$$f_i = q_i E_{rea_i} = -(2q_i^2/3c^2)w_i, \qquad i = 1,2,\dots,n \qquad (39.2)$$

will act, called RADIATION REACTION FORCE (or radiating damping force, or LORENTZ FRICTION FORCE). The power of these forces acting on all charges of the system, i.e., the work done by the radiation reaction forces in a unit of time, is (see formula (8.7))

$$P = \sum_{i=1}^{n} f_i . v_i . \qquad (39.3)$$

Substititing here (39.2), we get

$$P = -\frac{2}{3c^3}\sum_{i=1}^{n} q_i^2\, w_i . v_i = -\frac{2}{3c^3}\sum_{i=1}^{n} q_i^2 \{\frac{d}{dt}(u_i . v_i) - u_i^2)\}. \qquad (39.4)$$

Let us average this equation over time. At the averaging the first term on the right side will vanish as a total time derivative of a bounded function. Thus the average work performed in a unit of time by the damping force will be

$$P = \frac{2}{3c^3}\sum_{i=1}^{n} q_i^2 u_i^2 = \frac{2}{3c^3}\ddot{d}^2, \qquad (39.5)$$

where **d** is the dipole moment of the whole system of charges.

Comparing this formula with formula (38.5), we conclude that the average work done in a unit of time by the radiation reaction forces over the charge (i.e., the power of the radiation reaction) is just equal to the total energy flux of radiation (i.e., to the power of radiation). This conclusion gives a firm ground to consider the radiation reaction as an energetic balance to the radiated by the charges energy in the form of electromagnetic waves (photons).

In a frame of reference in which the velocity of the particle is low, the equation of motion, when we include the radiation reaction, has the form (see equation (8.5))

$$m\dot{u} = qE + (q/c)v\times B + (q/c)Sv + (2q^2/3c^3)w, \qquad (39.6)$$

where the first three terms on the right side represent the potential electromagnetic force of the external field and the last term represents the radiation reaction force. This radiation reaction force has the character of "kinetic" force and must be written on the left side of the equation of motion (8.3), so that on the right side of equation (39.6) it figures with opposite sign.

The charge can obtain an acceleration only when an external potential force acts on it. The accelerated charge will radiate photons and the radiation reaction will diminish its acceleration. Therefore the change (positive or negative) of the potential energy which the charge has with the external system will lead to a change in the kinetic energy of the charge (respectively, negative or positive) but will also lead to radiation; this radiation must always be considered as a positive change because the radiated photons have zero potential energy with the external system and carry away only energy. Therefore radiation damping can exist only when the charge moves in an external field and the radiation reaction force (at $v \ll c$) is always small with respect to the potential electromagnetic force.

If we take time derivative from equation (39.6), then, neglecting the Whittaker force and the term with the super-super-acceleration $\dot{\mathbf{w}}$ as small, we can write the super-acceleration in the following form

$$\mathbf{w} = (q/m)\dot{\mathbf{E}} + (q/mc)\mathbf{u}\times\mathbf{B}. \qquad (39.7)$$

Let us consider now the motion of the radiating charge in a frame in which it is at rest, i.e., where $\mathbf{v} = 0$. Now neglecting the radiation reaction force with respect to the potential electromagnetic force, we can write equation (39.6) in this frame as follows

$$\mathbf{u} = (q/m)\mathbf{E}. \qquad (39.8)$$

Substituting (39.8) into (39.7), we obtain (in the particular frame in which we now work there is $\mathbf{v} = 0$, but $\mathbf{u} \neq 0$, $\mathbf{w} \neq 0$)

$$\mathbf{w} = (q/m)\dot{\mathbf{E}} + (q^2/m^2c)\mathbf{E}\times\mathbf{B}. \qquad (39.9)$$

Thus after the substitution of (39.9) into (39.2), the radiation reaction force can be expressed by the external electric and magnetic intensities as follows

$$\mathbf{f} = -(2q^3/3mc^3)\dot{\mathbf{E}} - (2q^4/3m^2c^4)\mathbf{E}\times\mathbf{B}. \qquad (39.10)$$

In Ref. 5 I give the fundamental formulas for the radiation of polyperiodic and aperiodic systems and I consider the higher than zero approximations which lead to quadrupole and magnetic dipole radiations. Then I consider the effects which appear when the velocity of the radiating charge is comparable with light velocity and I give the most detailed calculations of the synchrotron radiation. I analyze also the the radiation damping at $v \to c$ when the radiation reaction force acting on the radiating charge can become larger than the potential electromagnetic force acting on it. One can make all these high-velocity considerations only by the use of the Lorentz invariance (see the end of Sect. 1).

40. GRAVIMAGRETIC WAVES

My mathematical apparatus in electromagnetism and gravimagretism are almost identical. Thus if taking into account the fundamental Newton-Marinov equation (7.11), by analogy with the electric and magnetic intensities (34.24) and (34.25), we can introduce the gravitational and magretic intensities produced by an arbitrarily moving mass m

$$\mathbf{G} = -\gamma m_0 \frac{(1 - v'^2/c^2)(\mathbf{n}' - \mathbf{v}'/c)}{r'^2(1 - \mathbf{n}'.\mathbf{v}'/c)^3} - \gamma\frac{m_0}{c^2}\frac{\mathbf{n}'\times\{(\mathbf{n}' - \mathbf{v}'/c)\times\mathbf{u}'\}}{r'(1 - \mathbf{n}'.\mathbf{v}'/c)^3} - \gamma\frac{m_0}{c^3}\mathbf{n}'\times(\mathbf{n}'\times\mathbf{w}'), \qquad (40.1)$$

$$\mathbf{B} = \gamma\frac{m_0}{c}\frac{(1 - v'^2/c^2)\mathbf{n}'\times\mathbf{v}'}{r'^2(1 - \mathbf{n}'.\mathbf{v}'/c)^3} - \gamma\frac{m_0}{c^2}\frac{\mathbf{n}'\times[\mathbf{n}'\times\{(\mathbf{n}' - \mathbf{v}'/c)\times\mathbf{u}'\}]}{r'(1 - \mathbf{n}'.\mathbf{v}'/c)^3} + \gamma\frac{m_0}{c^3}\mathbf{n}'\times\mathbf{w}', \qquad (40.2)$$

where γ is the gravitational constant, m_0 is the proper mass of the particle and $\mathbf{v}'$, $\mathbf{u}'$, $\mathbf{w}'$ are its velocity, acceleration and super-acceleration at the advanced moment $t' = t - r'/c$, t being the observation moment and r' the advanced distance.

The calculation of **G** and **B** can also be done with the retarded elements of motion, according to formulas analogical to (34.26) and (34.27).

I attribute the first terms in the above equations to the potential gravimagretic intensities, $\mathbf{G}_{pot}$, $\mathbf{B}_{pot}$, the second terms to the radiation gravimagretic intensities, $\mathbf{G}_{rad}$, $\mathbf{B}_{rad}$, and the third terms to the radiation reaction gravimagretic intensities $\mathbf{G}_{rea}$, $\mathbf{B}_{rea}$. I call the radiation gravimagretic field also gravimagretic waves. By analogy with the photons, we can introduce the gravitons as quanta of gravimagretic radiation.

The GRAVIMAGRETIC WAVES are extremely feeble and I am sceptical whether their existence can be detected at the present state of experimental technique. As an example I shall calculate the gravitation radiation intensity produced by a mass $m = 9$ g, performing oscillations with an acceleration $u = 10^6$ cm/sec (such is the acceleration of a steel ball falling from 1 m, if after the fall it must make repercussions between two steel surfaces, the distance between which is a little bit bigger than the diameter of the ball), at a distance $r = 6.67$ cm. Using formula (40.1) at the condition $v \ll c$, we obtain for the intensity along the direction of maximum radiation

$$G = \gamma mu/c^2 r = 10^{-22} \text{ cm/sec}^2. \tag{40.3}$$

This is such a feeble gravitational intensity that there are no methods for its detection.

V. SYSTEMS OF UNITS

41. NATURAL SYSTEMS OF UNITS

A SYSTEM OF UNITS of a science, where the logical apparatus of mathematics is used, represents the totality of the measuring standards (units of measurement) of all fundamental (non-definable) and derivative (definable) quantities which are common in this science.

A MEASURING STANDARD (UNIT OF MEASUREMENT) of a given quantity is such an element, chosen on the grounds of some considerations, which has the same character as the quantity to be measured, i.e., the difference between any particular representative of this quantity and its measuring standard can only be quantitative.

As it follows from my axioms, in physics only three non-definable quantities have been introduced: space, time and energy. I showed that all other physical quantities can be defined by the help of these three.

The three measuring standards for the fundamental physical quantities can be chosen arbitrarily on the grounds of some stipulation. The system of units used by the terrestrial inhabitants, where attributes of the Earth's dimensions and motion are used, cannot be introduced by the inhabitants of other planets. But in nature there exist standards representing universal constants, which can be chosen as measuring standards for the three fundamental quantities, say:

a) the wavelength of a certain spectral line,
b) the half-life of a certain isotope,
c) the value of a certain energetic quantum.

It is expedient to construct systems of units making use of such universal standards for the fundamental physical quantities. However, the choice of "universal" standards is to a great extent arbitrary. Such systems of units were proposed by Planck, Hartree and others.

In my axioms I postulated the existence of four universal constants that represent four fundamental measuring standards:

a) velocity of light,
b) Planck constant,
c) electron mass,
d) electron charge.

It is logical to build our system of units on the basis of these qualitatively different natural standards which are introduced in the axiom directly. As a matter of fact, all these standards have not the character of fundamental physical quantities, length, time and energy, as they are derivative, but it is easy to express the quantities velocity, action, mass and electric charge by the three fundamental quantities.

The unit of measurement E, T, L, i.e., the measuring standards for energy, time and length, are determined by the relations (2.5), (2.4) and (2.1), which I rewrite here in the form

$$E = e = mc^2, \qquad T = h/E = h/mc^2, \qquad L = cT = h/mc. \tag{41.1}$$

The first of these equalities must be understood as a symbolical one, i.e., if we choose the number m expressing the universal mass of a certain particle arbitrarily, then its universal energy e will have mc^2 energy units, and vice versa, if we choose the number e expressing the universal energy of a certain particle, then its universal mass will have e/c^2 mass units.

Thus, if we take $m = m_e = 1$, $c = 1$, $h = 1$, the measuring standards for energy, time and length are determined, namely, the energy unit will be equal to the universal energy of the electron

$$e_e = m_e c^2, \tag{41.2}$$

the time unit will be equal to the universal period of the electron

$$\tau_e = h/e_e = h/m_e c^2, \tag{41.3}$$

and the length unit will be equal to the universal wavelength of the electron (see (2.8))

$$\lambda_e = h/m_e c. \tag{41.4}$$

When the units for energy and length are established, the gravitational constant is to be established by measuring the gravitational energy of two electrons, the distance between which is equal to unity (see formula (2.9)). Analogically, the electric constant is to be determined by measuring the electric energy of two electrons, the distance between which is equal to unity (see formula (2.11)).

We must note that the electron mass does not represent a universal constant of such a fundamental importance as the electron charge, because all elementary particles have electric charges equal to q_e, $-q_e$ or 0 (see axiom V), while their masses are largely different. From an axiomatical point of view, we can choose the mass of the proton or of another elementary particle as a fourth measuring standard, as it is not possible to decide which elementary particle is the most important in nature. In general, any system of units in which the units of measurement for the fundamental (and thus for all derivative) physical quantities can be expressed with the help of some NATURAL STANDARDS (or of their combination) is called a NATURAL SYSTEM OF UNITS.

42. THE NATURAL SYSTEM OF UNITS CES. THE GAUSS SYSTEM OF UNITS CGS

I call the system of units in which the numerical values for c, h, m_e (or γ) and q_e (or ε_0) are chosen equal to unity the NATURAL SYSTEM OF UNITS CES. The following four types of natural systems of units CES are possible (see the fourth and fifth axioms):

1. When $\gamma = 1$, $m_e^2 = 2.78\times 10^{-46}$, the system is of type γ.

2. When $m_e = 1$, $\gamma = 2.78\ 10^{-46}$, the system is of type m_e.

3. When $\varepsilon_0 = 1$, $q_e^2 = 1/861$, the system if of type ε_0.

4. When $q_e = 1$, $\varepsilon_0 = 861$, the system is of type q_e.

From these four systems CES-$\gamma\varepsilon_0$, CES-$m_e\varepsilon_0$, CES-γq_e and CES-$m_e q_e$ I shall only use the system CES-$m_e\varepsilon_0$ which I shall shortly call NATURAL SYSTEM OF UNITS CES.

Thus the numerical values of the universal constants in the system CES (i.e., in the system CES-$m_e\varepsilon_0$) are

$$c = 1, \quad h = 1, \quad \gamma \cong 2.78\ 10^{-46}, \quad m_e = 1, \quad \varepsilon_0 = 1, \quad q_e \cong 3.41\ 10^{-2}. \tag{42.1}$$

The values of γ and q_e (or of ε_0 if we put $q_e = 1$) are not exact because only the experiment can say what part of the energetic unit represents the gravitational energy, respectively, the electric energy of two electrons separated by a unit distance. The experiment continuously increases the accuracy with which these two constants can be measured, and therefore the numerical values which we ascribe to γ and q_e (i.e., ε_0) will always be approximate.

The units of measurement for the fundamental physical quantities in the natural system CES are called:

a) the unit of length - NATURAL CENTIMETER,

b) the unit of energy - NATURAL ERG,

c) the unit of tim - NATURAL SECOND.

The GAUSS SYSTEM OF UNITS CGS is this one in which the numerical values for c, h, γ, m_e, ε_0, q_e are chosen as follows

$$\begin{aligned} c &= (2.997925 \pm 0.000003)\times 10^{10}, \\ h &= (6.62517 \pm 0.00023)\times 10^{-27}, \\ \gamma &= (6.670 \pm 0.007)\times 10^{-8} \\ m_e &= (9.1083 \pm 0.0003)\times 10^{-28} \\ \varepsilon_0 &= 1, \\ q_e &= (4.80298 \pm 0.00009)\times 10^{-10}. \end{aligned} \tag{42.2}$$

Here we can say the same as for the figures (42.1). But here we must add the following: In the system CGS first the units for length, time and mass (energy) are determined, and then, on the grounds of these arbitrarily chosen units, the numerical values of the universal constants are calculated. This has led to the result that the universal constants cannot be expressed with such simple and exact numbers as in the system CES. The value of these constants will vary with time, because, first, the standards for the fundamental units can vary (although in the last years mankind has firmly chosen these standards and, probably, will not change them in the future) and, second, the accuracy with which the constants can be measured increases incessantly. For the inexactitude of the universal constants in the system CES only the second cause is valid, and in this system four of the constants (c, h, m_e, ε_0) do not change in time at all. In the system CGS only one constant (ε_0) does not change in time. But in the system CGS the standards for the fundamental unit of measurement (say, the wavelength of a certain particle, its mass and its period), being once firmly chosen for good, do not change in time (i.e., all these standards will always be expressed by the same number), while in the system CES the standards for the fundamental units of measurement will change in time (i.e., the numbers with which these standards are expressed will vary in time).

Thus in both systems of units five elements suffer changes: in the system CGS those are the constants c, h, γ, m_e, q_e, while in the system CES those are the constants γ, q_e and the standards with which the units for length (L), time (T) and energy (E) are materialized.

The units of measurement for the fundamental physical quantities in the Gauss system CGS, called GAUSS UNITS OF MEASUREMENT, are:

a) the unit of length - CENTIMETER,

b) the unit of energy (mass) - ERG (GRAM),

c) the unit of time - SECOND.

We can establish the numerical relations between the units of measurement for the fundamental physical quantities in the systems CES and CGS as follows:

1. To find the relation between the units for energy, we calculate according to formula (2.5) with how many energetic units the universal energy of the electron is expressed in the systems CES and CGS

$$e_e = m_e c^2 = 1 \text{ nat.erg}, \qquad e_e = m_e c^2 = 8.19\times10^{-7} \text{ erg}. \qquad (42.3)$$

Thus

$$1 \text{ nat. erg} = 8.19\times10^{-7} \text{ erg}. \qquad (72.4)$$

2. To find the relation between the units for time, we write formula (2.4) in the systems CES and CGS

$$h_n = E_n T_n, \qquad h = ET. \qquad (42.5)$$

Dividing the first of these equalities by the second, we obtain

$$T_n = h_n ET/hE_n, \qquad (42.6)$$

and using (42.1), (42.2) and (42.4), we get

$$1 \text{ nat. second} = 8.09\times10^{-21} \text{ second} \qquad (42.7)$$

3. To find the relation between the units for length, we write formula (2.1) in the systems CES and CGS

$$L_n = c_n T_n, \qquad L = cT. \qquad (42.8)$$

Dividing the first of these equalities by the second, we obtain

$$L_n = c_n T_n/cT, \qquad (42.9)$$

and using (42.1), (42.2) and (42.7), we get

$$1 \text{ nat. centimeter} = 2.43\times10^{-10} \text{ centimeter}. \qquad (42.10)$$

If the relations (42.4), (42.7) and (42.10) between the units for the fundamental physical quantities are given as well as the numerical values of the universal constants in one of the system, we can find the values of the universal constants in the other system.

Let find the numerical values of the universal constants in the system CGS if the mentioned relations and the values of the universal constants in the system CES are given:

1. The numerical value if c can be found using formulas (2.1), (42.7) and (42.10).
2. The numerical value of h can be found using formulas (2.4), (42.4) and (42.7).
3. The numerical value of m_e can be found using formulas (2.5), (42.4) and the numerical values of c in the systems CES and CGS.
4. The numerical value of γ can be found writing formula (2.9) in the form

$$E = \gamma m_e^2/L, \qquad (42.11)$$

using formulas (42.4), (42.10), the numerical values of m_e in the systems CES and CGS and the numerical value of γ in the system CES.

5. The numerical value of q_e can be found writing formula (2.11) in the form

$$E = q_e^2/\varepsilon_0 L, \qquad (42.12)$$

using formulas (42.47), (42.10), the numerical value of q_e in the system CES and choosing the electric constant in the system CGS equal to unity, as it is also in the system CES.

Theoretically it is more expedient to choose the unit for energy as fundamental unit in the Gauss system and not the unit for mass, as it is commonly accepted. Taking into account (2.5), we conclude that both these approaches are almost identical. In the future, in principle, we shall not make difference between the Gauss systems "centimeter - gram - second" and "centimeter - erg - second". If necessary, we shall denote the first CGS-gr and the second CGS-erg.

