Physik II

Elektrostatik

Magnetostatik

Elektrodynamik (Elektromagnetismus)

Optik

(Spezielle Relativitätstheorie

Nichtlineare Dynamik)

K. Dransfeld, P. Kienle, Physik 2, Oldenbourg.

W. Demtröder, Experimentalphysik II, Springer.

M. Alonso, E.J. Finn, Fundamental University Physics II, Addison-Wesley; Deutsche Übersetzung: Physik, Oldenbourg.

R.P. Feynman, R.B. Leighton, M. Sands, The Feynman Lectures on Physics II, Addison-Wesley (1970); Deutsche Übersetzung und bilinguale Ausgabe bei Oldenbourg.

D. Meschede, Gerthsen, Physik, Springer.

Halliday, Resnick, Walker, Physik, Wiley-VCH.

Kittel, Knight, Ruderman, Berkeley-Physik-Kurs, Vieweg (1973).

P.A. Tipler, Physik, Spektrum Akademischer Verlag.

Giancoli, Physik, Pearson 2006.

N. Bronstein, K.A. Semendjajev, Taschenbuch der Mathematik,
5. Auflage, Deutsch (2001) oder Teubner Verlag (1996).

Kompakte Darstellung der mathematische Grundlagen. Formelsammlung mit allen benötigten Funktionen, Ableitungen, Integralen, Reihenentwicklungen etc.

D.R. Lide (Ed.), CRC Handbook of Chemistry and Physics, a ready-reference book of chemical and physical data.

Umfangreiche Sammlung wichtiger Materialeigenschaften und Konstanten. Zugänglich in Fachbibliothek des Physikzentrums oder in der UB.

Unsere Helden:

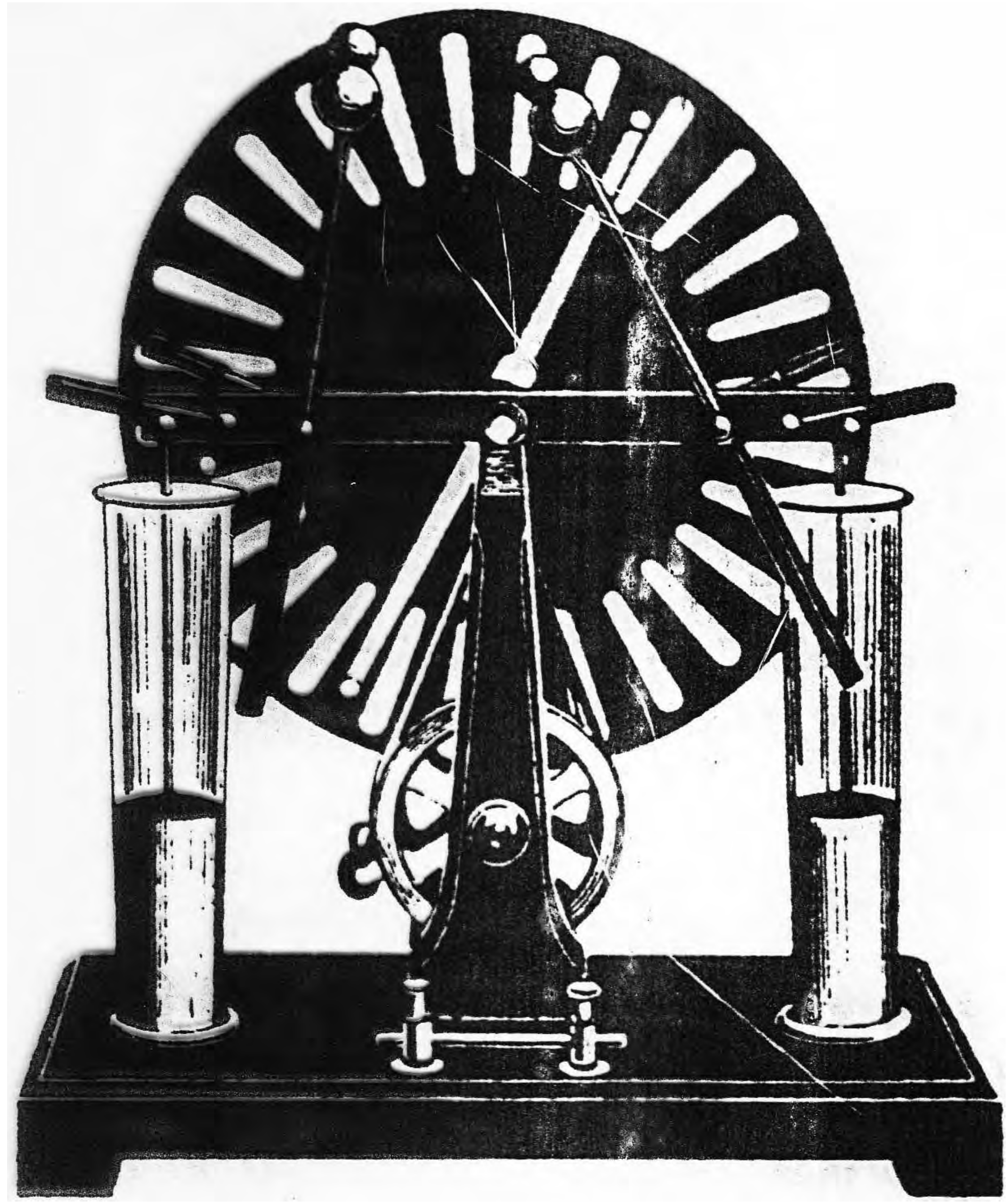
M. Faraday
September 22, 1791, ~ London
August 25, 1867, Hampton Court

