Miroslav Tibor Morovics, Andrej Šperka *

The beginnings of scientific interests in electrical phenomena in Hungarian Kingdom

THE ELECTRICITY SCIENCE is considered scientific discipline, whose intensive and profiling development was commenced in the 18th century. Unlike mechanics, acoustics, optics and several other physical disciplines, its specificity lies upon the fact that its characteristic qualities, apart from the atmospheric electricity and several species of electricity producing fish, as electric eels, can hardly be perceived by our senses for it does not exist naturally. While the examining of mechanical and related phenomena based on the sensory perception creates plenty of space for speculative interpretation, research into electrical effects requires experimental methodology and suitable equipment, making it relatively more exact even at its early stages. Mechanics became more exact only with an arrival of experimental, mathematically applicable methods. From its beginnings, electrostatics developed on the experimental basis, and albeit initial experiments were not quantified, this kind of transition occurred shortly afterwards, earlier in comparison with other disciplines.[1] Beginnings of scientific interests in electrical phenomena also attract attention for its' part in the process of forcing speculative pseudo-Aristotelian physics out to be replaced by progressive experimental methodology. As long as in the area of mechanics, astronomy and similar disciplines the former process took long time to succeed, in the 18th century several Hungarian scholars were quick to react properly to the pioneering discoveries in static or atmospheric electricity, including Galvani's and Volta's. Although in Hungarian Kingdom, neither the favorable conditions for scientific research in the area of physics were created in the meantime, nor the emerging interest in electricity produced any significant discovery, this kind of knowledge became an organic part of schooling at Jesuit universities and Protestant colleges, and pushed the way for substantial changes in science in the 19th century. Our paper is dedicated to the initial writings and authors, who were responsible for introducing problems of electricity into the scientific and textbook literature in Hungarian Kingdom during the 18th and the beginning of the 19th centuries.[2]

During the former, no convenient atmosphere unfolded in our homeland, in which scientific work and even teaching physics and mathematics could blossom, situation only changed in the first half of the latter. Trnava and Košice universities, then in function with a nationwide educational impact, were, as Jesuit institutions, founded particularly to support theological studies. Such an environment was not subject to progressive changes until the half of the 18th century, when amendments aimed to modernize educational system were set by the queen Maria Theresia. Prior to this, during the first half of the period we follow, Aristotelian physics pervaded throughout lectures given at the universities and similar higher school institutions. Thus configured schooling could scarcely allow modern perspectives to get implemented, while that stance was closely associated with a role natural sciences played in educational system of Jesuit universities. As an organic part of philosophical faculty courses, they were only awarded preparatory status, on account of theology. Although the position of mathematics was of slightly different character, it did not absorb any novelty until the second part of the 18th century.

At the University of Trnava, which we consider dominant pedagogically institution, significant changes occurred in 1753, when a reform mandated by Maria Theresia was set up following the similar one applied at the University of Vienna by Gerhard van Swieten. In opposition to *Ratio Studiorum*,

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[1] SIMONYI, K.: *A fizika kultúrtörténete* (Budapest: Gondolat, 1981), chapter 4.4, pp. 273–302; MAYER, D.: *Pohledy do minulosti elektrotechniky* (2. ed. České Budějovice: Kopp, 2004), mainly chapter 2, pp. 17–64.

[2] M. ZEMPLÉN, J.: *A magyarországi fizika története a XVIII. században* (Budapest: Akadémiai Kiadó 1964), chapter V. 2, pp. 397–424.

Jesuit educational standard, it became mandatory for the university professors to compose textbooks in order to uproot slavish scholastic dictating. Surprisingly, a host of progressive textbooks of physics and mathematics were published in Trnava shortly afterwards, consisting of eclectically treated Cartesian, Boskovichian and Newtonian principles and similar modern mathematical rules, thus giving us an evidence of complex competence the authors possessed. Contemporary changes found an approving answer right inside the core of Jesuit order, as the process got started via scientifically oriented professors, properly apprehending situation in society and science of that time. Several rigid attitudes of the Catholic church concerning particular scientific problems, for instance the Copernicus' theory, were subsequently being eased. The writings published by pioneering personalities of the order acting at Trnava and Košice universities, even before the mentioned reform, should by taken as proper evidences. Among others, there should be introduced the innovative works of Michael Lipsicz, *Algebra* (published in 1738) and *Statica* (published two years later). Diverse older works have to be included though, namely the anonymous *Compendium Newtonianae Philosophiae*, interesting manuscript dated to 1699. Following Trnava university library records, it was incorporated into by 1720. A bachelor dissertation *De Vi Electrica*, from 1746, with Ioannes Purgina as an assumed author, has also to be taken into account, being it regarded an initial authentic and comprehensive writing related to problems of static electricity in Hungarian Kingdom. Stepping into footsteps of mentioned works and textbooks, it took no longer time for such pieces as *Breviarium Astronomico-physicale secundum Principia Newtonii* (Trnava 1760) and, above all, innovative textbooks by Ioannes Baptista Horváth to get published, in which final victory of Newtonian physics appeared.

