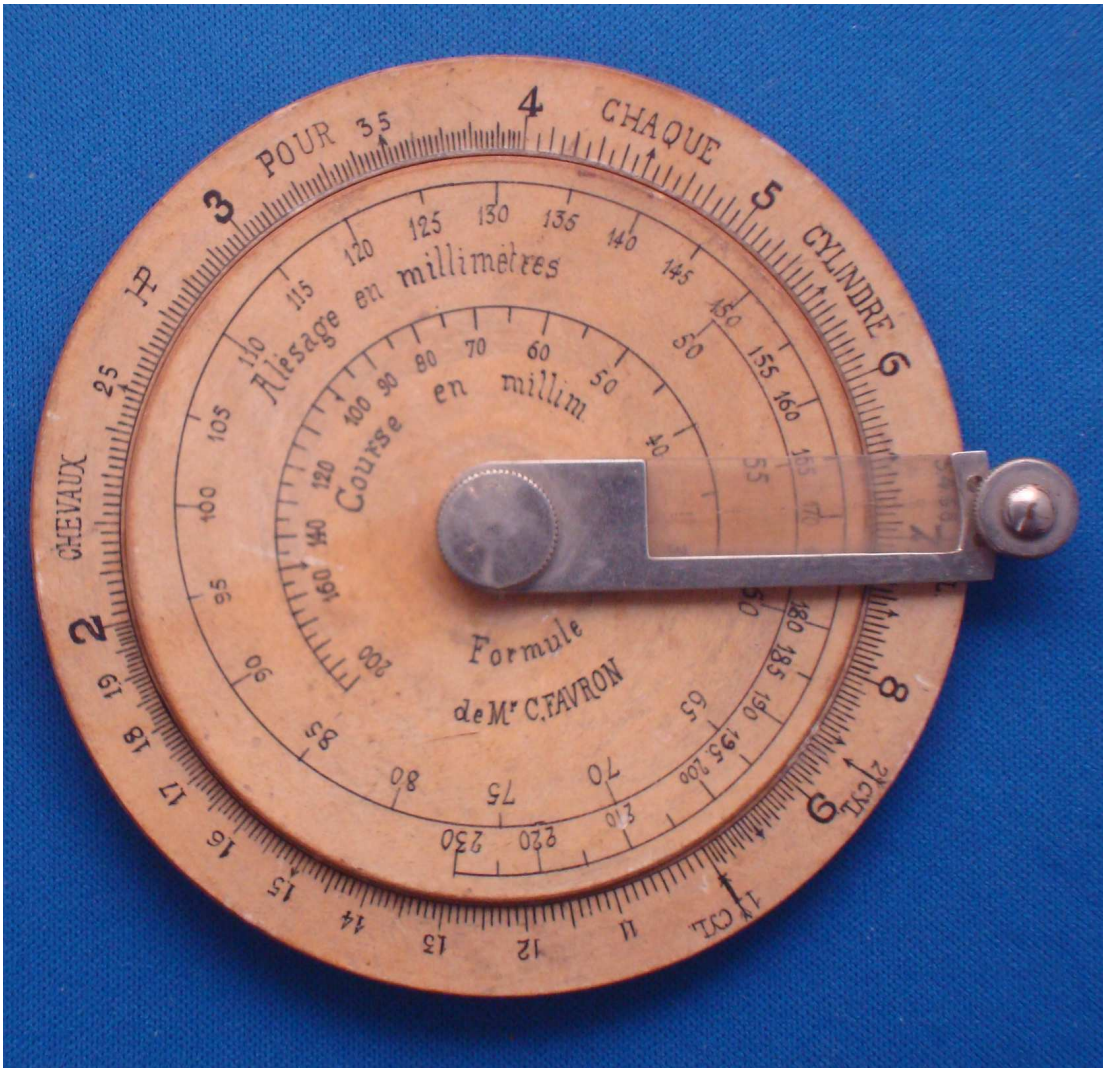


Figure 72: TCD-SCSS-U.20121208.013-fig72

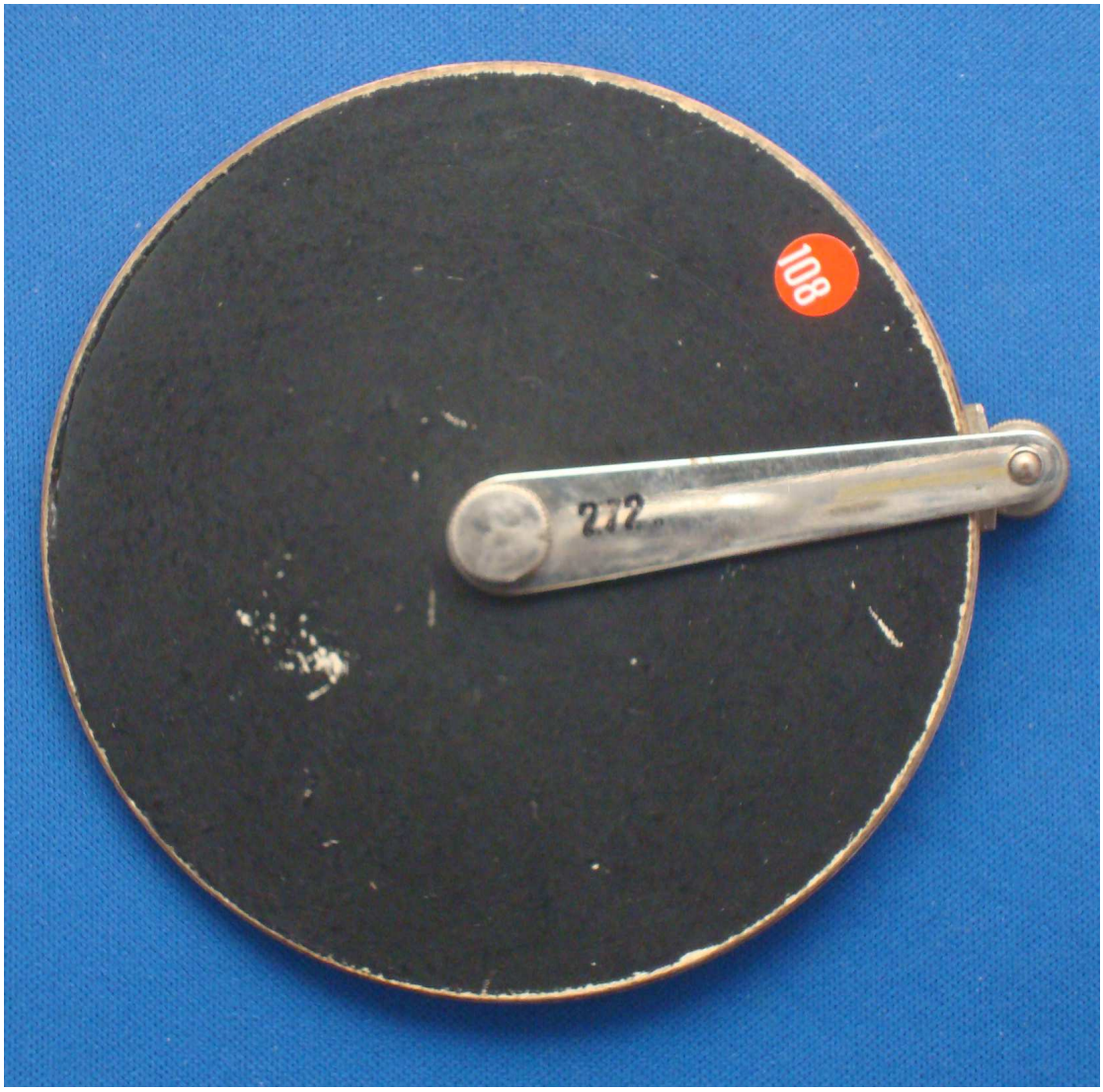


Figure 73: TCD-SCSS-U.20121208.013-fig73

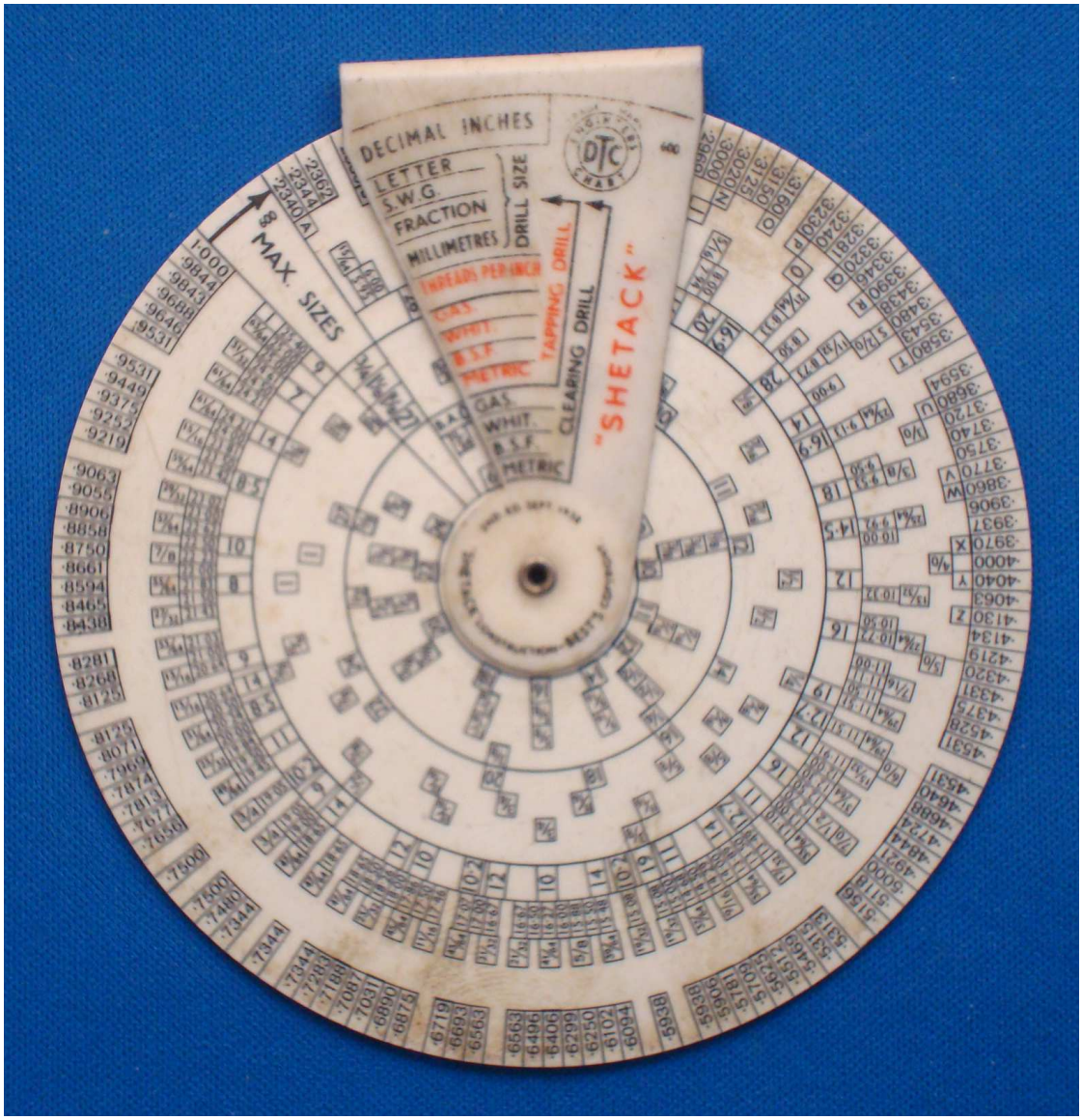


Figure 74: TCD-SCSS-U.20121208.013-fig74

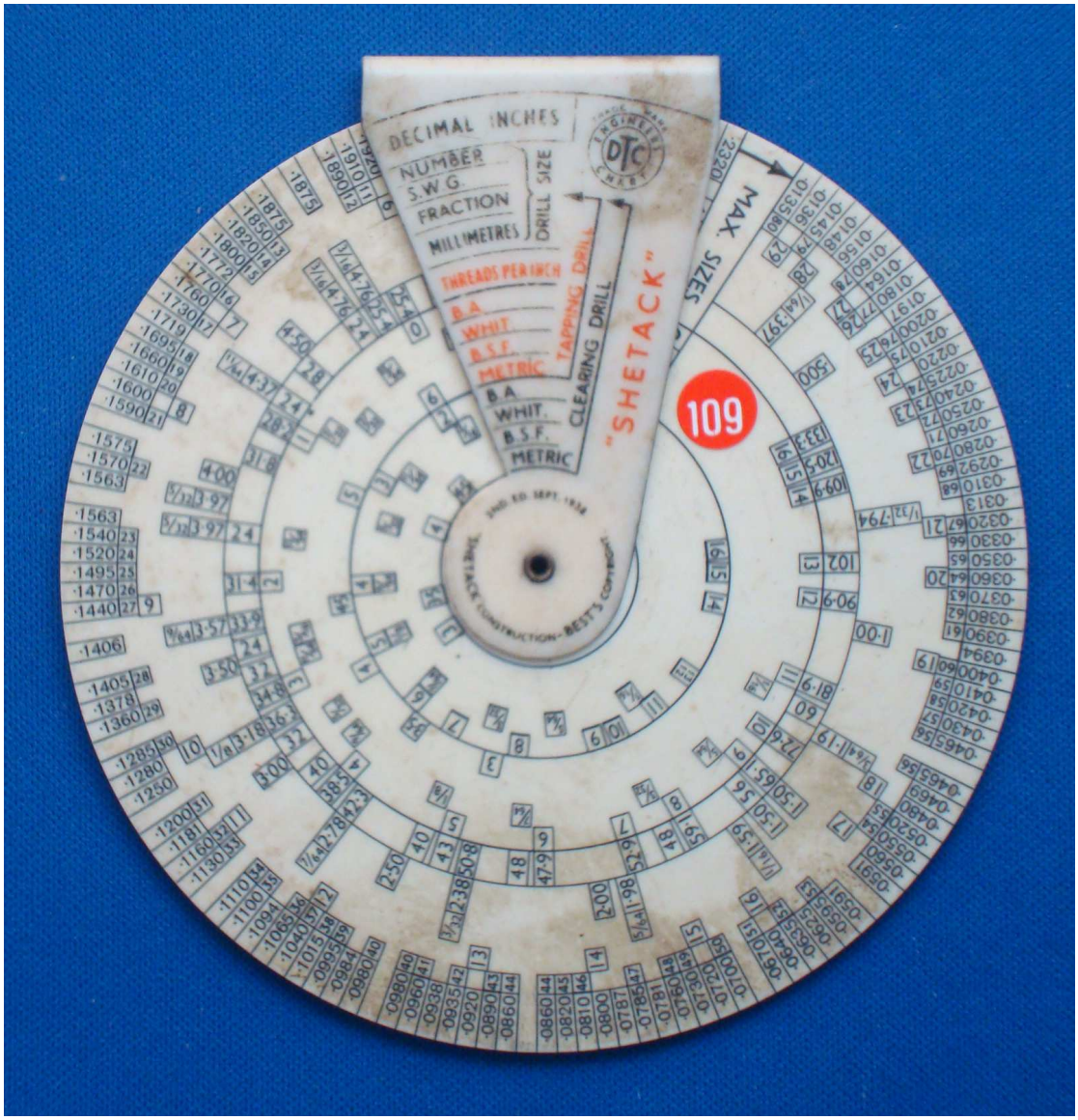