André-Marie Ampère
January 20, 1775, Lyon
June 10, 1836, Marseille

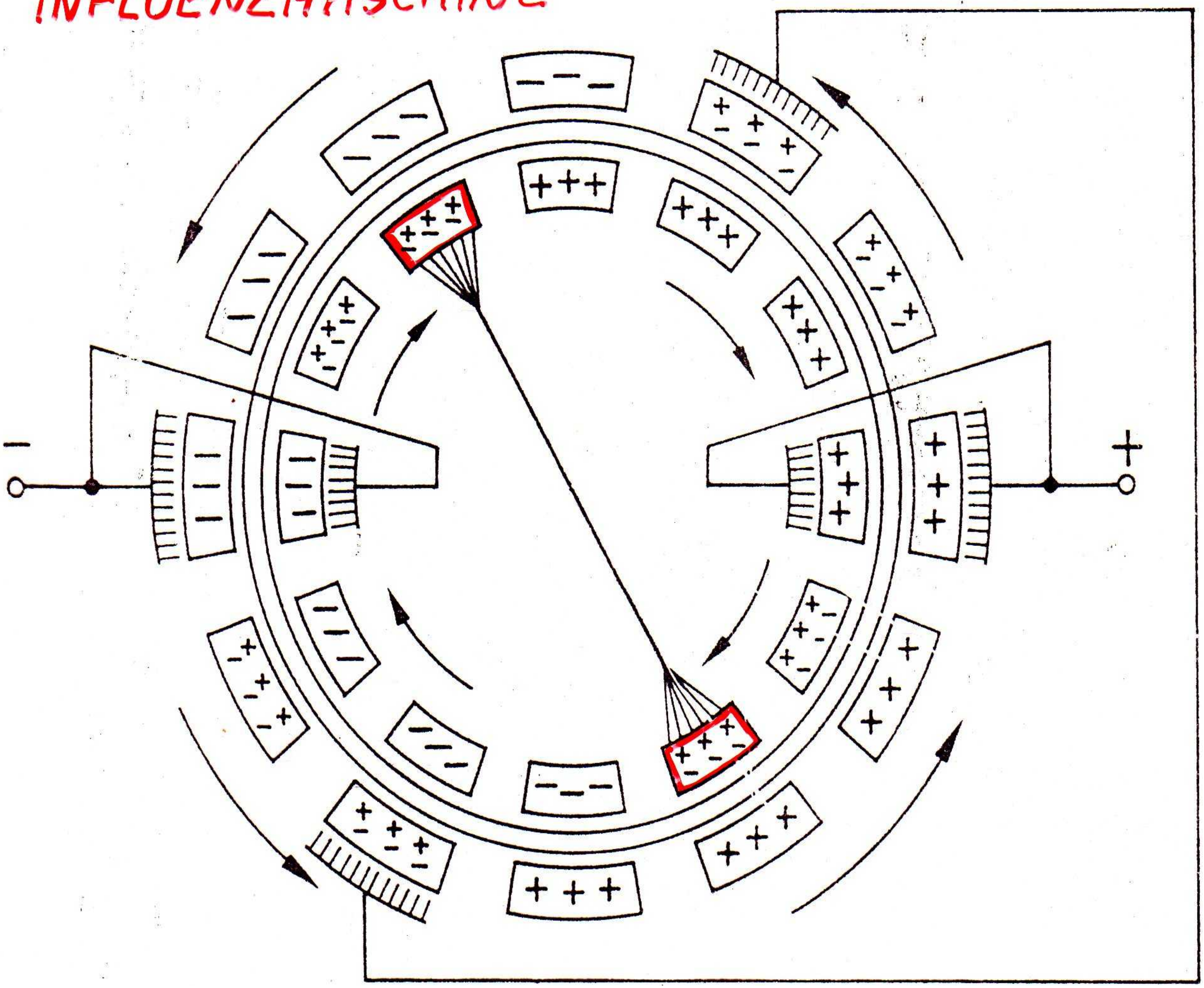
Maxwell showed that the equations predict waves of oscillating electric and magnetic fields that travel through empty space at a speed that could be predicted from simple electrical experiments—using the data available at the time, Maxwell obtained a velocity of 310,740,000 m/s. 1865 he wrote:

This velocity is so nearly that of light, that it seems we have strong reason to conclude that light itself (including radiant heat, and other radiations if any) is an electromagnetic disturbance in the form of waves propagated through the electromagnetic field according to electromagnetic laws.

13 Jun 1831, Edinburgh;
5 Nov 1879, Cambridge



INFLUENZMASCHINE

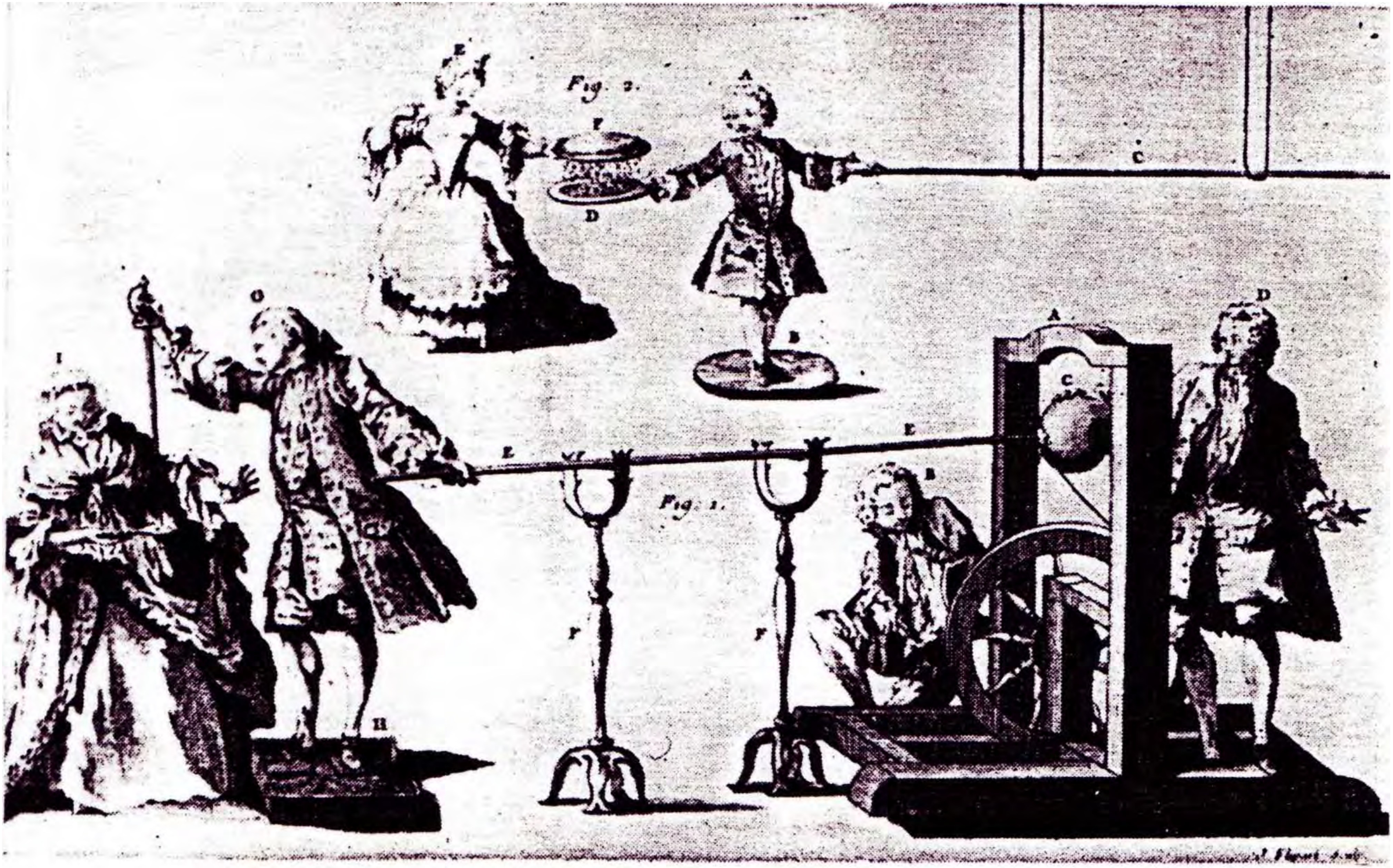


Elektrizität im Barock

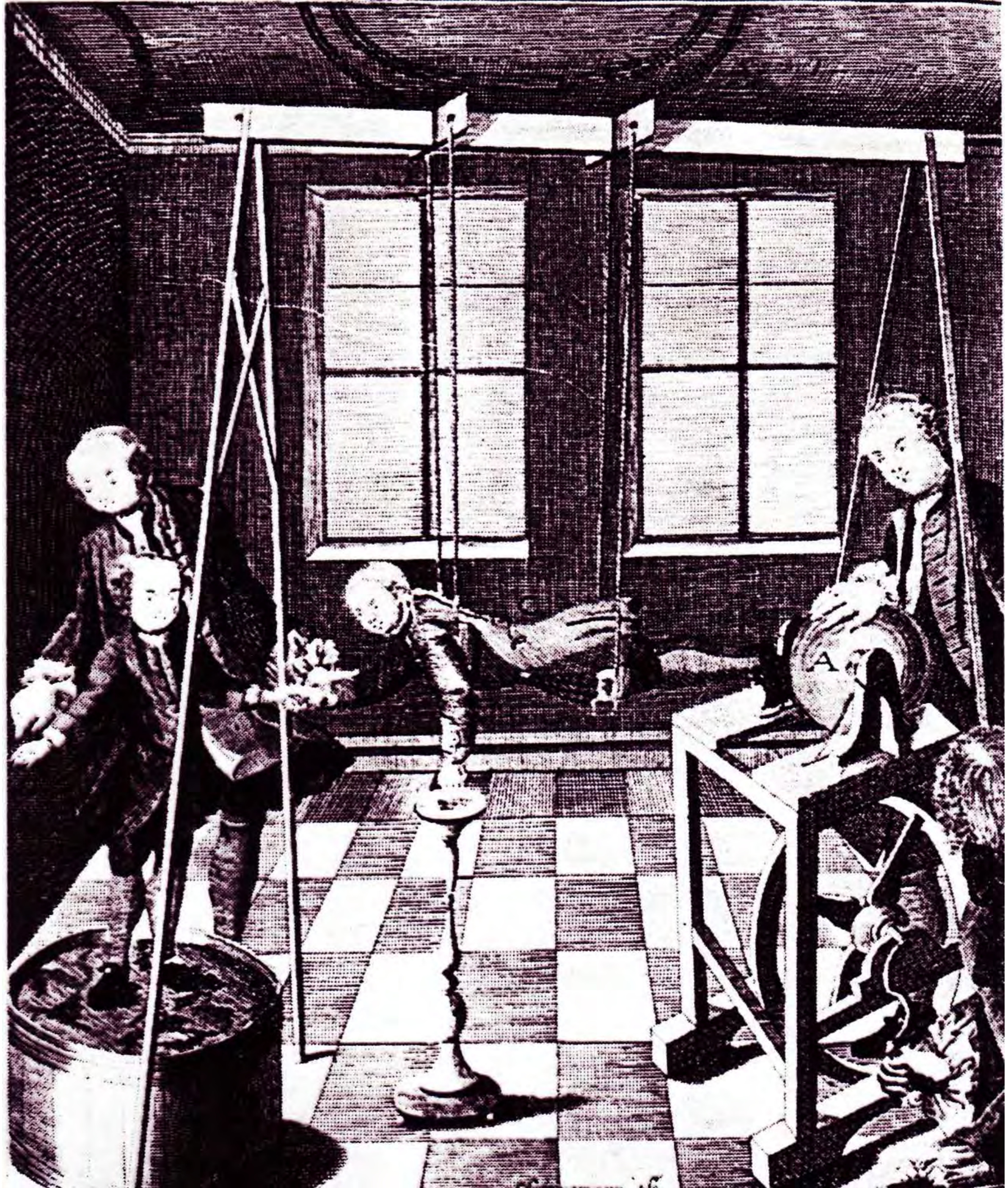
