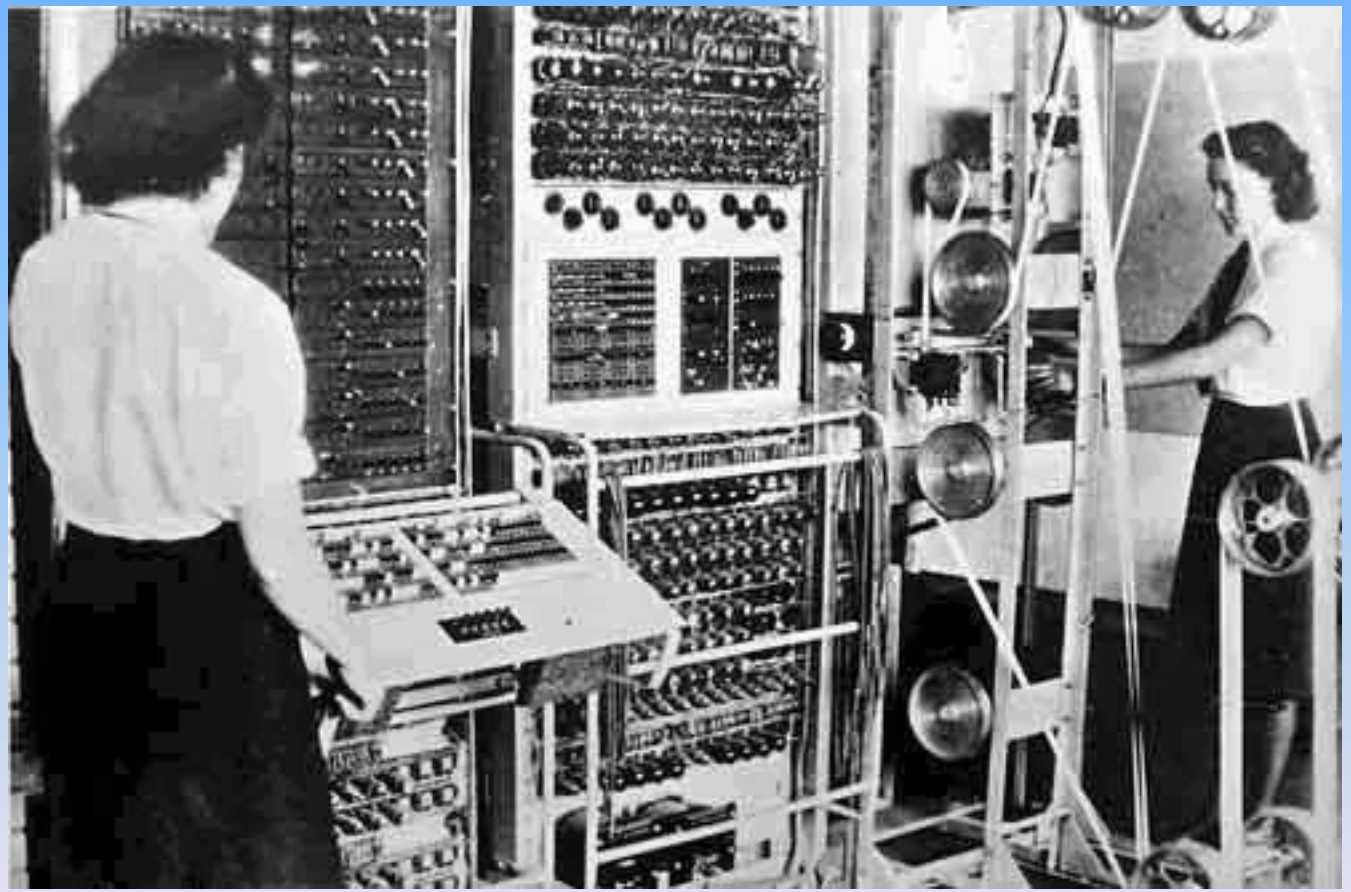
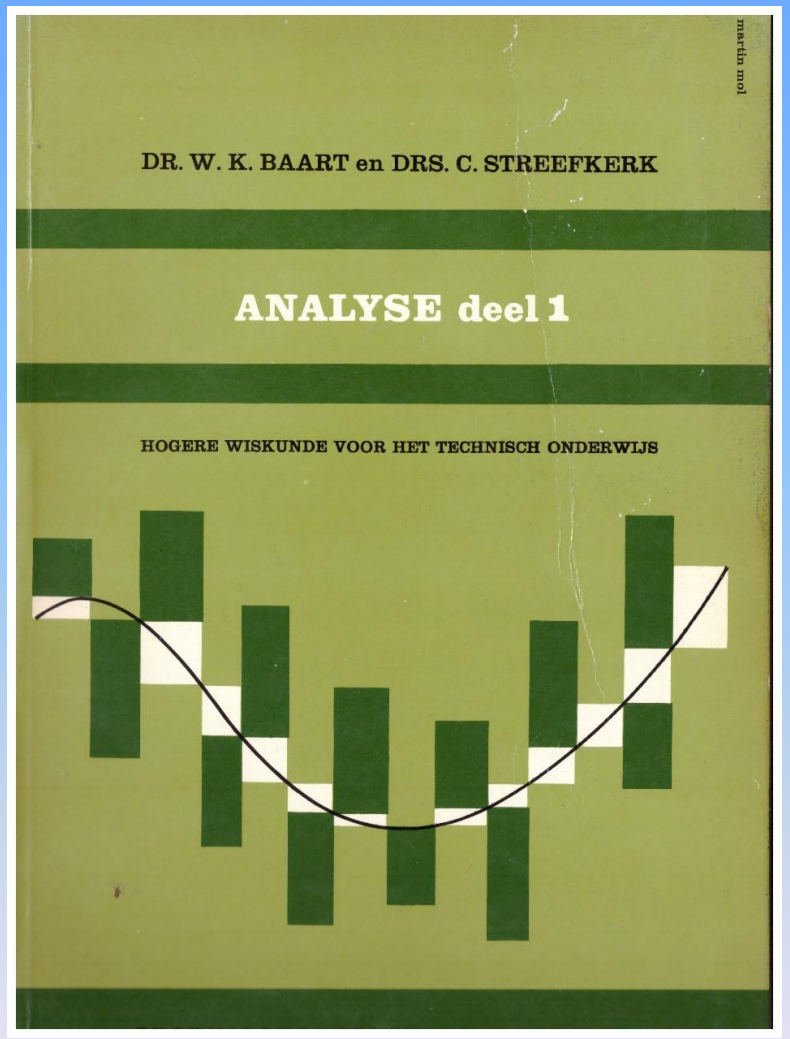
Planimeters: analoge computers

