Acta Scientific COMPUTER SCIENCES

Volume 4 Issue 6 June 2022

Review Article

Emergence and Development of Electric Energy Sources Before the XIX Century

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Received: March 29, 2022

Published: May 25, 2022

Abstract

The paper examines the evolution of electric energy sources up to the XIX century.

Keywords: Electric Energy; Electricity; Electromotive Force

Introduction

Nowadays it is difficult to imagine the life of a modern person without electricity. It has spread in all branches of production and has firmly entered our everyday life. Just as the energy of steam at one time contributed to technological progress, electricity gave a great impetus to the development of science and technology. That is why it is worth knowing who made a special contribution to the creation of sources of electrical energy.

In the distant past, presumably in the period 250 BC - 250 AD, the "Baghdad battery" was created, found in the vicinity of Baghdad and consisting of a clay container and an iron rod surrounded by a copper cylinder [1,2]. The iron rod was passed through a bitumen plug. When filling the container with wine sauce, the battery was able to create an electromotive force (EMF) about 1 V. Reliable information about the purpose of this device could not be found. Analysis of the known information allows us to conclude that the «Baghdad battery» could have been one of the early galvanic elements.

One of the first known electromechanical sources of electrical energy was an electrostatic machine, which was invented in 1663 by the German scientist Otto von Guericke (1602-1686) (Figure 1). The machine was a sulfur ball that could rotate around an iron rod as around an axis. Rotating the ball and rubbing it with his palms, Guericke electrified it. This source made it possible to investigate some electrical phenomena [2].

Figure 1: Otto von Guericke [3].

In 1705, Francis Hauksbee [4] (1666-1713) [5] created a more powerful electrostatic source of electrical energy - the "influence machine" [2]. Instead of the sulfur ball used in the Guericke machine, he used a glass ball. He pumped air out of the ball, bringing this ball into rapid rotation, and rubbed it with his hand. Obtaining relatively powerful sparks, electric lights in sparse space, reconstruction of an electric machine - here are the essential results of Hauksbee's experiments, which he described in 1709 in his essay "Physico-mechanical experiments on various subjects: Containing an Account of Several Surprising Phenomena Touching Light and Electricity" [4].

Figure 2 shows the variants of electrostatic machines (sources of electrical energy) of that time.

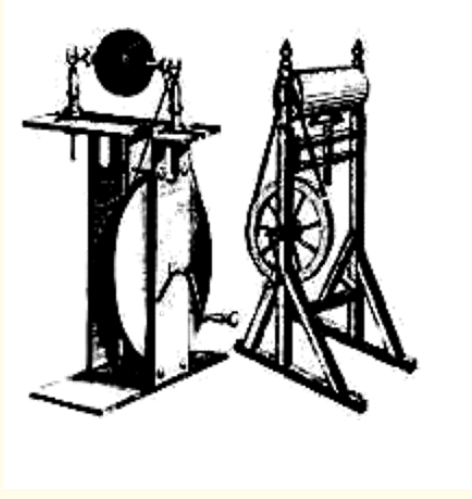

Figure 2: Early electrostatic machines [2].

French physicist Jean Antoine Nollet [2] (1700-1770) (Figure 3) and Czech priest and physicist Prokop Dyivicz [2] (1696 (98 [4])-1765) (Figure 4) with the help of their improved electrical machines investigated a number of electrical phenomena [6].

Further improvement of such machines is connected, first of all, with the name of the German physicist Johann Heinrich Winckler [2] (1703-1770), who built an electric machine in 1744 [6]. He, on the advice of the turner Gisling, replaced the manual rubbing of balls by friction against pillows pressed by screws (later springs) to the balls or cylinders being rubbed [4].

Figure 3: Jean Antoine Nollet [2].

Figure 4: Prokop Dyivicz [2].

By the beginning of 1745, one of the founders of works on electricity, a German by origin, Georg Wilhelm Richman [2,7] (1711-1753) [8], who is considered to be the first electrical technician in Russia, manufactured an improved electrostatic machine that allowed electrical experiments to be carried out in the St. Petersburg Kunstkamera. The "generated" electricity was measured on

an electrical measuring device manufactured by him, an integral part of which was a device resembling a pharmacy scale [9] (Figure 5). This device with a scale, called an "electric pointer" or "electrometer", in fact, was the first electrical measuring device for direct evaluation, a transitional design from an electroscope to an electrometer [10,11].