We shall call the units of measurement in the system CES by the same names as in the Gauss system CGS, but when speaking we shall pronounce the word "natural" before the respective term, and when writing, as a rule, we shall omit the word "natural" but noting the respective term with a capital letter. For concise writings of the names of the three fundamental units of measurement we shall also use only the letters Cm, E, S. Thus relations (42.4), (42.7) and (42.10) between the units of measurement for the fundamental physical quantities in systems CES and CGS can be written as follows:

$$1 \text{ natural centimeter} = 1 \text{ Cm} = 1 \text{ Cm} = 2.43\times10^{-10} \text{ cm},$$

$$1 \text{ natural erg} = 1 \text{ Erg} = 1 \text{ E} = 8.19\times10^{-7} \text{ erg}.$$

Table 42.1

Physical quantity	Symbol and definition equality	Name CGS: CES: natural	Dimensions CGS	Dimensions CES	Conversion factor 1 unit CES = ... units CGS
		FUNDAMENTAL UNITS			
Length	$r = r$	centimeter	cm	Cm	2.43×10^{-10}
Energy	$e = e$	erg	$g\ cm^2\ s^{-2}$	E(rg)	8.19×10^{-7}
Time	$t = t$	second	s(ec)	S(ec)	8.09×10^{-21}
		AUXILIARY UNITS			
Area	$s = r^2$	cm^2	cm^2	Cm^2	5.90×10^{-20}
Volume	$V = r^3$	cm^3	cm^3	Cm^3	1.43×10^{-29}
Angle	$\theta = \theta$	radian	-	-	1
		MECHANICAL UNITS			
Frequency	$\nu = 1/t$	hertz	s^{-1}	S^{-1}	1.24×10^{20}
Velocity	$\vec{v} = d\vec{r}/dt$	ces	$cm\ s^{-1}$	$Cm\ S^{-1}$	3.00×10^{10}
Acceleration	$\vec{u} = d\vec{v}/dt$	gal	$cm\ s^{-2}$	$Cm\ S^{-2}$	3.71×10^{30}
Super-acceler.	$\vec{w} = d\vec{u}/dt$	supergal	$cm\ s^{-3}$	$Cm\ S^{-3}$	4.59×10^{50}
Angul. velocity	$\vec{\Omega} = d\vec{\theta}/dt$	ras	s^{-1}	S^{-1}	1.24×10^{20}
Mass	$m = e/c^2$	gram	g	$E\ Cm^{-2}\ S^2$	9.11×10^{-28}
Mass density	$\mu = dm/dV$	$gram/cm^3$	$g\ cm^{-3}$	$E\ Cm^{-5}\ S^2$	6.37×10^{1}
Energy density	$\varepsilon = de/dV$	erg/cm^3	$g\ cm^{-1}\ s^{-2}$	$E\ Cm^{-3}$	5.73×10^{22}
Energy flux	$P = de/dt$	erg/sec	$g\ cm^2\ s^{-3}$	$E\ S^{-1}$	1.01×10^{14}
Energy fl. dens.	$\vec{I} = \varepsilon\vec{v}$	erg/cm^2sec	$g\ s^{-3}$	$E\ Cm^{-2}\ S^{-1}$	1.72×10^{33}
Space momentum	$\vec{p} = de/d\vec{v}$	erg/ces	$g\ cm\ s^{-1}$	$E\ Cm^{-1}\ S$	2.73×10^{-17}
Time momentum	$\bar{p} = e/c$	erg/ces	$g\ cm\ s^{-1}$	$E\ Cm^{-1}\ S$	2.73×10^{-17}
Force	$\vec{f} = d\vec{p}/dt$	dyne	$g\ cm\ s^{-2}$	$E\ Cm^{-1}$	3.37×10^{3}
Power	$P = \vec{f}.\vec{v}$	erg/sec	$g\ cm^2\ s^{-3}$	$E\ S^{-1}$	1.01×10^{14}
Angul. momentum	$\vec{I} = \vec{p}\times\vec{r}$	ergsec	$g\ cm^2\ s^{-1}$	E S	6.62×10^{-27}
Action	$S = e\,t$	ergsec	$g\ cm^2\ s^{-1}$	E S	6.62×10^{-27}
Inertial moment	$J = m\,r^2$	gram cm^2	$g\ cm^2$	$E\ S^2$	5.37×10^{-47}
Force moment	$\vec{M} = \vec{r}\times\vec{f}$	dyne cm	$g\ cm^2 s^{-2}$	E	8.19×10^{-7}

Physical quantity	Symbol and definition equality	Name CGS: CES: natural	Dimensions CGS	CES	Conversion factor 1 unit CES = ... units CGS
		GRAVIMAGRETIC UNITS			
Gravit. potential	$\Phi = -\gamma m/r$	gravpotent	$cm^2 s^{-2}$	$Cm^2 S^{-2}$	8.99×10^{20}
Gravit. intensity	$\vec{G} = -\text{grad}\Phi$	gravintens	$cm\ s^{-2}$	$Cm\ S^{-2}$	3.71×10^{30}
Magr. potential	$\vec{A} = -\gamma m\vec{v}/cr$	magrepotent	$cm^2 s^{-2}$	$Cm^2 S^{-2}$	8.99×10^{20}
Magr. intensity	$\vec{B} = \text{rot}\vec{A}$	magreintens	$cm\ s^{-2}$	$Cm\ S^{-2}$	3.71×10^{30}
		ELECTROMAGNETIC UNITS			
Electric charge	$q = U r$	abcoulomb	$g^{1/2}cm^{3/2}s^{-1}$	$E^{1/2}Cm^{1/2}$	1.41×10^{-8}
Charge density	$Q = dq/dV$	abcoul./cm^3	$g^{1/2}cm^{-3/2}s^{-1}$	$E^{1/2}Cm^{-5/2}$	9.86×10^{20}
Space current	$\vec{j} = q\vec{v}$	abampere cm	$g^{1/2}cm^{5/2}s^{-2}$	$E^{1/2}Cm^{3/2}S^{-1}$	4.23×10^{2}
Time current	$j = q\,c$	abampere cm	$g^{1/2}cm^{5/2}s^{-2}$	$E^{1/2}Cm^{3/2}S^{-1}$	4.23×10^{2}
Electric current	$I = dq/dt$	abampere	$g^{1/2}cm^{3/2}s^{-2}$	$E^{1/2}Cm^{1/2}S^{-1}$	1.74×10^{12}
Current density	$\vec{J} = Q\,\vec{v}$	abampere/cm^2	$g^{1/2}cm^{-1/2}s^{-2}$	$E^{1/2}Cm^{-3/2}S^{-1}$	2.96×10^{31}
Electr. potential	$\Phi = q/r$	abvolt	$g^{1/2}cm^{1/2}s^{-1}$	$E^{1/2}Cm^{-1/2}$	5.80×10^{1}
Electr. intensity	$\vec{E} = -\text{grad}\Phi$	abvolt/cm	$g^{1/2}cm^{-1/2}s^{-1}$	$E^{1/2}Cm^{-3/2}$	2.39×10^{11}
Magn. potential	$\vec{A} = q\vec{v}/cr$	gauss cm	$g^{1/2}cm^{1/2}s^{-1}$	$E^{1/2}Cm^{-1/2}$	5.80×10^{1}
Magn. intensity	$\vec{B} = \text{rot}\vec{A}$	gauss	$g^{1/2}cm^{-1/2}s^{-1}$	$E^{1/2}Cm^{-3/2}$	2.39×10^{11}
Magnetic flux	$\Phi = \vec{B}.\vec{s}$	maxwell	$g^{1/2}cm^{3/2}s^{-1}$	$E^{1/2}Cm^{1/2}$	1.41×10^{-8}
El. dipole moment	$\vec{d} = q\,\vec{r}$	abcoul. cm	$g^{1/2}cm^{5/2}s^{-1}$	$E^{1/2}Cm^{3/2}$	3.43×10^{-18}
Magn. dip. moment	$\vec{m} = \vec{r}\times\vec{J}/2c$	abcoul. cm	$g^{1/2}cm^{5/2}s^{-1}$	$E^{1/2}Cm^{3/2}$	3.43×10^{-18}

$$1 \text{ natural second} = 1 \text{ Sec} = 1 \text{ S} = 8.09\times10^{-21} \text{ s.} \qquad (42.13)$$

We see that the name of the system CES is constituted from the first letters of the units of measurement for the fundamental physical quantities length, energy and time.

The name of the system CGS is constituted from the first letters of the units of measurement for the fundamental quantities length, mass and time.

All formulas in the first four chapters of this book are written in the system CGS. If we put the fundamental constants c and h equal to untity, we obtain all formulas in the system CES.

Since the standard for mass as gravitational charge of the particle and the standard for mass as a measure of its time energy are one and the same quantity, the dimensions of the mass obtained with the help of the time energy (see formula (2.5)) determine the dimensions of the gravitational constant γ (see formula (2.9)).

This is not the case with the dimensions of the electric charge and the electric constant ε_0. If we choose the electric constant dimensionless (as we do in the systems CES and CGS), then the dimensions of the electric charge are established by the dimensions of the fundamental physical quantities. If we appropriate the dimensions of a fundamental (fourth) physical quantity to the electric charge (as we do in the system SI - see Sect. 43), then the electric constant will obtain definite dimensions. We must note that whether one chooses the electric constant dimensionless or not is only a question of taste (the choice of the electric constant with dimensions is an indication of bad taste!).

In table 42.1 I give the names and the dimensions of the units of measurement of the most important physical quantities in the systems CGS and CES. The physical quantities are fundamental (primary), auxiliary (which can be considered as fundamental) and derivative (secondary). Of the derivative physical quantities (mechanical, gravimagretic and electromagnetic) I give only these which are mainly used in this book. In the table I give also the connections which exist between the units of measurement in the systems CES and CGS. The dimensions of the physical quantities in the system CGS-erg are the same as in the system CES, only instead of the natural Cm, E, S, one must write the "normal" cm, erg, sec.

It is easy to see that if we assume the definition equalities in the second column as given, we can find the conversion factors between the units of measurement of all derivative physical quantities by making use only of the conversion factors between the fundamental physical quantities.

In table 42.2 the values and dimensions of the universal constants are given.

Table 42.2

Universal constant	Symbol	Dimensions		Numerical value	
		CGS	CES	CGS	CES
Velocity of light	c	$cm\ s^{-1}$	$Cm\ S^{-1}$	3.00×10^{10}	1
Planck constant	h	$g\ cm^2 s^{-1}$	$E\ S$	6.62×10^{-27}	1
Gravit. constant	γ	$g^{-1} cm^3 s^{-2}$	$E^{-1} Cm^5 S^{-4}$	6.67×10^{-8}	2.78×10^{-46}
Electron mass	m_e	g	$E\ Cm^{-2} S^2$	9.11×10^{-28}	1
Electric constant	ε_0	-	-	1	1
Electron charge	q_e	$g^{1/2} cm^{3/2} s^{-1}$	$E^{1/2} Cm^{1/2}$	4.80×10^{-10}	3.41×10^{-2}

43. SYSTEM OF UNITS SI

The systems of units CGS and CES are of common use in theoretical physics. In the last time, however, the RATIONALIZED SYSTEM OF UNITS MKSA (meter-kilogram-second-ampère) which was used first in the engineering sciences is used also in theoretical physics. It is also called the INTERNATIONAL SYSTEM OF UNITS (or SYSTEM SI) and one introduces it worldwide as the only system to be used. I am definitely against the use of the system SI in theoretical physics, and I write my theoretical papers and books in the system CGS (see the preface).

In the system MKSA (or SI) meter, kilogram (joule for energy) and second are chosen as units of measurement for the fundamental physical quantities. The relations between the units of measurement for the fundamental physical quantities in the systems MKSA (or SI) and CGS are:

$$1\ \text{m} = 100\ \text{cm},$$
$$1\ \text{kg} = 1000\ \text{g} \quad (\text{or } 1\ \text{joule} = 10^7\ \text{erg}),$$
$$1\ \text{s} = 1\ \text{s}. \tag{43.1}$$

For the universal constants c, h and γ in the system SI we obtain

$$c = 3.00\times 10^8\ \text{m s}^{-1},$$
$$h = 6.62\times 10^{-34}\ \text{kg m}^2\ \text{s}^{-1},$$
$$\gamma = 6.67\times 10^{-11}\ \text{kg}^{-1}\ \text{m}^3\ \text{s}^{-2}. \tag{43.2}$$

With the aim of avoiding the fractional powers in the dimensions of the electromagnetic quantities in the system SI, the unit for electric charge is introduced as a fourth fundamental unit of measurement (in one line with the meter, kiligram and second) and is called COULOMB (denoted by C). Some prefer to consider $A = C\ s^{-1}$, called AMPERE, as the fourth fundamental unit and for this reason the system is called MKSA. This is again a bad taste. Although now in the system SI the ampere is sanctioned as the fourth fundamental quantity, I shall consider here the coulomb as such a one, as this consideration is more "didactic".

Besides, with the aim of obtaining most formulas used in electro-engineering practice in a simpler form (to avoid factors 2π and 4π appearing in situations not involving circular or spherical symmetry, respectively), we work in system SI not with formula (2.11) but with $U_e = q_1q_2/4\pi\varepsilon_0 r$ and the numerical value of the electric constant is chosen

$$\varepsilon_0 = \frac{10^7}{4\pi c^2} = \frac{1}{36\pi 10^9}\ \text{C}^2\text{kg}^{-1}\ \text{m}^{-3}\ \text{s}^2. \tag{43.3}$$

One can easily see that if the electric charge is considered as a fourth fundamental physical quantity, the electric constant obtains the dimensions indicated in formula (43.3).

The relation between the electric and magnetic constants can be taken either in the form $\varepsilon_0\mu_0 = 1$ or in the form $\varepsilon_0\mu_0 = c^{-2}$. In the Gauss system CGS the first form is chosen. If we choose the second form, assuming $\varepsilon_0 = 1$, we obtain the so-called ELECTROSTATIC CGS SYSTEM OF UNITS (or SYSTEM CGSe), where all units of the electric quantities are the same as in the system CGS, but the units for the magnetic quantities are different, and the magnetic constant obtains the numerical value

$$\mu_0 = (1/9)10^{-20}\ \mathrm{cm}^{-2}\ \mathrm{sec}^2, \tag{43.4}$$

with the dimensions written on the right side.

If we choose the second form, assuming $\mu_0 = 1$, we obtain the so-called ELECTROMAGNETIC CGS SYSTEM OF UNITS (or SYSTEM CGSm), where all units for the magnetic quantities are the same as in the system CGS, but the units for the electric quantities are different, and the electric constant obtains the numerical value

$$\varepsilon_0 = (1/9)10^{-20}\ \mathrm{cm}^{-2}\ \mathrm{sec}^2, \tag{43.5}$$

with the dimensions written on the right side.

In the system SI the connection between the electric and magnetic constants is taken in the form $\varepsilon_0\mu_0 = c^{-2}$; thus, the numerical value of the magnetic constant in the system SI is

$$\mu_0 = 4\pi 10^{-7}\ \mathrm{C}^{-2}\ \mathrm{kg\ m}. \tag{43.6}$$

Now we shall find the value of the electron charge in the system SI. Dividing formula (2.11) by the formula

$$U_e = q_1 q_2/4\pi\varepsilon_0 r, \tag{43.7}$$

which is the Coulomb law in the system SI, we obtain, putting $q_1 = q_2 = q_e$,

$$q_e = q_e'\left(4\pi \frac{\varepsilon_0}{\varepsilon_0'} \frac{U_e}{U_e'} \frac{r}{r'}\right)^{1/2}, \tag{43.8}$$

where the unprimed quantities are in the system SI and the primed quantities are in the system CGS. Substituting ε_0 from (43.3), putting $\varepsilon_0' = 1$, $q_e' = 4.80\times10^{-10}$, and taking from (43.1) the conversion factors between the units of measurement for energy and length, we obtain the numerical value of the electron charge in the system SI

$$q_e = 1.6\times10^{-19}\ \mathrm{C}. \tag{43.9}$$

From here and from table 42.2 we obtain the connection between the units of measurement for electric charge in the systems SI and CGS

$$1\ \mathrm{Coulomb} = 3\times10^9\ \mathrm{abcoulomb}. \tag{43.10}$$

Let us note (see table 42.1) that the names of the electric quantities in the system CGS are obtained putting "ab" before the corresponding name in the system SI, as the Gauss system of units CGS is called also ABSOLUTE SYSTEM OF UNITS; the magnetic quantities in the system CGS have their proper names.

The names and dimensions of the units of measurement for the most important physical quantities in the system SI, and their relationship to the corresponding units of mesurement in the system CGS are given in table 43.1.

Concerning table 43.1 the following is to be noted:

The conversion factors between the units of measurement in the systems SI and

Table 43.1

Physical quantity	Symbol and definition equality	Name and symbol of the unit		Dimensions	Corr. factor	Conv. factor 1 unit SI = ... units CGS
		FUNDAMENTAL UNITS				
Length	$r = r$	meter	m	m		10^2
Mass	$m = m$	kilogram	kg	kg		10^3
Time	$t = t$	second	s	s		1
		MECHANICAL UNITS				
Velocity	$\vec{v} = d\vec{r}/dt$	mes	m/s	$m\ s^{-1}$		10^2
Energy	$e = mc^2$	joule	J	$kg\ m^2 s^{-2}$		10^7
Force	$\vec{f} = md\vec{v}/dt$	newton	N	$kg\ m\ s^{-2}$		10^5
Power	$P = \vec{f}.\vec{v}$	watt	W	$kg\ m^2 s^{-3}$		10^7
		ELECTROMAGNETIC UNITS				
Electric charge	$q = q$	coulomb	C	C		3×10^9
Space current	$\vec{j} = q\vec{v}$	ampere m	A m	$C\ m\ s^{-1}$		3×10^{11}
Time current	$\bar{j} = qc$	ampere m	A m	$C\ m\ s^{-1}$		3×10^{11}
Charge density	$Q = dq/dV$	coulomb/m^3	C/m^3	$C\ m^{-3}$		3×10^3
Electric current	$I = dq/dt$	ampere	A	$C\ s^{-1}$		3×10^9
Current density	$\vec{J} = Q\vec{v}$	ampere/m^2	A/m^2	$C\ m^{-2} s^{-1}$		3×10^5
Electr. potential	$\Phi = q/4\pi\varepsilon_0 r$	volt	V	$C^{-1} kg\ m^2 s^{-2}$		$(1/3)10^{-2}$
Electr. intensity	$\vec{E} = -\mathrm{grad}\Phi$	volt/m	V/m	$C^{-1} kg\ m\ s^{-2}$		$(1/3)10^{-4}$
Magnetic potential	$\vec{A} = \mu_0 q\vec{v}/4\pi r$	tesla m	T m	$C^{-1} kg\ m\ s^{-1}$	c	10^6
Magnetic intensity	$\vec{B} = \mathrm{rot}\vec{A}$	tesla	T	$C^{-1} kg\ s^{-1}$	c	10^4
Magnetic flux	$\Phi = \vec{B}\cdot\vec{S}$	weber	Wb	$C^{-1} kg m^2 s^{-1}$	c	10^8
El. dipole moment	$\vec{d} = q\vec{r}$	coulomb m	C m	C m		3×10^{11}
Magn. dipole moment	$\vec{m} = \vec{r}\times\vec{J}/2$	ampere m^2	$A m^2$	$C\ m^2\ s^{-1}$	c	9×10^{23}

CGS can be obtained if in the dimensions of the corresponding unit of measurement in the system SI we substitute the conversion factors for the fundamental physical quantities (relations (43.1) and (43.10)). When calculating the conversion factors for the magnetic units of measurement, we must take into account the corresponding correction factor c (the fifth column in table 43.1) appearing as a result of the fact that the system CGS is built proceeding from the relation $\varepsilon_0 = 1/\mu_0$, while the system SI is built proceeding from the relation $\varepsilon_0 = 1/c^2\mu_0$.