Further on, another crucial modification took place at our university in 1770. Based on *Norma Studiorum*, a document issued by the imperial administration, a substitution of archaic "Physica generalis et particularis" for "Physica experimentalis" was established as one of its aims. After Jesuit order's dissolution in 1773, several professors, with Ioannes Baptista Horváth among them as the then professor of physics, remained in charge in secularly positions. After all, the school was relocated to Buda in 1777, afterwards with Pest as its final destination, from where its activity of a sole high educational institution left in the kingdom was spread. Despite the former promising reforms, the status of scientific research activity in the field of natural sciences was not achieved at the university, not until the end of the century. In terms of scientific development, this status was being gradually modified throughout the second half of the 19th century. However, some exceptions can be observed, especially in the area of electricity science as it is presented hereinafter.[3]

Unlike Catholics, Protestants, neither Lutheran nor Calvinist, were not successful in finishing their endeavors to create educational institution of varsity status. However, the courses on natural sciences following Protestant educational standards, presented principally at Lutheran colleges in Prešov and Kežmarok (Slovakia) alongside Calvinist colleges in Sárospatak and Debrecen (Hungary), reached level of remarkable quality. Due to its vulnerable character, unprotected against the government impact, a quality of schooling, more or less, depended on the personal abilities of acting professors, it was of less systematic operation. On the other hand, compared with Catholic scholars, education of Protestant students was further cultivated through peregrinations around friendly universities in the West, with German schools as the most favored destinations. Hence they served as mediators, bringing innovative ideas and last (but) not least, by import of the experimental equipment to our homeland, throughout the 18th century predominantly applied in the area of mechanics, optics and thermal, with particular

[3] ČIČAJ (ed.), V. *Trnavská univerzita v slovenských dejinách* (Bratislava: Veda, 1987), especially see papers: ORAVCOVÁ, M.: *Novoveká prírodná filozofia a jej odraz vo filozofickom myslení na trnavskej univerzite.* pp. 151–161, and PÖSS; O.: *Fyzikálne odbory na trnavskej univerzite.* pp. 162–169; MOROVICS, M.T.: *O vedeckej a pedagogickej činnosti profesorov matematiky na Trnavskej univerzite,* in: NOVACKÁ, M. (ed.), *Trnavská univerzita v dejinách školstva a vzdelanosti* (Bratislava: Slovenská pedagogická knižnica ..., 1986), pp. 177–184; MOROVICS, M.T.: *Jezuitská univerzita v Košiciach a jej profesori matematiky a fyziky,* in: HYMPÁNOVÁ, I., MOROVICS, M.T. (eds.), *XXII. Zborník dejín fyziky* (Bratislava: Slovenská spoločnosť pre dejiny vied a techniky pri SAV, 2005), pp. 51–65; ŠPERKA, A.: *K počiatkom fyziky na Trnavskej univerzite*, in: HYMPÁNOVÁ, I., MOROVICS, M.T. (eds.): *XXII. Zborník dejín fyziky* (Bratislava: Slovenská spoločnosť pre dejiny vied a techniky pri SAV, 2005), pp. 67 – 77.

accent on primordial electrostatically devices. Such a competition boosted the development even at Catholic universities.[4]