Figure 75: TCD-SCSS-U.20121208.013-fig75

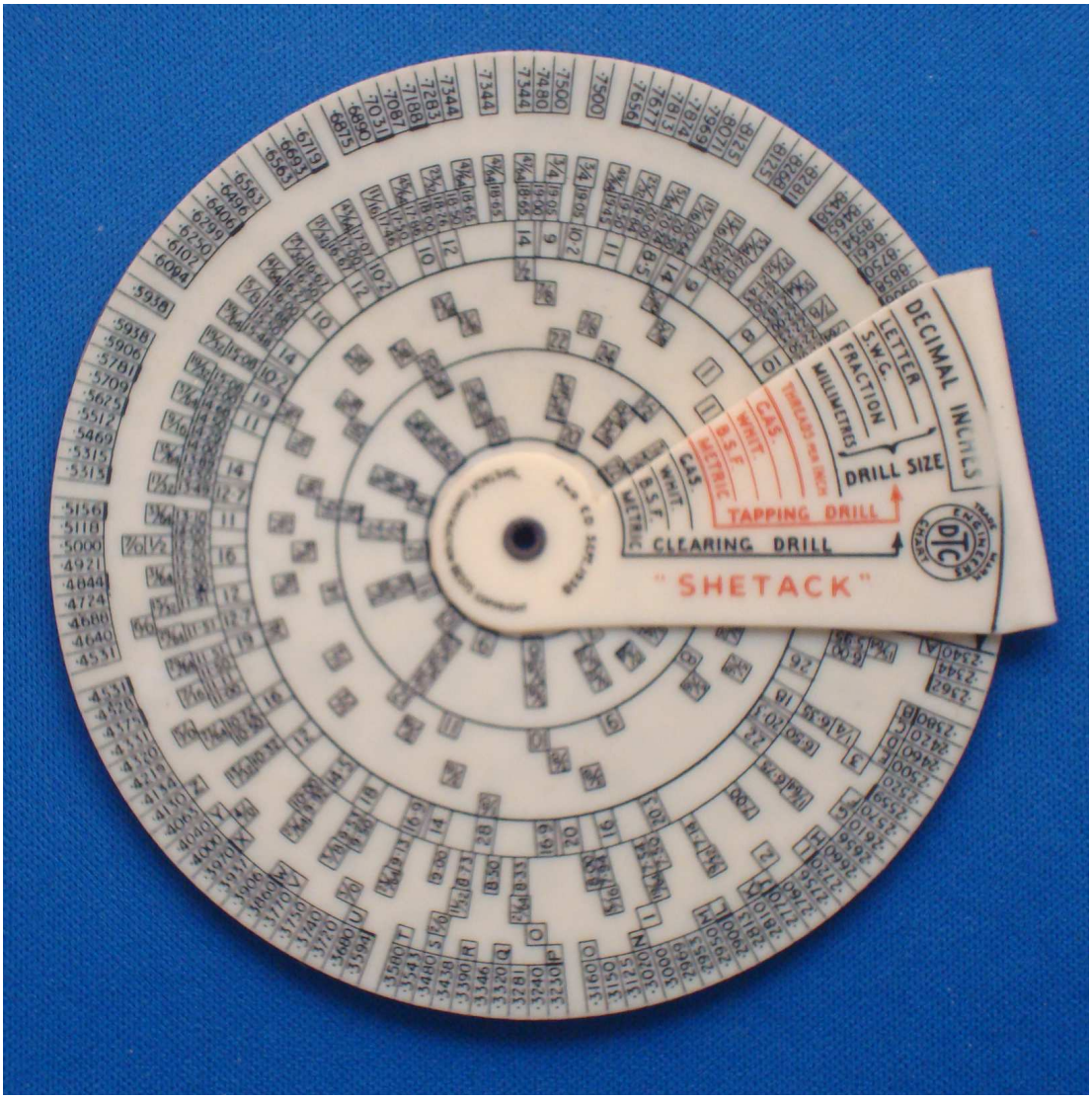


Figure 76: TCD-SCSS-U.20121208.013-fig76

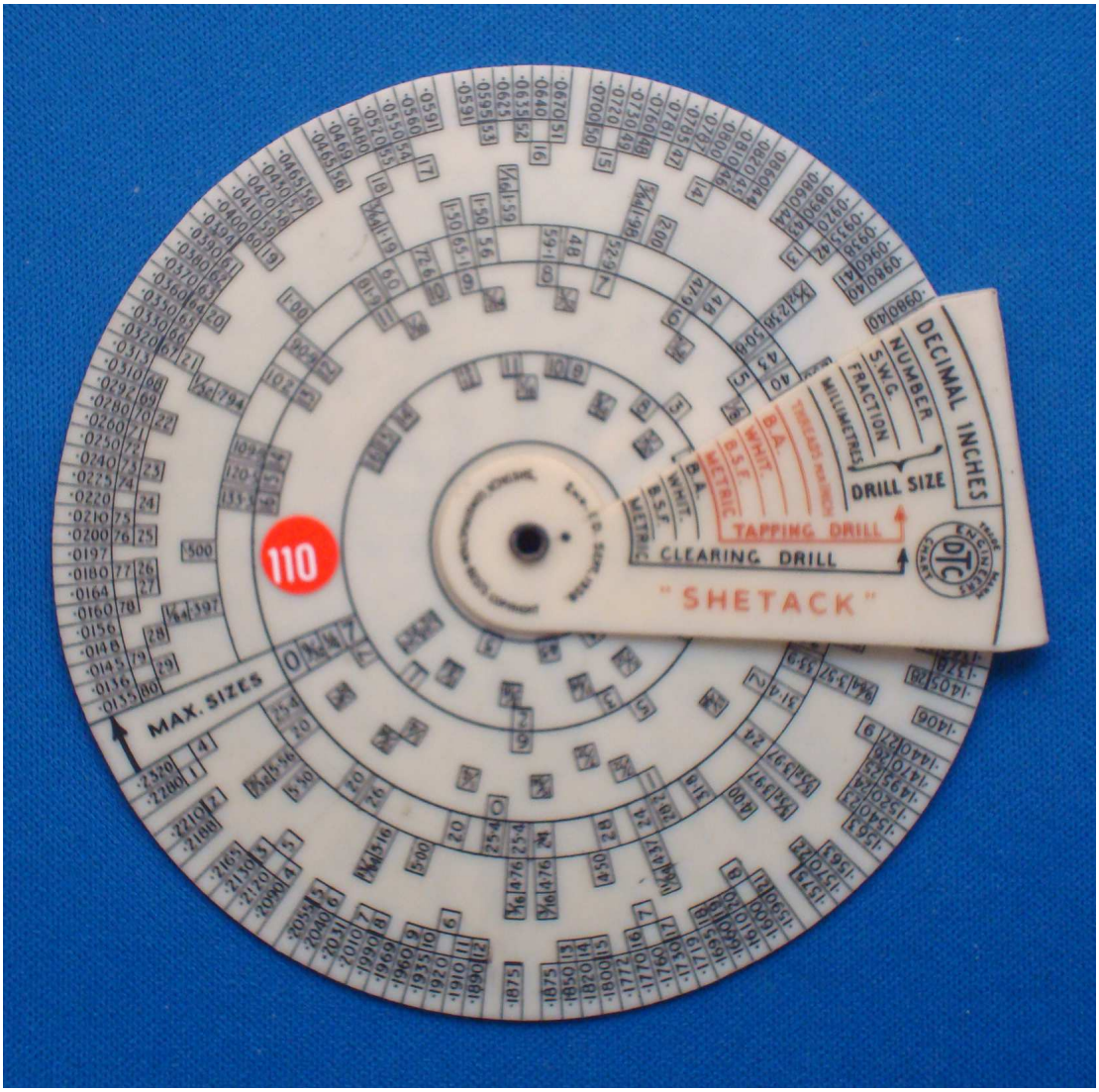


Figure 77: TCD-SCSS-U.20121208.013-fig77

Figure 78: TCD-SCSS-U.20121208.013-fig78

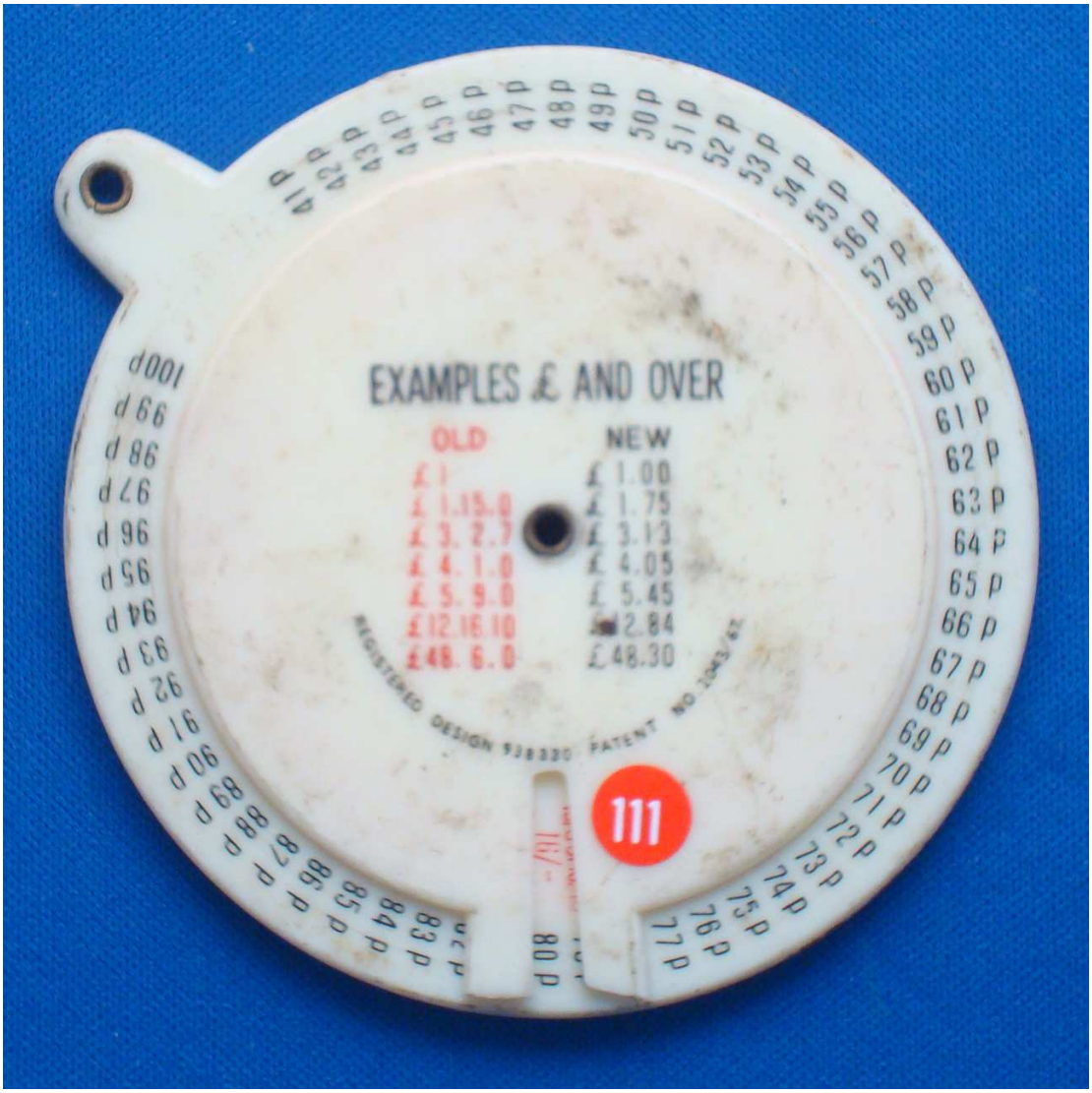