Fritz Fraunberger

Franklin's Versuch mit dem Drachen (Juni 1752)
Holzstich aus späterer Zeit.

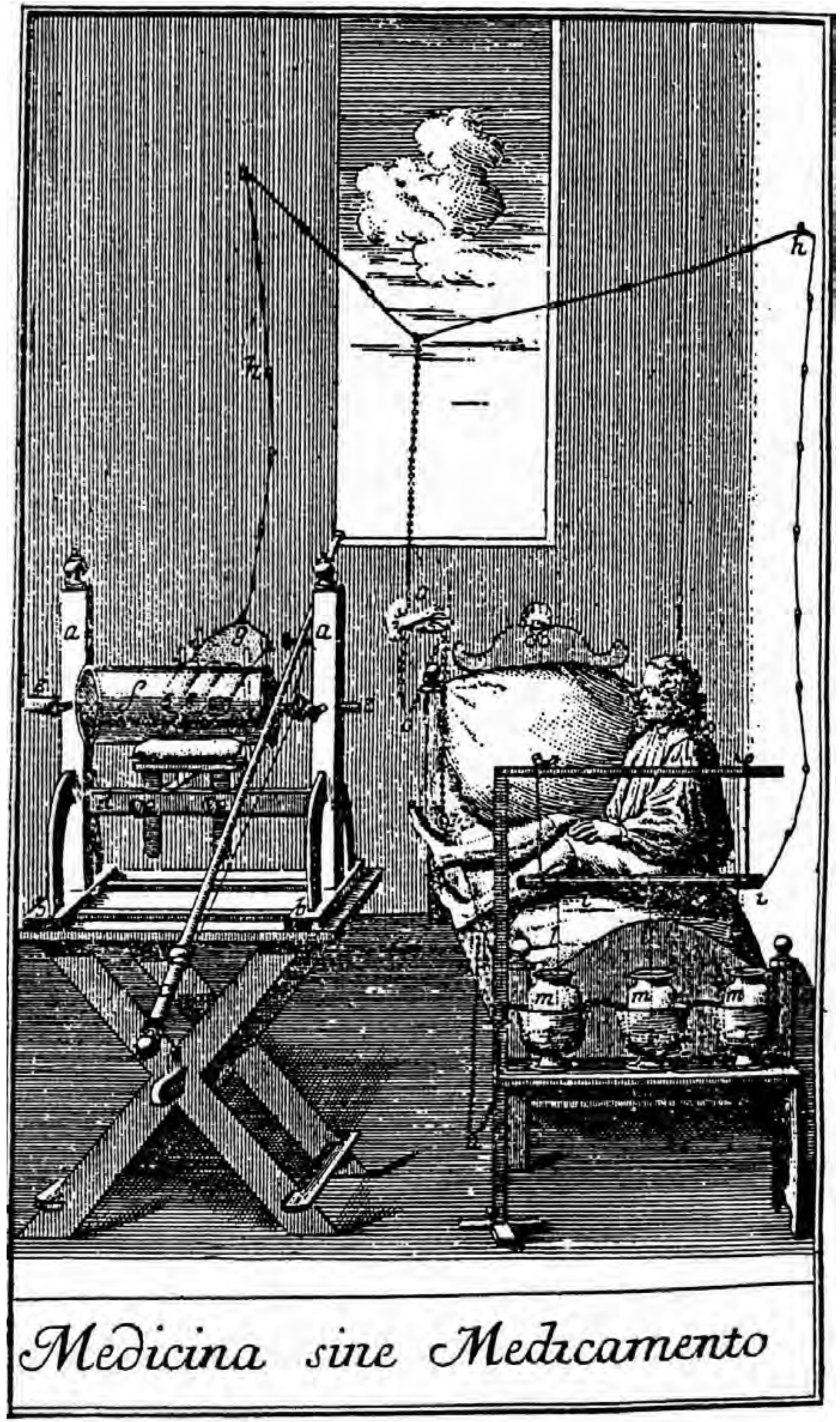
Auch die Mode macht vom Blitzschutz Gebrauch.
Damenhüte mit „Franklin-Drähten".