First separate paper of Hungarian scientific provenience dealing with static electricity was published as a part of the work by Martinus Sylvanus (M. Szilágyi Tönkö), professor of Calvinist college in Debrecen during the last third of the 17th century.[5] Sylvanus' notes concerning electricity were integrated into his philosophy handbook, of Cartesian nature, remaining onwards in usage as a textbook. Relevant thoughts were presented fairly briefly, with only a phenomenon of attraction generated from frictional electricity depicted, as if repulsion did not exist. The attraction was taken as a consequence of infiltration of corpuscles based on "materia prima" into porous structure of glass. The author himself was probably not involved in maintaining electric experiments, presented ideas were presumably sourced from somewhere else.[6]

Lightning, as threatening natural effect, became a frequently treated subject of diversified array of early physical publications ranging from almanac prints through dissertations to scientific handbooks. In Hungarian Kingdom, the situation was not different from that in the West, where prior to Dufay's hypothesis (1735) and Franklin's proof (1753), opinion scope obtained vast dimensions. Even thus scientifically oriented personalities like Mihály Vári, professor of the mentioned Debrecen college, together with Daniel Fischer, outstanding physician and natural scientist of Kežmarok, member of Academia Leopoldina, maintained speculative positions. Affected by tragically circumstances surrounding death of his daughter, caused by the lightning in 1713, Vári tried to describe the effect in one his philosophical writings published in Cluj in 1716.[7] In 17 pages long paper, the nature and attributes of "celestial fire" were depicted as an ignition of hot sulphuric vapours amid the clouds. Vapours' depiction followed Cartesian models explaining the releasing of substance particles. Similarly, Fischer's view should also be considered speculative, while his description of lightning research in experimental way, through usage of some kinds of explosives, should be regarded as innovative.[8] Material essence of the lightning is based on the mixture consisting of sulphur, saltpeter and alum, arrangable also in artificial conditions. Like it was revealed in his paper issued in 1717, dependently on its' proportion, the lightning is attended by the thunder, smaller or bigger, alongside with the similar ratio of fire. Common verdict on how to protect against the lightning's effects, presented simultaneously by both, Vári and Fischer, refers to efficient prayer.

Cartesian physics, traces of which can still be found within theories explaining the nature of lightning, remained preserved at Protestant colleges throughout the first third of the 18th century, as it is revealed all over the pages of related works arising from these schools. Therefore, there are targeted mainly the problems of material essence and variety of its existence, forms of kinesis, aether, as well as questions of mechanics and cosmography in these writings. Thus, the emerging electricity science gained only a partial presence. A mention, dealing with problems of electricity, can be discovered in Michael Szatmáry's textbook [9] from 1719 and in another Fischer's physical piece from 1730 as well.[10] It seems to be, like the experimental attitude towards electricity research was still not naturalized then. As an essence of electricity, there were introduced several material effluvia by majority of adopted interpretations. For instance, such a cause was applied by Szatmáry while concerning amber features. Although the mentioned theories followed Cartesian terms, in principle they corresponded with the then fluidic interpretations of electricity nature. Surprisingly, even the outstanding masterpiece of Stephanus Tőke, *Institutiones Philosophiae Naturalis Dogmatico Experimentalis,* assumed to be the

[4] M. ZEMPLÉN, J.: *A magyarországi fizika ... XVIII,* chapter II. 1, pp. 33–136. (See reference no. 2).

[5] SYLVANUS, M.: *Philosophia ad usum Scholarum praesentim Debrecinae* (Heidelberg: 1678).

[6] M. ZEMPLÉN, J.: *A magyarországi fizika története 1711-ig* (Budapest: Akadémiai Kiadó 1961), pp. 298–301.

[7] VÁRI, M.: *Thabera, az az: Istennek ollyan meggyulladott tüze ...* (Cluj 1716).

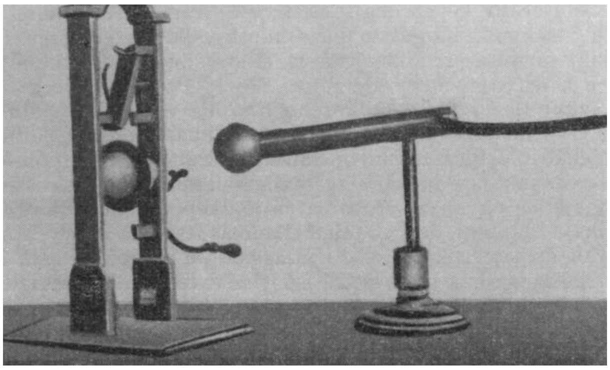
[8] FISCHER, D.: *Relatio ex Philosophia Naturali De Fulgure Tonitru et Fulmine cui Accedit Appendix de Insolito quodam Phenomeno* (?, approximately around 1717).