Figure 79: TCD-SCSS-U.20121208.013-fig79

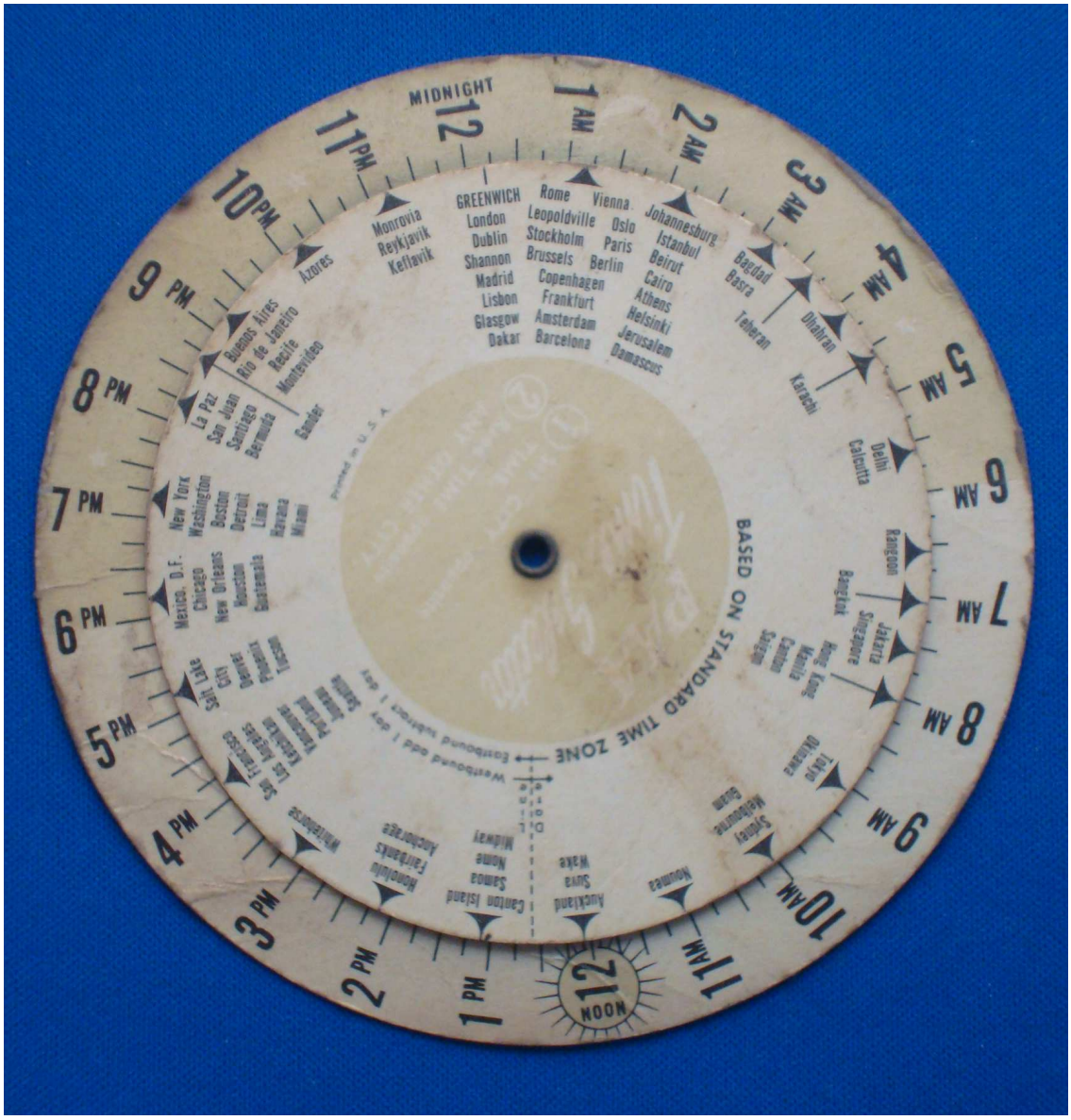


Figure 80: TCD-SCSS-U.20121208.013-fig80

Figure 81: TCD-SCSS-U.20121208.013-fig81

Figure 82: TCD-SCSS-U.20121208.013-fig82

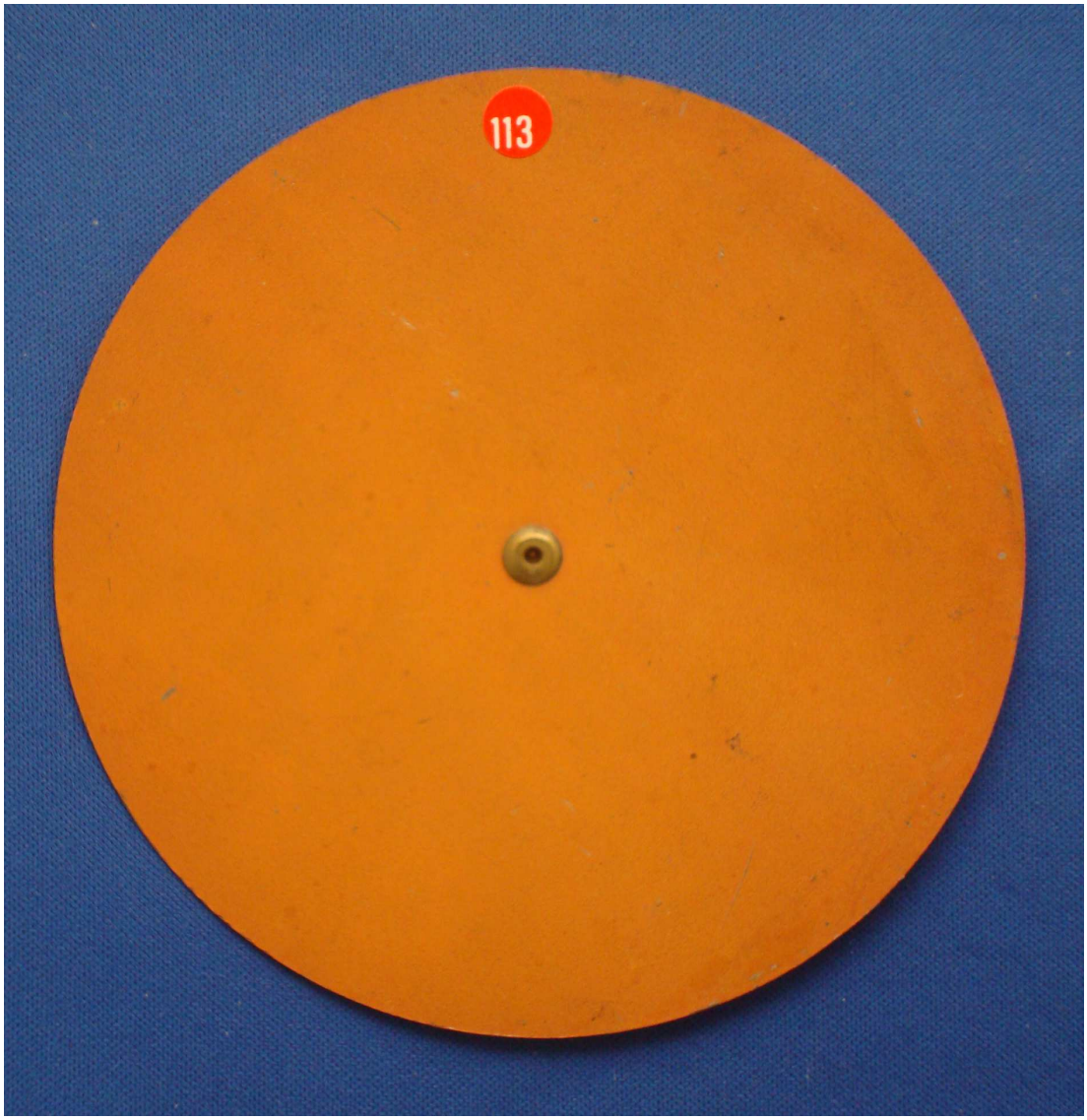


Figure 83: TCD-SCSS-U.20121208.013-fig83

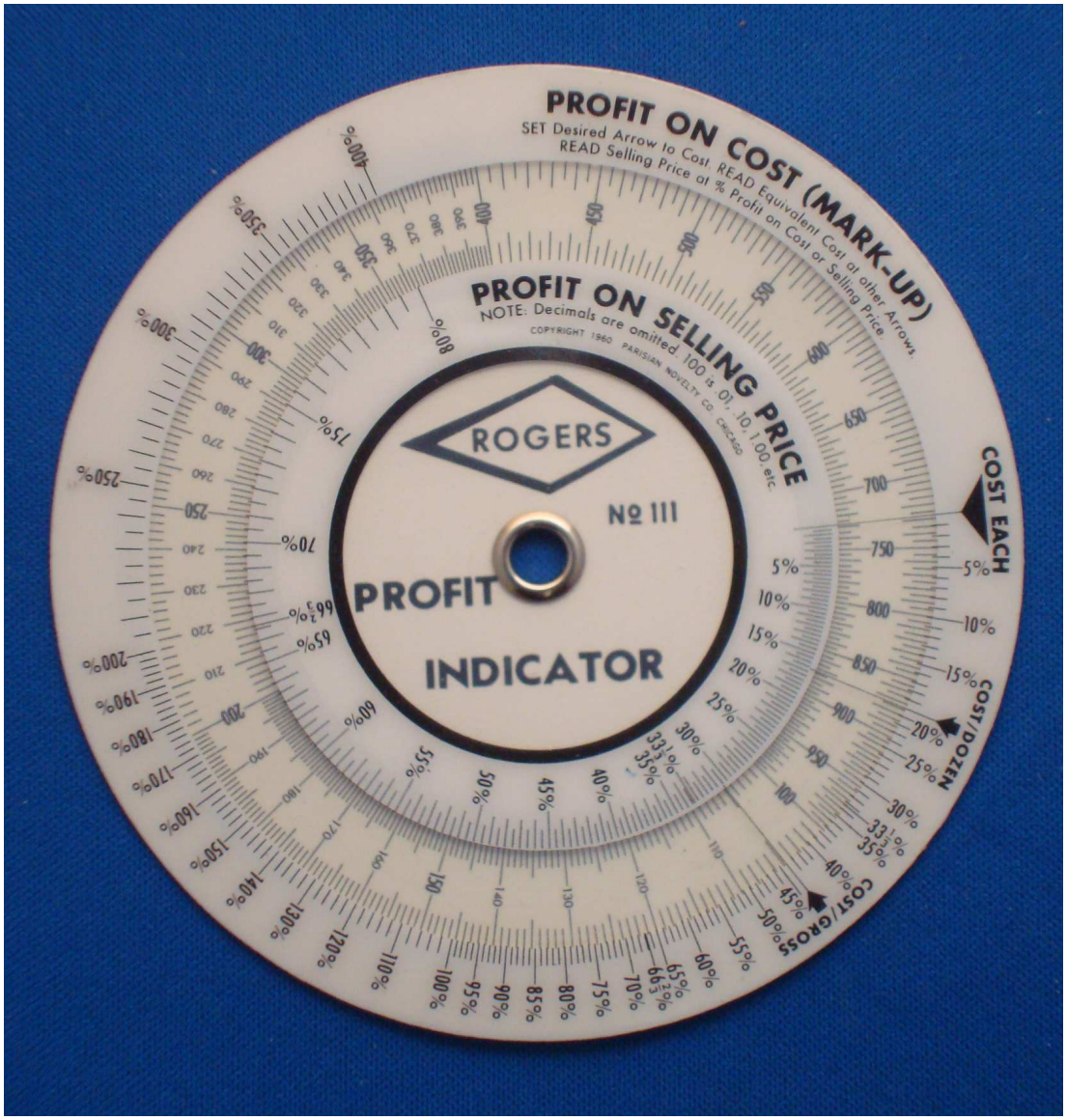