Entzündung von Spiritus vini mittels eines aus einem Degen fahrenden Funkens.

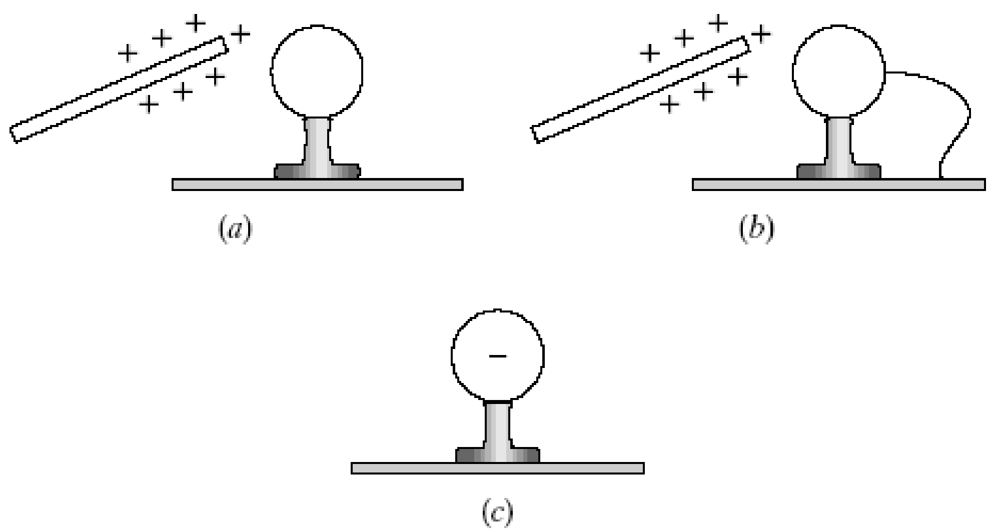


Stephen Gray's Gala-Experiment



Die Elektrizität am Krankenbett (1752).

A positively charged object is placed close to a conducting object attached to an insulating glass pedestal (*a*). After the opposite side of the conductor is grounded for a short time interval (*b*), the conductor becomes negatively charged (*c*). Based on this information, we can conclude that within the conductor



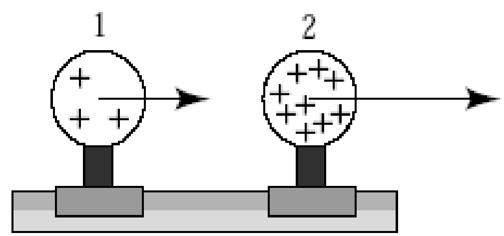
1. both positive and negative charges move freely.
2. only negative charges move freely.
3. only positive charges move freely.
4. We can’t really conclude anything.

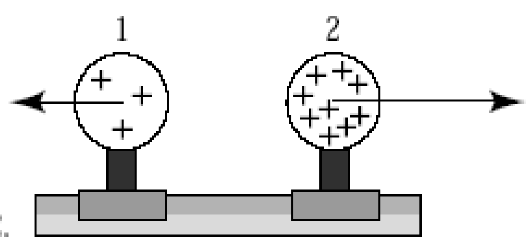
Holundermarkkügelchen

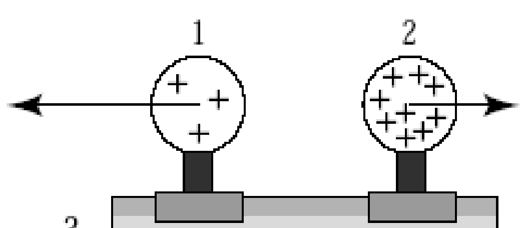
Three pithballs are suspended from thin threads. Various objects are then rubbed against other objects (nylon against silk, glass against polyester, etc.) and each of the pithballs is charged by touching them with one of these objects. It is found that pithballs 1 and 2 repel each other and that pithballs 2 and 3 repel each other. From this we can conclude that