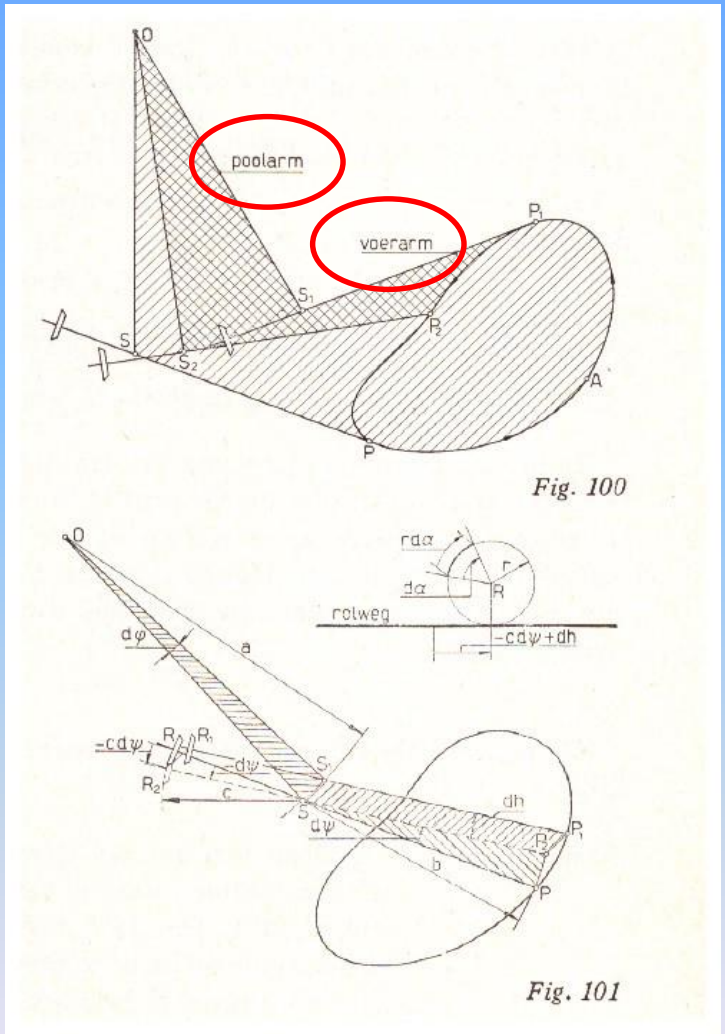
Simon van der Salm

1970: In digitale computers geloofden mijn leraren (nog) niet

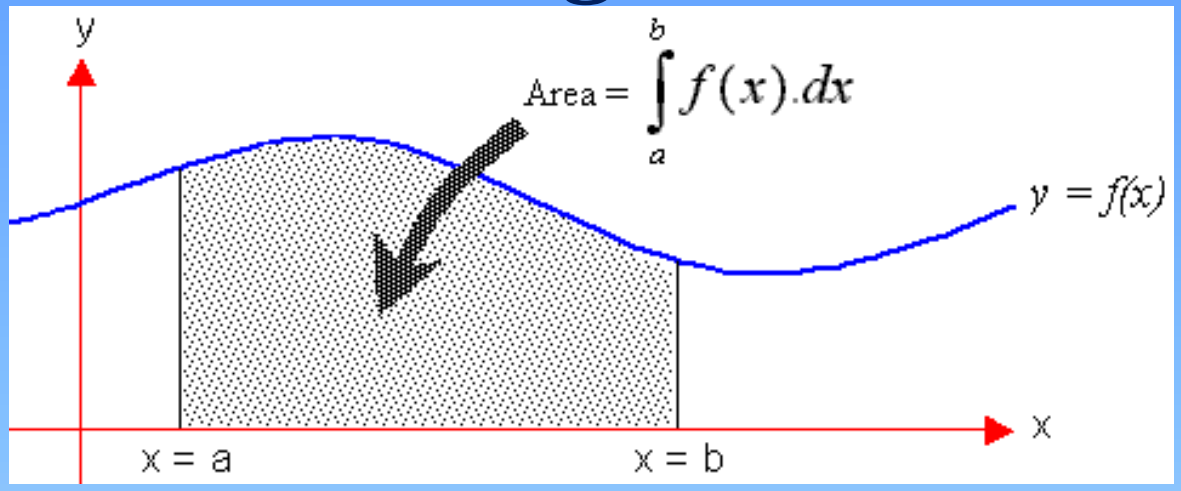


HTS 1970: poolplanimeter van Amsler





Integraal



Rand

$$\int_a^b f(x)\,dx = F(b) - F(a)$$

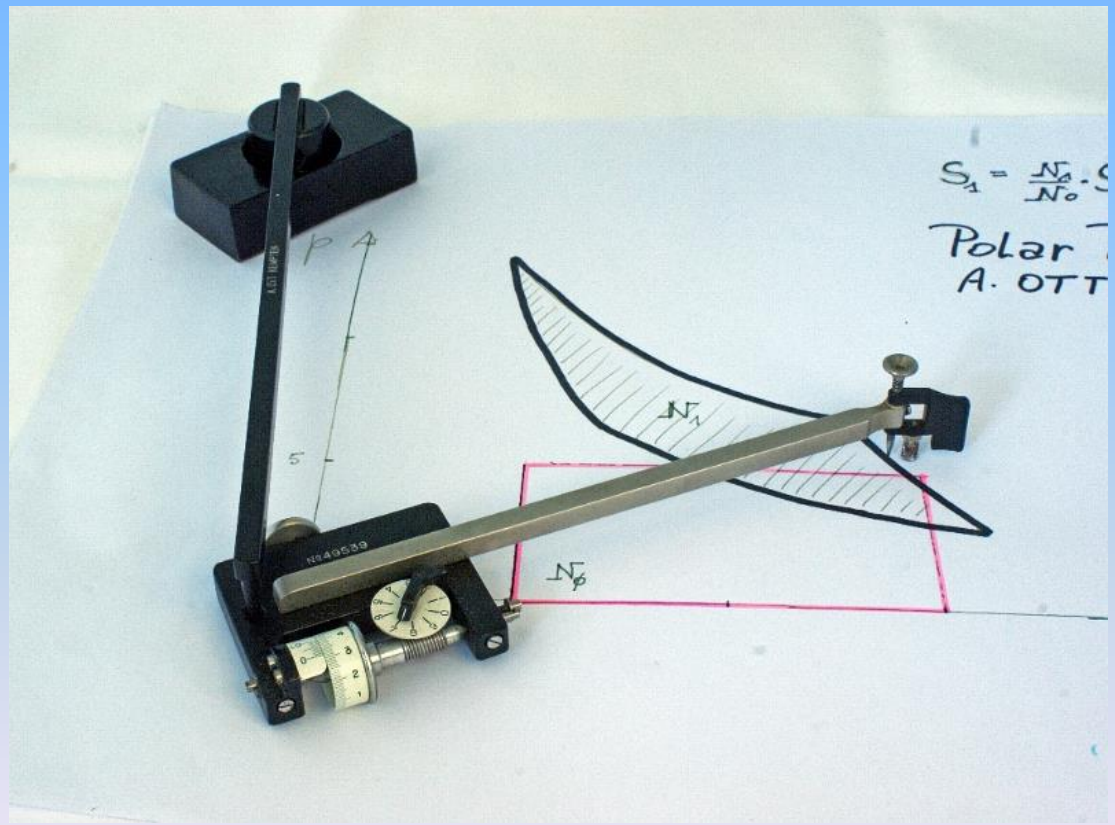
Randwaarden bepalen oppervlakte

Het exact bepalen van de oppervlakte van een willekeurige vlakke figuur, louter door aftasten van de rand