[9] SZATHMÁRY, M.: *Physica contracta juxta Principia Noetericorum* (Cluj 1719).

[10] FISCHER, D.: *Elementa Physicae* (Authore ... 1730; Manuscript. Library: Knižnica Evanjelického lýcea v Kežmarku).

first physical handbook written on experimental basis in 1736, presented just a single electric experiment, marginal to top it all, the phosphorescence of electrically charged sphere.[11]

Stephanus Hatvani, former disciple and the long-standing professor of Reformed college in Debrecen later on, is considered one of the first scholars provably maintaining electric experiments in Hungary. Following his studies in Basel, carrying out his peregrinations across the continent, he returned home well equipped with innovative knowledge, also of the new science comprised within, as he was familiarised with electricity problems by means of seminars led by Pieter van Muschenbroek. Even closer relations were set up between Hatvani and one of the most competent scholars of the era. According to a preserved record, he is thought to buy some kind of electrical apparatus in Vienna, as early as he stepped in charge at the college in 1749. It is a pitty, as neither of his lectures was published, nor single of its'manuscripts was hitherto preserved, hence there hardly exist any possibility to reconstruct this device. However, the mentioned device was without any doubt frequently used, together with several other mechanical gadgets of which the array belonging to his study of physics consisted of. Moreover, in 1776, the array was significantly expanded by the purchase of another machine, more powerful version, combined with electrophor. Year of purchase seems to be fairly noteworthy, given the previous year as a year of Volta's discovery of electrophor.[12]



Stephanus Hatvani (1718 – 1786)
and his „machina electrica" (1776)

It could easily happen though, that Hatvani may lose his brand of a spearhead in electric experiments in Hungarian Kingdom. Despite the shortage of achievments in the field of practical experience, extensive set of knowledge related to electricity was brouht out by anonymous author of thesis, entitled *De Vi Electrica Carmen Didacticum*. This appelation can hardly be considered oddity, since the author signed himself as a poet of Trnava, in addition to a form the work was shaped in, as it was published in Trnava university printing house in 1746, in the mode of classical Latin poem of dactylic hexameter. The piece was probably set up by Ioannes Purgina, Jesuit, in time of the publication acting as a professor of philosophy and poetics at the University of Trnava.[13] Not only it was the first separate work on problems of electricity in our country, its attractivity, alongside its pioneering character and versed form,

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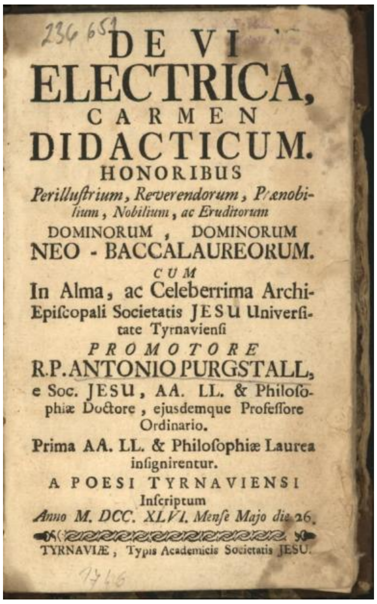
[11] TŐKE, S.: *Institutiones Philosophiae Naturalis Dogmatico Experimentalis* (Sibiu 1736). Experiment no. 84; M. ZEMPLÉN, J.: *A magyarországi fizika ... XVIII,* pp. 285. (See reference no. 2.)

[12] MOROVICS, M.T.: "Dotyky 'uhorského Fausta' Štefana Hatvaniho so svetovou vedou", *XVII. Zborník dejín fyziky* (Bratislava: Slovenská spoločnosť pre dejiny vied a techniky pri SAV, 2000), pp. 58–70.
Pictures: M. ZEMPLÉN, J.: *A magyarországi fizika ... XVIII,* p. 81, 93. (See reference no. 2.)