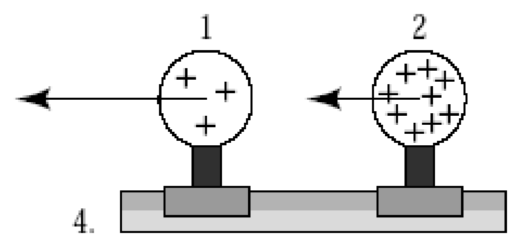
1. 1 and 3 carry charges of opposite sign.
2. 1 and 3 carry charges of equal sign.
3. all three carry the charges of the same sign.
4. one of the objects carries no charge.

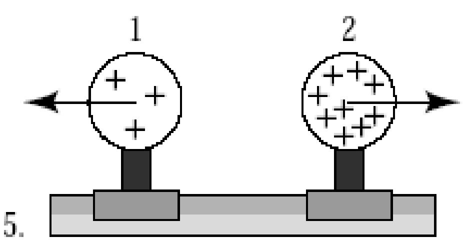
Two uniformly charged spheres are firmly fastened to and electrically insulated from frictionless pucks on an air table. The charge on sphere 2 is three times the charge on sphere 1. Which force diagram correctly shows the magnitude and direction of the electrostatic forces:

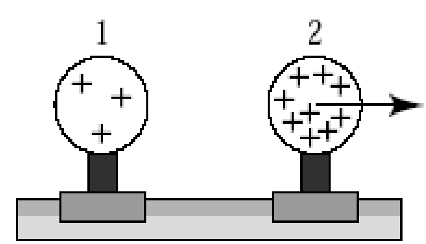
1.


2.


3.


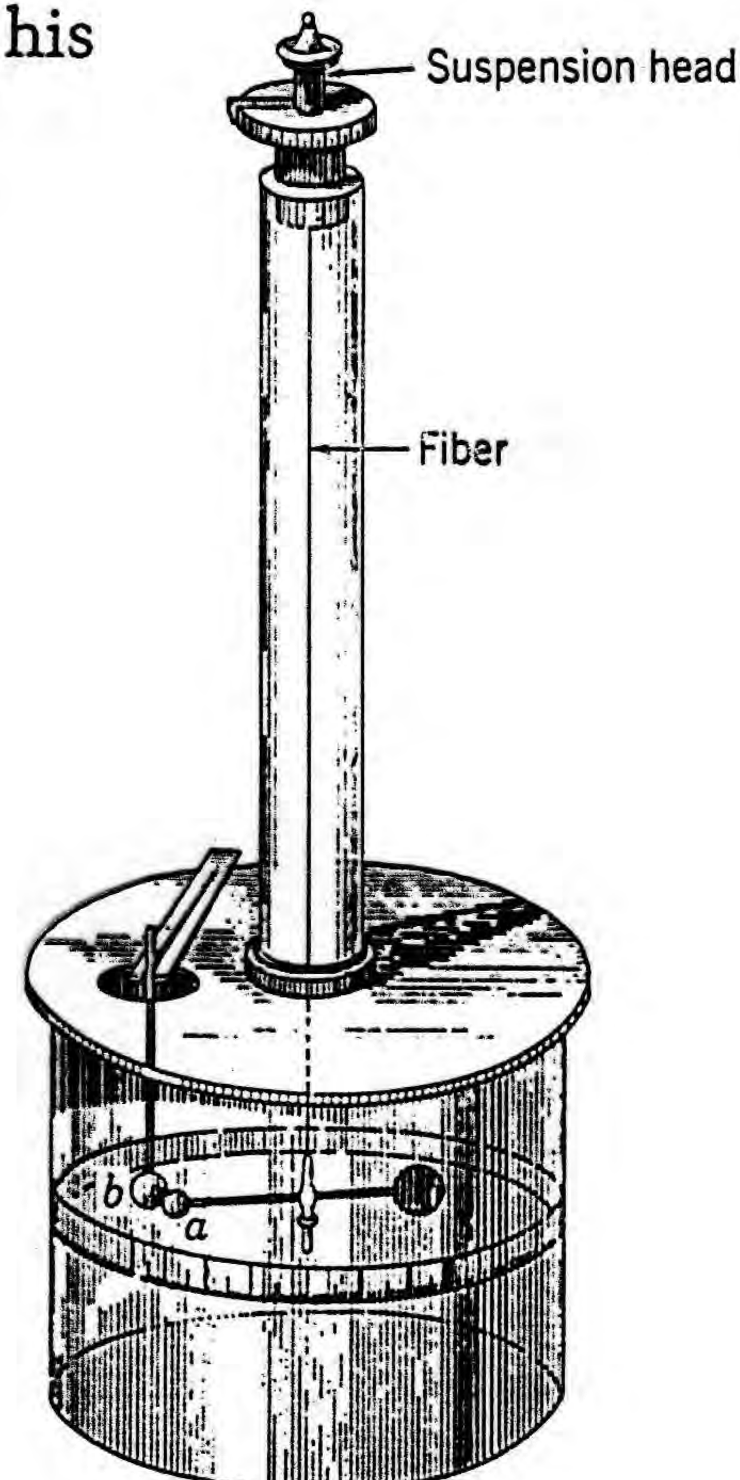
4.