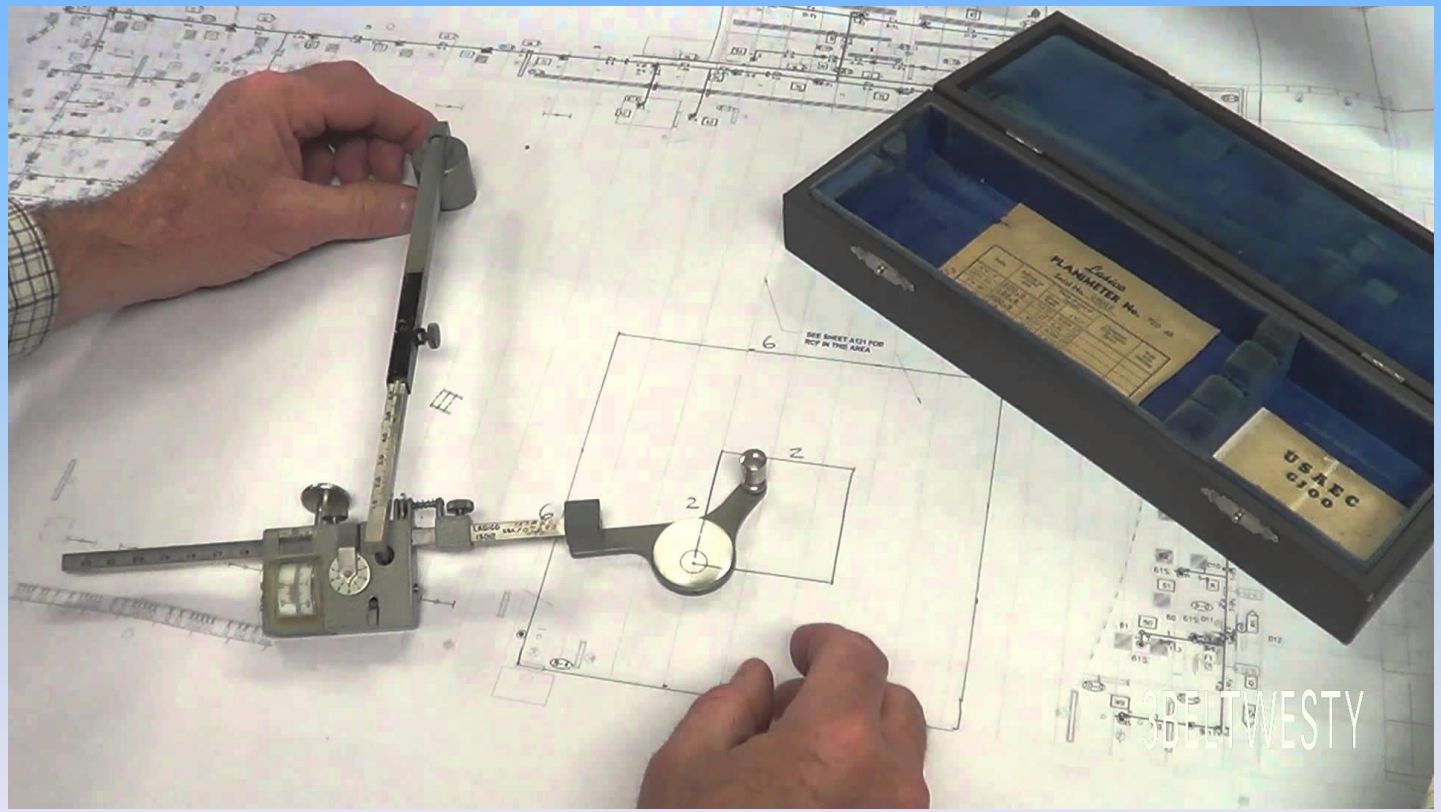
1815: Johann Martin Hermann:

"Rand bepaalt oppervlakte!"

1854, Jakob Amsler-Laffon:
je hebt daarvoor niet meer nodig dan:
2 armen + 1 meetwieltje



De Amsler-poolplanimeter werd tot ca.1980 in nagenoeg alle technische beroepen gebruikt

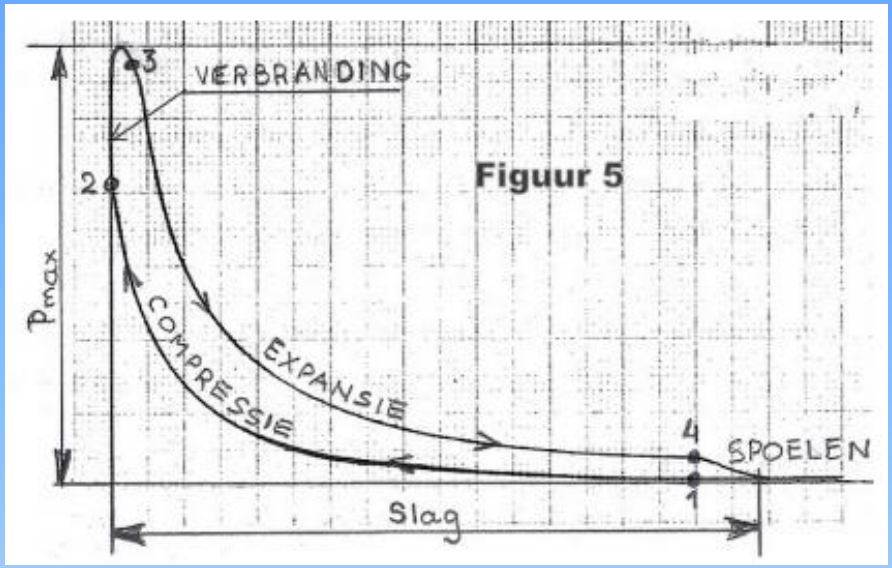


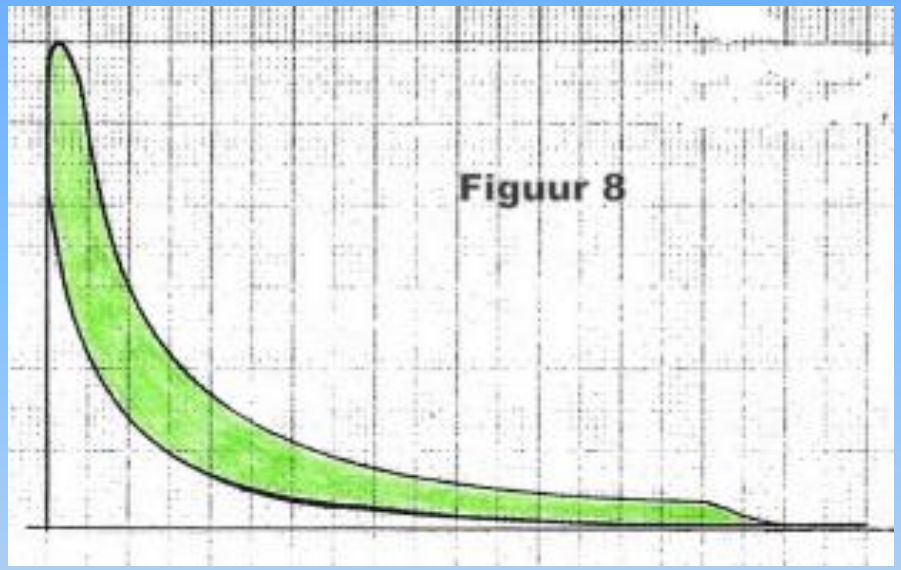
Op volle zee

1957: M.S. Stentor

Het rekenkistje van de hoofd-werktuigkundige (HWTK)

Cilinder-indicateurdiagrammen





$$\text{vermogen} = \frac{\text{zuigeroppervlak x gemiddelde effectieve druk x slag x toerental}}{75 \times 60}$$