[13] *Slovenský biografický slovník, IV*. Martin: Matica slovenská, 1990, pp. 555–556; M. ZEMPLÉN, J.: *A magyarországi fizika ... XVIII,* pp. 400–402. (See reference no. 2.)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DE VI
ELECTRICA,
CARMEN
DIDACTICUM.
HONORIBUS
Perillustrium, Reverendorum, Praenobi-lium, Nobilium, ac Eruditorum
DOMINORUM , DOMINORUM
NEO - BACCALAUREORUM.
CUM
In Alma, ac Celeberrima Archi-Episcopali Societatis JESU Universitate Tyrnaviensi
PROMOTORE
R.P. ANTONIO PURGSTALL,
e Soc. JESU, AA. LL. & Philosophiae Doctore, ejusdemque Professore Ordinario.
Prima AA. LL. & Philosophiae Laurea insignirentur.
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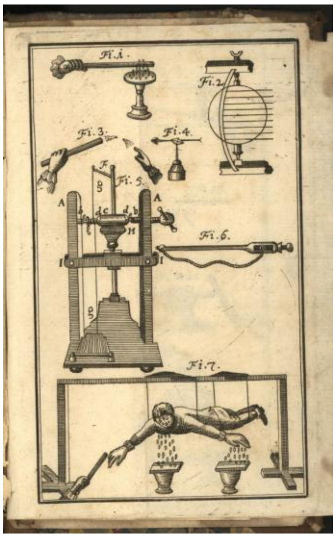
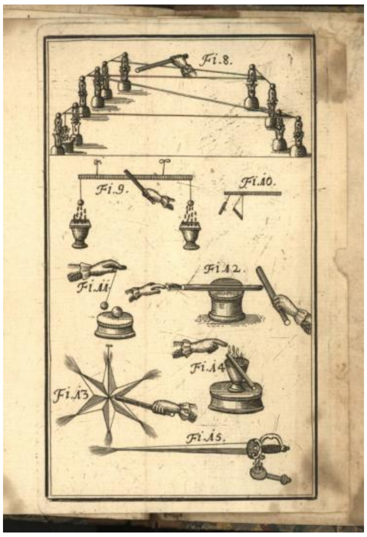
Anno M. DCC. XLVI. Mense Majo die 26.
TYRNAVIÆ, Typis Academicis Societatis JESU.
1746

results from introducing the questions of modern experimental practice onto university ground, with important reform of 1753 still to come. It is divided into three sections, ahead of texts of experiments' observations, structured in verses, there is a summary of the each individual section introduced. The first section is dedicated to proper electric power (*vis electrica propria*), thus the feature of electrifying gained within insulants by friction was denominated. The second part deals with mediated electric power (*vis electrica communicata*), it reveals, in modern terms, electric power obtained in solids by handover from insulant to conductor. The last section, called "About light and fire of electrified solids", is devoted to effects of corona and sparking, observed during several electric experiments.[14]

Front -page of "Tyrnavian poet's" masterpiece (I. Purgina) [15]

In Purgina's work, a majority of the then mastered electrical effects was concisely described, such as: electrifying by friction, both electrical attraction and repulsion, a difference between materials from the aspect of electrifying (insulants and conductors), electricity conduction in conductors set on insulated stands, a distinctions between electric features of resin (amber) and glass, or, in other words, a distinction between two electricity categories, spark discharge, phosphorescing of charged solids etc. Alongside various experiments held for the author's explanations delineated, a modern electrical device, offering frictional charge through a pedal drive was both described and depicted there.[16]





Pictures from De Vi Electrica ("machina electrica" and primary electrostatic experiments) [17]

It is necessary to mention, that after the initial Guericke's invention in 1672, more intensive development of the machines alike was started just in the forties of the 18th century. Leipzig University professor August Christian Hausen replaced sulphuric sphere used in Guericke's machine with vitreous one, while the sphere was swapped for a glass cylinder by Scotish physicist Andrew Gordon. While

[14] *De Vi Electrica, Carmen Didacticum* (Trnava: Typis Academicis Societatis Jesu, 1746).

[15] *Ibid.*, front-page.

[16] *Ibid*,, pp. 23–26.