Figure 84: TCD-SCSS-U.20121208.013-fig84

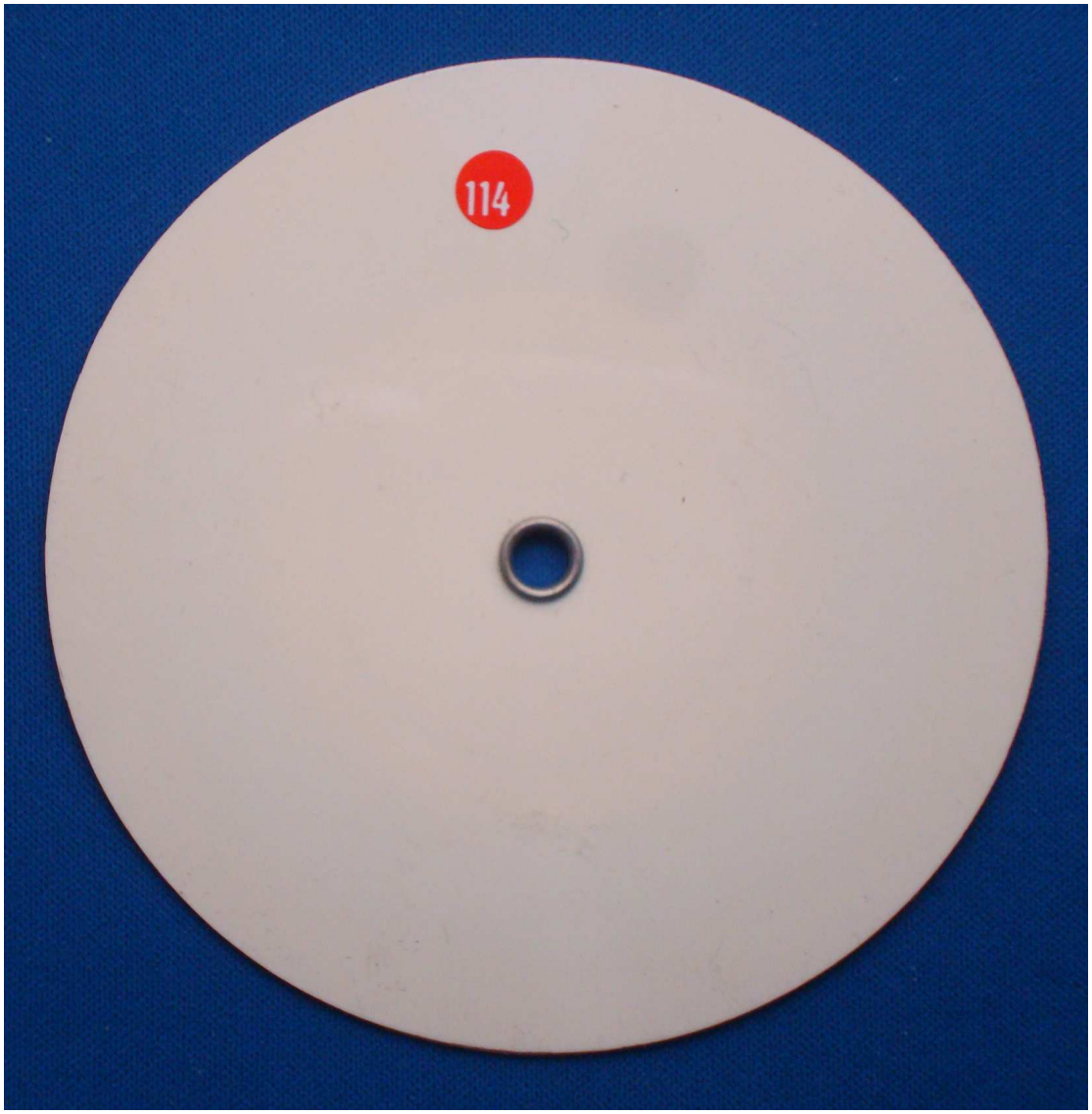


Figure 85: TCD-SCSS-U.20121208.013-fig85

Figure 86: TCD-SCSS-U.20121208.013-fig86

Figure 87: TCD-SCSS-U.20121208.013-fig87

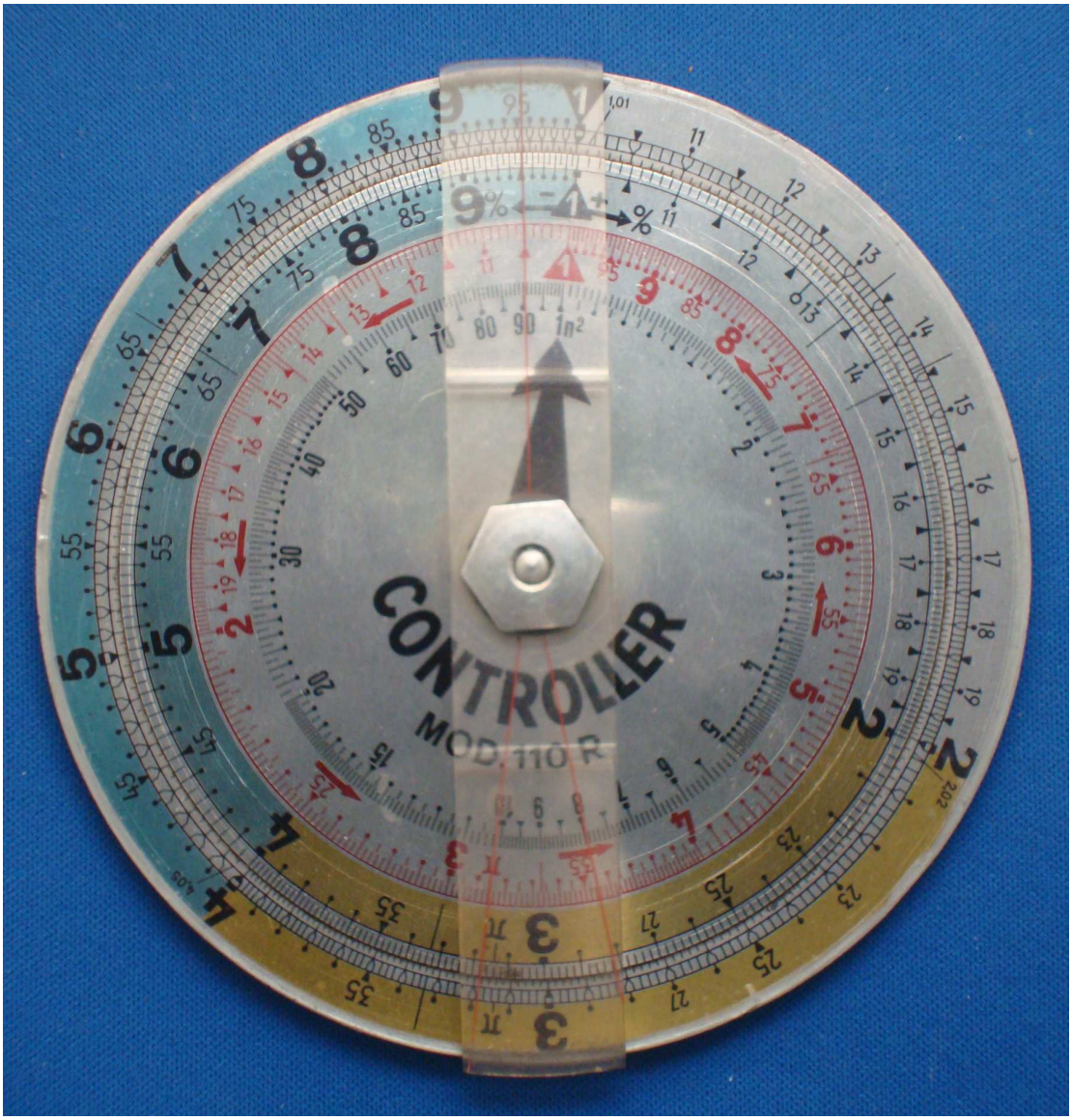
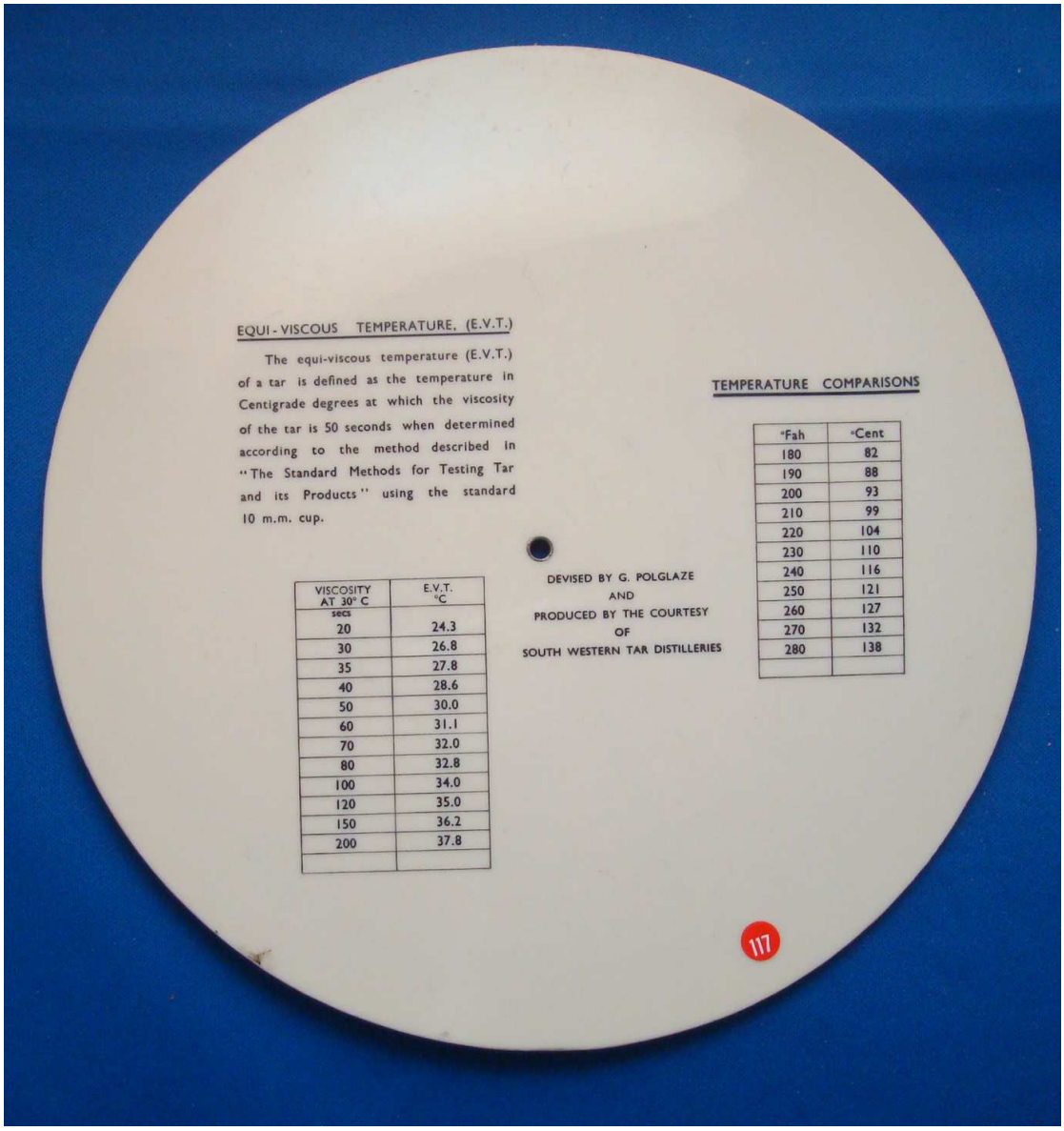