5.


6.


7. none of the above

Coulomb's torsion balance, from his 1785 memoir to the French Academy of Sciences.



Test of Coulomb's inverse square law[a]

$$F \sim \frac{q_1 q_2}{r^{2+n}}$$

Experimenters	Date	n
Benjamin Franklin[c]	1755	—
Joseph Priestley[c]	1767	". . . according to the squares of the distance . . ."
John Robison[b]	1769	$\leqslant 0.06$
Henry Cavendish[b,c]	1773	$\leqslant 0.02$
Charles A. Coulomb	1785	a few percent at most
James Clerk Maxwell[c]	1873	$\leqslant 5 \times 10^{-5}$
Samuel J. Plimpton and Willard E. Lawton[c,d]	1936	$\leqslant 2 \times 10^{-9}$
Edwin R. Williams, James E. Faller, and Henry A. Hill[c,e]	1971	$\leqslant 2 \times 10^{-16}$

[a] Values of n (see Eq. 28-8) are subject to a probable error, not shown. All results are consistent with $n = 0$.
[b] Robison's and Cavendish's results were not made public until after Coulomb had published his results.
[c] These are "Gauss's law" experiments, in the spirit of Fig. 28-7. The others are direct tests of Coulomb's law.
[d] Work done at Worcester Polytechnic Institute.
[e] Work done at Wesleyan University.

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		$1/r^{2+q}$	photon rest mass
Author (date)	Experimental scheme	Deviation of q	Upper limit on m_γ/g
Robison (1769)	Gravitational torque on a pivot arm	6×10^{-2}	4×10^{-40}
Cavendish (1773)	Two concentric metal spheres	2×10^{-2}	1×10^{-40}
Coulomb (1785)	Torsion balance	4×10^{-2}	$\sim 10^{-39}$
Maxwell (1873)	Two concentric spheres	5×10^{-5}	1×10^{-41}
Plimpton and Lawton (1936)	Two concentric spheres	2×10^{-9}	3.4×10^{-44}
Cochran and Franken (1967)	Concentric cubical conductors	9.2×10^{-12}	3×10^{-45}
Bartlett *et al* (1970)	Five concentric spheres	1.3×10^{-13}	3×10^{-46}
Williams *et al* (1971)	Five concentric icosahedra	$(2.7 \pm 3.1) \times 10^{-16}$	1.6×10^{-47}
Fulcher (1985)	Improved on Williams' experiment	$(1.0 \pm 1.2) \times 10^{-16}$	1.6×10^{-47}
Crandall *et al* (1983)	Three concentric icosahedra	6×10^{-17}	8×10^{-48}
Ryan *et al* (1985)	Cryogenic experiment		$(1.5 \pm 1.4) \times 10^{-42}$

Unschärfe: $m_\gamma c^2 \approx h/(2\pi \; \Delta t)$

$\Delta t \approx 10^{10}$ a

ult. meaningful limit: $m_\gamma \approx 10^{-66}$ g

Proca A (1936) J. Phys. Radium Ser. VII **7**, 3473; (1937) ibidem **8**, 23

De Broglie L (1940) La Méchanique Ondulatoire du Photon, Une Nouvelle Théorie de Lumière, vol. 1, (Paris: Hermann) pp. 39–40