[17] *Ibid.*, picture plates.

spheres and cylinders of the primordial exempla were rubbed by a hand, Leipzig mechanic Giessling began to equip his machines with suitable woolen cushion, following the idea of German physicist Johann Friedrich Winkler. The device presented by Purgina reminds of such developmental stage: it consisted of vitreous cylinder as well as replacable cushion, albeit lacked detachable brushes, unveiled by Benjamin Wilson right around 1746.[18]

Although the thesis originated simultaneously with the ivention of first capacitors, (Leyden jar, developed by P. van Musschenbroek and E. G. Kleist in 1745–46), it said nothing about it. Theory of electrical phenomena, as presented by Purgina, bears similarities to those by our Protestant physicists, that means speculative. Concerning glass, for instance, the effect of electrical attraction was supposed to be evoked thanks to subtle effluvia arising from a surface to get into a whirl, ripping the soft particles off. Although solely description of experiments presented in his work does not bring evidence they really were maintained by the author, its' authentic description indicates that at least the simplest could be carried out.

Alongside the former, another personality should not be omitted — Alexius Horányi. More literary historian and bibliographer, but since he acted as a teacher at Piarist schools, he was involved in natural sciences, predominantly targeting physics. After being sent by his order to Rome for his studies' improvement, in 1756 he passed his exams, defending a 14 pages long thesis on electricity problems, "following the theories by Benjamin Franklin".[19] Presumably influenced by Piarist Giovanni Battista Peccaria, Italian physicist, professor at University of Turin, only a brief summarization of the then coped knowledge on the topic is included in his work. After he refused to step in charge as a professor in Naples, he returned back to his homeland to teach at several Piarist schools.

Alongside him, several other scholars there were getting their education abroad, with their professional careers further being flourished there. Andreas Segner, Mathias Butschany, Ladislaus Chernak to name only the few, with the latter pair to be quick in reaction to Franklin's discoveries.[20]

In connection with the mentioned, it is only natural to find problems of electricity and related experiments presented in the first textbooks on physics published following Maria Theresia's reform of Trnava university. However, in extensive volumes by Andreas Ádány, Andreas Jaszlinszky and Antonius Reviczky from the years 1755–1758 only a few to electricity related viewpoints were introduced as the works were principally devoted to the questions of mechanics, cosmography with methodological solutions of transition from Aristotelian to exact experimental physics.[21] Despite all this, even a brief form of its' presentation should be considered novelty since its' immediate imple-mentation into formerly antagonist Jesuit environment. Influenced by Nollet's theory based on Dufay's discoveries, combined with omnipresent aether, the essence of electricity was understood as an electrical aura consisted of primary fire and sulphuric particles. All in all, althoug minor accent was put on the experiment, thus presented ideas might be regarded appropriate according to the half of the 18th century.[22]

Concerning modern comprehension of the electricity, substantially bigger progress can be discovered in writings of another Jesuits, Antonius Radics and Paulus Makó published in 1762– 1765.[23] In terms of science, Makó is considered more significant, since he was an internationally accepted mathematician and physicist not only for being an author of the first comprehensive handbook of the infinitesimal calculus in the whole Habsburg monarchy. Both Makó and Radics were already acquainted of the novelties of their era, like Leyden jar and Franklin's inventions, namely his lightning conductor. They both refused to accept Nollet's theory of dual fluidum (aura) inclining towards Franklin's perspective,

[18] GAZDA, I., SAIN, M.: *Fizikatörténeti ABC* (Budapest: Tankönyvkiadó, 1980), p. 86.

[19] HORÁNYI, A.: *Ex Physica selectas Propositiones* ... (Roma: 1756), Chapter: "Tractatio de artificiali Electricismo ex Beniamini Franklini Theoria".

[20] BUTSCHANY, M.: *Dissertatione Physicae de Fulgure et Tonitru ex Phenomenis electricis, I–II.* (Göttingen: 1757); CHERNAK, L.: *Dissertatio Physica de Theoria Electricitatis Franklini* (Groningen: 1771).

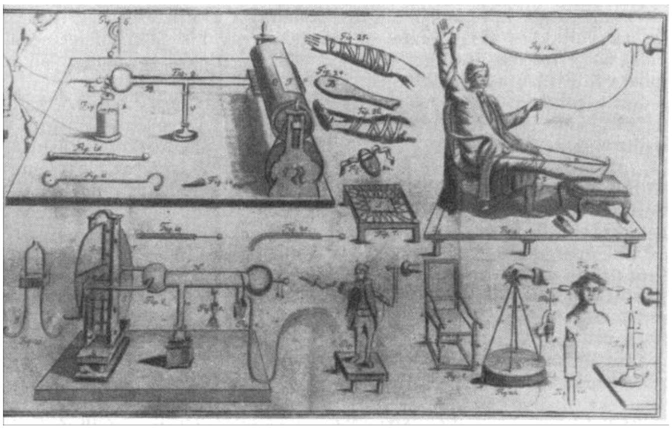
[21] See reference no. 3.