Figure 88: TCD-SCSS-U.20121208.013-fig88

Figure 89: TCD-SCSS-U.20121208.013-fig89



EQUI-VISCOUS TEMPERATURE, (E.V.T.)

The equi-viscous temperature (E.V.T.) of a tar is defined as the temperature in Centigrade degrees at which the viscosity of the tar is 50 seconds when determined according to the method described in "The Standard Methods for Testing Tar and its Products" using the standard 10 m.m. cup.

VISCOSITY AT 30° C secs	E.V.T. °C
20	24.3
30	26.8
35	27.8
40	28.6
50	30.0
60	31.1
70	32.0
80	32.8
100	34.0
120	35.0
150	36.2
200	37.8

DEVISED BY G. POLGLAZE
AND
PRODUCED BY THE COURTESY
OF
SOUTH WESTERN TAR DISTILLERIES

TEMPERATURE COMPARISONS

°Fah	°Cent
180	82
190	88
200	93
210	99
220	104
230	110
240	116
250	121
260	127
270	132
280	138

117

Figure 90: TCD-SCSS-U.20121208.013-fig90

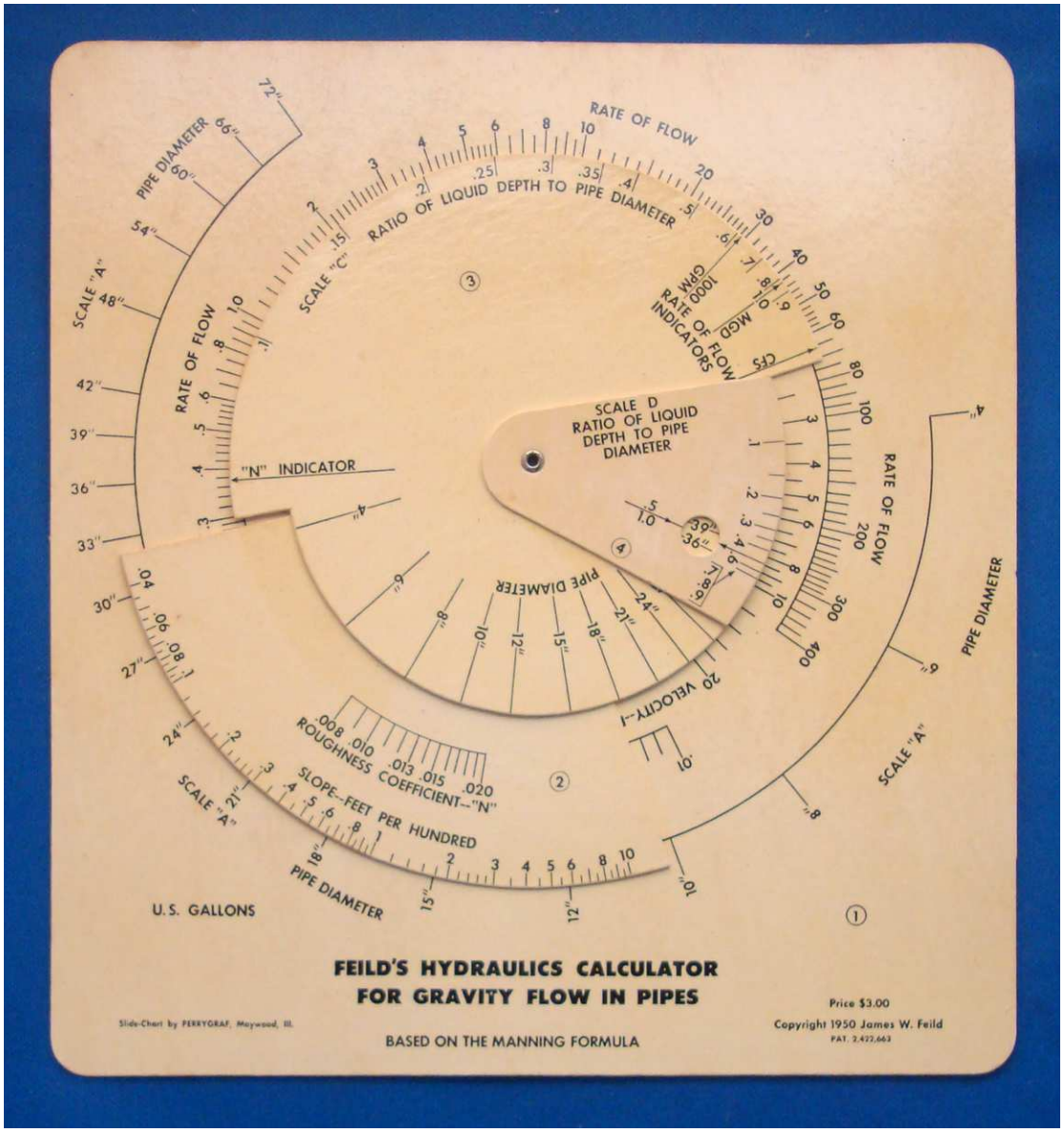


Figure 91: TCD-SCSS-U.20121208.013-fig91

OPERATING INSTRUCTIONS

The *Rate of Flow Indicators*, on Member 3, cooperate with the *Rate of Flow Scale*, on Member 1, to indicate rate of flow. Rate of flow is indicated in three different units of measure—million gallons per day, thousand gallons per minute and cubic feet per second—simultaneously.

The *Velocity Scale*, on Member 1, cooperates with *Scale B*, on Member 3, to indicate velocities and pipe sizes required for the indicated rate of flow, pipe flowing full.

The *N Indicator*, on Member 3, and the *N Scale*, on Member 2, cooperate to indicate coefficient of roughness, N.

The *Slope Scale*, on Member 2, and *Scale A*, on Member 1, cooperate to indicate slopes and corresponding pipe sizes required for the indicated rate of flow, pipe flowing full.

Scale C, on Member 3, and the *Rate of Flow Scale* cooperate to indicate ratios of liquid depth to pipe diameter at various rates of flow when the pipe is flowing less than full. As Scale C is referenced to the MGD Indicator, rate of flow must be expressed in MGD when Scale C is used.

The *Window* in Member 4 and *Scale D*, on Member 4, respectively, cooperate with *Scale B* and the *Velocity Scale* to indicate velocities, in pipes of selected size, corresponding to various ratios of liquid depth to pipe diameter determined for various rates of flow.

ILLUSTRATIVE EXAMPLES

Problem 1. Convert 6.2 CFS to equivalent rates of flow expressed in MGD and in GPM.

Solution. Set the CFS Indicator to 6.2 on the Rate of Flow Scale. The MGD Indicator and the 1000 GPM Indicator point, respectively, to 4.0 and to 2.8 (2800 GPM), *answers*.

Problem 2. Determine the required diameter and slope for the discharge of 2.28 MGD through a pipe having a coefficient of roughness of 0.013 and flowing full at a velocity of 2 feet per second. Also determine the ratio of liquid depth to pipe diameter and the velocity when the rate of flow decreases to 0.44 MGD.

Solution. Set the MGD Indicator to 2.28 on the Rate of Flow Scale and the N Scale with 0.013 opposite the N Indicator. The required pipe diameter is 18", *answer*, found on Scale B opposite 2 on the Velocity Scale. The required slope, 0.113 feet per hundred, *answer*, is found on the Slope Scale, opposite 18" on Scale A. When the rate of flow decreases to 0.44 MGD, the ratio of liquid depth to pipe diameter is 0.3, *answer*, found on Scale C, opposite 0.44 on the Rate of Flow Scale. Next, set the Window to 18" on Scale B. When the rate of flow decreases to 0.44 MGD, the velocity is 1.55 feet per second, *answer*, found on the Velocity Scale, opposite 0.3 on Scale D.

Problem 3. For the discharge of 3.9 MGD, determine the required diameter of pipe whose slope is 0.10 feet per hundred and whose coefficient of roughness is 0.013. Also determine the velocities at this rate of flow and at 0.9 MGD.

Solution. Set the MGD Indicator to 3.90 on the Rate of Flow Scale and the N Scale with 0.013 opposite the N Indicator. Opposite 0.10 on the Slope Scale, the diameter is indicated to be between 21" and 24". Therefore the required diameter is 24", *answer*. Next, set the Slope Scale so that 0.10 is opposite 24" on Scale A and set the N Scale again with 0.013 opposite the N Indicator. The MGD Indicator now indicates the pipe discharge capacity as 4.6 MGD. When the flow rates are 3.9 MGD and 0.9 MGD, the ratios of liquid depth to pipe diameter are 0.7 and 0.3, respectively, and the respective velocities are 2.5 and 1.8 feet per second, *answers*, determined as illustrated in Problem 2.