If the magnetic potential in the Gauss system would be defined not in the form given in table 42.1 but in the following form

$$A = qv/c^2 r, \tag{43.11}$$

then we had not to take into account the correction factor. At such a definition of A, c in the denominators of many formulas in the Gauss system would disappear and the formulas would look much more similar to the formulas in the system SI.

Furthermore we have to note that the number 3 appearing in some conversion factors is to be substituted in more precise calculations by 2.99793 (see the transition between formulas (43.8), (43.9) and (43.10)).

With the help of table 43.2 we can make the transition from a formula written in

Table43.2

Physical quantity	System CGS	System SI	
Velocity of light	c	$(\varepsilon_0\mu_0)^{-1/2}$	
Electric charge	q		q
Electric charge density	Q		Q
Space current	$\vec{j}$		$\vec{j}$
Time current	$\vec{J}$	$(4\pi\varepsilon_0)^{-1/2}\times$	$\vec{J}$
Electric current	I		I
Electric current density	$\vec{J}$		$\vec{J}$
Electric dipole moment	$\vec{d}$		$\vec{d}$
Magnetic dipole moment	$\vec{m}$	$(\mu_0/4\pi)^{1/2}$	$\vec{m}$
Electric potential	Φ	$(4\pi\varepsilon_0)^{1/2}\times$	Φ
Electric intensity	$\vec{E}$		$\vec{E}$
Magnetic potential	$\vec{A}$		$\vec{A}$
Magnetic intensity	$\vec{B}$	$(4\pi/\mu_0)^{1/2}\times$	$\vec{B}$
Magnetic flux	Φ		Φ

the system CGS to the corresponding formula written in the system SI, and vice versa. To make this transition, it is necessary to substitute all quantities in the formula written in the system CGS (see column "system CGS") by the corresponding quantities taken with the attached coefficient from the column "system SI". For the inverse transition (from a formula written in the system SI to obtain the formula written in the system CGS) we have to transfer the coefficients from the column "system SI" to the corresponding quantities in the column "system CGS", according to the rules of proportion, and to proceed analogically as above.

Table 43.2 is obtained in the following way:

1. The connection between the constant c in the system CGS and the constants ε_0, μ_0 in the system SI is found on the grounds of the fundamental relation $\varepsilon_0\mu_0 = 1/c^2$.

2. The conversion factor for the electric charge is to be found from the relations

$$U_e = \frac{q^2}{4\pi\varepsilon_0 r}, \qquad U'_e = \frac{q'^2}{r}, \tag{43.12}$$

where the first relation is written in the system SI and the second in the system CGS, so that

$$q' = \frac{q}{(4\pi\varepsilon_0)^{1/2}}. \tag{43.13}$$

3. All other conversion factors are obtained on the grounds of the dimensions of the corresponding quantity in the system SI (see table 43.1), where the meter, kilogram and second are to be taken without any corrective multiplier, and only the coulomb is to be taken according to the relation (43.13).

In the SI system the electric displacement D and the magnetic intensity H in vacuum are expressed through the electric intensity E and the magnetic induction B (which, I repeat, I call "magnetic intensity", as B and H have exactly the same physical character!) not according to formula (20.2) and (20.8), with $\varepsilon = 1$, $\mu = 1$ (as we do in the system CGS) but according to the formulas $D = \varepsilon_0 E$, $H = (1/\mu_0)B$, and as ε_0 and μ_0 in the system SI are quantities with dimensions (see (43.3) and (43.6)), D and H have dimensions different from E and B. The name of the SI unit of D is coulomb/m^2 and the symbol and the dimensions are $C\ m^{-2}$. The name of the SI unit of H is ampere/m, the symbol is A/m and the dimensions are $C\ s^{-1} m^{-1}$.

If some quantity is not included in table 43.2, in order to find the conversion factor, the quantity is to be presented by some of the indicated quantities. So we shall have:

For resistance, $R = U/I = \Phi/I$, the conversion factor is $4\pi\varepsilon_0$.

For capacitance, $C = q/U = q/\Phi$, the conversion factor is $1/4\pi\varepsilon_0$.

For inductance, $L = \Phi/I$, the conversion factor is $4\pi(\varepsilon_0/\mu_0)^{1/2}$.

The following prefixes should be used to indicate decimal fractions or multiples of a unity:

Table 43.3

Name	Value	Symbol	Name	Value	Symbol
deci	10^{-1}	d	deca	10^{1}	da
centi	10^{-2}	c	hecto	10^{2}	h
milli	10^{-3}	m	kilo	10^{3}	k
micro	10^{-6}	μ	mega	10^{6}	M
nano	10^{-9}	n	giga	10^{9}	G
pico	10^{-12}	p	tera	10^{12}	T
femto	10^{-15}	f	peta	10^{15}	P
atto	10^{-18}	a	exa	10^{18}	E

All formulas in Chapter VI, which is dedicated only to experiments, will be written in the system SI, with the exception of Sect. 46.2 which has important theoretical character and thus this Subsection is written in the Gauss system.

VI. EXPERIMENTAL VERIFICATIONS

44. THE COUPLED SHUTTERS EXPERIMENT

44.1. INTRODUCTION.

The first experimental verification of the theory presented in the preceding chapters will be my "coupled shutters" experiment for measurement of the Earth's absolute velocity in a laboratory.

This was my third optical measurement of the Earth's absolute velocity. For a first time I measured this velocity with my DEVIATIVE "COUPLED MIRRORS" EXPERIMENT in 1973[1] and for a second time with my INTERFEROMETRIC "COUPLED MIRRORS" EXPERIMENT in 1975/76.[4] With this second experiment which was carried out during a year I could register the absolute motion of the Sun.

I give here only the report on my "coupled shutters" experiment.

The COUPLED SHUTTERS EXPERIMENT was carried out for a first time in 1979 in Brussels[24]. The accuracy achieved with this first experiment was not sufficient for registering the Earth's absolute velocity. Thus with its help I could only establish that this velocity was not larger than 3,000 km/sec. The "coupled shutters" experiment is relatively very simple and cheap[24], however no scientist in the world has repeated it. The general opinion expressed in numerous letters to me, in referees' comments on my papers, and in speeches on different space-time conferences which I visited or organized[25] is that my experiments are very sophisticated and difficult for execution. The only discussion in the press on the technical aspects of my experiments is made by Chambers.[26] Here I should like to cite the comments of my anonymous FOUNDATIONS OF PHYSICS referee sent to me by the editor, Prof. van der Merwe, on the 23 June 1983:

> I was informed by (the name deleted) of the Department of the Air Force, Air Force Office of Scientific research, Bolling Air Force Base, that Dr. Marinov's experiments were to be repeated by the Joint Institute for Laboratory Astrophysics. On inquiry, I learnt that JILA is not carrying out the experiments, because preliminary engineering studies had indicated that it lay beyond the expertise of the laboratory to achieve the mechanical tolerances needed to ensure a valid result.

After presenting my objections that the fact that JILA in the USA is unable to repeat my experiments cannot be considered as a ground for the rejection of my papers dedicated not at all to measurement of absolute velocity, Prof. van der Merwe sent me on the 24 January 1984 the following "second report" of the same referee:

> It is with regret that I cannot change my recommandation regarding Dr. Marinov's papers. In trying to justify the validity of his experimental

work, Dr. Marinov highlights the points which cause the rest of the community so much concern. He states, "If I in a second-hand workshop in a fortnight for $ 500 achieve the necessary accuracy, then, I suppose, JILA can achieve it too." I know of no one in the precision measurement community who believes that measurements of the quality claimed by Dr. Marinov could be realized under such conditions and in so short a time. It will take very much more than this to change the direction of physics. I suspect that even scientists working in the most reputable laboratories in the U.S. or the world, would encounter great opposition in attempting to publish results as revolutionary as those claimed by Dr. Marinov.

In this paper I present the account on the measurement of the laboratory's absolute velocity, executed by me in Graz with the help of a new construction of my "coupled shutters" experiment. Now the apparatus was built not in seven days but in four. As the work was "black" (a mechanician in a university workshop did it after the working hours and I paid him "in the hand"), the apparatus was built predomenantly at the week-end and cost 12,000 Shillings. The driving motor was taken from an old washing-machine and cost nothing.

As no scientific laboratory was inclined to offer me hospitality and possibility to use a laser source and laboratory mirrors, my first intention was to use as a light source the sun. As I earn my bread and money for continuing the scientific research working as a groom and sleeping in a stall in a small village near Graz, I carried out the experiment in the appartment of my girl-friend. The sensitivity which I obtained with sun's light (a perfect source of homogeneous parallel light) was good, but there were two inconveniences: 1) The motion of the sun is considerable during the time when one makes the reversal of the axle and one cannot be sure whether the observed effect is due to the delay times of the light pulses or to the Sun's motion. 2) One can perform measurements only for a couple of hours about noon and thus there is no possibility to obtain a 24-hours "sinusoid" (see further the paper for explanation of the measuring procedure). On the other hand, at fast rotation of the axle the holed rotating disks became two sirens, so that when my apparatus began to whistle the neighbours knocked on the door, asking in dismay: "Fliegt schon der Russe über Wien?" (Is Ivan over Vienna flying?). After a couple of altercations, my girl-friend threw away from her appartment not only my apparatus but also me.

Later, however, I found a possibility to execute the experiment in a laboratory (fig. 18). The scheme of the experiment, its theoretical background and measuring procedure are exactly the same as of the Brussels variation[24]. Since the description is extremely simple and short, I shall give it also here, noting that the mounting of the laser and of the mirrors on the laboratory table lasted two hours.

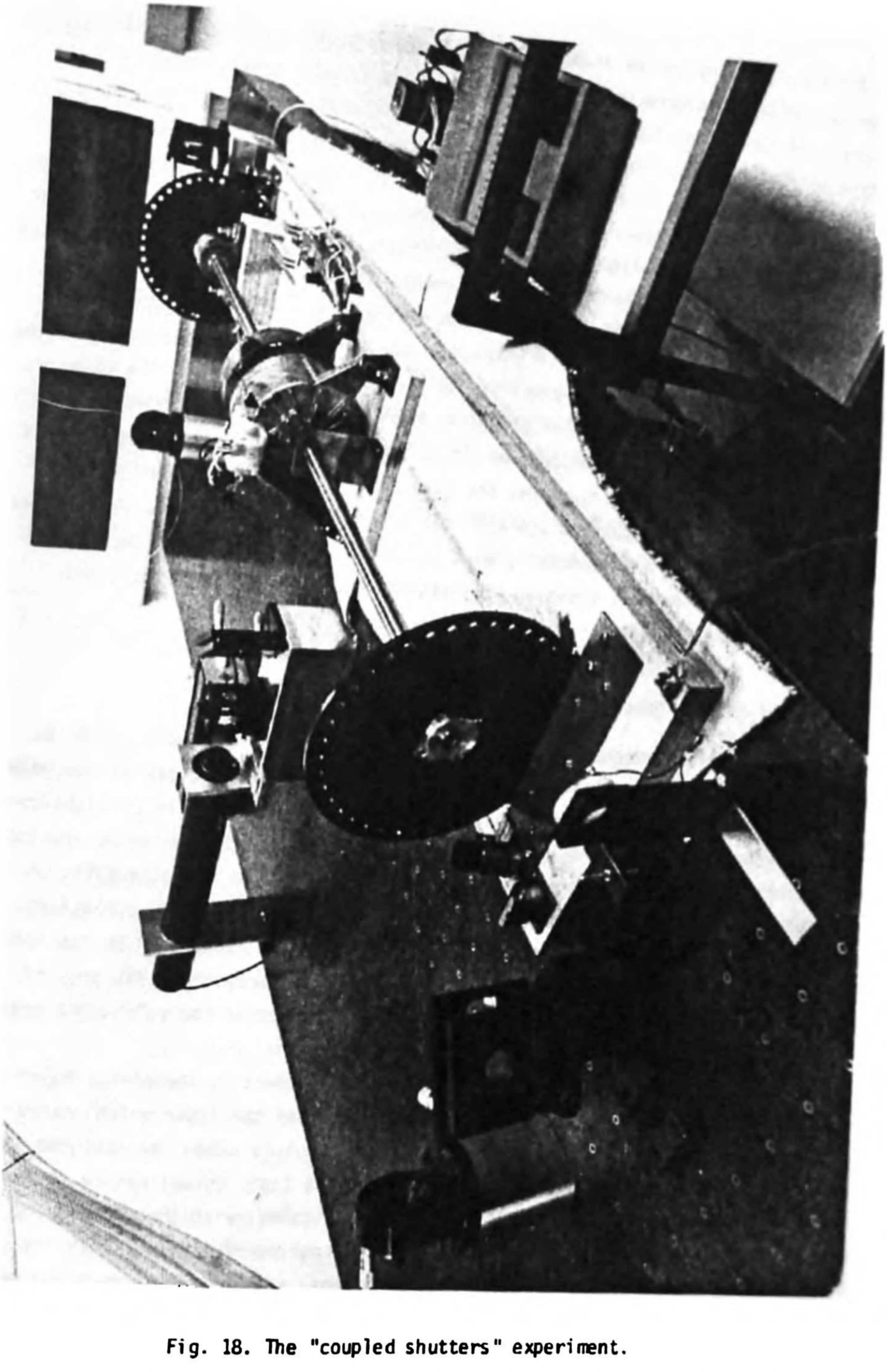

Fig. 18. The "coupled shutters" experiment.

But first, following the example of NATURE which gives interesting quotations from its editions hundred years ago, I should like to give also a similar one:

> If it were possible to measure with sufficient accuracy the velocity of light without returning the ray to its starting point, the problem of measuring the first power of the relative velocity of the Earth with respect to the aether would be solved. This may be not as hopeless as might appear at first sight, since the difficulties are entirely mechanical and may possibly be surmounted in the course of time.

The names of the authors are Michelson and Morley, the year of publication is 1887. This is the paper in which Michelson and Morley give their account on the historical experiment for "measurement" of the two-way light velocity. The paper is published in two journals: THE PHILOSOPHICAL MAGAZINE and AMERICAN JOURNAL OF SCIENCE. After giving this general opinion, Michelson and Morley present the proposition of an experiment which is almost the same as my deviative "coupled mirrors" experiment.(1) They propose to use a bridge method with two selenium cells where the null instrument is a telephone. I must emphasize that I could not succeed to find a single paper or book treating the historic Michelson-Morley experiment, where information on their one-way proposal should be given.

44.2. THEORY OF THE COUPLED SHUTTERS EXPERIMENT.

A rotating axle driven by an electromotor, put exactly at the axle's middle, has two holed disks at its extremities. The distance from the centers of the holes to the center of the axle is R and the distance between the disks is d. Light coming from a laser is divided by a semitransparent prism and the two beams are led by a couple of adjustable mirrors to the opposite ends of the rotating axle, so that the beams can fly through the disks' holes in mutually opposite directions. Any of the beams, after being chopped by the near disk and "detected" by the far disk, illuminates a photocell. By a galvanometer one measures the difference of the currents generated by both photocells. If covering one of the cells, one measures the current produced by the other cell.

One arranges the position of the laser beam with respect to the disks' holes in such a manner that when the axle is at rest the light of the laser which passes through the near hole illuminates the half of the far hole. Then one sets the axle in rotation gradually increasing its speed. Since the light pulses cut by the near holes have a transit time in order to reach the far holes, with the increase of the rate of rotation less and less light will pass through the far holes, when the distant holes "escape" from the light beam positions, and, conversely, more and more light will pass through the far holes, when the distant holes "enter" into the light beam positions. For brevity I shall call the first kind of far holes "escaping" and the second kind of far holes "entering".

If one assumes that the holes as well as the beams' cross-sections are rectangular and the illuminations homogeneous, then the current I_{hom} produced by any of the photocells will be proportional to the breadth b of the light spot measured on the surface of the photocell when the axle is rotating, i.e., $I_{hom} \sim b$. When the rotational rate of the axle increases with ΔN, the breadth of the light beam passing through "escaping" holes will become $b - \Delta b$, while the breadth of the light beam passing through "entering" holes will become $b + \Delta b$, and the produced currents will become $I_{hom} - \Delta I \sim b - \Delta b$, $I_{hom} + \Delta I \sim b + \Delta b$. Thus

$$\Delta b = b \frac{\Delta I}{I_{hom}}, \tag{44.1}$$

where ΔI is the half of the change in the difference of the currents produced by the photocells.

One rotates the axle first with $\Delta N/2$ counter-clockwise and then with $\Delta N/2$ clockwise, that corresponds to a change ΔN in the rate of rotation. Since

$$\Delta b = (d/c)\, 2\pi\, \Delta N\, R\,, \tag{44.2}$$

for the one-way velocity of light one obtains

$$c = \frac{2\pi\, \Delta N\, R\, d}{b} \frac{I_{hom}}{\Delta I}. \tag{44.3}$$

In my experiment the holes as well as the light beams were circular and not rectangular. Consequently instead of the measured light spot's breadth one has to take certain slightly different "effective" breadth. As the breadth b can never be measured accurately, the discussion of the difference between real breadth and "effective" breadth is senseless. Much more important, however, was the fact that the illumination in the beams' cross-sections was not homogeneous: at the center it was maximum and at the periphery minimum. Thus the simplified relation(44.1) did not correspond to reality if under I_{hom} one would understand the measured current. I shall give a certain improvement of formula (44.1), taking into account the character of the illumination intensity over the light spot and the speciphic way in which this light spot is "projected" across the "chopping" holes of the near disk and the "detecting" holes of the far disk. At this consideration the illumination will be assumed to increase linearly from zero on the periphery of the light beam to a maximum at its center where the beam is "cut" by the holes' rims. The real current I which one measures is proportional to a certain middle illumination across the whole light beam, while the real current ΔI is proportional to the maximum illumination at the center of the light beam. On the other hand, one must take into account that when the holes let the light beam fall on the photocell, first light comes from the peripheral parts and at the end from the central parts. When the half of the beam has illuminated the photocell, the "left" part of the beam begins to disappear and its "right" part begins to appear, the breadth remaining always the half of the beam. Then the holes' rims begin to extinguish first the central parts of the beam and at the end the peripheral parts. Here, for simplicity, I suppose that the cross-sections of the beams and of the holes are the same (in reality the former were smaller than the latter). Thus during the first one-third of the time of illumination the "left" half of the light beam appears, during the second one-third of the time of illumination the "left" half goes over to the "right" half, and during the last one-third of the time of illumination the "right" half disappears. Consequently, the real current, I, produced by the photocell will be related with the idealized current, I_{hom}, corresponding to a homogeneous illumination with the central intensity and generated by a light spot having the half-breadth of the measured one, by the following connection

$$I = \frac{1}{2}\int_0^1 I_{hom}\, x\left(\frac{2}{3} - \frac{x}{3}\right) dx = \frac{I_{hom}}{6}\left(x^2 - \frac{x^3}{3}\right)\Big|_0^1 = \frac{I_{hom}}{9}. \qquad (44.4)$$

In this formula $I_{hom}\, x\, dx$ is the current produced by a strip with breadth dx of the light beam; at the periphery of the beam (where x = 0) the produced current is zero and at the center (where x = 1) it is $I_{hom} dx$. The current $I_{hom}\, x\, dx$ is produced (i.e., the corresponding photons strike the photocell) during time 2/3 - x/3; for the periphery of the beam this time is 2/3 - 0/3 = 2/3 and for the center of the beam this time is 2/3 - 1/3 = 1/3. The factor 1/2 before the integral is taken because the measured breadth of the light spot over the photocell is twice its working breadth. Putting (44.4) into (44.3), one obtains

$$c = \frac{2\pi\, \Delta N\, R\, d}{b}\, \frac{9I}{\Delta I}. \qquad (44.5)$$

According to my absolute space-time theory[3,5] (and according to everybody who is acquainted even superficially with the experimental evidence accumulated by humanity), if the absolute velocity's component of the laboratory along the direction of light propagation is v, then the velocity of light is c - v along the propagation direction and c + v against. For these two cases formula (44.5) is to be replaced by the following two

$$c - v = \frac{2\pi\, \Delta N\, R\, d}{b}\, \frac{9I}{\Delta I + \delta I}, \qquad c + v = \frac{2\pi\, \Delta N\, R\, d}{b}\, \frac{9I}{\Delta I - \delta I}, \qquad (44.6)$$

where $\Delta I + \delta I$ and $\Delta I - \delta I$ are the changes of the currents generated by the photocells when the rate of rotation changes by ΔN. Dividing the second formula (44.6) by the first one, one obtains

$$v = (\delta I/\Delta I)\, c. \qquad (44.7)$$

Thus the measuring method consists in the following: One changes the rotational rate with ΔN and one measures the change in the current of any of the photocells which is $\Delta I \cong \Delta I \pm \delta I$; then one measures the difference of these two changes which is $2\delta I$. I made both these measurements by a differential method with the same galvanometer, applying to it the difference of the outputs of both photocells. To measure $2\Delta I$ I made the far holes for one of the beam "escaping" and for the other "entering". To measure $2\delta I$ I made all far holes "escaping" (or all "entering").

