

Ferner ist den Sitzungsberichten der Generalbericht über die Fortschritte der Europäischen Gradmessung im Jahre 1877 angefügt und zum Schluss noch eine Abhandlung des Herrn *Plantamour*: „Recherches expérimentales sur le mouvement simultané d'un pendule et de ses supports,“ abgedruckt.

Das befriedigende Resultat dieser letzteren Untersuchungen ist, dass den Pendellängen, die mit dem Schweizer Apparat ermittelt sind, die Grösse $0^{\text{m}}1724 \pm 0^{\text{m}}0014$ für Genf und $0^{\text{m}}1302 \pm 0^{\text{m}}0032$ für die übrigen Schweizer Stationen, sowie $0^{\text{m}}1357 \pm 0^{\text{m}}0027$ für Berlin hinzugefügt werden muss.

Die permanente Commission hat durch Circular für die diesjährige Sitzung Hamburg einstimmig gewählt, nachdem dieselbe von dem Hohen Senate dieser Stadt eine freundliche Einladung erhalten hatte, für welche die permanente Commission hierdurch ihren lebhaften Dank sich auszusprechen erlaubt.

Die permanente Commission hat, wie leider fast alljährlich, auch dieses Jahr den Tod eines Commissars, des Directors der Delfter polytechnischen Schule, des Herrn *Cohen Stuart*, welcher besonders durch die Nivellements in Holland die Europäische Gradmessung gefördert hat, zu beklagen. Bewahren wir demselben ein freundliches Andenken.

Als neuer Commissar für Spanien ist Herr Oberst *Barraquer* eingetreten.

Mit Freuden können wir constatiren, wie auch aus dem Generalbericht hervorgeht, dass in allen beteiligten Ländern die Arbeiten der Europäischen Gradmessung fortgeschritten sind.

Eine Anzahl neuer Publicationen sind seit der vorigen Conferenz erschienen z. B. die Arbeiten des geodätischen Instituts in Berlin im Jahre 1877, enthaltend die Bestimmung des Längenunterschieds zwischen Berlin und Paris, Berlin und Bonn, Bonn und Paris; ferner ein Präcisionsnivellement der Elbe; ein Werk „Ueber die Figur der Erde“ von Professor *Bruns*. Ein erster Theil des dritten Bandes der „Triangulation du royaume de Belgique, Observations astronomiques, partie théorique“, ist erschienen von dem Dépôt de la guerre in Brüssel. Ferner: „Die geodätischen Hauptpunkte der dänischen Gradmessung und ihre Coordinaten“; eine Publication der Schweizer Commission, enthaltend die Bestimmung der Längendifferenz zwischen Zürich—Pfänder—Gäbris; eine Publication der französischen Commissare: „Die Längenbestimmung zwischen Paris und Algier“, u. A.

Von den in diesem Jahre ausgeführten Arbeiten werden wir im Laufe dieser Sitzungen hören, und ist das Material, welches uns zur schliesslichen Ableitung der Grösse und Figur der Erde dienen wird, auch im verflossenen Jahre wesentlich vermehrt.

Herr *Sadebeck* trägt auf Ersuchen des Herrn *Baeyer* den Bericht des Central-Büreaus vor.

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VERHANDLUNGEN

DER VOM 4. BIS 8. SEPTEMBER 1878 IN HAMBURG VEREINIGTEN

Internationale enduraving PERMANENTEN COMMISSION
DER EUROPÄISCHEN GRADMESSUNG

redigirt von den Schriftführern

C. BRUHNS. A. HIRSCH.

ZUGLEICH MIT DEM GENERALBERICHT FÜR DAS JAHR 1878

herausgegeben vom

CENTRALBUREAU DER EUROPÄISCHEN GRADMESSUNG.

MIT ZWEI LITHOGRAPHIRTEN TAFELN.

COMPTES-RENDUS

DES SÉANCES DE LA COMMISSION PERMANENTE DE

L'ASSOCIATION GÉODÉSIQUE INTERNATIONALE

POUR LA MESURE DES DEGRÉS EN EUROPE

RÉUNIE À HAMBOURG DU 4 AU 8 SEPTEMBRE 1878

rédigés par les secrétaires

C. BRUHNS. A. HIRSCH.

Publiés pour servir de rapport général pour l'année 1878

PAR

LE BUREAU CENTRAL DE L'ASSOCIATION GÉODÉSIQUE INTERNATIONALE.

AVEC DEUX PLANCHES.

BERLIN, 1879.

VERLAG VON GEORG REIMER.

DRUCK VON P. STANKIEWICZ' BUCHDRUCKEREI, BEUTH-STR. 5.

Württemberg.

Nach Vollendung des Nivellements übernahm Herr Schoder die Ausgleichung der Resultate mit Rücksicht auf die Anschlüsse an Baden und Bayern. Ehe er zum Ziele kam, erkrankte er jedoch schwer, so dass die Arbeit, obgleich sie bereits vollendet ist, noch nicht publicirt werden konnte.