Figure 92: TCD-SCSS-U.20121208.013-fig92

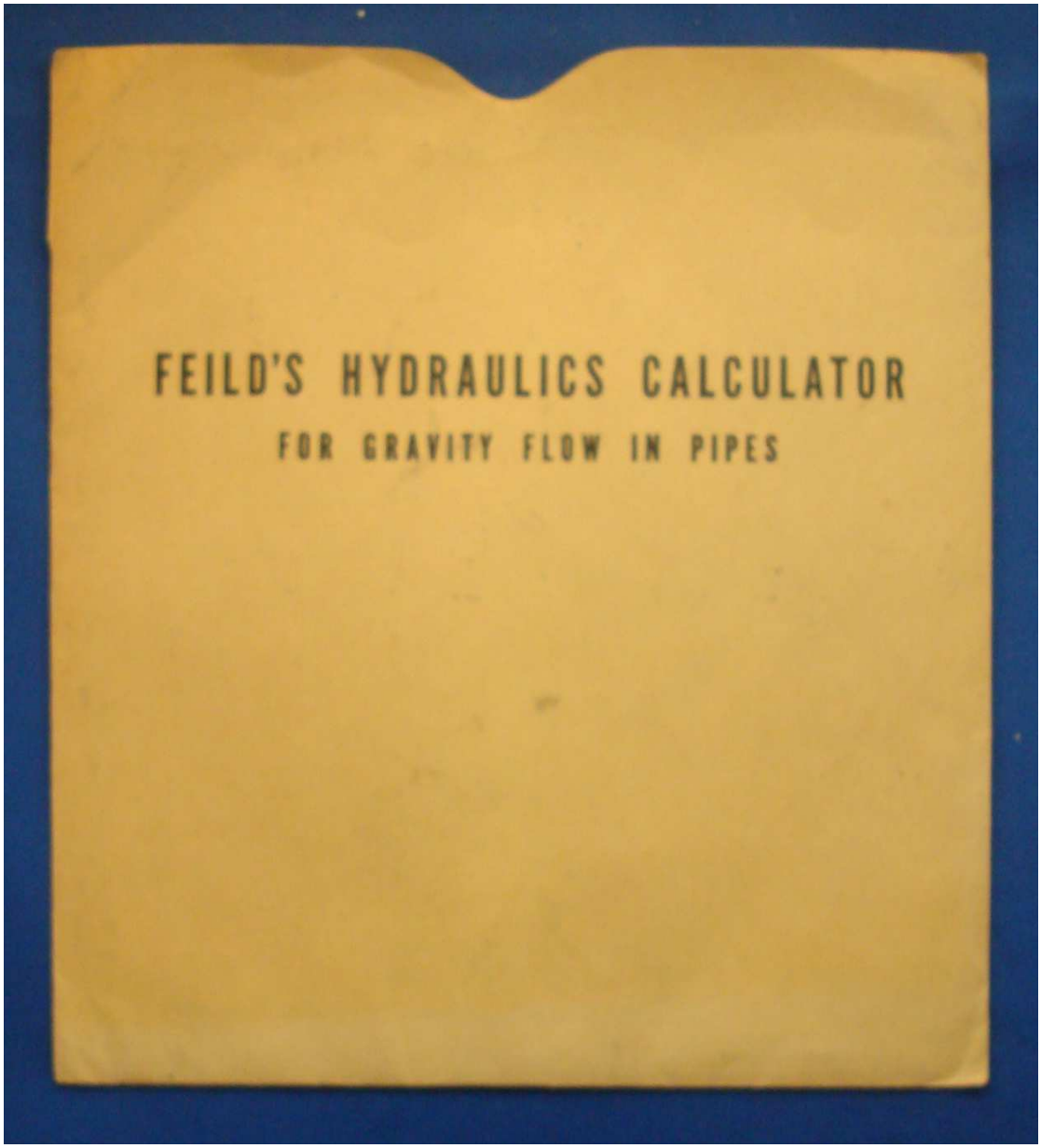


Figure 93: TCD-SCSS-U.20121208.013-fig93

Figure 94: TCD-SCSS-U.20121208.013-fig94

Figure 95: TCD-SCSS-U.20121208.013-fig95

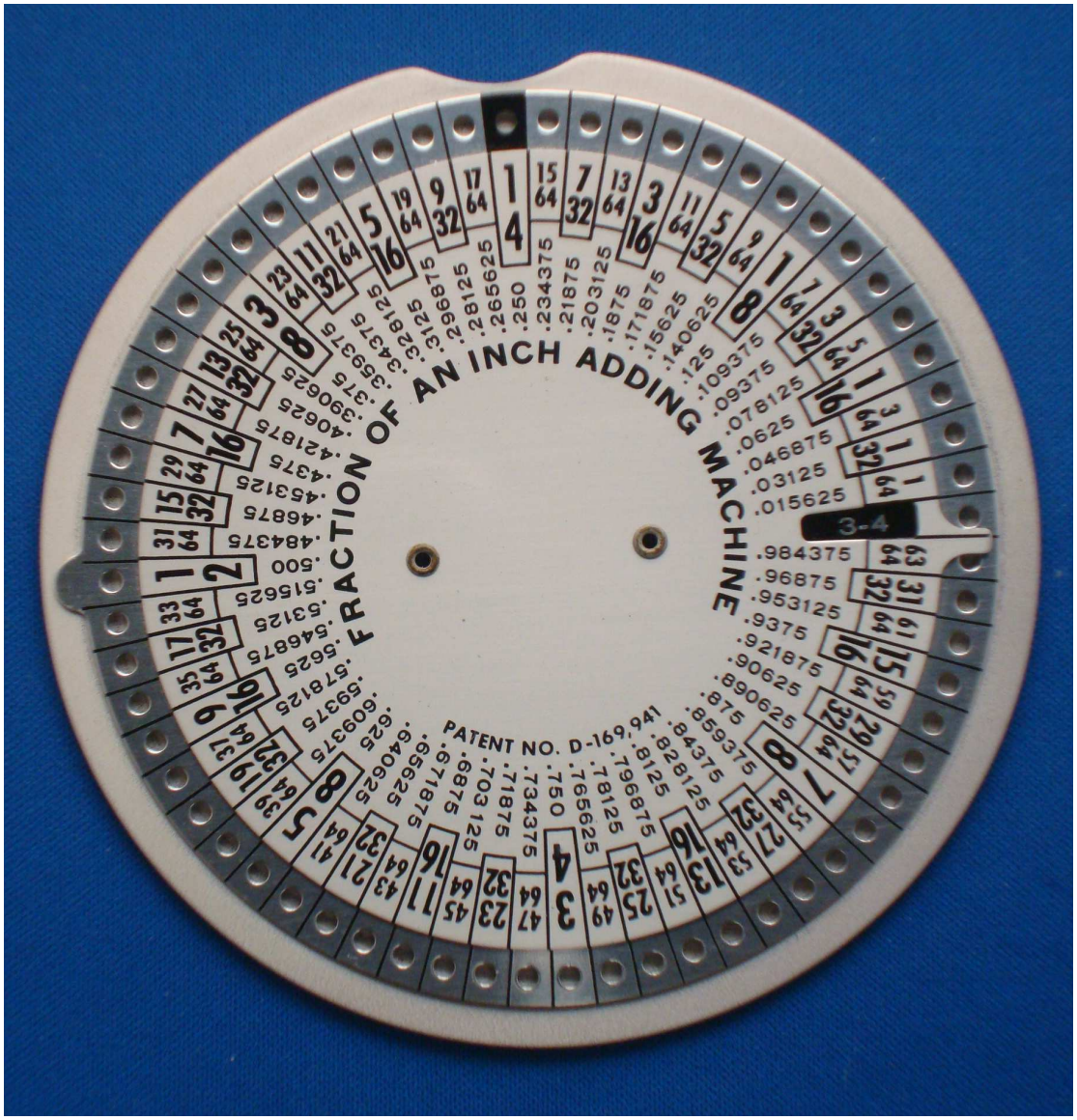


Figure 96: TCD-SCSS-U.20121208.013-fig96

Figure 97: TCD-SCSS-U.20121208.013-fig97

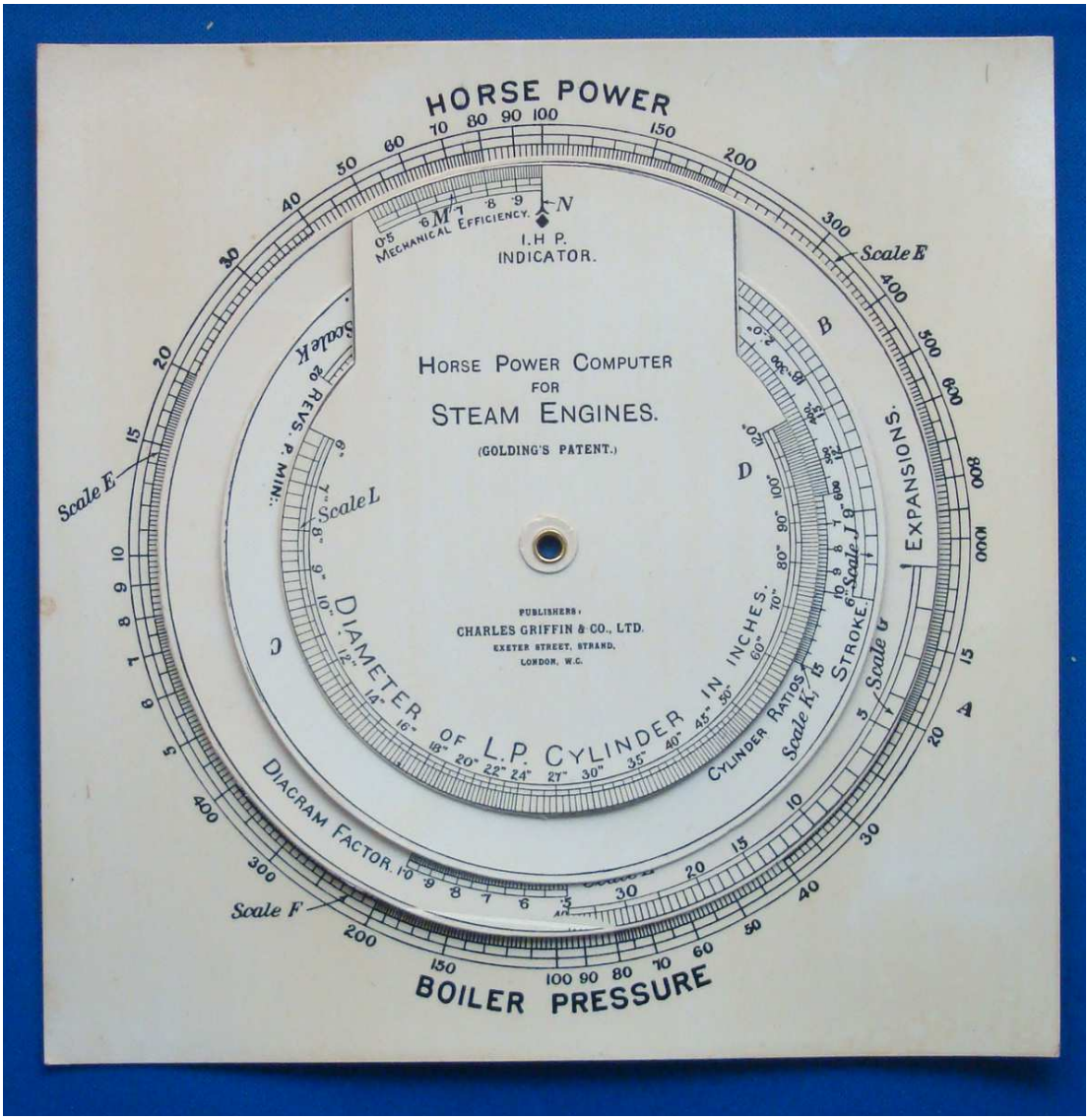


Figure 98: TCD-SCSS-U.20121208.013-fig98

Figure 99: TCD-SCSS-U.20121208.013-fig99

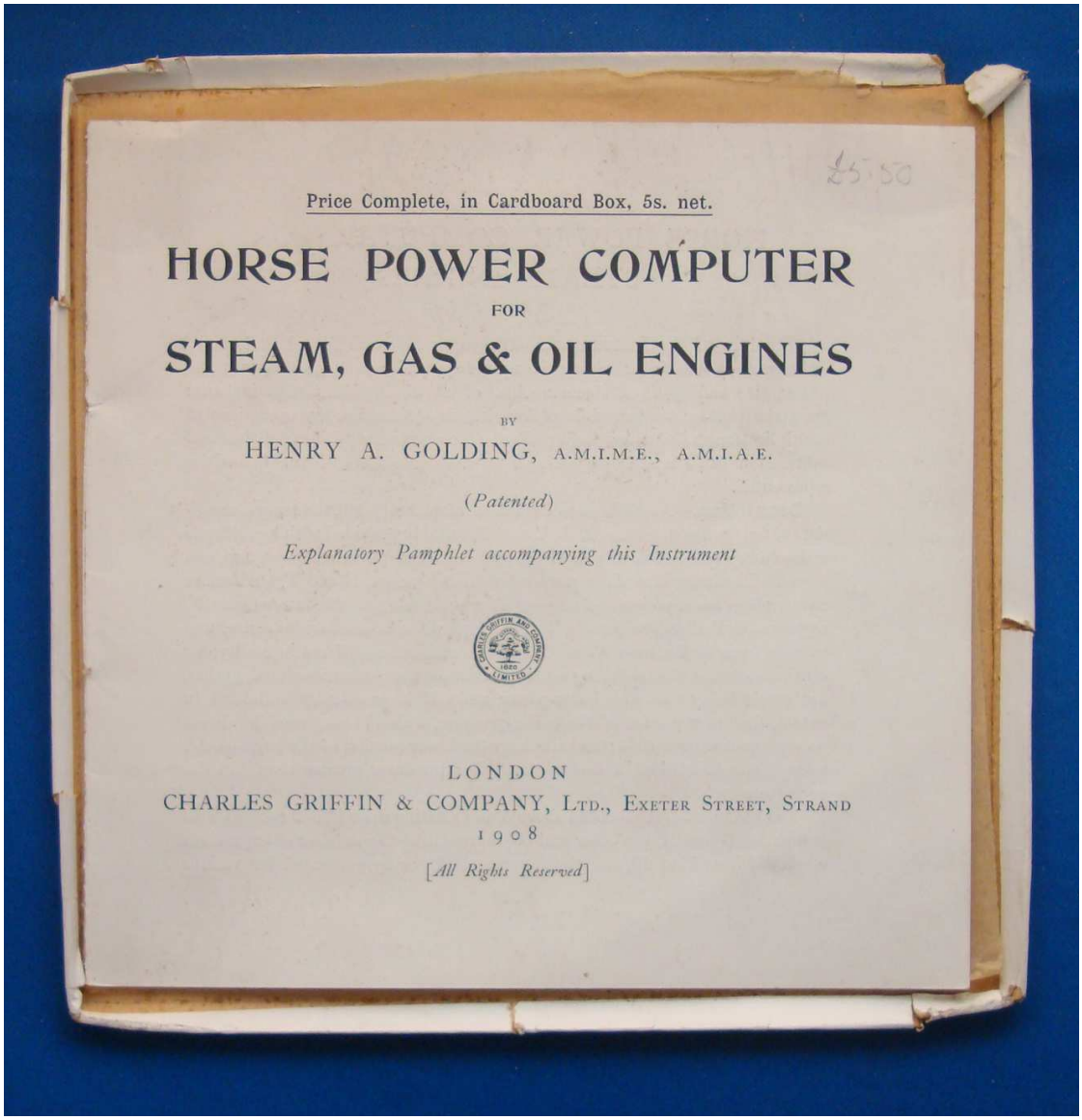


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Figure 100: TCD-SCSS-U.20121208.013-fig100