44.3. MEASUREMENT OF c.

In the Graz variation of my "coupled-shutters" experiment I had: d = 120 cm, R = 12 cm. The light source was an Ar laser, the photocells were silicon photocollectors, and the measuring instrument was an Austrian "Norma" galvanometer. I measured I = 21 mA (i.e., I_{hom} = 189 mA) at a rotational rate of 200 rev/sec. Changing the rotation from clockwise to counter-clockwise, i.e., with ΔN = 400 rev/sec, I measured ΔI = 52.5 μA (i.e., the measured change in the difference current at "escaping" and "entering" far holes was $2\Delta I$ = 105 μA). I evaluated a breadth of the light spot b = 4.3 ± 0.9 mm and thus I obtained c = $(3.0 \pm 0.6)\times 10^8$ m/sec, where as error is taken only the error in the estimation of b, because the "weights" of the errors introduced by the measurement of d, R, ΔN, I, ΔI were much smaller. I repeat, the breadth b cannot be measured exactly as the peripheries of the light spot are not sharp. As a matter of fact, I chose such a breadth in the possible incertainty range of ±1 mm, so that the exact value of c to be obtained. I wish once more to emphasize that the theory for the measurement of c is built on the assumption of rectangular holes and light beams cross-sections and linear increase of the illumination from the periphery to the center. These simplified assumptions do not correspond to the more complicated real situation. Let me state clearly: The "coupled shutters" experiment is not to be used for an <u>exact</u> measurement of c. It is, however, to be used for an enough exact measurement of the variations of c due to the absolute velocity of the laboratory when during the different hours of the day the axis of the apparatus takes different orientations in absolute space due to the daily rotation of the Earth (or if one will be able to put the set-up on a rotating platform). The reader will see this now.

44.4. MEASUREMENT OF v.

The measurement of c is an <u>absolute</u>, while the measurement of v is a <u>relative</u>, taking the velocity of light c as known. According to formula (44.7) one has to measure <u>only</u> <u>two</u> difference currents: $2\Delta I$ (at "escaping" <u>and</u> "entering" far holes) and $2\delta I$ (at "escaping" <u>or</u> "entering" far holes). The measurement in the air of the laboratory had two important inconveniences: 1) The dust in the air led to very big fluctuations in the measured current differences and I had to use a big condenser in parallel to the galvanometer's entrance, making the apparatus very sluggish. 2) The shrill of the holed disks at high rotational rate could lead to the same gloomy result as when executing the experiment in the appartment of my girl-friend. Thus I covered the whole set-up with a metal cover and evacuated the air by an oil pump (this amelioration cost additional 9,000 Shilling). The performance of the experiment in vacuum has also this advantage that the people who wish to save at any price the wrong light velocity constancy dogma cannot raise the objection that the observed effect is due to temperature disturbances.

The measurement of ΔI is a simple problem as the effect is huge. Moreover all existing physical schools cannot raise objections against the presented above theory. However, the measurement of δI which is with three orders lower than ΔI has certain peculiarities which must be well understood. When changing the rotation from clockwise to counter-clockwise, the current produced by the one photocell changes, say, from I_1 to $I_1 + \Delta I_1 + \delta I_1$ and of the other photocell from, say, I_2 to $I_2 + \Delta I_2 - \delta I_2$. One makes I_1 to be equal to I_2 changing the light beam positions by manipulating the reflecting mirrors micrometrically. One can difficultly receive an exact compensation, so that the galvanometer shows certain residual current I'. The current change ΔI_1 will be equal to the current change ΔI_2 only if the experiment is entirely symmetric. But it is difficult to achieve a complete symmetry (and, of course, I could not achieve it in my experiment). There are the following disturbances: On the one hand, the distribution of the light intensities in the cross-sections of both beams and the forms of the beams are not exactly the same; thus the covering of the same geometrical parts of both beams when changing the rotation of the axle does not lead to equal changes in the light intensities of both beams and, consequently, to $\Delta I_1 = \Delta I_2$. On the other hand, although the photocells were taken from a unique sun collector cut in two pieces, even if the changes in the illuminations should be equal, the produced currents may become different (the current gain at the different points of the photocells is not the same, the internal resistances of the cells are not equal, etc. etc). Thus after changing the rotational rate from clockwise to counter-clockwise, I measured certain current I'', but $I'' - I'$ was not equal to $2\delta I$, as it must be for an entirely symmetric set-up. However, measuring the difference $I'' - I'$ during different hours of the day, I established that it was "sinusoidally modulated". This "sinusoidal modulation" was due to the absolute velocity v. All critics of my "rotating axle" experiments vociferate at the most against the vibrations of the axle, affirming that these vibrations will mar the whole measurement. Meanwhile the axle caused me absolutely no troubles. When measuring in vacuum the axis of the apparatus pointed north/south.

I measured the "sinusoidal modulation" during 5 days, from the 9th to the 13th February 1984. As I did the experiment alone, I could not cover all 24 hours of every day. The results of the measurements are presented in fig.19. The most sensible scale unit of the galvanometer was 10 nA and the fluctuations were never bigger than 20 nA. The day hours are taken on the abscissa and the current differences on the left ordinate. After plotting the registered values of I" - I' and drawing the best fit curve, the "null line" (i.e., the abscissa) is drawn at such a "height" that the curve has to cut equal parts of the abscissa (of 12 hours any). Then on the right ordinate the current 2δI is taken positive upwards from the null line and negative downwards. Since 105 μA correspond to a velocity 300,000 km/sec, 10 nA will correspond approximately to 30 km/sec. Considering the fluctuations of the galvanometer as a unique source of errors, I took ± 30 km/sec as the uncertainty error in the measurement of v.

When 2δI has maximum or minimum the Earth's absolute velocity lies in the plane of the laboratory's meridian (fig.20). The velocity components pointing to the north are taken positive and those pointing to the south negative. I note by v_a always this component whose algebraic value is smaller. When both light beams pass through "escaping" holes, then, in the case that the absolute velocity component points to the north, the "north" photocell produces less current than the "south" photocell (with respect to the case when the absolute velocity component is perpendicular to the axis of the apparatus), while, in the case that the absolute velocity component points to the south, the "north" photocell produces more current. If the light beams pass through "entering" holes, all is vice versa. Let me note that for the case shown

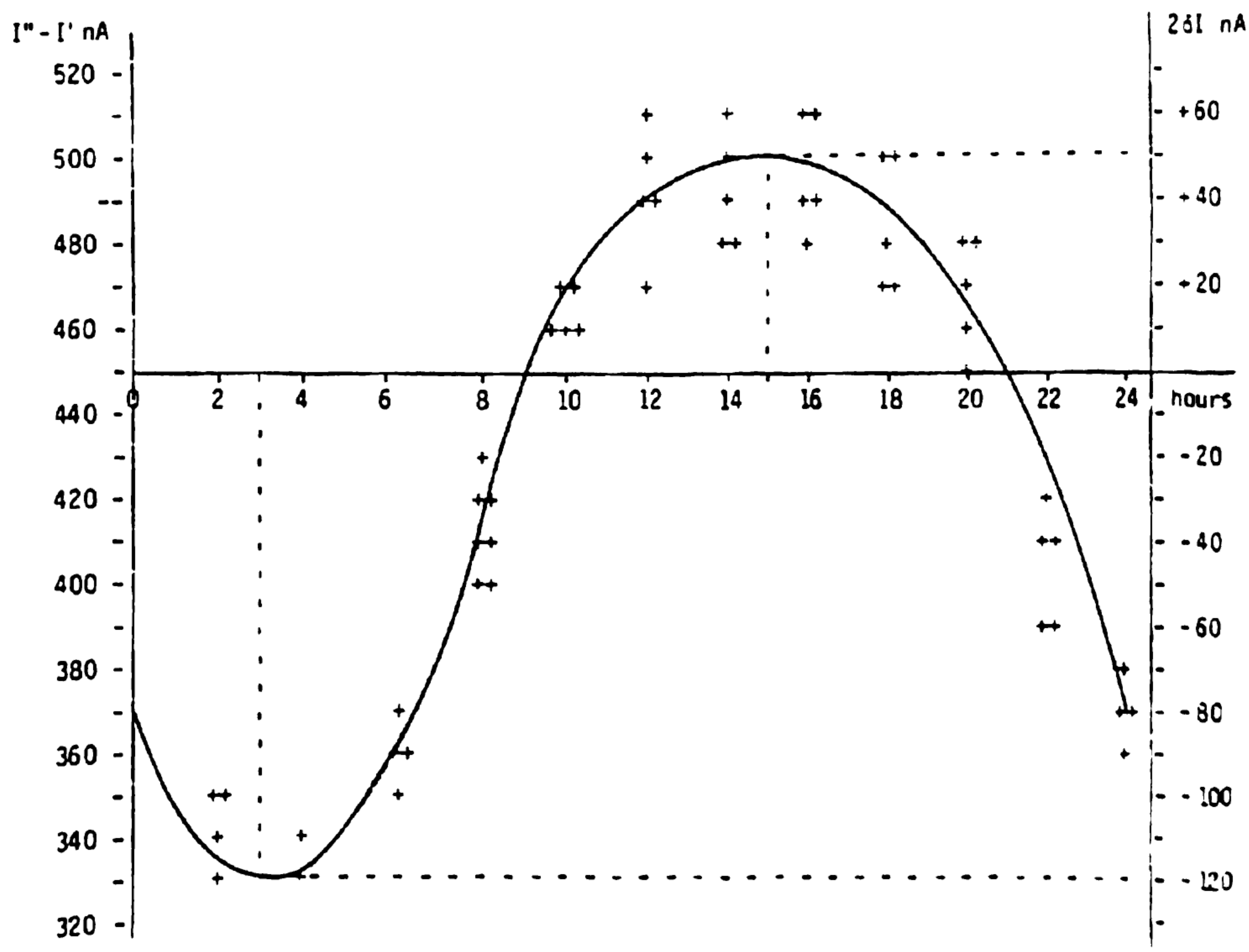

Fig. 19. Measurement of 2δI in the "coupled shutters" experiment.

in fig. 20 (which does not correspond to the real situation, as in reality v_a is negative) both velocity components point to the north and both v_a and v_b are positive. In this case the "variation curve" has no more the character of a "sinusoid"; it has 4 extrema (for 24 hours) and the "null line" must be drawn tangent to the lowest minimum.

As it can be seen from fig. 20, the two components of the Earth's absolute velocity in the horizontal plane of the laboratory, v_a and v_b, are connected with the magnitude v of the absolute velocity by the following relations

$$v_a = v\sin(\delta - \phi), \qquad v_b = v\sin(\delta + \phi), \tag{44.8}$$

where ϕ is the latitude of the laboratory and δ is the declination of the velocity's apex. From these one obtains

$$v = \frac{\{v_a^2 + v_b^2 - 2 v_a v_b(\cos^2\phi - \sin^2\phi)\}^{1/2}}{2\sin\phi\cos\phi}, \qquad \tan\delta = \frac{v_b + v_a}{v_b - v_a}\tan\phi. \tag{44.9}$$

Obviously the apex of v points to the meridian of v_a. Thus the right ascension α of the apex equaled the local sideral time of registration of v_a. From fig. 19 it is to be seen that this moment can be determined with an accuracy of $\pm 1^h$. Thus it was enough to calculate (with an inaccuracy not larger than $\pm$ 5 min) the sideral time t_{si} for the meridian where the local time is the same as the standard time t_{st} of registration, taking into account that the sideral time at a middle midnight

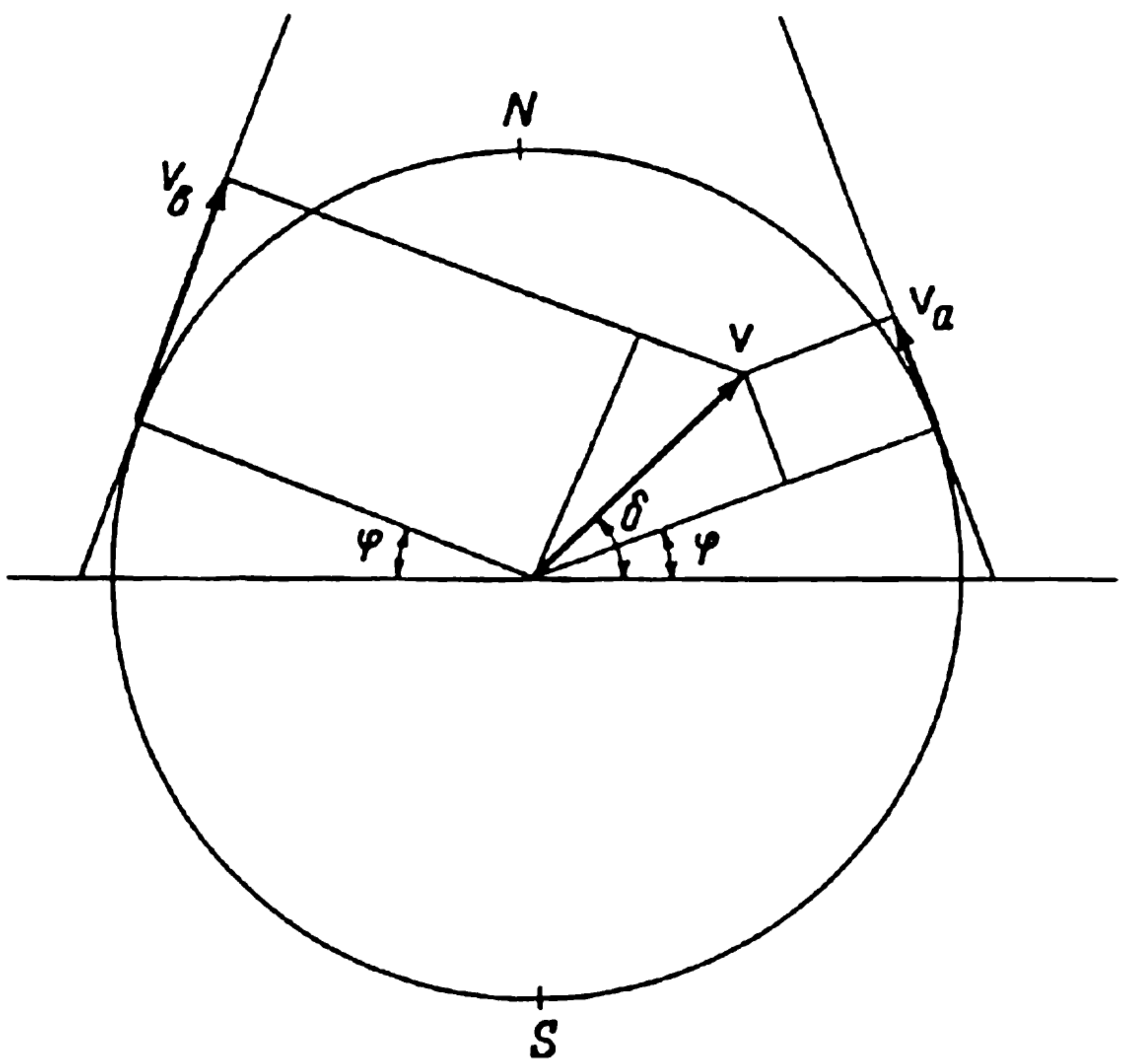

Fig. 20. The Earth and its absolute velocity at the moments when the laboratory meridian lies in the velocity's plane.

is as follows:

22 September	- 0^h	23 March	- 12^h
22 October	- 2^h	23 April	- 14^h
22 November	- 4^h	23 May	- 16^h
22 December	- 6^h	22 June	- 18^h
21 January	- 8^h	23 July	- 20^h
21 February	- 10^h	22 August	- 22^h.

The graph in fig. 19 shows that on the 11th February (the middle day of observation) I registered in Graz ($\phi = 47^0$, $\delta = 15^0\ 26'$) the following absolute velocity's components at the following hours (for $2(\delta I)_a = -120$ nA, $2(\delta I)_b = 50$ nA)

$$v_a = -342 \pm 30 \text{ km/sec}, \qquad (t_{st})_a = 3^h \pm 1^h,$$

$$v_b = +143 \pm 30 \text{ km/sec}, \qquad (t_{st})_b = 15^h \pm 1^h, \qquad (44.10)$$

and formulas (9) give

$$v = 362 \pm 40 \text{ km/sec}, \qquad \delta = -24^0 \pm 7^0, \qquad \alpha = (t_{si})_a = 12.5^h \pm 1^h, \qquad (44.11)$$

where the errors are calculated supposing $\phi = 45^0$.

The local sideral time for the observation of v_a (i.e., the right ascension of the absolute velocity's apex) was calculated in the following manner: As for any day the sideral time inreases by 4^m (with respect to the solar time), the sideral time at midnight on the 11th February (which follows 21 days after midnight on the 21 January) was $8^h + 1^h\ 24^m = 9^h\ 24^m$. At 3^h middle European (i.e., Graz) time on the 11th February the local sideral time on the 15th meridian was $9^h\ 24^m + 3^h = 12^h\ 24^m$. On the Graz meridian the local sideral time was $12^h\ 24^m + 2^m = 12^h\ 26^m \cong 12.5^h$.

Important remark. Now I establish that when calculating the local sideral time of observation of v_a for my interferometric "coupled mirrors" experiment[2,3,4,5], I made a very unpleasant error. As Sofia ($\lambda = 23^0\ 21'$) lies westwards from the middle zonal meridian ($\lambda = 30^0$), I had to subtract the difference of $6^0\ 39'$, which correspond to 27^m, from the local sideral time of the zonal meridian. Instead to do this, I wrongly added. Thus the given by me numbers are to be corrected as follows:

	wrongly calculated:	to be corrected to:
Observation on the 12 July 1975:	$(t_{si})_a = 14^h\ 23^m$	$(t_{si})_a = 13^h\ 30^m$
Observation on the 11 Jan. 1976:	$(t_{si})_a = 14^h\ 11^m$	$(t_{si})_a = 13^h\ 17^m$
Right ascension of the apex of the Sun's absolute velocity:	$\alpha = 14^h\ 17^m$	$\alpha = 13^h\ 23^m$

I beg the persons who will refer to the measurement of the Sun's absolute velocity done by me in 1975/76 to cite always the corrected here figures and not the wrongly calculated figures presented in Refs. 1-5, 27, 28 and in some other of my papers.

