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Research

Tentare licet. *The Theresian Academy's Question on the Theory of Beams of 1783*

Abstract. The four answers to the prize question of the Brussels' Academy of 1783 on the development of a theory of beams demonstrates that the modeling and mathematical mastering of the problem remained for a long time limited to a very small circle of men. With *savants* such as the Viscount de Nieuport (1746-1827), who worked on the calculus of vaults and who formulated this question on beams, the Academy appears such a privileged milieu. In Belgium, it would at take least until the creation of the polytechnic school at the State University of Ghent in 1835 for this approach to be diffused in a systematic and institutionally way among (an elite of) construction professionals.

Introduction

The exact sciences' section of the *Theresian Academy* of the Austrian Netherlands proposed the formulation of a theory for beams as the subject of the annual competitions of 1783. The four answers to this question which this institution received are kept in the Old Archives of the Belgian Royal Academy¹ and constitute one of the few written sources on the subject, valuable information on an interesting moment in the history of building mechanics in Belgium, which remains to be written.²

Although the competition was not a success – none of the four manuscript papers received a prize or even an honorable mention and, afterwards, the subject was abandoned –, an analysis of these papers offers valuable insight into the state of the art on the problem in the Austrian Netherlands. The difficulties of these authors with the subject reveal the novelty of the approach represented by a member of this academy, Viscount de Nieuport, who had worked and published before on the calculus of vaulted structures and who invented the prize question discussed here.

The Theresian Academy, de Nieuport and the “scientification” of building construction

The “learned society” in the Austrian Netherlands, equivalent to the French *Académie des Sciences* and to the English *Royal Society* was instituted by patent letter of Maria Theresia in 1769 as *Société littéraire*, and transformed, on 16 December 1772, into the *Académie impériale et royale des sciences et belles-lettres de Bruxelles*.³ Like the French *Académie des Sciences* this institution was patronized by the central government (of the Austrian Netherlands), and counted among its members only scientists, *savants*. From its foundation, the academy consisted of two sections: the *classe historique* – a department with historians – and the *classe physique* – a department with mathematicians, physicists, military engineers, geologists, chemists and physicians. Both sections reflect the double mission of the Academy: to write a national history and to apply the sciences in order to

enhance the economical prosperity of the Austrian Netherlands. From the beginning it was clear that the institution stood in service of the nation: “the first object without doubt that our newly born society must look for is being useful to the country”, wrote Abbé Needham in 1769.⁴

The small group of members of the Academy met regularly to discuss their work. In these sessions as well prize questions were chosen, and papers answering those questions were studied, evaluated, and eventually rewarded with a prize and with their publication in the Academy’s publication series. The system of prize questions was an affirmed strategy for engaging the learned population in contributing to questions judged of national interest by the Academy and to enhance the emulation of the competitors.

In the Austrian Netherlands, the Theresian Academy was the only scientific institution which was actively involved in the theory of hydraulics, building mechanics, fireproof constructions and building materials, and which published on those subjects [Van de Vijver 2003a, 108-119 (“De Theresiaanse academie en het bouwen”)]. (The curriculum at the Old Leuven University remained limited to basic courses; some of them, such as the ones on architecture, on mechanics and on surveying weren’t even printed [Van de Vijver 2003a, 102-107 (“Architectuur aan de universiteit”)].) Members of the Academy, such as the Englishman Theodore-Augustin Mann (1735-1809) [Van de Vijver 2003a, 111-117, cat. n. 39 (“Een overheidsonderzoek naar brandveilige constructies”)], who published on hydraulics and on fire proof constructions, operated within a broad European context. In the Southern Low Countries, they belong to the principal representatives of an evolution towards the ‘scientification’ of building construction in the last third of the eighteenth century.