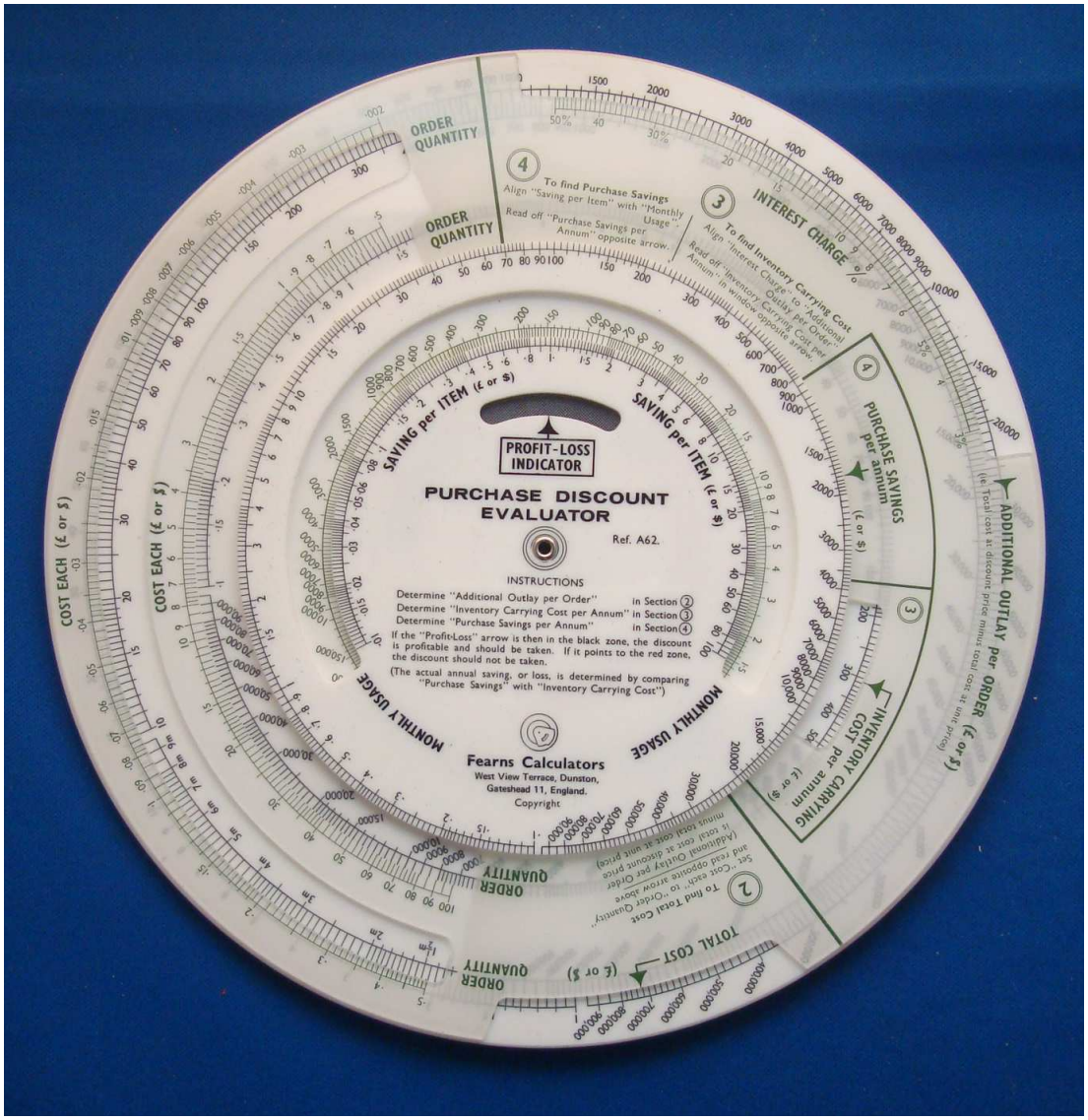

Figure 101: TCD-SCSS-U.20121208.013-fig101

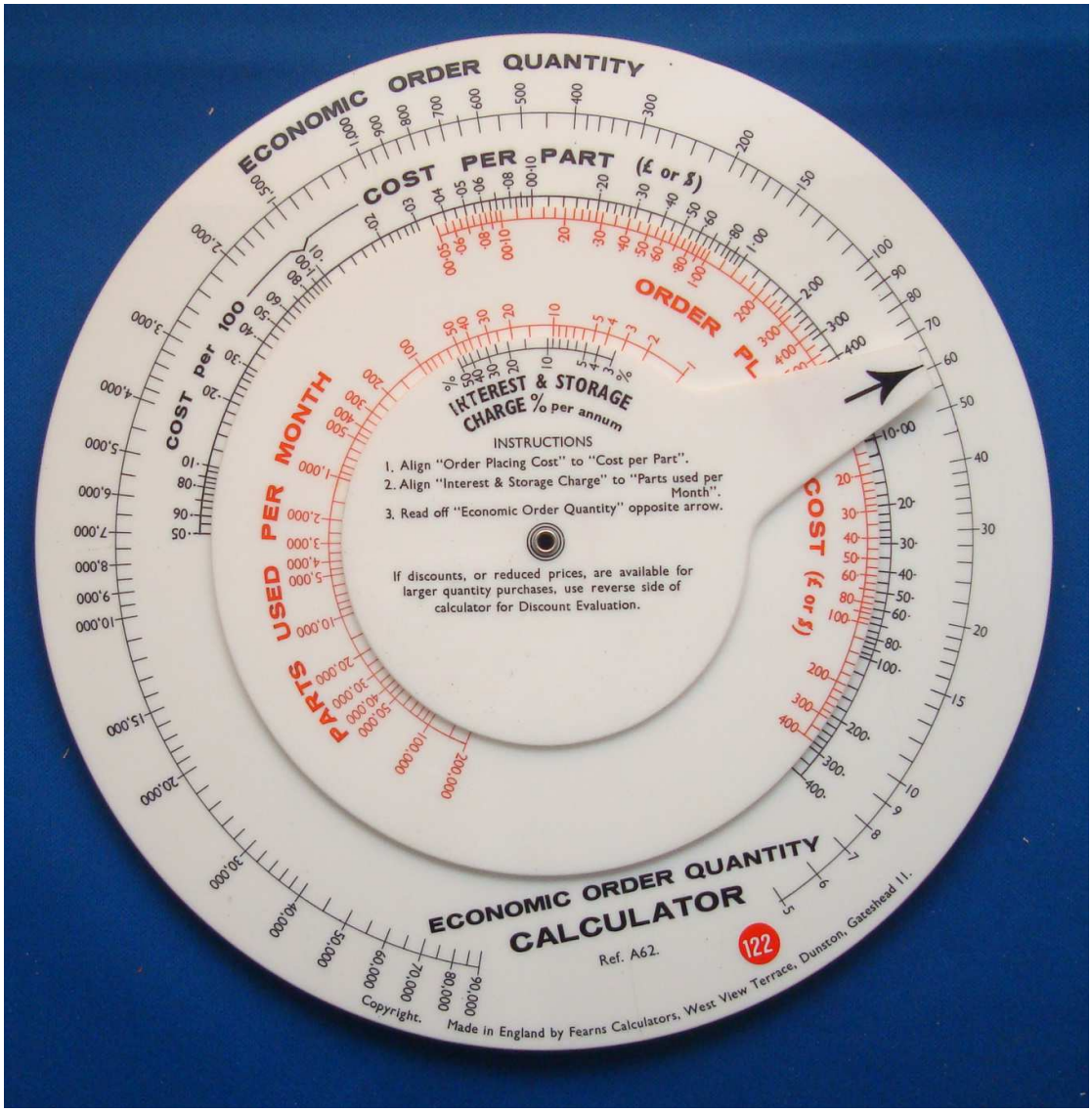

Figure 102: TCD-SCSS-U.20121208.013-fig102

Figure 103: TCD-SCSS-U.20121208.013-fig103

Figure 104: TCD-SCSS-U.20121208.013-fig104

Figure 105: TCD-SCSS-U.20121208.013-fig105

H. O. NO. 2102-C

HYDROGRAPHIC OFFICE

RUDE

STAR FINDER AND IDENTIFIER

(WITH HYDROGRAPHIC OFFICE MODIFICATIONS)

TO PLOT PLANETS OR MOON

Subtract the G. H. A. of the Planet or Moon from the G. H. A. ♈ (plus 360° if necessary). These values are taken from the same line in the Air Almanac. Place the 5° template on the Star Base and set its extended 0°—180° line at the resulting value on the outer periphery of the Base. Through the slot cut in the template, plot the planet or moon at the body's declination.

This distance may be measured on the scale below with dividers and transferred to the Base:

North

30° N.

20° N.

10° N.

Celestial — Equator

10° S.

20° S.

30° S.

South

Published at the Hydrographic Office, Washington, D. C., March 1942
under the authority of THE SECRETARY OF THE NAVY.

(over)

Figure 106: TCD-SCSS-U.20121208.013-fig106

DESCRIPTION

This device is designed especially for use of aircraft. It gives the positions of all the stars included in both the American and British Air Almanacs, and may be used either for identifying or spotting stars. It consists of a Star Base with the northern sky on one side and the southern on the other, seven (7) templates centered at 10° intervals of latitude, this instruction card, and a leatherette container.

INSTRUCTIONS

Choose the template nearest to the D. R. Latitude. Center it on the Star Base by placing the hole over the pin in the center of the Base, with proper hemisphere side up. For any given G.C.T. take the G.H.A. of Aries (♈) from the Air Almanac. Apply the D. R. longitude to find the L. H. A. ♈, combining above quantities by subtracting in W. long. and adding in E. long. (add 360° when necessary). Rotate the template to bring the arrow of the 0°—180° line to the degree mark on the outer edge of the Base corresponding to the L. H. A. ♈. The 0°—180° line when thus set for a specified time becomes the observer's local meridian. Stars in the visible sky whose altitudes are over 10° are then inclosed within the blue grid of the template and their approximate altitudes and azimuths may be picked off.

Example: At sea, April 10, 1942, in D. R. Lat. 40° N., Long. 150° W., G. C. T. $4^h\ 47^m\ 00^s$ (April 11). Find Alt. and Az. of stars.

G. C. T.	$4^h\ 47^m\ 00^s$
G. H. A. ♈	270° 31′ W.
Long.	150° 00′ W.
L. H. A. ♈	120° 31′

Set arrow of Lat. 35° N. template on L. H. A. ♈ of 120° 30′ and read alt. and az. of stars inclosed within the blue grid.

To spot stars, find the G. C. T. of sunrise, or sunset, and convert it to L. H. A. ♈. Select desirable stars and pick off their approximate altitudes and azimuths.