44.5. CONCLUSIONS.

Comparing the figures obtained now by the Graz variation of my "coupled shutters" experiment with the figures obtained some ten years ago in Sofia by the interferometric "coupled mirrors" experiment, one sees that within the limits of the supposed errors they overlap. Indeed, on the 11 January 1976 I registered in Sofia the following figures

$$v = 327 \pm 20 \text{ km/sec}, \qquad \delta = -21^{o} \pm 4^{o}, \qquad \alpha = 13^{h}\, 17^{m} \pm 20^{m}. \qquad (44.12)$$

As for the time of one month the figures do not change significantly, one can compare directly the figures (44.11) with the figures (44.12). The declinations are the same. As the Graz measurements were done every two hours, the registration of the right ascension was not exact enough and the difference of about one hour is not substantial. I wish to point only to the difference between the magnitudes which is 35 km/sec. I have the intuitive feeling that the figures obtained in Sofia are more near to reality. The reason is that I profoundly believe in the mystic of the numbers, and my Sofia measurements led to the magic number 300 km/sec for the Sun's absolute velocity (which number is to be considered together with 300,000 km/sec for light velocity and 30 km/sec for the Earth's orbital velocity). The Graz measurement destroys this mystic harmony.

The presented acount on the Graz "coupled shutters" experiment shows that the experiment is childishly simple, as I always asserted(29). If the scientific community so many years refuses to accept my measurements and nobody tries to repeat them, the answer can be found in the following words of an acanite fighter against authorities:

TERRIBLE IS THE POWER WHICH AN AUTHORITY EXERTS OVER THE WORLD.

Albert Einstein

I wish to add in the end that with a letter of the 29 December 1983 I informed the Nobel committee that I am ready at any time to bring (for my account) the "coupled shutters" experiment to Stockholm and to demonstrate the registration of the Earth's absolute motion. With a letter of 28 January 1984 Dr. B. Nagel of the Physics Nobel committee informed me that my letter has been received.

After about forty submissions, this report on the execution of the "coupled shutters" experiment was finaly published in Ref. 30.

45. THE QUASI-KENNARD EXPERIMENT

The electromagnetic experiment with whose help I succeeded to measure the Earth's absolute velocity (as a matter of fact to register the right ascension of its apex) was the QUASI-KENNARD EXPERIMENT whose theory was shortly considered in Sect. 21 and whose diagram was given in fig. 5. The execution of the experiment was the following (see fig. 5):

In a rectangular loop with length $d = 150$ cm and breadth $b = 15$ cm a metal bar with length $b - b_0 = 14.5$ cm was placed. The loop had $N = 100$ windings and a current $I_0 = 3$ A was sent through the wire, so that the total current along the rectangle was $I = NI_0 = 300$ A. Let us assume that the magnetic intensity generated by the horizontal wires of the loop at a distance r from the wires is the same as of an infinitely long wire, i.e., $B = \mu_0 I/2\pi r$ (see formula (21.12)).

If moving the bar to the right with a velcoity v, at the indicated direction of the current along the loop, an induced motional electric tension with the indicated polarity will appear along the bar, whose magnitude will be (take into account that the horizontal current wires are double and assume $b \gg b_0$)

$$U_{mot} = \int_{b_0/2}^{b-b_0/2} 2vBdy = \frac{\mu_0 vI}{\pi} \int_{b_0/2}^{b-b_0/2} dy/y \cong \frac{\mu_0 vI}{\pi} \ln\frac{2b}{b_0}, \tag{45.1}$$

what is formula (21.10) which was written in the CGS system of units.

Let us now assume that the vertical bar is kept at rest and the rectangular loop is moved with the same velocity to the left. Now the induction will be motional-transformer and the calculation is to be done by using formula (21.4). The x-component of the magnetic potential, A_x, will be a function only of y, the y-component (for $d \gg |x|$),

$$A_y = \frac{\mu_0 Ib}{4\pi(d/2 - x)} - \frac{\mu_0 Ib}{4\pi(d/2 + x)} = \frac{2\mu_0 Ibx}{\pi d^2}, \tag{45.2}$$

will be a function only of x, and the z-component, A_z, will be equal to zero. Thus the only term of the vector gradient (21.4) which is different from zero gives the motional-transformer electric intensity which will be induced

$$E_{mot-tr} = v_x \frac{\partial A_y}{\partial x} \hat{y} = - \frac{2\mu_0 vIb}{\pi d^2} \hat{y}, \tag{45.3}$$

as $v_x = -v$. From formula (45.3) we find the magnitude of the induced motional-transformer tension

$$U_{mot-tr} = 2\mu_0 vIb^2/\pi d^2 \cong 0, \tag{45.4}$$

and the approximate null result (for $d \gg b$) was obtained in formula (21.11). Thus U_{mot} is much bigger than U_{mot-tr} and the latter, to a good approximation can be taken equal to zero.

If the loop and the bar will be moved together, then, as $U_{mot-tr} \cong 0$, the tension which will remain to act along the bar will be the motional tension. But if the loop and the bar move together, the question is to be posed: with respect to what? The answer, of course, can be only one: with respect to absolute space. This answer was given also in Sect. 23 by the help of the relative Newton-Lorentz equation.

Taking[4,30] for the Earth's absolute velocity approximately V = 300 km/sec (see Sect. 44), we obtain from formula (45.1) for our experiment U = 147 V.

It is clear that this tension cannot be measured by a voltmeter, as the tension in a closed loop must be null (see the end of Sect. 21). Thus I did "electrometric" measurements by putting very thin foils of damped aluminium at the extremities of the bar. The dimensions of the bar were 14.5×1.5×0.3 cm. The one side of the foils was conducting and the other not. The foils were attached to the bar by their conducting faces.

The detector showed an effect (opening of the foils) by putting on the bar tensions down to 12 V.

As in the laboratory there were many different causes which led to an opening of the aluminium foils (let us call them disturbing effects), I did not care about to try to specify and eventually eliminate them. Thus the Al-foils were always to a certain extent open and during the different days the opening was different. I could observe the effect of the absolute motion of the Earth only by mounting the set-up on a rotating platform. I observed by rotation that there were two positions where the opening of the foils was maximal and two positions where it was minimal. The difference between those positions was always about 90^0.

It was difficult to make calibration of the detector, as the check tension was applied by connecting the bar with one electrode of a variable tension, while the induced tension to be measured was applied between the end points of the bar. Thus it was very difficult to fit the degree of opening of the foils to formula (45.1) as the geometry of the experiment was not easily calculable (the foils had to cover the smallest sides of the bar, not the extremities of the largest side, as it was in my experiment) and the readings were not enough stable and repeatable.

The method for establishing the magnitude of the Earth's absolute velocity and of the equatorial coordinates of its apex (if the readings of the calibrated detector would reliably correspond to the tension induced along the bar) is given in Sect. 44.4. I used this method only for establishing the right ascension of the apex. For this reason I registered the two moments when the opening of the foils was maximum for a direction of the axis of the set-up "north-south".

On the 22 January 1989 I registered in Graz ($\phi = 47^0$, $\lambda = 15^026'$) maximum openings of the leaves at the following two moments of Middle-European standard time: $(t_{st})_a = 3.8^h$, $(t_{st})_b = 15.8^h$. The local sideral times corresponding to these two moments were: $(t_{si})_a = 11.8^h$, $(t_{si})_b = 23.8^h$. One of these times was equal to the right ascension of the velocity's apex. The inaccuracy was estimated $\pm 1^h$. (Cf. Sect. 44.4.)

This report on the quasi-Kennard experiment was published in Refs. 31 and 32.

46. THE DIRECT AND INVERSE ROWLAND EXPERIMENTS

46.1. INTRODUCTION.

Rowland [33] carried out in 1876 the following experiment: A disk was charged with positive (or negative) electricity. There was a magnetic needle in the neighbourhood of the disk. When the disk was set in rotation, the needle experienced a torque due to the magnetic action produced by the convection current of the charges rotating with the disk. A call this the DIRECT ROWLAND EXPERIMENT (fig. 21).

According to the principle of relativity, if the disk will be kept at rest and the needle will be set in rotation, the same torque has to act on it. Such an experiment is called by me the INVERSE ROWLAND EXPERIMENT (fig. 22). However, as I shall show in the following subsection, according to the relative Newton-Lorentz equation (23.4), the magnetic needle will <u>not</u> experience a torque at the inverse Rowland experiment.

The above two experiments can be called ROTATIONAL Rowland experiments. It is easy to transform them into INERTIAL experiments. So if we charge a conveyer belt and set it in action, the motion of the charges can be considered as intertial (i.e., with a velocity constant in value in direction) over a considerable length of the belt and we shall realize thus the inertial direct Rowland experiment. On the other

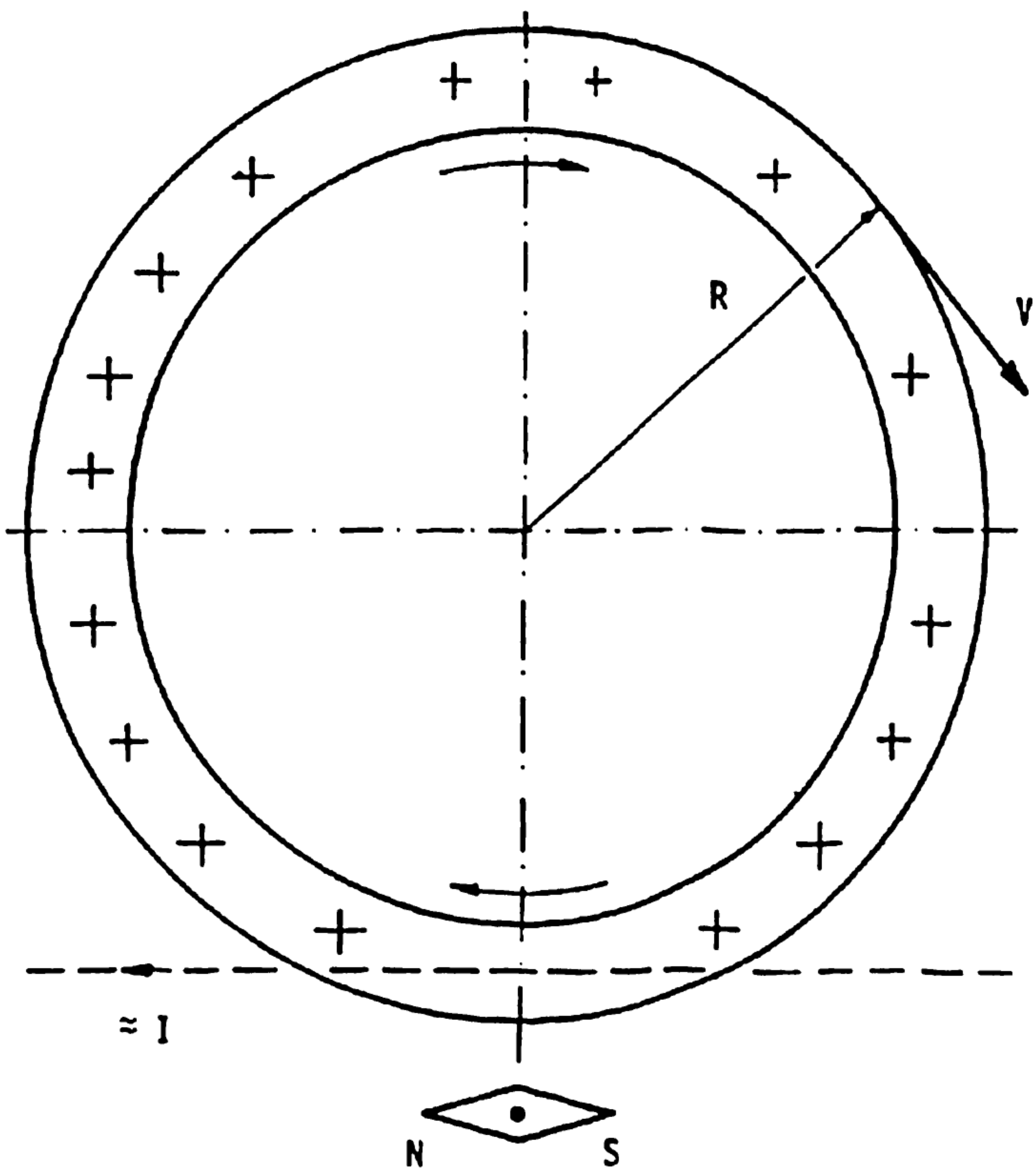

Fig. 21. The direct Rowland experiment.

hand, if we move the magnetic needle with a constant velocity along the belt at rest, this will be the inertial inverse Rowland experiment.

As far as I know nobody has carried out either the rotational nor the inertial inverse Rowland experiments.

46.2. THE EFFECT IN THE INVERSE ROWLAND EXPERIMENT IS NULL.

Now I shall show that, contrary to the prediction of the principle of relativity, the inverse Rowland experiment must be null, i.e., a magnet moving with respect to charges at rest does not experience torque.

As the treatement of the inverse Rowland experiment has an important theoretical aspect, the formulas in Sect. 46.2 will be written in the CGS system of units.

Thus, proceeding from the Newton-Lorentz equation (23.4), I shall show that when there is an infinitely long (or very long) belt covered with electric charges and a magnet in its neighbourhood (let us consider a solenoid feeded by constant current), then, in the case that the belt will be moved with the relative velocity **v** in the laboratory, there will be a torque acting on the magnet at rest, however, in the case that the belt will be at rest and the magnet will be moved with the same velocity **v**, there will be no torque.

Let us suppose that the absolute velocity of the laboratory is **V** and let us consider an electric charge q moving with the laboratory velocity v_m in an wire element of the magnet (as I showed - see Sect. 16 - $\mathbf{v}_m$ is of the order of c). Denoting by Φ and **A** the laboratory electric and magnetic potentials generated by the electric charges fixed to the belt at the point of location of the charge q, we shall have for the potential force acting on this charge q, according to eq. (23.4), for the case when belt and magnet are at rest in the labiratory,

$$\mathbf{F} = - q\,\mathrm{grad}\Phi + q(\mathbf{v}_m.\mathbf{V}/c^2)\mathrm{grad}\Phi. \qquad (46.1)$$

As $v_m \cong c$ and $qv_m = Idr\mathbf{n}$, where I is the current in the coil, dr is its wire element and **n** is the unit vector along this wire element in the direction of the curent, we shall have

$$\mathbf{F} = - (Idr/c)\mathrm{grad}\Phi(1 - \mathbf{n}.\mathbf{V}/c) \cong - (Idr/c)\mathrm{grad}\Phi. \qquad (46.2)$$

It can be shown that this force is small with respect to the force of attraction due to the electrostatic induction of the charges on the belt and the induced charges on the metal wire of the coil.

For the case when the magnet will be moved with the relative velocity **v** in the laboratory, the acting force will be

$$\mathbf{F}' = - q\,\mathrm{grad}\Phi + q\{(\mathbf{v}_m + \mathbf{v}).\mathbf{V}/c^2\}\mathrm{grad}\Phi = \mathbf{F} + q(\mathbf{v}.\mathbf{V}/c^2)\mathrm{grad}\Phi. \qquad (46.3)$$

As $v \ll c$, the additionally acting force

$$\mathbf{F}' - \mathbf{F} = q(\mathbf{v}.\mathbf{V}/c^2)\mathrm{grad}\Phi \qquad (46.4)$$

is extremely small with respect to the initial force F and surely there will be no experimental possibility to register it, so that we can write

$$F' = F. \tag{46.5}$$

For the case when the belt will be moved with the velocity $\mathbf{v}$ in the laboratory, the force acting on the charge q of the magnet at rest will be, taking now the laboratory magnetic potential of the charges on the belt as $\mathbf{A} = \Phi\mathbf{v}/c$ and using in the last two terms of (46.6) the formulas for rotation and vector-gradient of double products,

$$F'' = -\,q\,\mathrm{grad}\Phi + q(\mathbf{v}_m.\mathbf{V}/c^2)\mathrm{grad}\Phi + (q/c)\mathbf{v}_m\times\mathrm{rot}\mathbf{A} + (q/c)\mathbf{V}\times\mathrm{rot}\mathbf{A} + (q/c)(\mathbf{V}.\mathrm{grad})\mathbf{A} =$$

$$-\,q\,\mathrm{grad}\Phi + q(\mathbf{v}_m.V/c^2)\mathrm{grad}\Phi + (q/c)v_m\times\mathrm{rot}\mathbf{A} + q(v.\mathbf{V}/c^2)\mathrm{grad}\Phi =$$

$$F + (q/c)\mathbf{v}_m\times\mathrm{rot}\mathbf{A} + q(v.\mathbf{V}/c^2)\mathrm{grad}\Phi. \tag{46.6}$$

Now, taking into account that $v \ll c$, we shall obtain for the additionally acting force

$$F'' - F \cong (q/c)v_m\times\mathrm{rot}\mathbf{A} = Id\mathbf{r}\mathbf{n}\times\mathbf{B}/c, \tag{46.7}$$

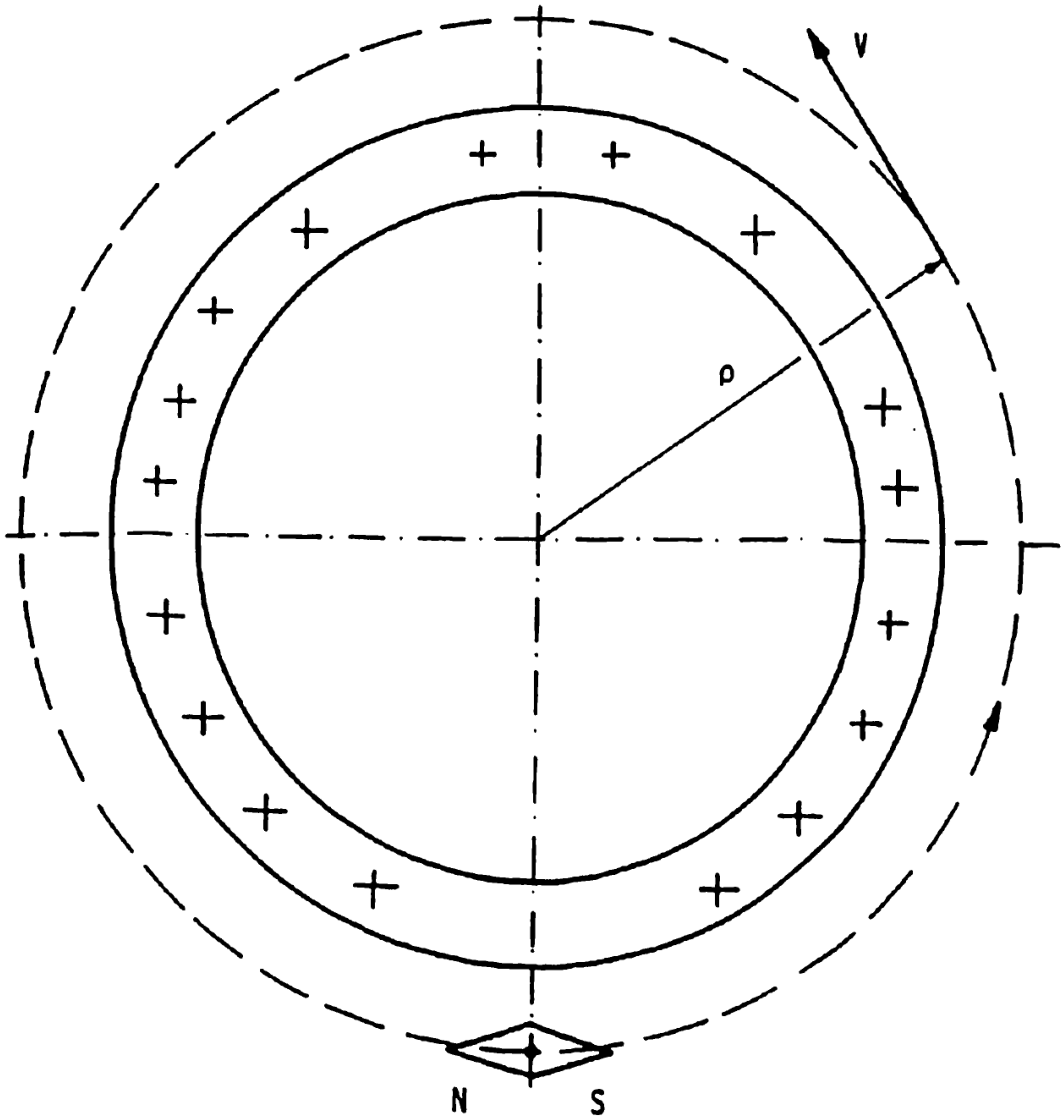

Fig. 22. The inverse Rowland experiment.

where B is the magnetic intensity generated by the charges moving with the belt. This force is considerable and there will be a torque acting on the magnet.