Die Pfeilerbauten sind jetzt alle fertig und im September wurden die ersten Messungen auf dem Hohentwiel ausgeführt. In derselben Woche (der ersten des Monats September) wurden die beinahe einzigen klaren Tage des Sommers zur Bestimmung der Polhöhe des Bussen verwendet, indem 5 Sterne an 4 Abenden im ersten Vertikal beobachtet wurden. Die Bestimmung des Azimuths war nicht möglich, da das Instrument von Pistor und Martins, das dem Polytechnikum gehört, eine Hebung des Fernrohrs nur bis 45° gestattet. Die Berechnung konnte bisher noch nicht ausgeführt werden.

Zech.

Vereinigte Staaten von Nord-Amerika.*)

U. S. Coast Survey.

New York, 42, 7th Street, 1878. Sept. 6.

I should like to have you communicate to the standing Committee of the international geodetical Association the following brief statement of my experimental pendulum work during the last year.

I have, in the first place, oscillated the reversible pendulum under various atmospheric pressures between 76 cm. and 1 cm., and at the three temperatures of 10°, 20° and 35° C. I find, in regard to the decrement of the arc, that it shows two terms of the resistance, one proportional to the velocity and the other to the square of the velocity. The latter is proportional to the density; the former may be represented as the sum of two terms, one proportional to the density and the other

*) Nach einem kürzlich erhaltenen Schreiben des Herrn Hilgard ist derselbe durch seine zahlreichen Arbeiten zum Behufe der Reorganisation der Amerikanischen Geodäsie verhindert worden, seine für den gegenwärtigen Generalbericht bestimmte Abhandlung „Ueber den Einfluss der Amerikanischen Gradmessung auf die Gestalt der Erde“ zur rechten Zeit fertig zu bringen. Dieselbe wird für den nächsten Generalbericht geliefert werden. Herr Hilgard sendet als diesjährige Beiträge folgenden Brief des Herrn Peirce und eine Note des Herrn Schott. *A. Hirsch.*

to the cube root of the density. In regard to the effect of the air upon the time of oscillation, I find it to be very nearly proportional to the density; and in amount to be somewhat larger than the formulae of Stökes would make it, even when due allowance has been made for the mass of air carried along in the interior of the tube which forms the shaft of the pendulum. From these results we can deduce certain theoretical conclusions in regard to the manner of the movement of the air by means of the formulae given in my father's Analytic Mechanics. I will not here dwell upon these as they will be given in my forthcoming memoir. The chief object of making these experiments has been to enable me to apply such corrections to the times of oscillation (on account of: 1st atmospheric density, 2nd temperature, and 3rd altering distance between the knife-edges), as will enable me to treat the observations of the reversible pendulum as observations of an invariable pendulum, thus greatly diminishing the determinations of relative gravity, and making the experiments at all the stations available for determining the absolute gravity at any one. As I have swung at the high temperatures with both heavy end up and heavy end down, the experiments also give the coefficient of expansion of the pendulum. The experiments in vacuo approach in accuracy experiments with the best invariable pendulums. For example, on one day, with heavy end up, pressure 1 cm., I oscillated the pendulum twice, with the following results:

TIME OF TRANSIT	INTERVALS	Corr. for arc	No. of swings	PERIOD
10 ^h 46 ^m 34.876				
11 30 42.130	2647.254	.185	2632	1.005725
12 30 42.790	3600.660	.156	3580	1.005727
13 34 50.774	3847.984	.091	3826	1.005722
14 31 44.256	3413.482	.044	3394	1.005727
15 27 37.353	3353.097	.026	3334	1.005720
15 33 29.257				
16 33 2.802	3573.545	.194	3553	1.005728
17 43 40.999	4238.197	.122	4214	1.005713
19 10 34.758	5213.759	.070	5184	1.005727
19 45 48.809	2114.051	.015	2102	1.005726
20 34 54.573	2945.764	.014	2929	1.005719

This day has been selected as the one upon which observations were continued the longest. The less degree of quiet towards morning (although it was a Sunday morning) naturally shows itself in an increasing irregularity of the movement of the pendulum.

My experience leads me to believe that the most accurate determinations of relative gravity can be made with invariable pendulums swung in vacuum chambers. Such pendulums should be constructed not with knife-edges as a part of them, but to rest upon stationary knife-edges; and the centre of gravity should be half way between the point of support and the centre of oscillation. If, however, reversible pendulums are to be used, they should be made as nearly invariable as possible, without knife-edges, and with the centre of gravity dividing the distance between the knife-edges in the ratio of 9 to 1. The reversible pendulums should equally be swung in vacuo.