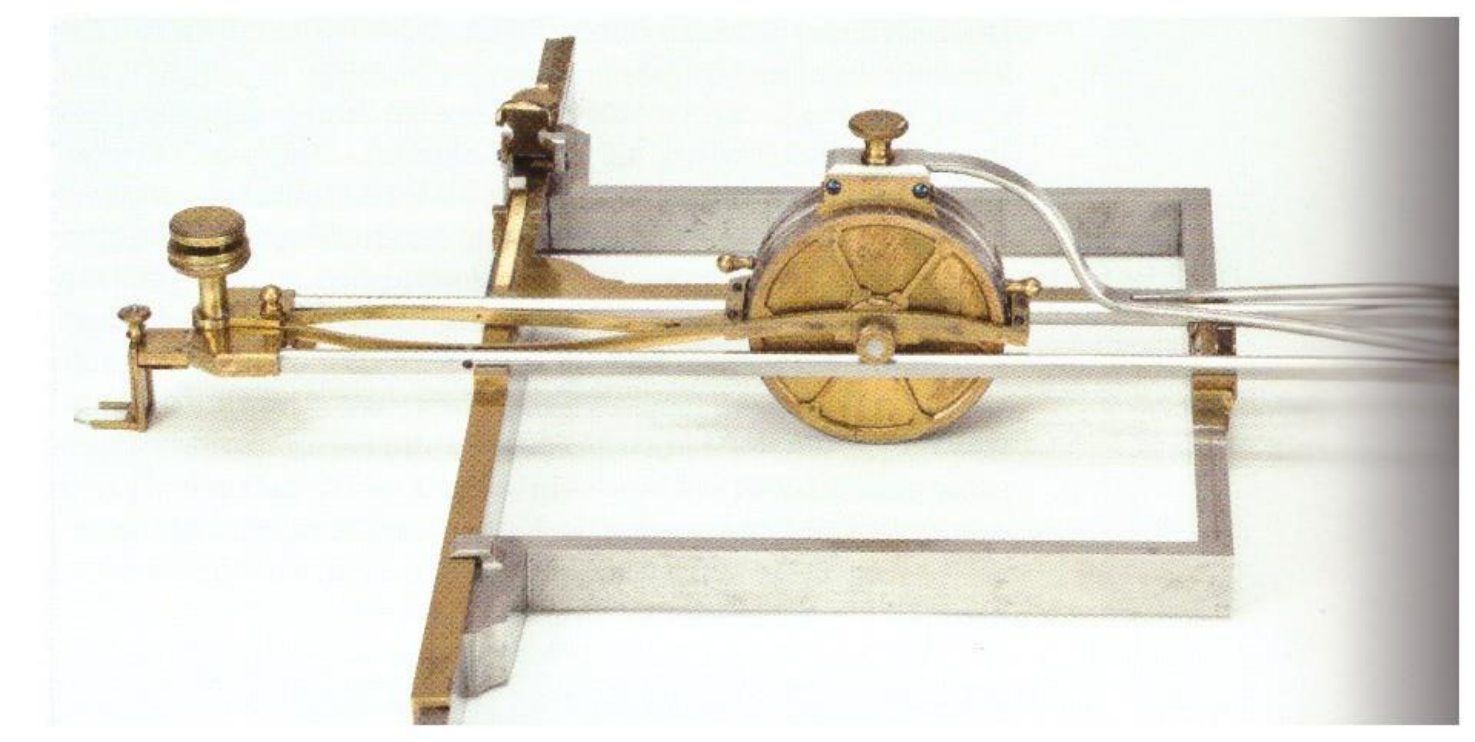
waarbij :
- Vermogen in pk (1 pk = 75 kgm/s)
- Oppervlak in cm^2
- Druk in kg/cm^2
- Slag in m
- Toerental in omw/min (rpm)

Oppervlakte werd analoog bepaald, eerst benaderend, later exact, met mechanische integratie