Another member of the Theresian Academy, Charles-François-Ferdinand le Prud’homme d’Hailly, Viscount de Nieuport (1746-1827), lieutenant of the corps of military engineers of the Austrian Netherlands, was the first mathematician of the country to model vaults as consisting of infinitesimally small parts and to apply the calculus of differentials to them.⁵ Like Claude-Antoine Couplet (1729), Georg Wolfgang Krafft (1754-1755) and Abbé Charles Bossut (1770), de Nieuport tried to apply in his *Essay analytique sur la mécanique des voûtes* (presented at the Academy on 18 May 1778 and published in 1780), the theoretical model proposed by Jacob Bernoulli [De Nieuport 1780; Radelet-de Grave 1995]. In a second study, entitled *Mémoire sur la propriété prétendue des voûtes en chaînettes* (presented at the Academy on 6 November 1780 and published in the *Mémoires de l’Académie impériale et royale des sciences et des belles-lettres de Bruxelles* in 1783), he commented on a paper by Krafft that contradicted a theoretical fundament of Jacob Bernoulli [De Nieuport 1783; Radelet-de Grave 1995]. The Brussels Academy preferred these memoirs in applied mathematics over his more purely mathematical subjects: the former were considered to be more useful to the general public. In his report on the *Essay analytique sur la mécanique des voûtes*, Abbé Mann states: “This important paper seems in every way well done, curious and interesting. I don’t hesitate to say that it merits a place in the second volume of our *Mémoires*, in preference to two other papers of the same author, which treat subjects less useful than this one”.⁶ Abbé Chevalier judged the publication of the latter paper important “for the public good” (*pour l’utilité publique*) [Mailly 1883, II: 110 (session of 12 October 1780)]. However, although the subject of vault construction came from ordinary life, Nieuport’s approach and the mathematical methods applied by him were certainly not. As Patricia Radelet de Grave argues, de

Nieuport's approach shows clearly the author's obsession for the mathematical aspects of the problem.⁷

The prize question of a theory on beams

The Viscount de Nieuport's proposition of the mechanical behavior of beams as a subject for an academy prize question was discussed and agreed upon in the Theresian Academy's session of 19 October 1781.⁸ The question, distributed in French and Dutch in the principal newspapers, was formulated as follows:

Develop a theory on beams which rest with both ends upon points of support, considering them in the hypothesis most conform to nature, that is, as a collection of weighting, extensible and elastic fibers, united among each other over the whole length. Deduct from this consideration the cause and the place of rupture in the different cases of solicitation by weights, and, consequently, determine the best use of hanging trusses.⁹

The research question is formulated with precision and detail. It specifies the way of modeling the material (wood) – “in the hypothesis most conform to nature, that is, as a collection of weighting, extensible and elastic fibers, united among each other over the whole length” – and fixes the geometrical side-conditions of the problem: a beam which “rest[s] with both ends upon a point of support”. Furthermore, the general question on the development of a theory on beams is defined as a response to two fundamental problems: the cause and place of rupture in different cases of solicitation; and an applied, correlated problem: how to strengthen the structure by secondary means (*liens pendants*) – an applied, practical, real-life aspect absent in de Nieuport's earlier papers on vaults.

With the specification of the geometrical side-condition, the Academy got rid of the statically more complicated, but more realistic situation of a beam wedged in a wall – turning at the same time a hyperstatic problem into a static one. The hypothesis of considering the material as consisting of elastic fibers refers to the modeling of solids by Jacob I Bernouilli (1654-1705) [Bernouilli 1705]; it makes it not only possible to describe the fiber/cord under solicitation mathematically with an “elastic curve”, but also eliminated the complexity of the real composition of a wooden beam – a natural product which not only depends on the species, growing conditions and incidental deficiencies, but as well on the manufacturing process of a stem of a tree into a beam – by replacing it with an “ideal material”. These two elements reduce the complex reality into an abstract model disposed to a mathematical solution. The proposed modeling of the problem permits the assumption that de Nieuport expected a response in the line of his work on vaults, in which mathematical tools helped to understand the mechanical behavior of a structure.

The question of the cause and place of rupture in different cases of solicitation refers of course to Galileo's treatment of the problem [Galileo 1638]. The absence of words and concepts such as “strength of wood” (*force des bois*) or “experiments” make it clear that de Nieuport and his colleagues of the Academy didn't want to orient the question towards the experimental study of the resistance or strength of wood, a field in which many scholars became particularly active in the eighteenth century (for example, Edme Mariotte, Bernard Forest de Belidor, Pieter van Musschenbroek, Antoine Parent, Duhamel de Monceau, and Buffon).¹⁰

The conclusion of the commissioners after the lecture of the answers received – “neither to present any prize, nor to give any honorable mention and to abandon the question”¹¹ – already suggests that they did not receive an answer in the direction suggested by the line of questioning, and that we should not expect to find an innovative mathematical or mechanical approach to the problem, nor an answer which falls within the canon of historical solutions to this mechanical problem.