[22] M. ZEMPLÉN, J.: *A magyarországi fizika ... XVIII*, pp. 239–240 (see reference no. 2.); JASZLINSZKY, A.: *Institutiones Physicae. Pars II. Physica particularis* (Trnava: 1756); REVICZKY, A.: *Elementa Philosophiae naturalis, II* (Trnava: 1758).

[23] MAKÓ, P.: *Compendaria Physicae Institutio, 1–2* (Wien: 1762–1763); RADICS, A.: *Institutiones Physicae, 1–2* (Buda: 1766).

through which disparity is caused by deficiency or surplus of the only fluidum (aura) respectively. They were in inquiries into similarity fire and the lightning whose equality cathegorically rejected as they were both well aware of electric substance of the lightning.

Above mentioned Ioannes Baptista Horváth was also dealing with electricity problems scientific way, since he was the first author presenting explications of electricity and magnetism in common chapter, as magnets were extracted from between "minerals" in one of his works. Theories of dual fluidum (aura) were refused by him as well, while he was fairly quick to introduce current Volta's inventions (electrophor, electroscope, capacitor etc.). At same time he characterized conductivity of diverse materials rejecting obsolete denominations "symperelectrica" and "idioelectrica" alongside installing new terms such as conductors (coductores), insulants (conductores, insulatores) and even semiconductors (semiconductores), without contemporary meaning of course. In one of his later writings there were also mentioned some sanitary effects of electricity, the topic well advanced at the end of the 18th century thanks to Josepf Franciscus Domin, professor at the Universtity of Pest (formerly Trnava University).[24]



Ilustration from the work of J.F. Domin [25]

The problems related to the lightning and lightning conductor also drawn strong response from scientific community with already mentioned Paulus Makó as a premier pesonality in Hungary and author of model to one of the first physical papers published in Hungarian. [26] Slovak works were still to come.

On account of Franklin's interpretations of the lightning there has to be introduced two dissertations from Trnava University, by Antonius Pongrácz and samuel Verestói, from 1762 and 1767 respectively.[27] Less scientifically concepted thesis of the latter consisted of summarized interpretations connected with the lightning, from which he pointed its electric substance out as the only proper. The former, more scientifically oriented scholar stated: "I believed nothing to anyone, contrariwise, I tried to maintain adequate experiments to prove my own statements". He obviously provided experiments using electroscope and electrophor, since he considered those devices less reliable in practical usage. Franklinean experiments throughout thunder storms were incotrovertibly provided by Piarist Leopold Schaffrath, later Pest University professor. He stressed the importance of earthing, following the tragical death of Georg W. Richmann.[28]

In Hungarian Kingdom of the 18th century there were still no appropriate opportunities to proper physical research available. However, from cultural history's point of wiev as well as educational development end even the science, those condidtions can be regarded as slightly progressive. It can

[24] HORVÁTH, J. B.: *Institutiones Physicae particularis* (Trnava 1770; the other editions: Augsburg 1772, 1775; Eger 1774; Trnava 1777); HORVÁTH, J. B.: *Elementa Physicae* (Buda: 1790; the other editions: Buda 1792, 1793, 1799, 1807, 1819); M. ZEMPLÉN, J.: *A magyarországi fizika ... XVIII*, pp. 257–258 (see reference no. 2.)

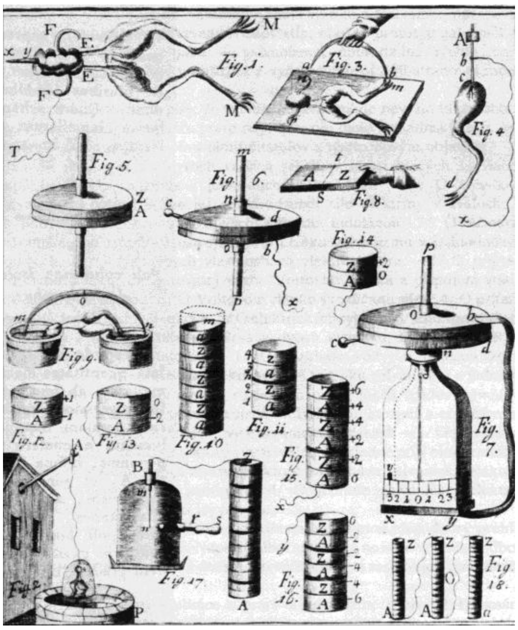
[25] DOMIN, J.F.: *Commentatio altera de electricitate medica …* (Pest:1793).