46.3. THE EXPERIMENT SUPPORTS THE ABSOLUTE SPACE-TIME CONCEPTS.

I carried out the rotational direct and inverse Rowland experiments (fig. 23). A rim of a plastic disk was covered with a brass ring. This metal ring, cut over a small distance, was connected by a wire with the axle of rotation and this axle was connected by the help of sliding contacts with one pole of a Wimshurst machine which produced tension between both poles $U = 80$ kV, and I assumed that the potential to which the disk was charged was $\Phi = U/2 = 40$ kV. For a detector of the magnetic field I took not a magnetic needle, as was the case in the historic Rowland experiment, but a small Hall detector whose output was led to an amplifier ending with a trigger. When the trigger was overturned, it illuminated a lamp. The trigger could be tuned so that an increase of the magnetic intensity over the Hall detector of few micro Gauss the lamp was illuminated. The capacitance of the disk with radius R = 20 cm was of the order of $C = 10^{-11}$ F.

If charged to a potential Φ, the charge over the disk will be $q = C\Phi$. At N rotations in a second this charge will produce current $I = qN$. This convection current, from its side, will produce at a distance ρ ($\rho > R$) from the center of the disk the following magnetic intensity (see (18.6))

$$B = \frac{\mu_0 I R^2}{4(\rho^2 - R^2)^{3/2}} = \frac{\mu_0 I R^2}{4\{2R(\rho - R)\}^{3/2}} = \frac{\mu_0 C\Phi N R^{1/2}}{4\{2(\rho - R)\}^{3/2}}. \qquad (46.8)$$

Putting here $\mu_0 = 4\pi 10^{-7}$, $C = 10^{-11}$ F, $\Phi = 4\times10^4$ V, $N = 1$ rev/sec, $R = 0.2$ m, $\rho - R = 0.004$ m, we obtain $B = (\pi/4)10^{-10}$ T/rev $\cong 1$ μG/rev.

When rotating the charged disk, the lamp became illuminated at some $N = 10$ rev/sec. However when the disk was kept at rest and the Hall detector together with its battery the amplifier, the trigger and the lamp was rotated about the disk, there was no light even for $N = 20$ rev/sec.

Of course, because of the mechanical vibrations and the Earth's magnetism, it was pretty difficult to establish such a null effect and my experiment, naturally, needs confirmation carried out in a first class laboratory. According to me, the inverse Rowland experiment has been not carried until now not because of technical difficulties but because of a fear that the result will be null (this is also the reason that "rotating axle " experiments - see Sect. 44 - for measurement of the Earth's absolute velocity have been not carried out until now).

The plane of the Hall detector lied in the plane of the disk. When rotating the Hall detector, its plane must remain exactly parallel to the plane of rotation. If the Hall detector will make a small angle with the plane of rotation, the lamp was illuminated and extinguished even when the disk was not charged, because of the change of the Earth's magnetic intensity over the Hall detector. This effect served as an indication of the sensitivity of the Hall detector. As the Earth's magnetic intensity is $B_E = 0.5$ G $= 5\times10^{-5}$ T, then if the angle between B_E and the plane of the Hall detector is θ, the component of the Earth's magnetic intensity p rpendicularly to the plane of the detector will be $B_{E\perp} = B_E \sin\theta$. Thus, for $\theta = 0$, $\Delta\theta = 1^0 = 1/57$ rad, we shall have $\Delta B_{E\perp} \cong 10$ mG $= 10^{-6}$ T Earth's magnetic intensity over the whole detector. With the increase of θ the change $\Delta B_{E\perp}$ for $\Delta\theta = 1^0$ decreases.

It is obvious that there are no technical problems for realizing also the inertial direct and inverse Rowland experiments.

46.4. CONCLUSIONS.

Thus the direct and inverse Rowland experiments carried out by me showed that the effects observed are not the same. Contrary to the prediction of my absolute space-time theory and contrary to the experimental results, the theory of relativity predicts the following nonsense:(34)

> A stationary magnetic dipole (e.g., a compass needle) in general experiences a torque in the presence of a moving charge, since the latter creates a B field; transferring our observations once more to the inertial rest frame of the charge, we conclude that a magnetic dipole moving through a static electric field must experience a torque.

This report on the execution of the direct and inverse Rowland experiments was published in Ref. 33.

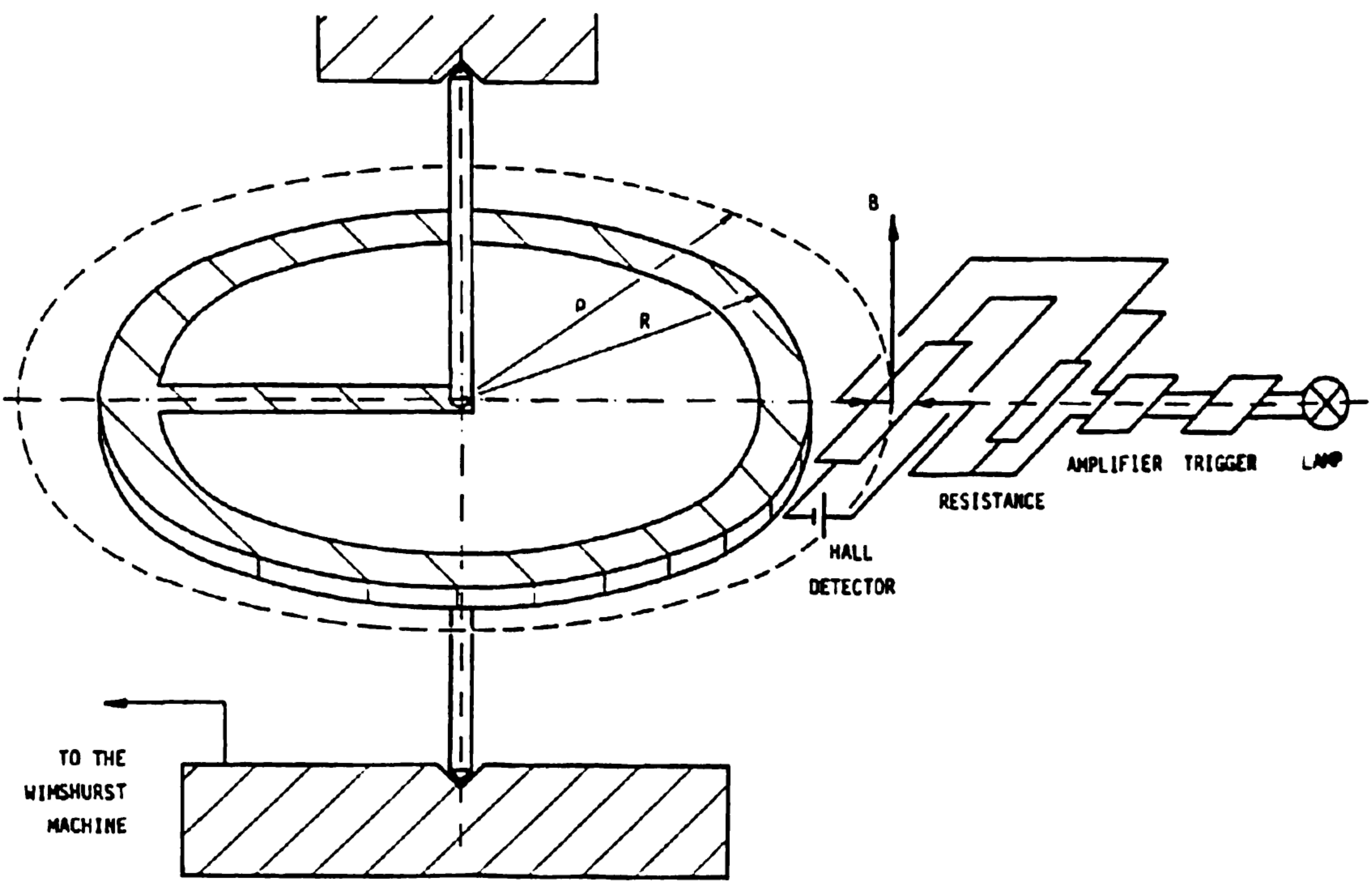

Fig. 23. Diagaram of the apparatus for the direct and inverse Rowland experiments.

47. CLASSIFICATION OF THE ELECTROMAGNETIC MACHINES (THE B-MACHINES)

The ELECTROMAGNETIC MACHINES consist of a magnet (permanent magnet, electromagnet or current wire) and a coil (wire). In Sect. 29 I separated the electromagnetic machines in motors and generators with respect to the kind of forces which the machine produces: ponderomotive or electromotive. Then in Sect. 29 I separated the electromagnetic machines in B-motors and generators and in S-motors and generators with respect to the kind of the driving magnetic field: vector or scalar.

Now I shall introduce a classification of the B-motors and B-generators with respect to the part of the magnet's pole covered by the wire at its motion (rotation). Of course, in the B-machine the wire can remain at rest and the magnet can be rotated, but, for definiteness, I shall always assume that the magnet is at rest and the wire moves. Formulas (21.14) and (24.6) show that for the electromagnetic machines with closed loops the principle of relativity holds good.

1. NONPOLAR MACHINES. In these machines there is no motion of the wire at all. Such machines are only generators and their coil always has an iron core. A change in the magnetic flux through the coil is caused by a respective motion of permanent magnets, however, current sent in the coil does not set these permanent magnets in motion. Such machine is my MAMIN COLIU machine which produces energy from nothing (see Sect. 53). In the nonpolar machines the wire covers no part of the magnet's poles.

2. HALF POLAR MACHINES. In these machines the wire covers only the half of the magnet's pole at its rotation. Official physics calls these machines UNIPOLAR or HOMOPOLAR, but in my classification the unipolar machines (see later) have another character. The typical half polar machines are the so-called BARLOW and FARADAY DISKS (BARLOW and FARADAY HALF POLAR MACHINES).

In fig. 24 an OPEN half polar machines is shown: The cylindrical magnet generates a cylindrical magnetic field (indicated by the dashed lines). If via the sliding contacts a and b current is sent along the disk's radius, it comes into rotation. This is called the Barlow disk and the third formula (21.1) is to be used for the calculation of the force acting on the current elements along the disk's radius. If the disk will be rotated by an external torque, at the points a and b an induced tension will appear. This is called the Faraday disk and again the third formula (21.1) is to be used for the calculation of the electric intensity induced at the different points of the disk's radius.

If the disk is not solid to the cylindrical magnet, I call the Barlow and Faraday disks UNCEMENTED. If the disk is fixed to the cylindrical magnet and both rotate together, I call the Barlow and Faraday disks CEMENTED. Whether the cylindrical magnet is cemented or non-cemented nothing changes in the acting forces, as in Sect. 27 I showed that the torque exerted by a rectangular wire on a circular wire is null and N circular wires make a circular solenoid.

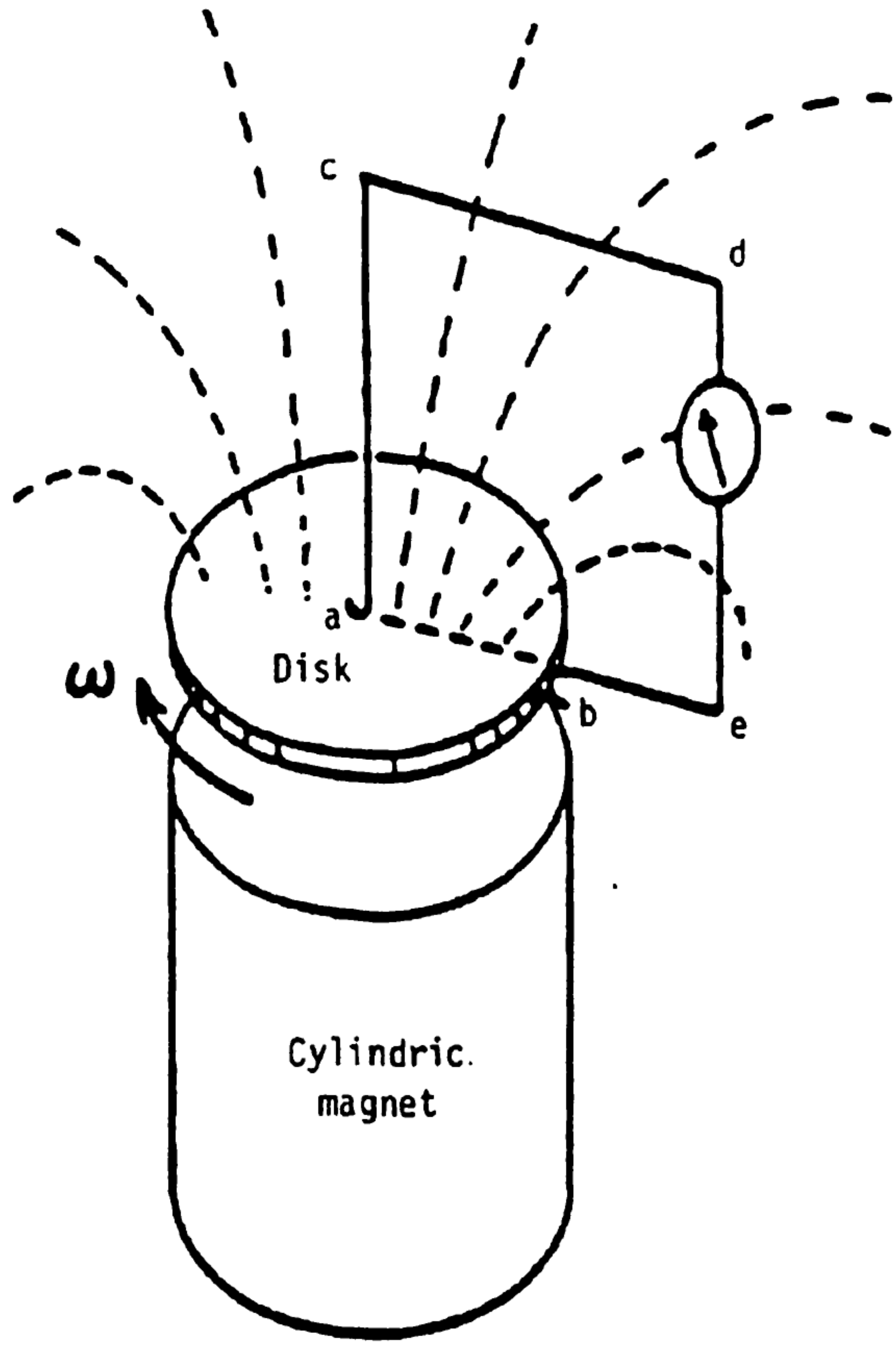

Fig. 24. Open half polar machine.

In fig. 25 a CLOSED half polar machine is shown. We have, respectively, a closed Barlow disk and a closed Faraday disk, however now the cemented machines neither rotate nor generate current.

If current is sent in the coil, the whole coil begins to rotate and the salting contacts allow to make the rotation continuous. On the other side, rotating continuously the coil with the salting contacts, a direct current will be induced in it.

3. UNIPOLAR MACHINES. Such are the machines in figs. 26 and 27, called, respectively, unipolar machines with MÜLLER RING and with MARINOV RING. The character of the Müller and Marinov rings is shown schematically in fig. 28.

The unipolar machine with Müller's ring consists of permannet slab magnets arranged in a ring with their north poles pointing outwards. A frame consisting of two parallel circles, which for more clariry is drawn at the left of fig. 26, is to be put on the ring and then the slider ab can slide along the two parallel circles, the circuit being closed by the fixed wire cd.

In the unipolar machine with Marinov's ring the same slider can continuously rotate, but the pushing force will be no constant as in the Müller's ring. In fig. 27 a variation is shown for realizing continuous rotation of the magnets by the help of salting contacts; meanwhile a Müller's ring cannot be set in rotation.