The Flemish answers

Three of the four *mémoires*, or papers, received, were written in Dutch and are rather brief. In fact, as they usually were read aloud in the Academy’s sessions, the length of the contributions was limited to a text of about half an hour. The only paper in French stands a bit outside this group, not only because of its length (the text numbers forty-one pages and eight full-page illustrations), but above all because of its “learned” content. In order to enhance an unbiased judgment, it was standard practice to send in the answers anonymously, only marked by a motto. As the prize was not distributed, all authors of the papers remain unidentified. We shall identify the anonymous papers by their motto and actual archive number.

Of the four papers, one paper can already directly be excluded from further analysis, as it doesn’t give an answer to the question. In fact, the author of paper ARB AA 215 with the motto *Alle deeze t’saemen-gevoegde/ is hart met hart* (“All these united, heart with heart”), transposed the question to a whole different field of reference (religion and death penalty), which falls totally outside our topic.¹²

Of the other two Flemish papers, the hypothesis of a homogenous beam doesn’t seem to have been an obvious modeling of the material at all. For the author of memoir ARB AA 213, with the motto *De oordeelen der menschen worden heel verschillig gevonden, op eene merkwaardige zaake* (Men’s judgments are very different in a curious matter), the hypothesis of an “ideal” beam without deficiencies (*weeren ofte quaele plekken*), such as the one described in the academy question, isn’t an obvious assumption at all. Four out of ten paragraphs enumerate the possible deficiencies of “real beams”: they differ regarding the part of the tree they come from (§ 2); heartwood will split (§ 3); trees which are not straight give beams with cut fibers which compromise the strength; also beams which are larger on one side have usually cut fibers (§ 4); bad spots in wood (*groote were of quaele plekken*) will split or fall out; it is preferable to use hard wood such as oak and to avoid *morise hout*, which won’t survive insect attack (§ 5). Unlike the author of paper 213, which after his objection goes one with the suggested hypothesis, memoir ARB AA 216 with the motto *Den Zang verheugd/ In eer en deugt/ Hunne Zoetigheijt/ Maeckt ons verbleijt* (Singing rejoices/ In Honor and Virtue/ Their Sweetness/ Makes us happy), never accepted the proposed modeling of the wood.¹³ As a tree is smaller upwards and thicker downwards, the author of the latter paper argues that a straight wooden beam without faults will crack a bit out of the middle. (Note that this even makes the problem asymmetrical!) This “bit” is different for each beam/tree, he states. He concludes that there is no fixed rule for all beams, because the differences of the wood make that impossible: it’s different each time.¹⁴ The author indicates the side of the crack a “bit” near the middle: the one which corresponds to the former upper side of the tree. The argument is that the wood there is “sweeter of fiber” (*souter van draet ofte vesels*) – less weight makes it more fragile. In fact, the author of paper 216 doesn’t seem to accept the implicit suggestion imbedded in the question that in the proposed model the wood consists of fibers of a uniform diameter.

For the author of paper 213, the place of failure for symmetrical loading conditions is in the middle of the beam “in the union or joints of the fibers to which place the weight always takes its refuge”,¹⁵ or in other loading conditions at the place of the weight/solicitation. For him the reason of failure of a pure wooden beam without deficiencies is an “internal fracture of the fibers” (*inwendige breuke, splinteren ofte veselen*).

The same author considers the use of *hangende banden* (hanging trusses) as a polyvalent solution, which permits for instance to use core wood, and prevent it from splitting; also for beams with split fibers, the bond is used to hold wood together. He proposes one or three “bonds”, the strongest in the middle, the others at the ends (§ 8). To prevent a profusion of bonds, the author proposes combining an iron plate under the beam (as well as at the supports) with a bond in the middle, complemented as necessary with two supplementary bonds at both ends (§ 9). This method is also advised for a beam composed of different parts of wood (this is wood with cut fibers) to prevent cracking, and in the many cases where wood fibers are not continuous (bent trees, sick spots or wrongly cut wood) (§ 10). The author of *mémoire* AA 216 says that the best way to strengthen the wood, is to place a support in the middle (or a bit out of the middle) – a solution only adopted in bonded warehouses. Subsequently, the author enumerates a series of alternative ways of support: (a) to add a second beam on top of the first, and to join them with a screw, using a small piece of wood under the original first beam; (b) to attach a piece of wood under the original beam by screwing, using an iron device, or by nailing; (c) to use pieces of wood neither over nor under the beam, but at the sides, and to join them with pieces of iron; (d) in cases of strong loads upon the beam, use a masonry arch to evacuate the loads: the beam can be hung by iron tires to the masonry arch; (e) the arch can be replaced by a wooden triangle; (f) a short piece of wood can be fixed on top of the beam; or, finally, (g) an iron plate can be put under the beam.