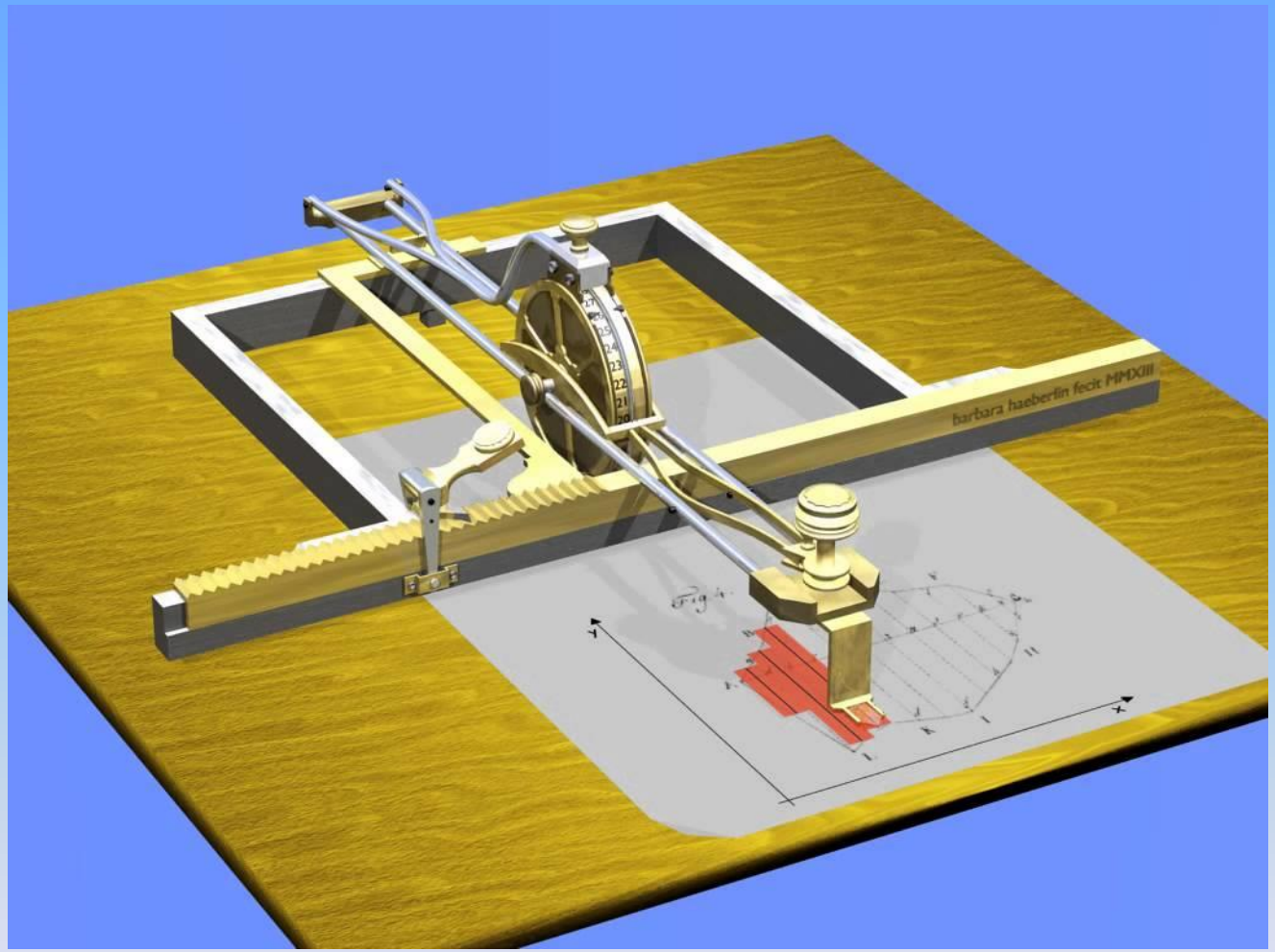
Geschiedenis begint ≈ 1815

1. Pioniers

≈ 1815: Johann Georg Zobel & Joseph Müller: Vlakberekeningsmachine

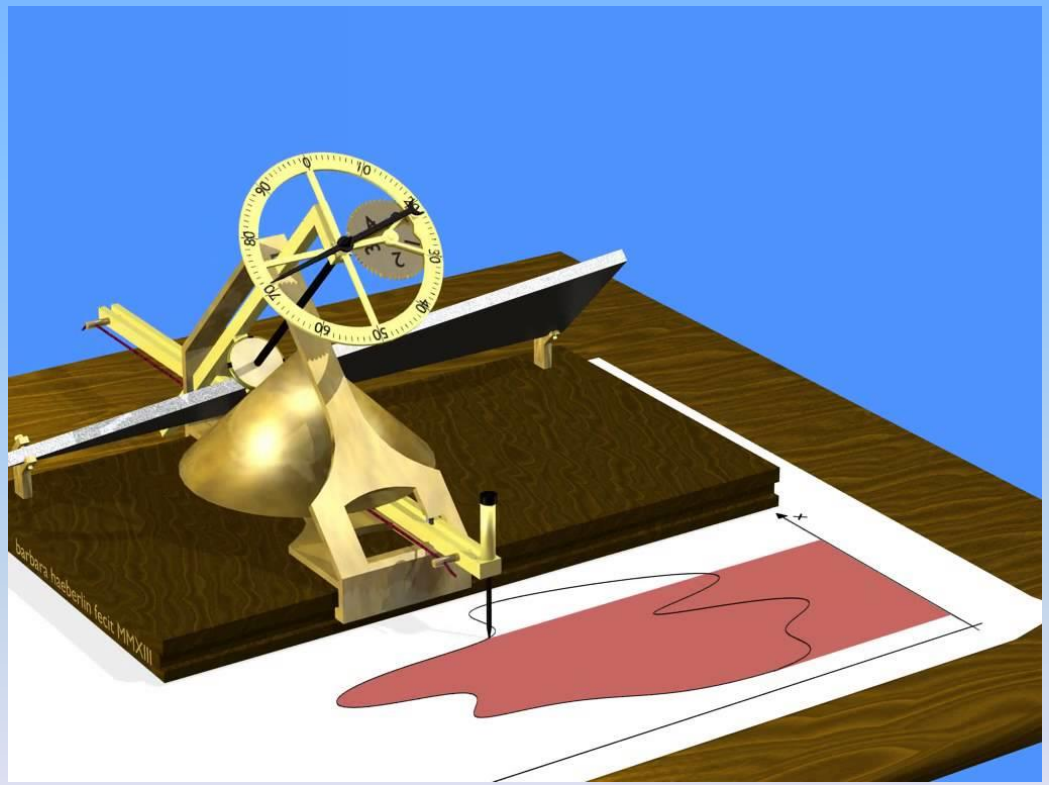


Animatie 1: Zobel-planimeter

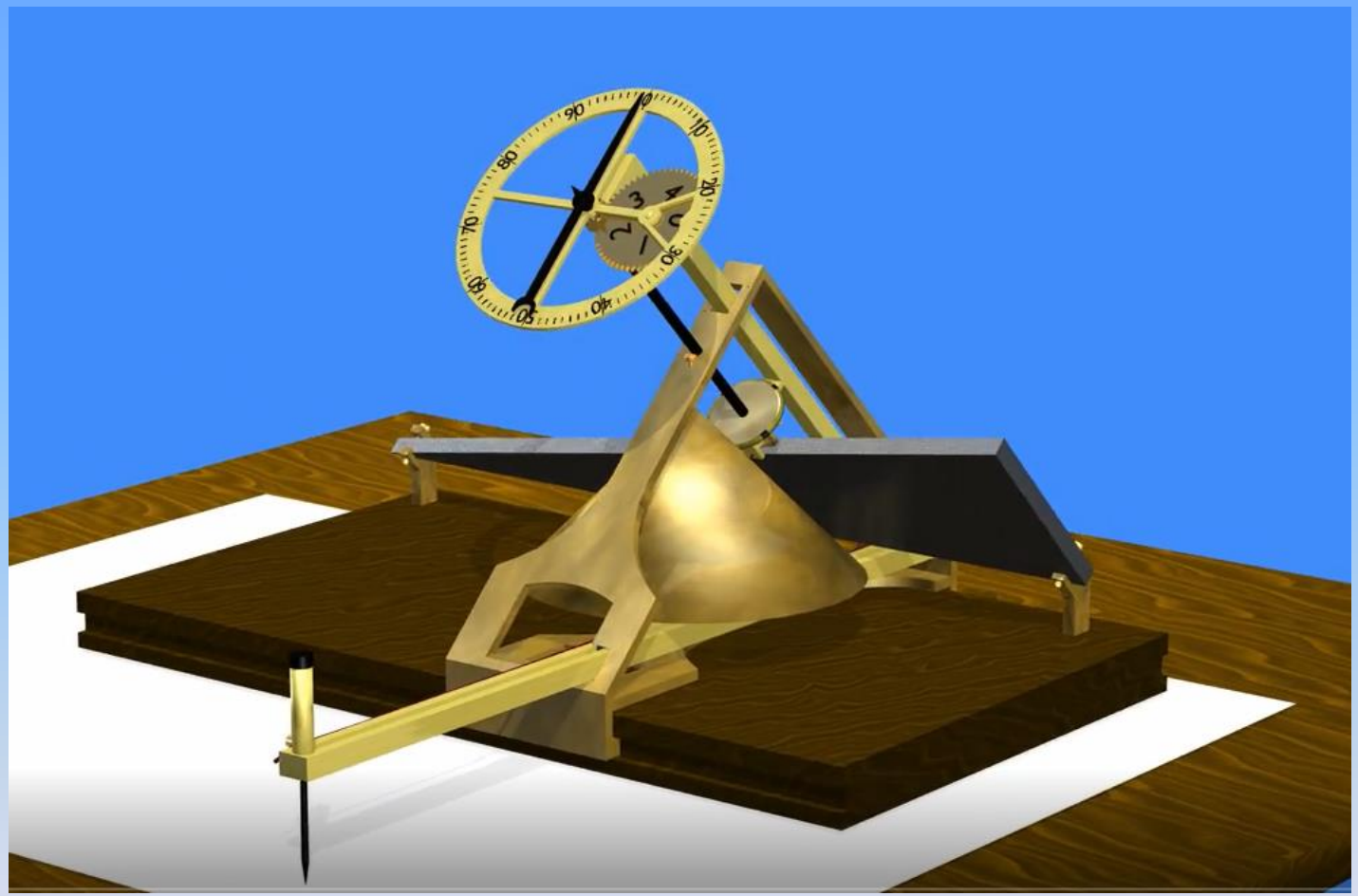


2. Pioniers

≈ 1817: Johann Martin Hermann (1785-1841): Kegel-wiel-integrator (exact)



Animatie 2: Hermann-planimeter



Wiskunde van de Hermann-planimeter?