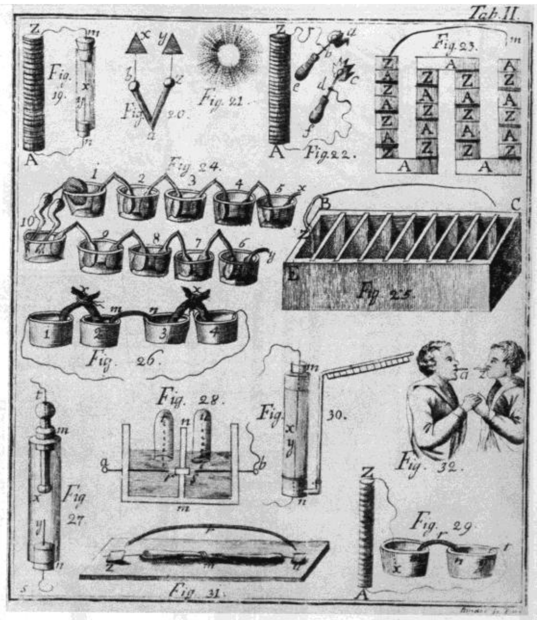
[26] MAKO, P.: *Physikalische Abhandlung von den Eigenschaften des Donners und den Mitteln wider des Einschlagen* (Wien 1772; 2. ed. Wien 1775); MAKO, P.: *Dissertatio physica de nature et remediis fulminum (*Gorizia 1773; MAKÓ, P.: *A mennykönek mivoltáról, s eltávoztatásáról való böltselkedés* (Pozsony–Kassa Bratislava–Košice 1781).

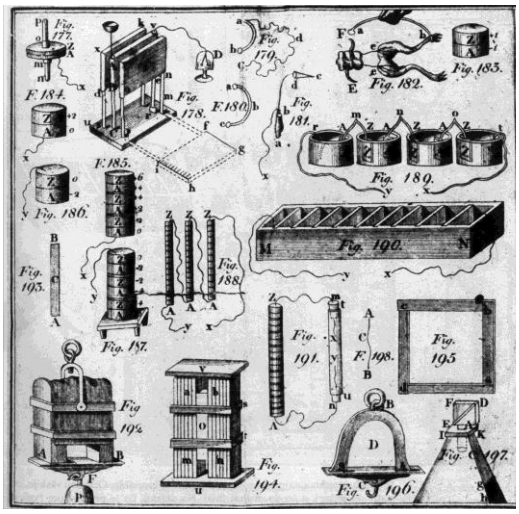
[27] PONGRÁCZ, A.: *Dissertatio experimentalis de Electricitatis Theoria* (Wien 1762); VERESTÓI, S.: *Dissertatio Physica. Fulgur, fulmen et tonitru eorumque phoenomena ex nova electricitatis doctrina explicans et confirmans* ...(Cluj 1767).

[28] SCHAFFRATH, L.: *De electricitate coelesti* ... (Pest 1778).

hardly be considered accidentally, that only in the beginning of the next century there was created a comprehensive, 350 pages long monography on galvanic electricity. In *Dissertatio de Theoria Phaenomenorum Electricitatis Galvaniae* (Buda 1809) by Adam Tomtsányi such a novelties as Volta's column and batteries were introduced. Our aim is not to go through the details of the work, these depictions the volume contains are as much a reflective. Unlike tragical motivations leading Michael Vári to publish his work in 1716, Tomtsányi's aims were truly scientific. Moreover, he found a successor in Stephanus Anian Jedlik, in whose study first electromotor and self-charging generator coul be found.







Pictures as an argument:
Illustrations from Tomtsányi's treatise [29]

[29] TOMTSÁNYI, A.: *Dissertatio de Theoria Phaenomenorum Electricitatis Galvaniae* (Buda 1809).