Tentare licet

The French paper, entitled *Tentare licet* (“One may try”), ARB AA 214, is the most extensive paper and the only illustrated one. It is also unique in mentioning some authors, such as Pieter van Musschenbroek (1692-1761) and Jean-Antoine Nollet (1700-1770).¹⁶ This already suggests that here again we shouldn’t expect a mathematical answer: the paper is more situated in an experimental approach of physics where tests determine the strength of materials, and the resistance of wood.

The *mémoire* is structured in chapters and principles. The first chapter goes into the so-called “intrinsic reactive force” of the fibers, the second deals with the causes of rupture and the places where they occur, the third and final chapter explains the ways to strengthen the beam; in an appendix the opinions of a carpenter and an architect of the region of Reims are given, illustrated with some case studies derived from their practices.

In the first chapter the author introduces the intrinsic reactive force (*force intrinseque réactive*) of the longitudinal fibers: a force which reacts against the perpendicular weight which makes the fibers bow and break. He states (a) that this force is in direct relation to the horizontal surface of the supporting ends; (b) that it is inversely related to the distance of the supporting ends (the length of the beam between the supports); (c) that it is more directly related to the height than to the width of the beam; and, finally, (d, related to a), that without support at the ends, there is no reactive force. To illustrate the latest point he

quotes an experiment taken out of the *Récréations mathématiques et physiques* by Jacques Ozanam [1778]. In this chapter, the author especially exploits the fiber-model of wood to warn that a fiber is only effective when it remains intact and when it is supported at the ends, condemning general habits, such as the practice of building craftsmen who destroy a part of the beam in order to create a bite for the mortar of the ceiling.

The author is rather vague on the direct relationships – linear or otherwise? – between the length, height and width, and the resistance of a beam. He clearly didn't follow Galileo's relationship between the resistance and the square of height of the section (which he must have known via Musschenbroek's book), a proposition which was however put into doubt by experimental research (by Buffon, among others) for so-called elastic solids, such as wood [Diderot and d'Alembert 1751, II: 302]. However, due to the extremely vague formulation and the lack of references, it is not possible to determine if the author of the *Tentare licet* paper knew and understood these writings.

The first figure (fig. 1) of *Tentare licet* illustrates clearly that the geometrical side condition proposed by de Nieuport – a beam resting on its two ends – is not well understood. In fact, the author represents in general a condition closer to reality: a beam wedged in the wall at both ends.

Fig. 1

In the second chapter the author deals with the causes of rupture and the places where they occur. He formulates the following principles: (a) that a force must provoke a sharp angle in the longitudinal fibers, and as a consequence, provoke decomposition of the elementary molecules; (b) that a rope cracks in the middle in the case of symmetrical forces and at the end in the case of asymmetrical forces; and (c) that fibers crack in points of excessive force. Fig. 3 of the paper illustrates this chapter and shows an elementary modeling of the problem with ropes and weights.

Fig. 2

Fig. 3

Fig. 4

Fig. 5

Fig. 6

In the third chapter, the author shows ways of strengthening the beam, based on the analysis of the first chapter: strengthening the supporting ends of the beams (fig. 4); reducing the span by attaching the lowest beam of a timber frame at the ends through *liens pendants* (fig. 5) and at the middle (fig. 6); the same technique is used on the other parts of the timber frame; reducing the span by supplementary wooden supports and increasing the height of the beam section by adding a supplementary piece of wood above the beam (fig. 7). The other figures (figs. 8 and 9) illustrate case studies discussed in the appendix.