3. Pioniers

Tito Gonnella (1794-1867)

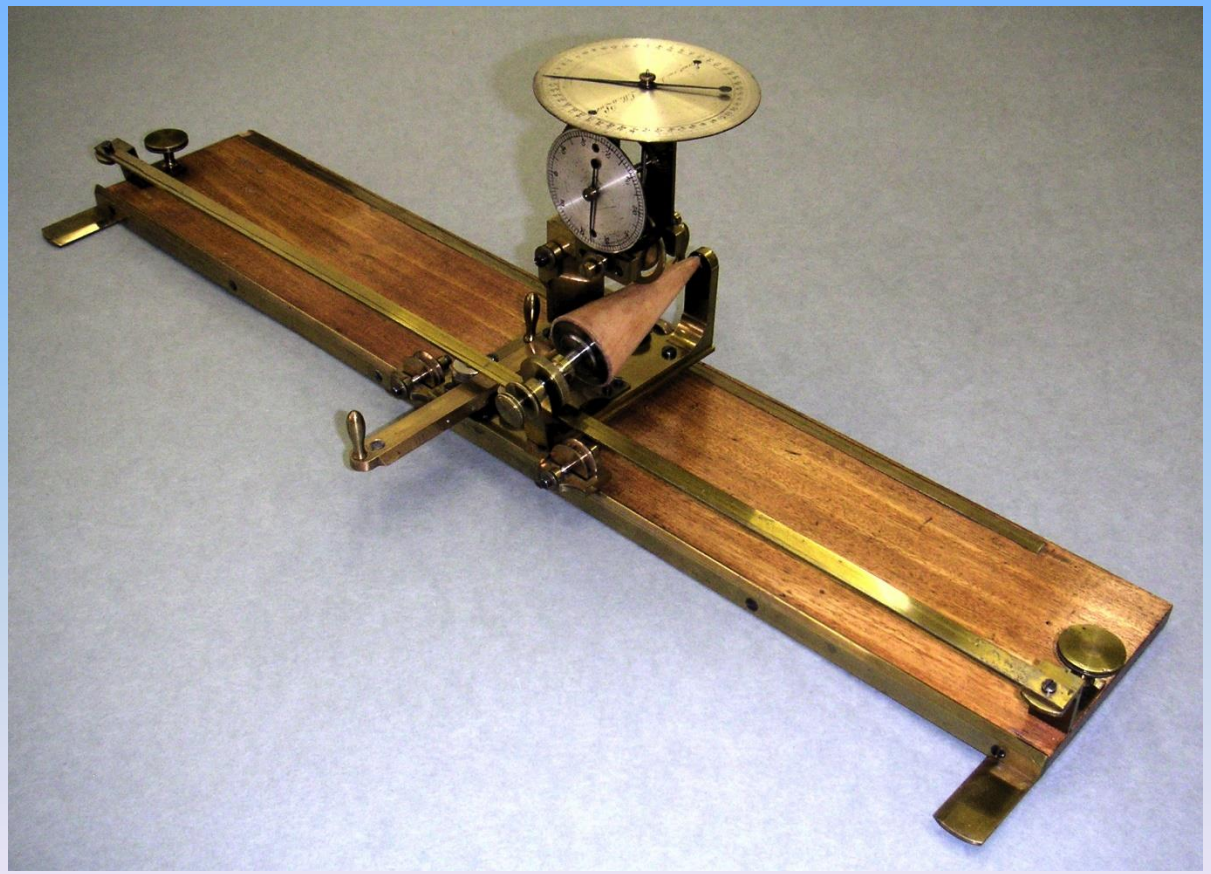
Johannes Oppikofer (1783-1864)

≈ 1826: Kegel-wiel-mechanisme

4. Pioniers

Heinrich Rudolf Ernst (1803-1863):

1834: verbeterde het kegel-wielprincipe

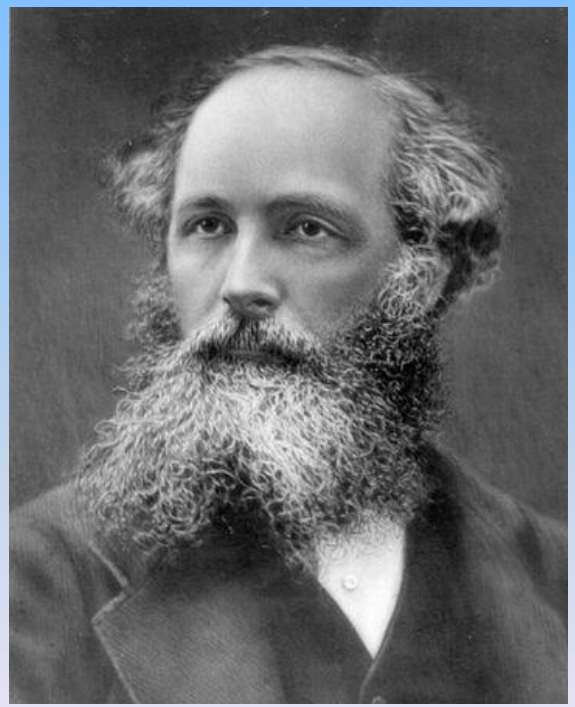


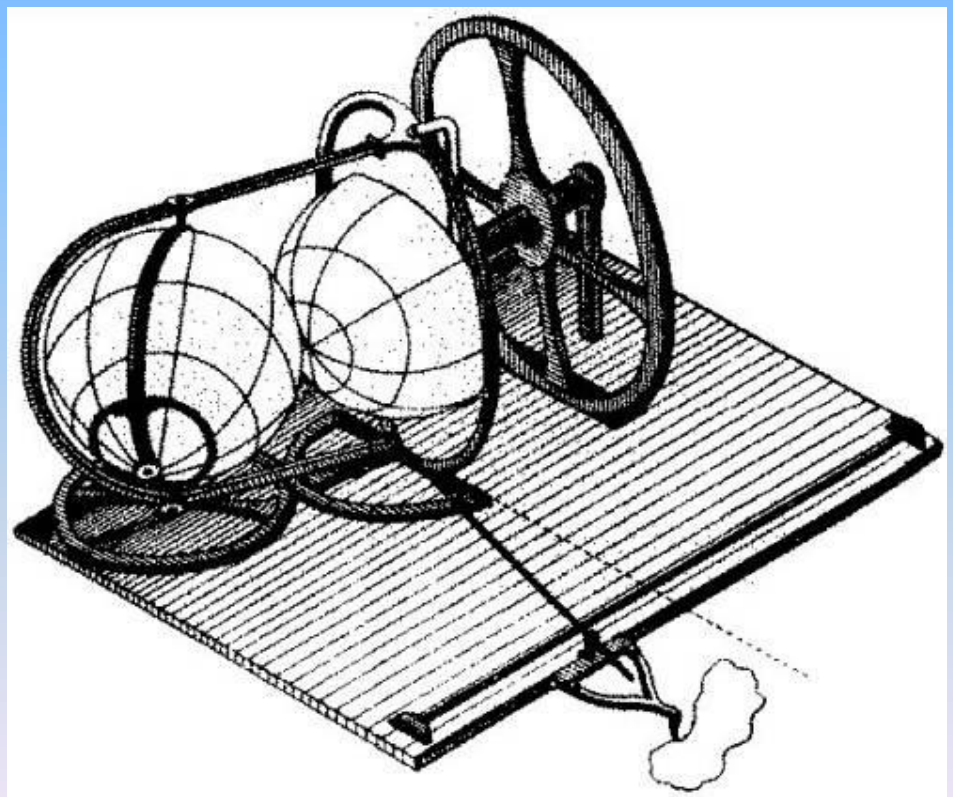
5. Laatse pionier:

James Clerk Maxwell (1831-1879)

1854/1855:

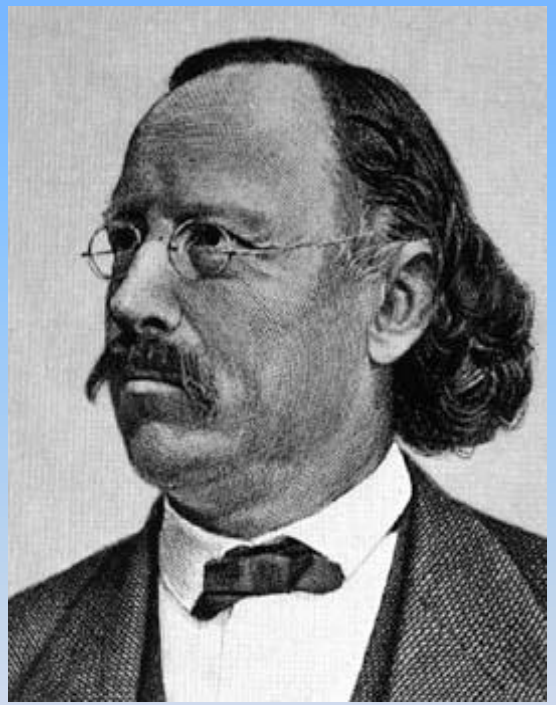
schetsontwerp van een sferische integrator

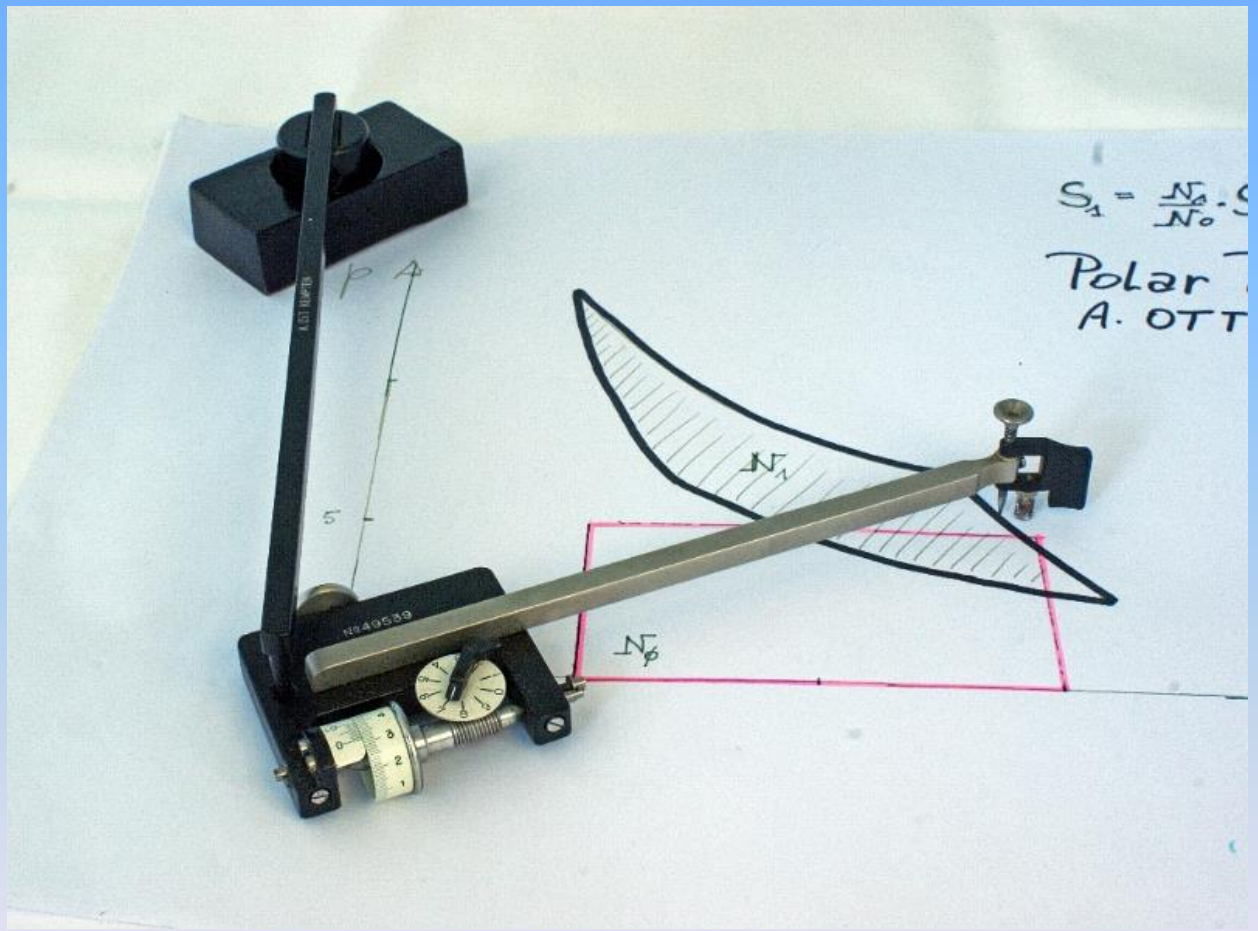




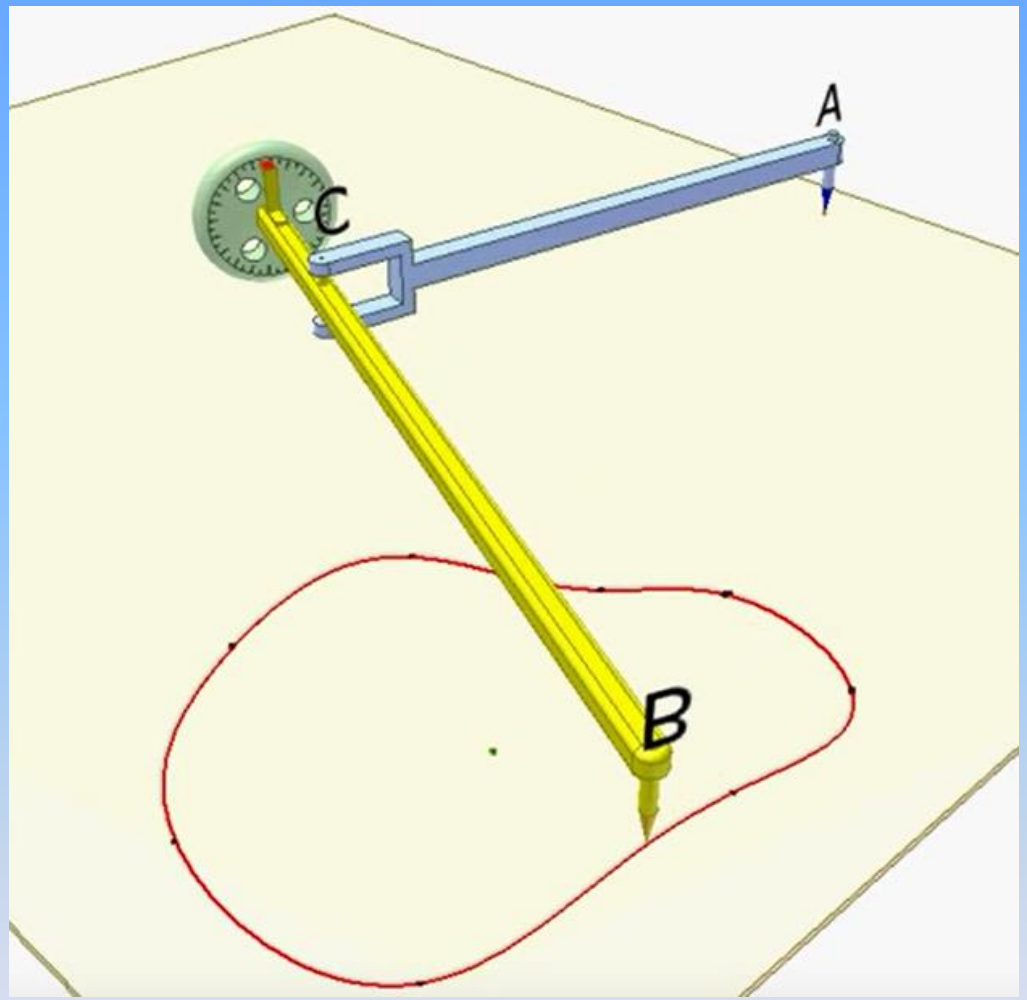
1854: Jakob Amsler-Laffon:

Integrator met slechts 2 armen en 1 wieltje





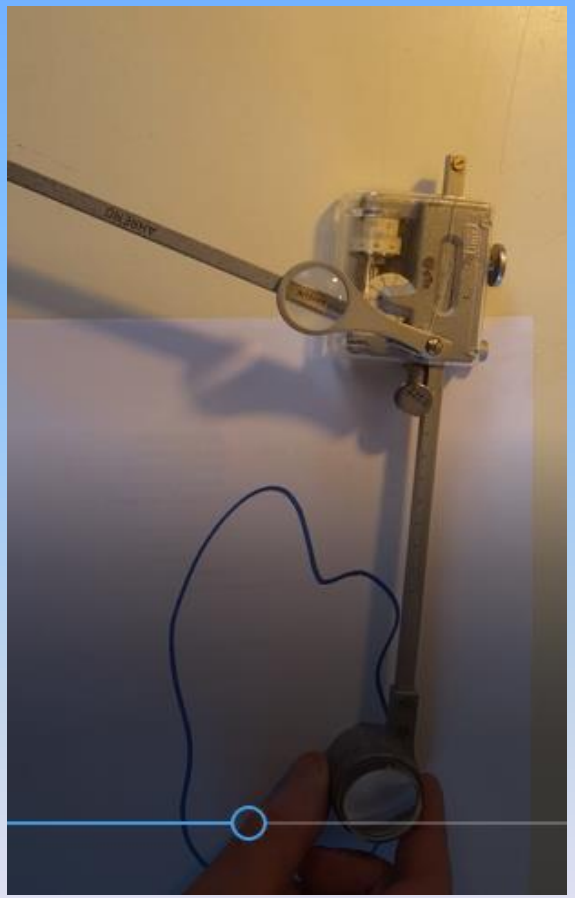
Essentie van de poolplanimeter



A: pool
B: tastpunt
C: meetwieltje
AC: poolarm
CB: tastarm

https://www.youtube.com/watch?v=kdxPEZnv-U0

Animatie 4: Poolplanimeter van Amsler volgens Ott



Wiskunde?

Hoe kan een zo
eenvoudige constructie
exact de oppervlakte bepalen?

Zie artikel:

De poolplanimeter van Jakob Amsler-Laffon

Simon van der Salm

Stelling van Green:

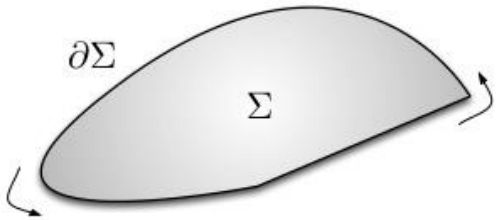
Meeste ‘moderne’ bewijzen gaan uit van de stelling van Green voor het vlak uit 1828, maar die stelling kende Amsler (en ook Maxwell) helemaal niet.

1828: Stelling van Green voor het vlak

The Green's theorem (GT)

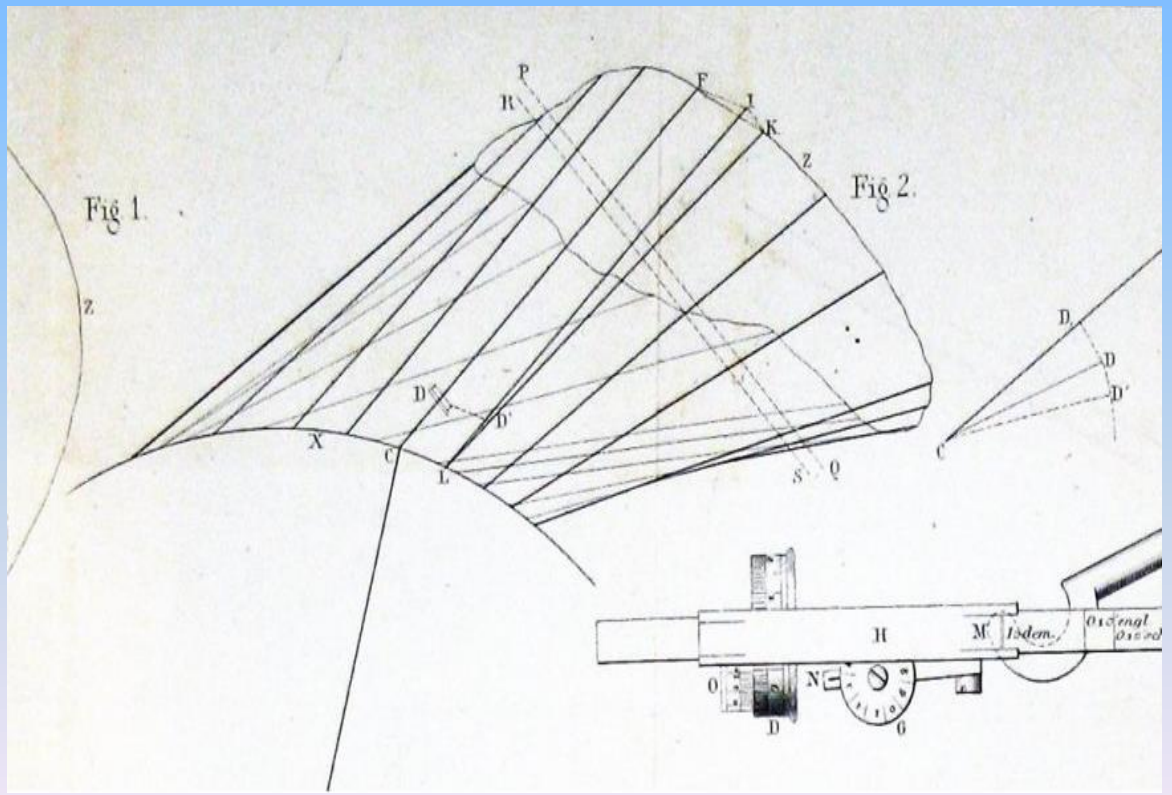
- Consider a two-dimensional domain $\mathcal{D}$ with one-dimensional boundary $\partial\mathcal{D}$ then for smooth functions $M(x,y)$ and $L(x,y)$ we have the integral relation:

$$\oint_{\partial\Sigma} (L\mathrm{d}x + M\mathrm{d}y) = \iint_{\Sigma} \left(\frac{\partial M}{\partial x} - \frac{\partial L}{\partial y} \right) \mathrm{d}x\mathrm{d}y$$



Wednesday, January 23, 13

Bleef 40 jaar onbekend

Amsler:

Een oppervlak = collectie van lijnstukken waarbij de één via translatie en rotatie volgt uit de andere