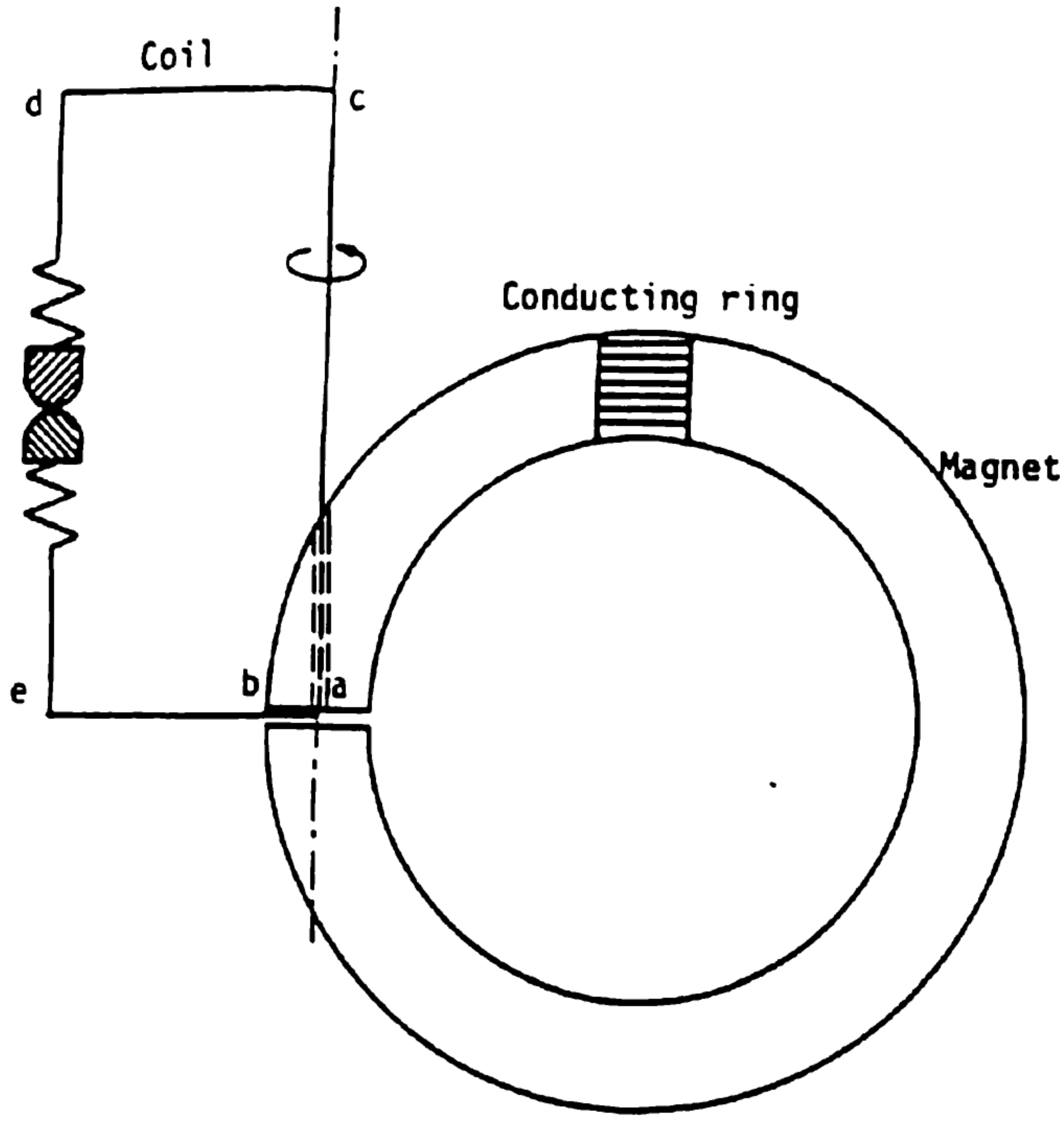

Fig. 25. Closed half polar machine.

4. ONE-AND-A-HALF POLAR MACHINES. This is the machine BUL-CUB analysed in Sect. 48. The inventor of this machine is F. Müller.(36) Müller observed its electromotive effects. I constructed a variation for observing also its poneromotive effects and called this hybrid MACHINE BUL-CUB, an abbreviation of BULgaria - CUBa, my and Müller's native countries.

5. TWO POLAR MACHINES. Those are almost all electromagnetic machines which huma-

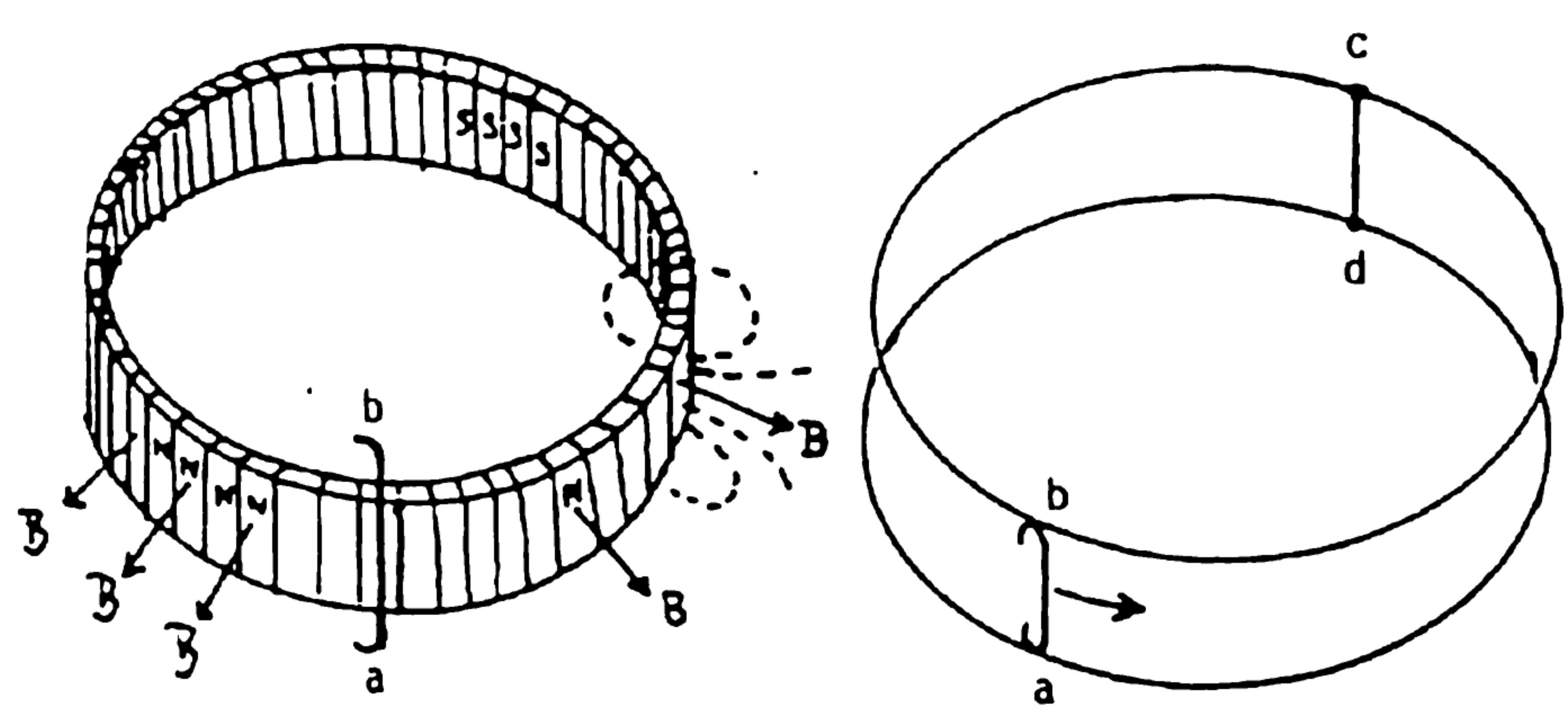

Fig. 26. Unipolar machine with Müller's ring.

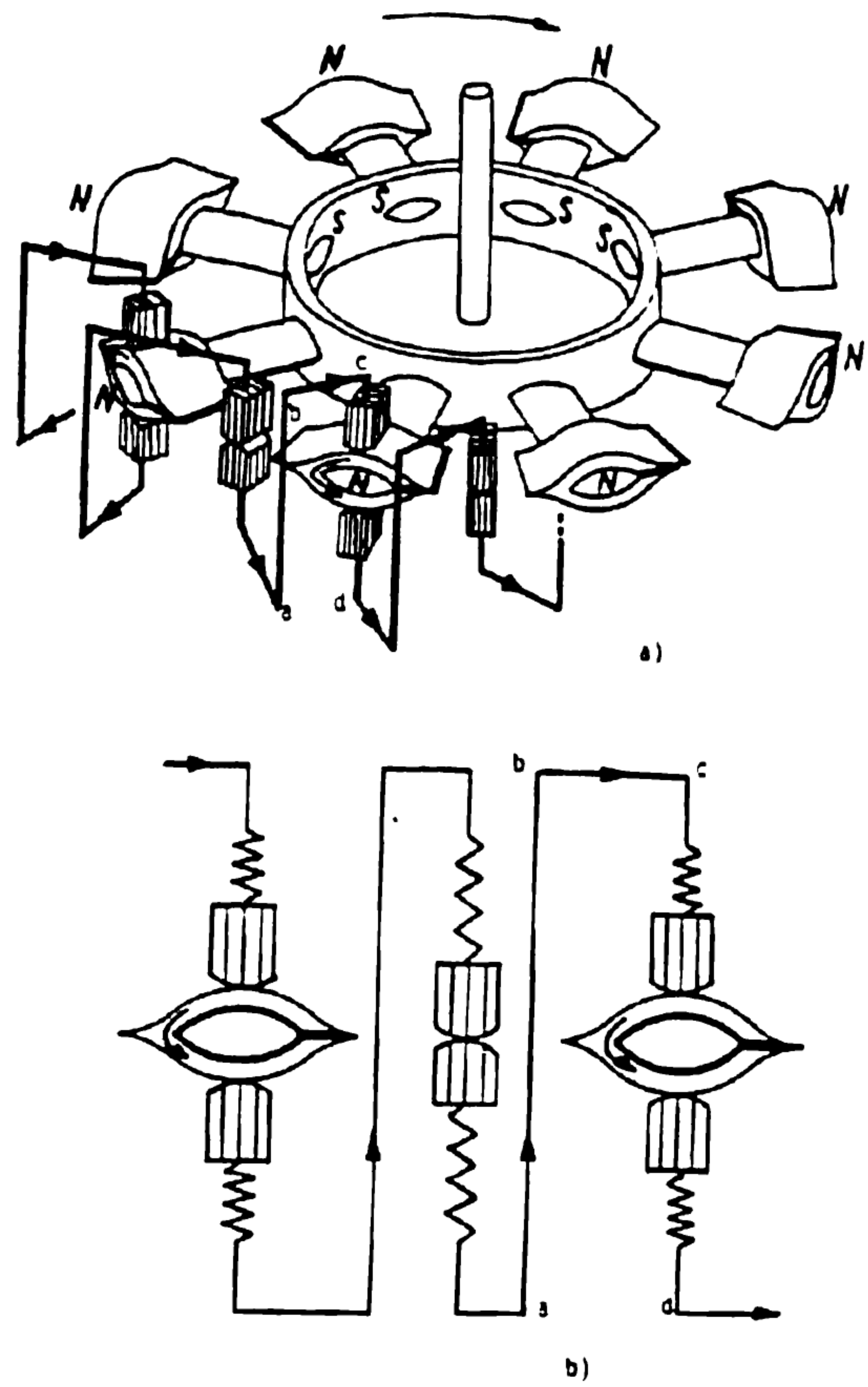

Fig. 27. Unipolar machine with Marinov's ring.

nity builds. Here the wire covers both poles of the magnet at its motion.

In the half and unipolar machines the induced current is direct continuous. In the one-and-a-half polar machines the induced current is direct interrupted. In the non-polar and two polar machines the induced current is alternating.

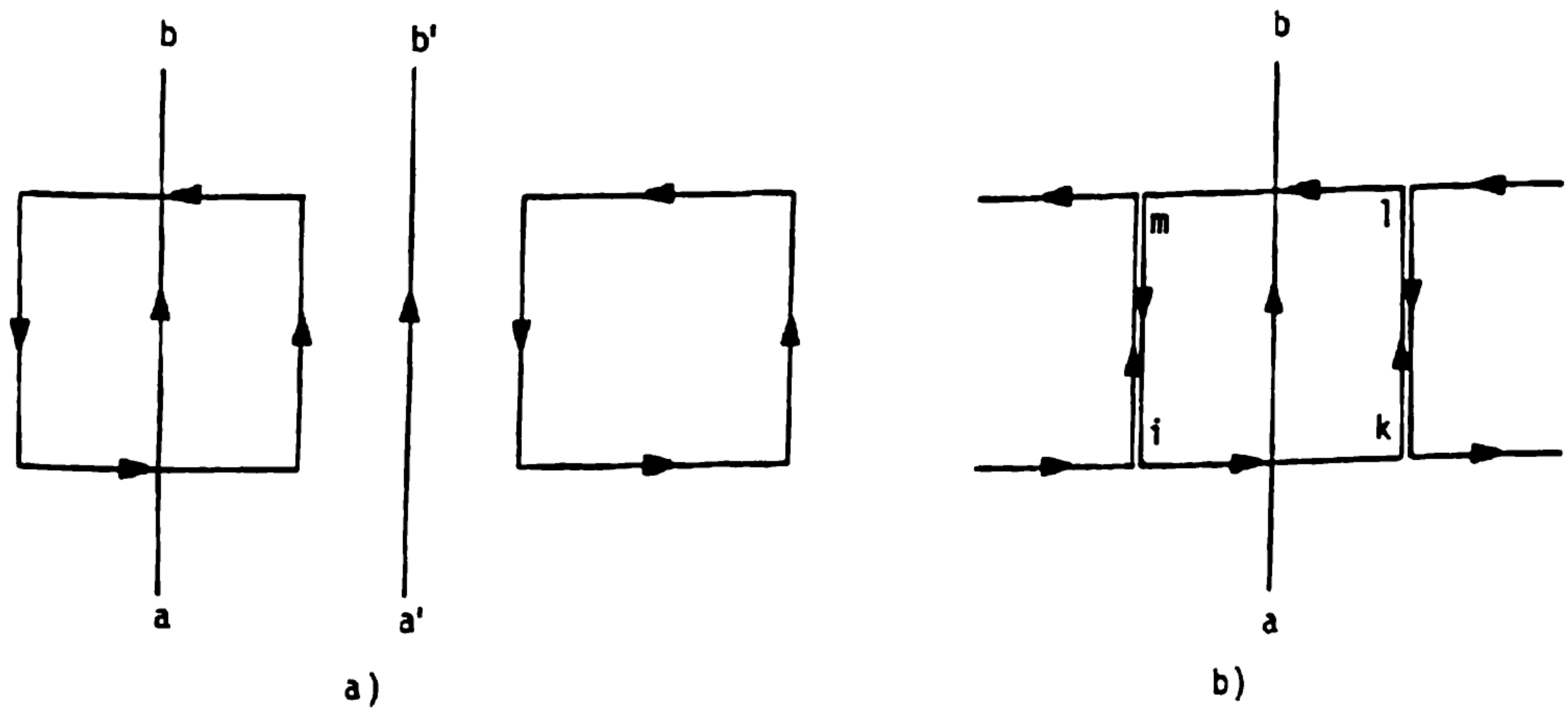

Fig. 28. Diagrams of the Marinov and Müller rings.

48. THE ONE-AND-A-HALF POLAR BUL-CUB MACHINE

48.1. MÜLLER'S ONE-AND-A-HALF POLAR MACHINE.

First I would like to note that only about 10% of the physicists and electro-engineers can understand the notion "SEAT OF THE INDUCED ELECTRIC TENSION", as for the other 90% (whom I call the "butchers") the magnetic flux is a sausage and the loop a knife. Indeed, official physics, considering the electromagnetic effects as "field", "closed lines" and "flux" effects, do not pay attention to the differential interactions and to the extremely important problem about the electromotive and ponderomotive forces exerted on the single current elements and on the single wire's elements, i.e., to the problem about the SEATS OF THE ELECTROMOTIVE AND PONDEROMOTIVE FORCES.

Müller(36) was the first physicist perhaps who tried to locate the seat of the electromotive forces in a couple of experiments, developing a very clever technology(36) which brought him to brilliant successes. Unfortunately he has not investigated the problem about the seat of the ponderomotive forces which is of no less importance.

The MÜLLER'S MACHINE on which he carried out his measurements is shown in fig. 29.

The magnet is a permanent cylindrical magnet. The almost cylindrical core and the two-wing yoke are of soft iron. As the rotation of the cylindrical magnet and core does not influence the effects observed, I shall assume that magnet, core and yoke are solid one to another, and further I shall call this "magneto-core-yoke" with the common name "magnet". The rectangular loop abdc will be called "coil". The magnet and the coil can be rotated independently or together. The wires ab and bdc can also be independently moved (at short distances). It is shown at the right of fig. 29 how Müller has realized this independent motion of the wires by the help of sliding contacts in mercury.

The yoke has the gaps pq and p'q' through which the coil can pass, so that a continuous rotation can be realized. At rotation of the coil outside the gaps the machine can be considered as closed half polar machine. Those are the gaps pq and p'q' which make it one-and-a-half polar.

Müller observed on his machine the effects which are presented in tables 48.1 and 48.2, where "no motion" is indicated by "0" and "motion" ("rotation") by "m".

First the wire bdc was outside the gaps and the measured tensions are given in table 48.1.

Then the wire bdc was in the gap p'q' and the measured tensions are given in table 48.2.

The motional induction in ab and de when the latter are in the gap is obvious. Not so obvious is the motional-transformer induction and I needed 10 years to understand thoroughly the effects in Müller's machine. I began to ruminate on the effects in Müller's machine in 1983 and even in my last experiment in 1992 with the machine ACHMAC(37,38) (see also Sect. 50), which is a closed half polar machine, I gave a wrong prediction[37] and only after constructing it[38] I saw that the prediction was wrong.

But after the construction of the machine ACHMAC all induction effects in the electromagnetic machines became entirely clear to me.

Table 48.1

	Motion or rest of wire ab	Motion or rest of wire bdc	Motion or rest of magnet	Induced tension	Kind of the induced tension and its seat
1	0	0	0	0	
2	m	0	0	U	motional in ab
3	0	m	0	0	
4	0	0	m	U	motional-transformer in ab
5	m	m	0	U	motional in ab
6	m	0	m	0	motional in ab opp. motional-transformer in ab
7	0	m	m	U	motional-transformer in ab
8	m	m	m	0	motional in ab opp. motional-transformer in ab

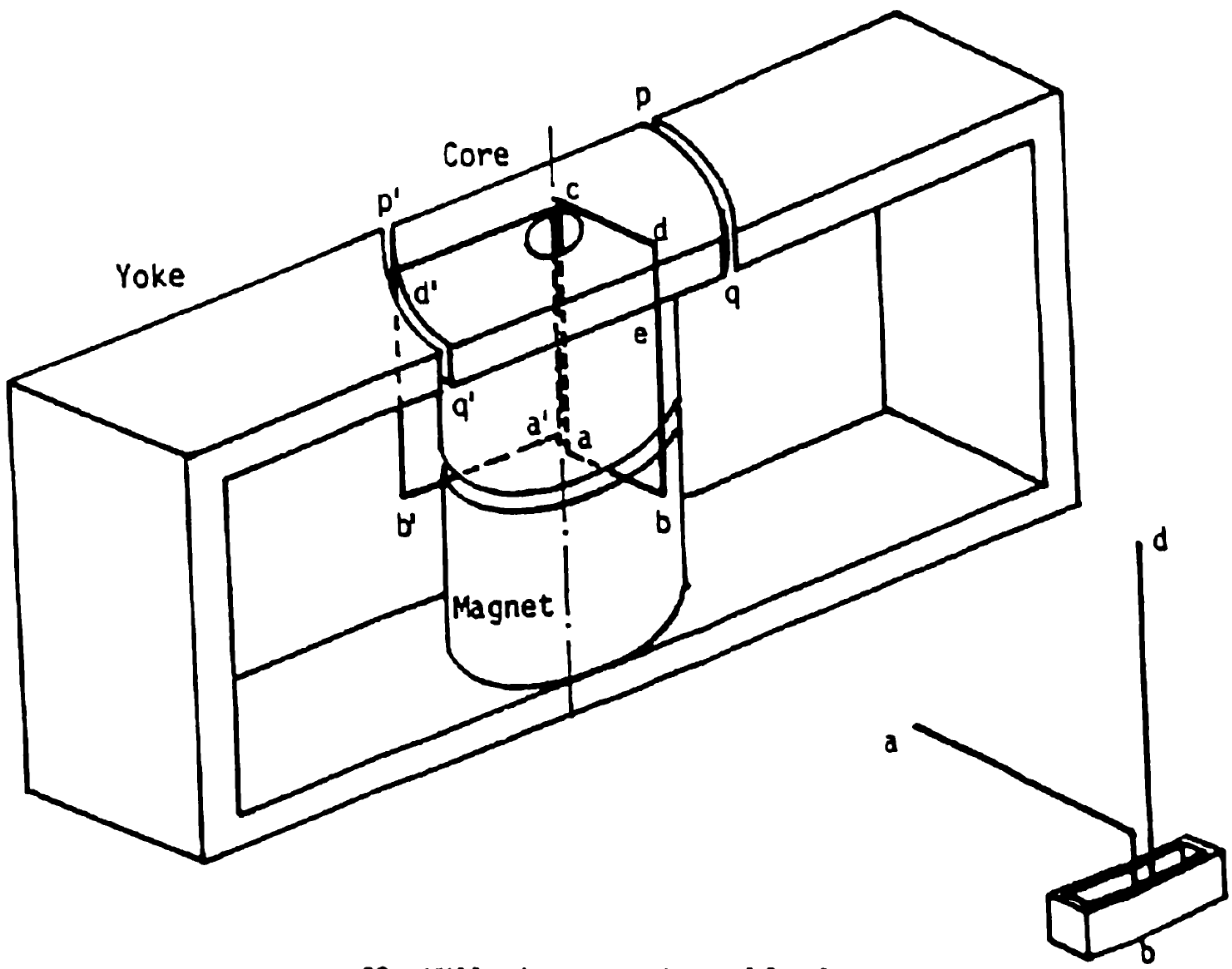

Fig. 29. Müller's one-and-a-half polar machine.