Fig. 7

Fig. 8

Fig. 9

It is stunning that none of these papers, even the more elaborated French one, fully exploited the available literature. That it was difficult to obtain the very specialized publications on the theoretical modeling and mathematical treatment of the problem can perhaps be an excuse, but references to the vast and related field of research, such as that of the experiments on the strength of wood, which became a popular subject in experimental physics, are lacking as well, as are references to the pioneering work of Galileo, or other works on statics. This is all rather painful, because this knowledge was easily available in the articles “wood” and “beam” of the *Encyclopédie ou dictionnaire raisonné des sciences, des arts et des métiers* [Diderot and d’Alembert 1751; Diderot and d’Alembert 1765]. Even extremely popular reference tables of wood sections (height and width of a beam in relation to the length) – proposed in Bullet’s *Architecture pratique* [1691, 222] and in De la Hire’s edition of Mathurin Jousse’s *Traité de Charpenterie* [1702, 190-191], and quoted over and over again in architectural manuals [Gauthier 1716, 50; Jombert 1728, I, 32-33], as well as in the engineering treatise *par excellence*, Bernard Forest de Bélidor’s *La Science des ingénieurs* [1727, II, 30]¹⁷ – aren’t mentioned. It must indeed be asked if the Academy succeeded in reaching its intended audience with this question, because almost none of the relevant works in the field of architecture, engineering, strength of wood and statics seem to be used.

In fact, the basic challenge of the prize question – to theorize the problem, that is, to make an abstraction of the particular wooden part with its deficiencies – seems to constitute for those authors an almost insurmountable problem. Even in the French *mémoire*, whose author at least used some references, the level of abstraction remains low: the qualitative remarks weren’t put into a formula; neither were the geometrical aspects of the problem exploited, nor was the available data on the strength of wood taken into consideration. As a result, even the most elaborated paper ended up as no more than a small instruction book for carpentry.

Conclusion

The physics question of the Brussels academy of 1783 on the theory of the beam, proposed by Viscount de Nieupoort illustrates marvelously a historical moment in the local history of building science: a new schism presents itself, a schism between an new “mathematical” engineering culture (characterized by the modeling and the calculus of structures), represented in the Southern Low Countries by such “isolated incidents” as the Academy’s papers on vaults and the formulation of the beam question, and an existing, intuitive, practice-based artisan’s culture, which would remain for a long time in a sort of autarchic condition, uninfluenced even by architectural and engineering manuals.

The answers to this prize question make us aware of the novelty of the rising mathematical approach to solving mechanical problems. The numerous hints and suggestions hidden in the precise formulation of the question weren’t evident enough for the general public – nor even the “learned” public – to decode. In this case, one can also recognize a serious problem in the transfer of knowledge, as well as the difficulty that the Academy had in reaching its audience (engineers/architects, mathematicians, and physicists). It would be decades before the new mathematical approach, which was intended to make structures calculable through “modeling”, the use of advanced mathematics, and tested material characteristics would have a concrete effect in Belgian building construction.

Acknowledgment

Figs. 1-9 are reproduced with the kind permission from Bruxelles, Académie des Sciences, des Lettres et des Beaux-Arts de Belgique, Archives Anciennes 214.