I have made many observations to determine the relative length of the pendulum metre at different temperatures as compared with a metre obtained at the German Eichungs-Amt. I have also made an absolute determination of the coefficient of expansion of the latter.

All the micrometer scales used by me have been brought into comparison with the metre.

I have made a considerable number of observations to determine the difference between the statical and dynamical flexure of the Repsold brass tripod and other pendulum supports. I have avoided all machinery for multiplying the motion, as there is obvious room to question whether the whole phenomenon might not be due to that. I find however that the difference really exists, although it does not exceed 2 per cent of the whole flexure, and is, therefore, entirely insignificant. Placing the tripod upon three bevells of wood, approximately cubes of 15 cm. side, however, the difference mounts up to 6 per cent. The following are the results of different measures made in this way:

	Statical flexure.	Dynamical flexure.
	13.9	12.3
	13.3	12.4
	12.6	12.4
	13.2	
Means . . .	13.2	12.4

In my experiments, I have attached to the tongue, upon which the pendulum rests, a long and light brass tube of 2 cm. The attachment was made by a clamp of wood or iron made for the purpose. This tongue reaches downward and forward, so that its extremity is 35 cm. forward of the axis of the pendulum at rest and 12 cm.

below the lower knife-edge. At the end of this tongue was soldered a horizontal table of brass carrying a glass micrometer scale in a horizontal plane. This was looked at with a high power microscope directed vertically downwards and carrying an eye-piece micrometer scale. The experiments consisted first in drawing the pendulum to one side by means of a string passing through the hole just above the lower knife-edge, this string being a long one and carefully kept perpendicular to the axis of the pendulum. The effect for the small angles of deflection used (less than 3°) is sensibly the same as if the force were applied at the knife-edge. The pendulum being thus deflected, the arc of deflection and the displacement of the micrometer scale were both carefully observed. To get the dynamical deflection, the pendulum was simply set swinging by applying the finger close to the lower knife-edge, and readings of the amplitude of its oscillation and that of the scale attached to the stand were alternately made. In this way, I found in three sets of experiments as follows:

Statical flexure.	Dynamical flexure.
268 \pm 3	255 \pm 2
260 \pm 2	258 \pm 4
263 \pm 2	257 \pm 1
Mean . . . 263 \pm 1	257 \pm 1

The near equality of the two was further shown by the fact that the ratio of the dynamical flexure to the arc of oscillation remained constant from the first starting of the pendulum; for the statical flexure is nothing but the initial value of the dynamical flexure.

Lest it might be objected that the long tube which I attached to the pendulum stand could in some mysterious way produce an error in my result, I have made other experiments, in which the micrometer scale was attached directly to the upper part of the Repsold tripod in a vertical plane parallel to that of the oscillation of the pendulum and have looked at it with the microscope directed horizontally. These experiments are naturally less accurate than the others, but they give the same result, the ratio of dynamical to statical flexure being according to six sets of experiments:

0.996
0.973
0.979
0.992
0.963
0.986

The details of all this work will be given in my forthcoming memoir upon the comparison of the European and American pendulum work. I think it completely refutes the idea of any important difference between statical and dynamical flexure in metallic stands and in those of masonry.

The total statical flexure of the piers used by me at Hoboken is so small that the difference of dynamical and statical flexure would be totally insignificant if it amounted to 20 per cent of the latter.

The details of any numerous experiments will be given in my forthcoming memoir, as well as a mathematical discussion intended to show the effect of the phenomenon upon the time of oscillation. My general conclusion is, that good judgment having been exercised in selecting a stiff support, it is quite unnecessary to trouble ourselves about any difference between the statical and dynamical flexure, although there is no difficulty in measuring the difference in a purely optical way, not open to the slightest suspicion of inherent error.

Yours very faithfully

C. S. Peirce.

(C)

Des. the Personal Equation or Split eye-piece,
constr. by A. Saegmüller, mechanician at the Coast-Survey Office.

This eye-piece consists of two prisms cemented together, by means of which the field of view of the telescope is divided into two equal fields of less than half the illumination of the original field, the two observers tapping the transit of a star over all the threads. The same phenomenon is here observed and recorded under absolutely the same circumstances. The lower right angled prism receives the rays from the telescope and reflects them from its backsurface throwing them upwards into the second prism and against the two sides forming the upper edge and close to it. The angles of the second prism are nearly 60° .

By reflection on the two sides* of this prism and after refraction the split bundles of rays pass into the eye tubes, where, near the surface of the prism, they are collected by a lens and pass on to the ordinary or Huygenian eye-piece combination. Each observer will focus his own eye-piece; this of course is in no way connected with the sidereal focus of the diaphragm in the transit telescope. To make observations for personal equation take out the ordinary or prismatic eye-piece and insert the split eye-piece and adjust its foci.

The local circuit containing the observers keys and the clock (or chronometer) must be divided to break for each of the two pens of the chronograph. Each observer