Table 48.2

	Motion or rest of			Induced tension	Kind of the induced tension and its seat
	wire ab	wire bdc	magnet		
1	0	0	0	0	
2	m	0	0	U	motional in ab
3	0	m	0	U	motional in de
4	0	0	m	0	motional-transformer in ab opp. motional-transformer in de
5	m	m	0	0	motional in ab opp. motional in de
6	m	0	m	U	motional in ab opp. motional-transformer in ab motional-transformer in de
7	0	m	m	U	motional-transformer in ab motional in de opp. motional-transformer in de
8	m	m	m	0	motional in ab opp. motional-transformer in ab motional in de opp. motional-transformer in de

Now all is simple and lucid but there were so many subtleties and puzzles in the observed effects that for their undrestanding and revelation Müller has sacrified two times more years than me. Our common fight for the revelation of the scientific truth with the contributions of my friends Pappas and Wesley is well documented in the series of documents THE THORNY WAY OF TRUTH.

It is worth to emphasize that I discovered the motional-transformer unduction exactly when analysing Müller's and my experiments. The fact that this fundamental kind of electromagnetic induction was not revealed by humanity during 150 years of electromagnetism shows that the problem has its difficulties. Now looking from the top of the mountain, all seems childishly simple, but to arrive at the top crossing the jungle of intricated Faraday-Maxwell and wrong relativity concepts was not so easy. The motional-transformer induction is not difficult for understanding. Every child has to deduce formula (21.3). But I had to discover this formula and the motional-transformer induction with Faraday, Maxwell, Lorentz and Einstein on the shoulders.

Newton said once that he has so easily seen the truth because he sat on the shoulders of giants. But to see the truth with giants on the shoulders is not so easy.

48.2. THE BUL-CUB MACHINE.

Proceeding from Müller's machine I constructed my BUL-CUB machine with the scope to observe there not only the electromotive but also the ponderomotive effects.

The diagram of the BUL-CUB machine is shown in fig. 30 and the photographs of the first and second variations in figs. 31 and 32.

The BUL-CUB MACHINE consists of a cylindrical magnet (I had an electromagnet but a permanent magnet can also be used), a yoke of soft iron, and a coil wound as shown in the figures on a cylindrical core of soft iron with a cylindrical axial hole. The winding goes along the generatrix of the cylinder, along the radius of one of its bases, along the generatrix of the axial hole, along the radius of the other basis, and then again along the generatrix of the cylinder, tightly to the previous winding, until the whole cylinder is covered by windings. I note by "ab" the radial wires of the coil and by "cd" the parts of the cylindrical wires which "enter under the yoke". The coil's wires between the marginal points p and q (resp., p' and q') are "under the yoke" and between the marginal points p and p' (resp., q and q') are "outside the yoke". In fig. 30 the magnetic flux in the iron of the magnet, core and yoke is indicated by dashed lines. I assume $B \neq 0$ only in the magnet's and both yoke's gaps.

To calculate the electromotive and ponderomotive effects in the BUL-CUB machine, I take a reference frame as follows (fig.30): The x-axis is horizontal pointing to the left, the y-axis is horizontal pointing to the reader and the z-axis is vertical pointing upwards.

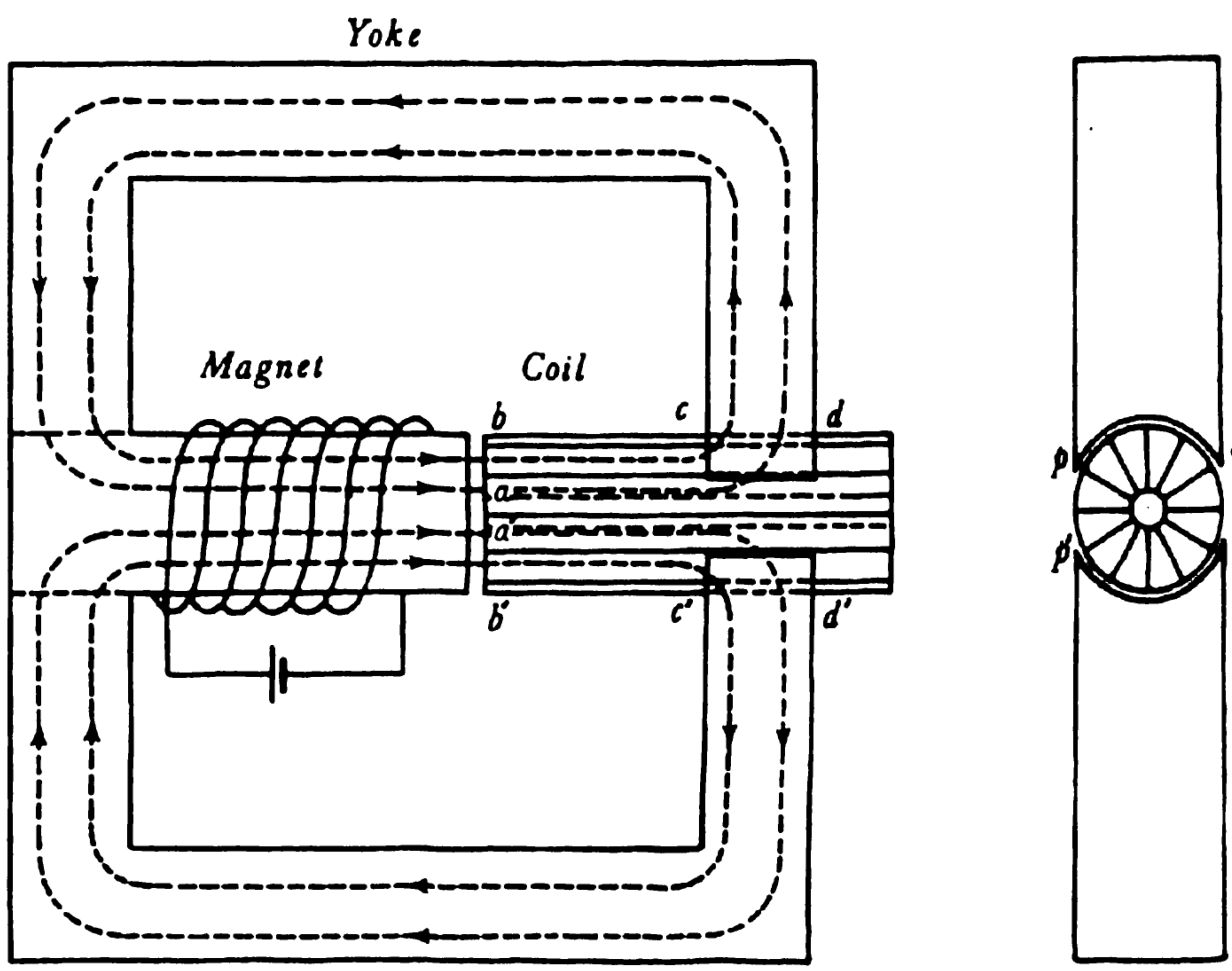

Fig. 30. Diagram of the one-and-a-half polar BUL-CUB machine.

48.3. THE BUL-CUB GENERATOR.

The following motional electric intensity will be induced in the wires cd in the yoke's gap when they move with a velocity **v**, indicating by a subscript "yo" the quantities related to the yoke's gap and by "ma" the quantities related to the magnet's gap

$$E_{yo} = \mathbf{v}\times\mathbf{B} = v\hat{\mathbf{y}}\times B\hat{\mathbf{z}} = vB\hat{\mathbf{x}}, \tag{48.1}$$

and the following intensity in the wires ab of the magnet's gap

$$E_{ma} = \mathbf{v}\times\mathbf{B} = \Omega r\hat{\mathbf{y}}\times(-B\hat{\mathbf{x}}) = \Omega rB\hat{\mathbf{z}}, \tag{48.2}$$

where Ω is the angular velocity of rotation of the coil and r is the distance of the wire's element from the coil's axis. The <u>average</u> electric intensity induced along the wires ab will be

$$\overline{E_{ma}} = (\Omega R/2)B\hat{\mathbf{z}} = (v/2)B\hat{\mathbf{z}}, \tag{48.3}$$

where R is the radius of the coil.

Let us assume that the cross-section of the yoke is rectangular with a side s parallel to the wires and a side h perpendicular to the wires. To make the calculation simpler, I shall suppose h much smaller than R, consequently s much bigger than R, as the cross-section of the magnet's gap and of <u>both</u> yoke's gaps will be assumed equal

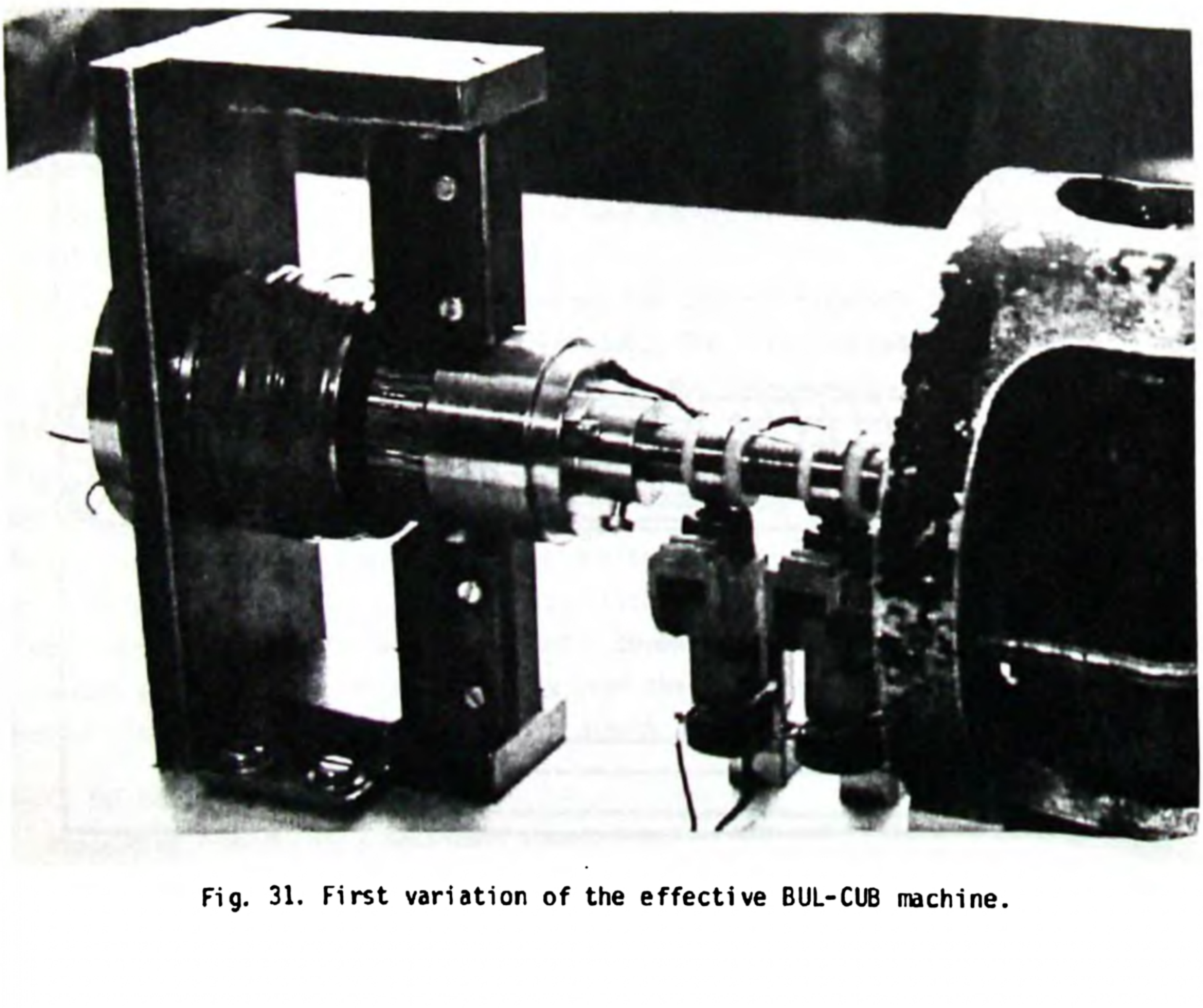

Fig. 31. First variation of the effective BUL-CUB machine.

to have the same magnetic intensity in all gaps. Thus, at this assumption, the cylindrical surface of the coil in the yoke's gaps can be considered as a plane rectangle. If n wires pass through a unit of length on the circumference of the coil's cylinder, we find that the length of the wire in <u>both</u> yoke's gaps is $l_{yo} = 2(nh)s = 2nsh$, so that the tension induced in the yoke's gaps will be

$$U_{yo} = \int_{l_{yo}} E_{yo}.dl\hat{\mathbf{x}} = E_{yo}l_{yo} = vB(2nsh) = 2nshvB = n v\Phi, \qquad (48.4)$$

having taken (here and below) a positive orientation along the wire in the direction d-c-b-a, and denoting by $\Phi = 2shB$ the magnetic flux produced by the magnet.

To calculate the induced tension in the magnet's gap, we must multiply scalarly the average induced intensity (48.3) by the oriented length (positive from b to a) of the wire in the magnet's gap which is $l_{ma} = n(\pi R)2R = 2\pi nR^2 = 4nsh$, as $\pi R^2 = 2sh$. Thus the tension induced in the magnet's gap will be

$$U_{ma} = \int_{l_{ma}} \overline{E_{ma}}.(-dl\hat{\mathbf{z}}) = -\overline{E_{ma}}l_{ma} = -2nshvB = -nv\Phi. \qquad (48.5)$$

As U_{yo} and U_{ma} are equal and oppositely directed, the motional tension induced in the whole coil will be null.

The tension induced in the coil when the magnet (magnet + yoke + core) rotates and the coil is at rest, or when the magneto-yoke rotates and coil+core are at rest, can

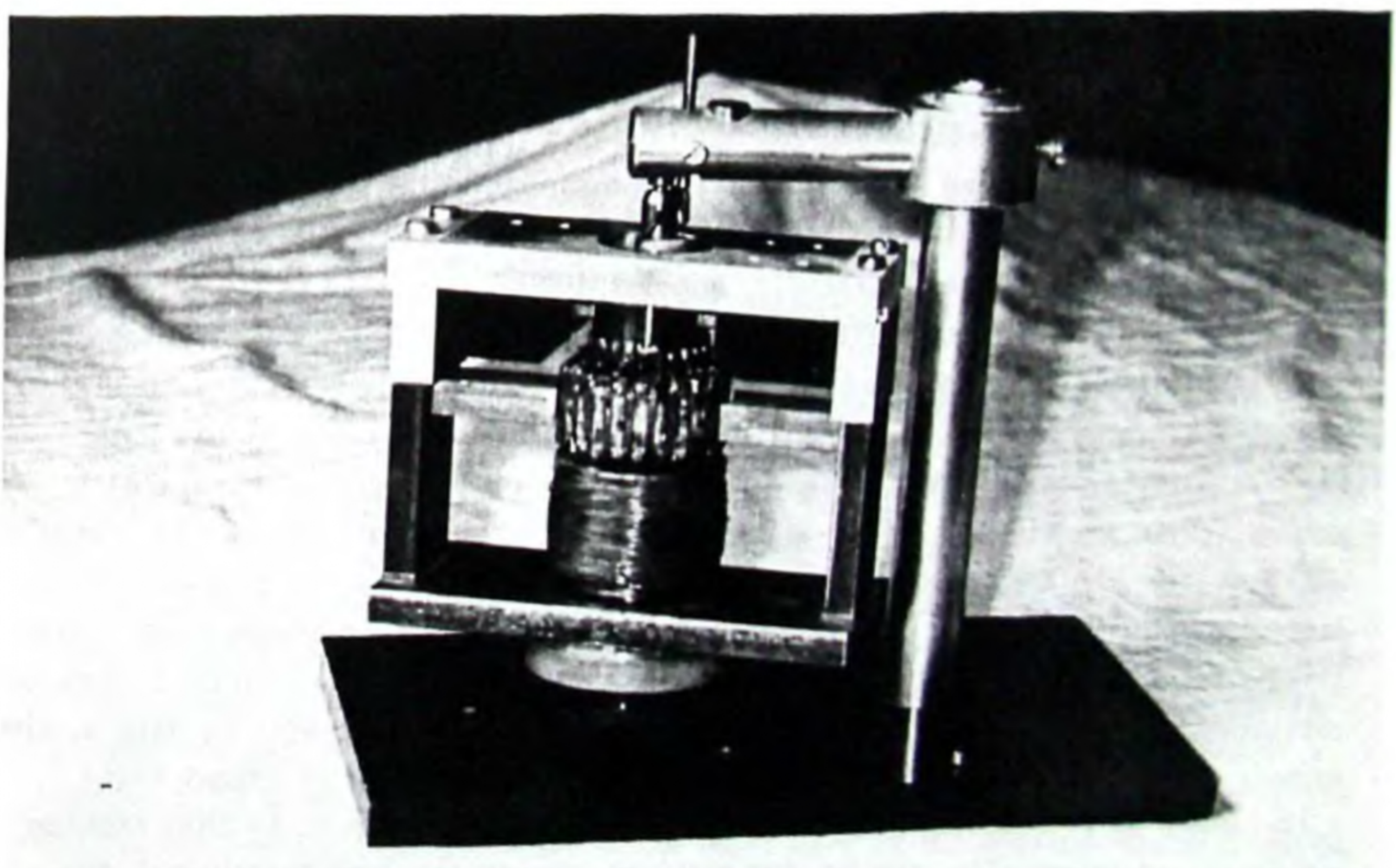

Fig. 32. Second variation of the effective BUL-CUB machine. The position of this machine corresponds to the position of Müller's machine in fig. 29.