(over)

Figure 107: TCD-SCSS-U.20121208.013-fig107

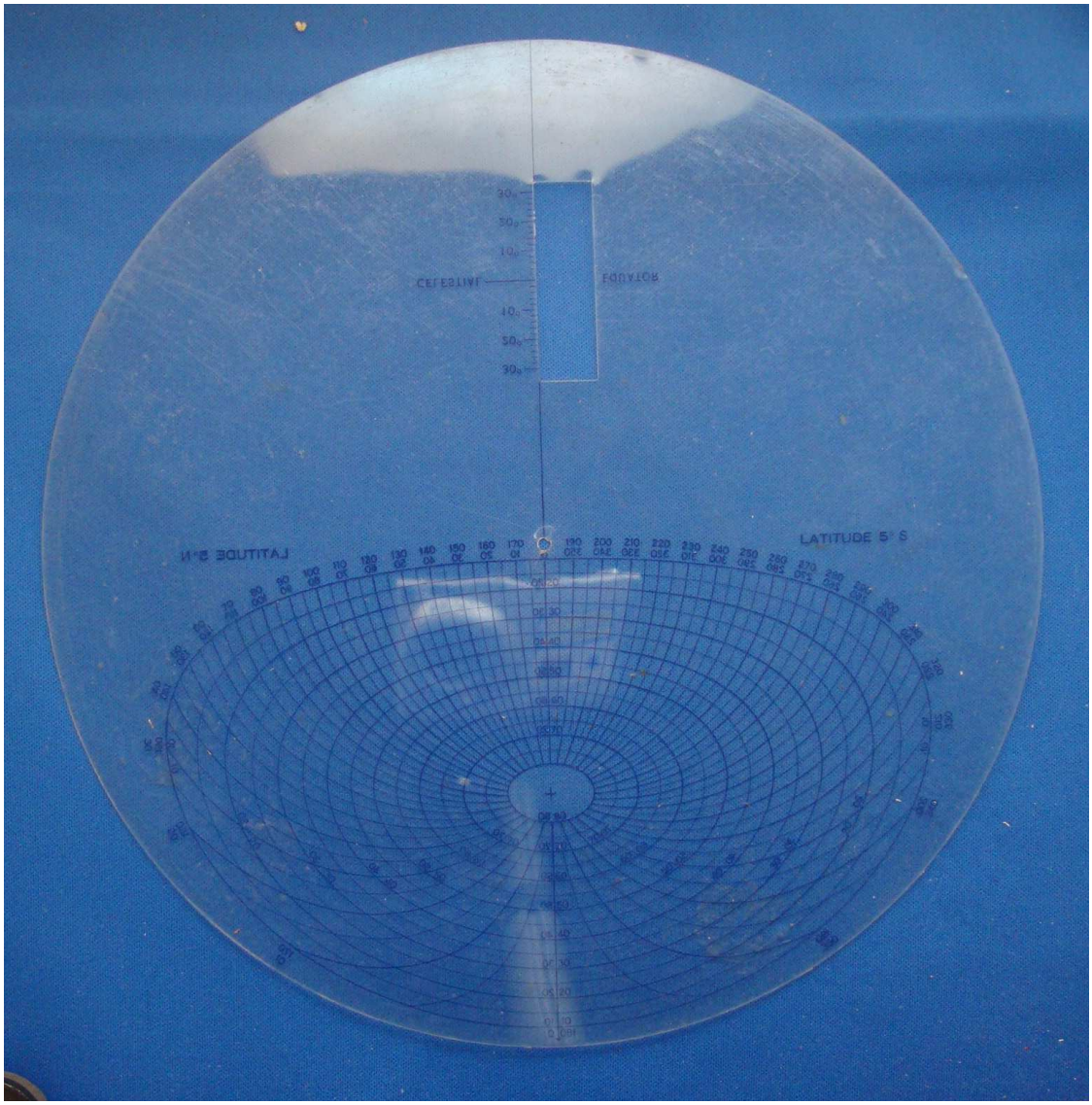

Figure 108: TCD-SCSS-U.20121208.013-fig108

Figure 109: TCD-SCSS-U.20121208.013-fig109

Figure 110: TCD-SCSS-U.20121208.013-fig110

Figure 111: TCD-SCSS-U.20121208.013-fig111

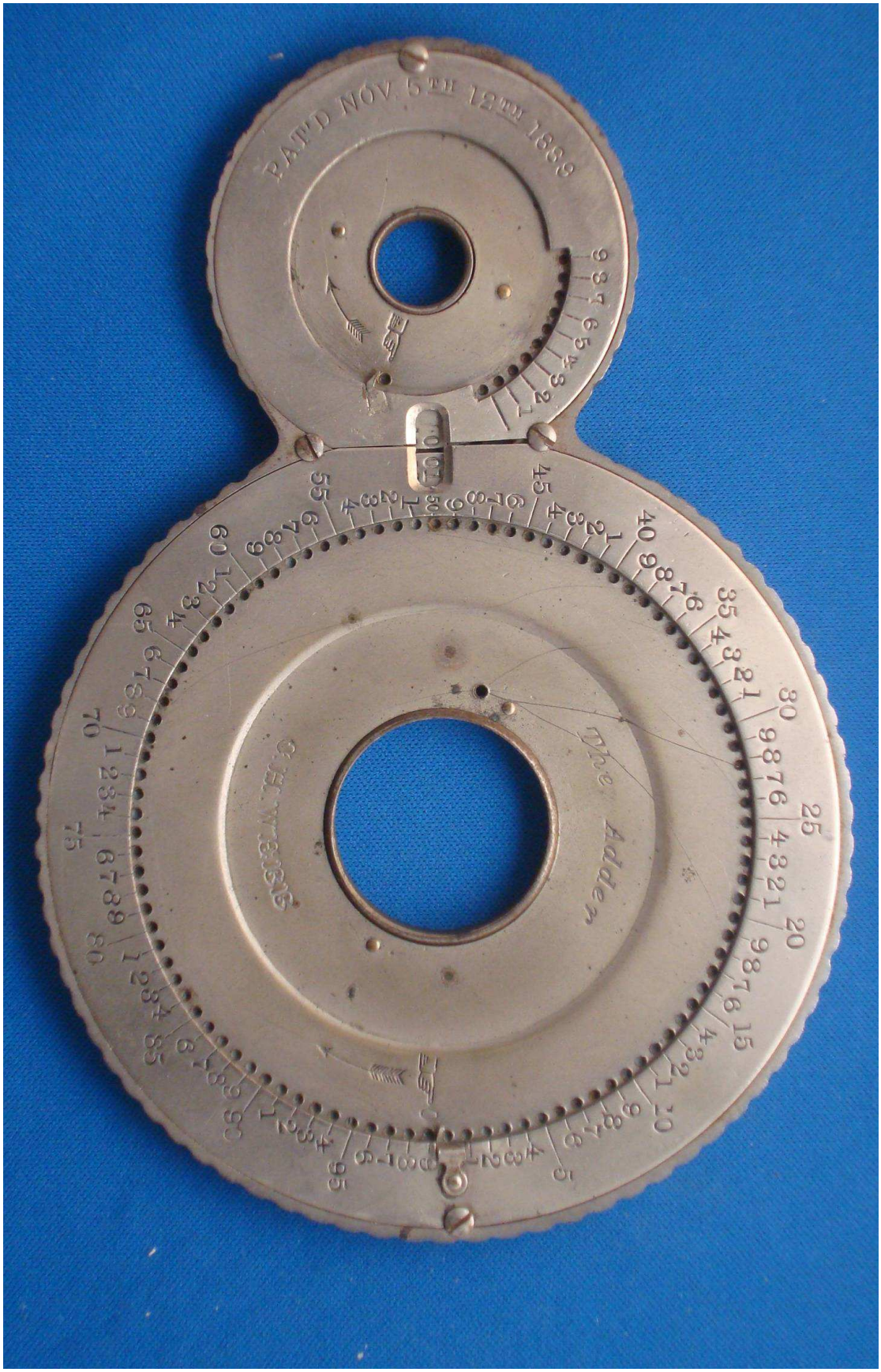

Figure 112: TCD-SCSS-U.20121208.013-fig112

Figure 113: TCD-SCSS-U.20121208.013-fig113

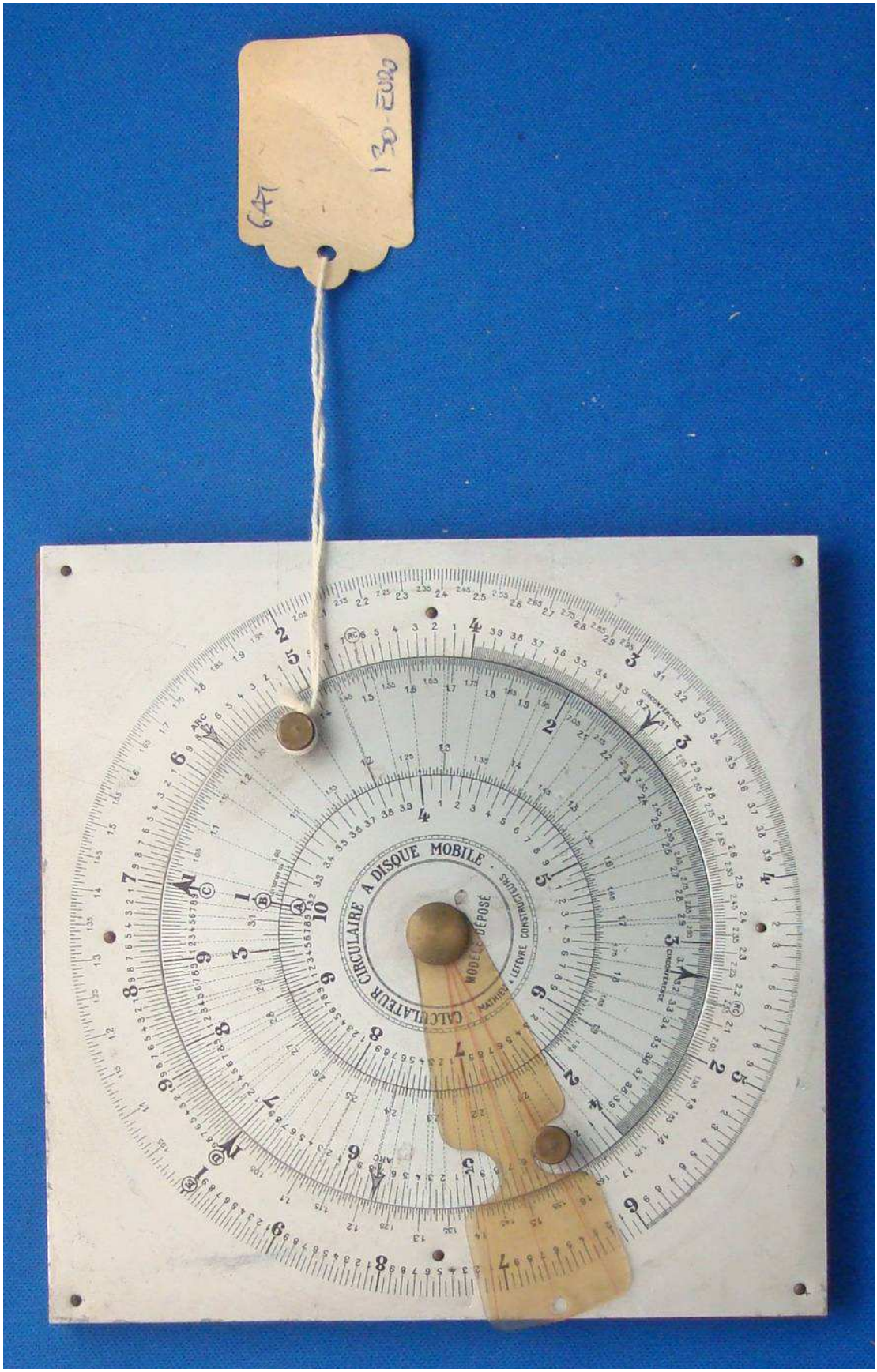

Figure 114: TCD-SCSS-U.20121208.013-fig114

Figure 115: TCD-SCSS-U.20121208.013-fig115

Figure 116: TCD-SCSS-U.20121208.013-fig116

Figure 117: TCD-SCSS-U.20121208.013-fig117