Notes

1. Bruxelles, Académie Royale des Sciences, des Lettres et des Beaux-Arts de Belgique, Archives Anciennes (further abbreviated as ARB, AA), 213 “N. 1 *De oordeelen der menschen worden heel verschillig gevonden, op eene merkwierdige zaake*”; ARB, AA 214 “N. 2 *Tentare licet*”; ARB, AA 215 “N.3 *Alle deeze t’saemen-gevoegde/ is hart met hart*”; ARB, AA 216 “N.4. *Den Zang verheugd/ In eer en deugt/ Hunne Zoetigheijt/ Maeckt ons verbleijt*”.
2. For the short overview with bibliography, we refer to our institutional approach of the subject [Van de Vijver 2003b].
3. On the Theresian Academy, especially its *classe physique* see: [Académie royale de Belgique 1872]; [Mailly 1883]; [Académie royale de Belgique 1922]; [Marx 1977]; [Maton, Bockstaele, Van Hoof, Van Dormael, Vandepitte and Gullentops 1983]; [Roegiers 1983].
4. *Le premier objet sans doute que notre Société (littéraire) naissance doit envisager est de se rendre utile à la patrie* [Mailly 1883, II, 1]. All the translations in this article are by the author.
5. On de Nieuport see: [de Gavre 1827, vii]; [Garnier n.d.]; [de Rieffenberg 1829, IV: 142 (notice nécrologique)]; [Bigwood 1889]; [Bockstaele 1983: 106-108]. On de Nieuport’s calculus of vaults, see: [Radelet-de Grave 1995]; [Van de Vijver 2003a: cat. n. 36-37 (“De Nieuport en het berekenen van gewelven”)]; [Mailly 1883, II, 110 (session of 12 October 1780)]..
6. *Ce grand mémoire me paraît, à tous égard, bien fait, curieux et intéressant, et je n’hésite pas de dire qu’il mérite d’avoir place dans le second volume de nos Mémoires, par préférence aux deux autres du même auteur, qui traitent de sujets moins utiles que celui-ci* [Mailly 1883, II, 86-87 (session of 18 May 1778)].
7. [Radelet-de Grave 1995: 157-161 (“V. 1778. Charles François le Prud’homme d’Hailly, Vicomte de Nieuport, Essai analytique sur la mécanique des voûtes présenté le 18 mai 1778”)].
8. [Mailly 1883, II, 136-137 (Session of 18 March 1784); 309-310 (question in French); 314]; [Van de Vijver 2003a: cat. n. 38 (“De prijsvraag van 1784 over het berekenen van een vrij opgelegde balk op twee steunpunten”)].
9. *Développer la théorie des poutres qui reposent par leurs extrémités sur deux points d’appui, en les considérant dans l’hypothèse la plus conforme à la nature, c’est-à-dire, comme des amas de fibres pesantes, extensibles, élastiques et unies entre elles dans toute leur longueur. Déduire de cette considération la cause de leur rupture et l’endroit où elle doit se faire dans les différentes cas, par rapport aux différentes situations des masses dont ces poutres pourraient être chargées, et déterminer en conséquence le meilleur emploi des liens pendants* [Mailly 1883, II, 309]. The contemporary Dutch translation of the question is: *Te ontknoopen de Theorie der Balken, die door hunne beyden eynder op twee steunsels rusten, de zelve aenmerkende in de Hypothese, meest overeenkomstig aen de nature, dat is te zeggen: als versaemeling van wegende vesels, extensibel, elastig en onder elkanderen vereenigd in hunne geheele lengde. Van deze aenmerkinge voord te brengen de oorsaeke van hunne breuke, en de plaetse, alwaer de selve in de verscheyde gevallen moet geschieden ten opsigte van de verscheyde gelegentheden der gewichten, waermede die balken sauden mogen gelaeden zyn, en gevolgendlyk te bepaelen het beste gebruyk van de hangende banden* [Den Vlaemschen indicator ofte aenwyzer der wetenschappen en vrye-konsten, 1783, Ghent, X, 291-292 (“Akademische Berichten”), 292]; also quoted in ARB, AA 213.
10. On this aspect see: [Licoppe 1996, 195-242 (“Dure comme du bois: la preuve utilitaire et la question de la résistance des solides au Siècle des Lumières”)].
11. *A ne point distribuer le prix, à ne faire aucune mention honorable et à abandonner la question* [Mailly 1883, II, 310].
12. To the author of the paper *Alle deeze t’saemen-gevoegde/ is hart met hart*, a beam on two supports symbolizes the death penalty through hanging (sic). He considers this penalty to be the

only one apt to punish repetitive disloyalty to the Ten Commandments; for a first offence to the Ten Commandments, he judges corporal punishment as being sufficient.

13. *Een "suyveren balk sonder weeren ofte quade plekken, ende den selven aen merkende als bij het vraagstuk bepaeld"* (ARB AA 213).
14. *... geen en vasten regel op alle balcken, want het verschil van hout, is seer ongelijck van den eenen balck tot den anderen, en daerom onmogelijk daer van eenen vasten regel te geven* (ARB AA 216).
15. *... in de vergaederen en ofte jointuren der maillie/ Naer welke plaetse het gewicht altijd sijne toevlucht neemt* (ARB AA 213: § 7).
16. [Musschenbroek 1739]; [Nollet 1745-1755]. However, it is important to mention that the Theresian Academy didn't share the general opinion, acquired by Nollet through his written work, that he was a "great physicist" (*grand physicien*), or a respectable man, handy in experiments and physical machines (*cela n'est pas conforme à l'idée générale qui s'est formée de cet homme respectable, de cet habile faiseur d'expériences et de machines physiques, d'après ses propres ouvrages*) [Mailly 1883, II, 136-137 (session of 18 March 1784)].
17. The table in Briseux [1761, II, 93] is different.

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