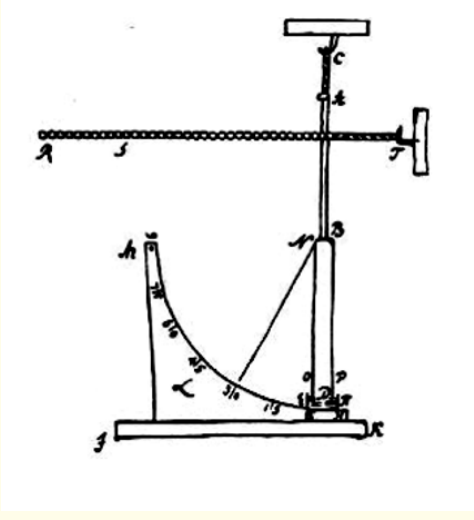

Figure 5: "Electric pointer" (drawing by G. W. Richman) [3].

In the middle of the XVIII century Johann Gottlieb Krueger (1715-1759) Professor of Medicine at the University of Halle (Germany) was engaged in research on electricity. From experiments with rubbing glass tubes, he moved on to a qualitatively new stage - the use of electric machines. At the initiative of Gausen such a machine was built in the image and likeness of the Englishman F. Hauksbee's machine, although with minor structural changes [2].

A model of electrostatic sources of electrical energy of that time can serve as a machine with leather cushions and an insulated rod for collecting electric charges, described in 1761 by the great scientist, a native of Switzerland Leonhard Euler (1707-1783) [12] in the work "Letters about various physical and philosophical matters written to a certain German princess" [4,13].

It can be assumed that the evolution of electrostatic sources of electricity ("friction machines") ended with the creation of devices with flat disks in the XVIII century.

In 1775, the Italian physicist and physiologist Alessandro Volta (1745-1827) (Figure 6), built an electric energy source based on the idea of Epinus, different from those created earlier – "resin electrophor" ("electrophoro perpetuo" – "permanent carrier of electricity") [2]. The principle of operation of the Volta's electrophorical machine, unlike electrostatic machines in which electricity was generated by friction, was based on the phenomenon of electrification by induction (electrostatic induction). It consisted of two metal discs, one of which was covered with a layer of resin. When rubbing it with a hand, leather glove or fur, the disk is charged with negative electric charge. If you bring another disk to it, the latter will be charged with an inner surface with a «+» sign, and an outer one with a «-» sign. When a negative charge is withdrawn from this disk into the ground, it will be charged positively. Repeating the cycle many times, you can multiply increase the charge. Volta noted: "My machine makes it possible to get electricity in any weather and produces an effect more excellent than the best disk and ball machines" [2].

Figure 6: Alessandro Volta [14].

One of the founders of the doctrine of electricity is the Italian scientist Luigi Galvani (1737-1798) (Figure 7). In his experiments since 1780, Galvani used an electrophoretic machine as a source of electrical energy, shown in figure 8 (a fragment of a drawing from the "Treatise on the Forces of Electricity in Muscular Movement") [2].

Figure 7: Luigi Galvani [2].

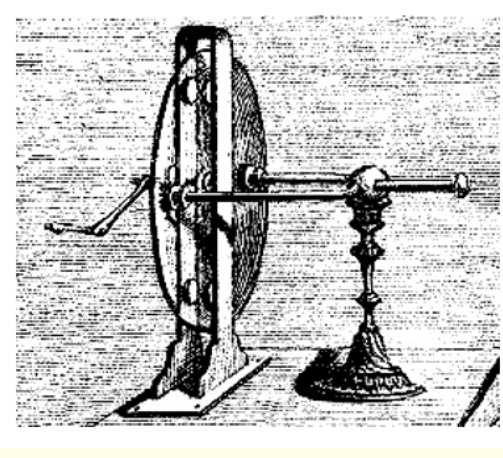

Figure 8: Electrophoretic machine [2].

A number of electrophoric (induction) machines were created on the basis of A. Volta's machine. The implemented spark discharges of electrophoric machines of that time provided charges of the order of 10^{-6}...10^{-4} C [15].

In addition to electrostatic and electrophoric sources of electrical energy, which can be considered as electromechanical generators, in the XVIII century. work was also carried out on the development of other sources of electrical energy, in particular electrochemical.

According to A. Volta, when two different metals come into contact, an «electric excitatory» force arises, under the influence of which electricity of one sign is concentrated on one of the metals, and electricity of the opposite sign is concentrated on the other.

To sum up the action of individual pairs, it is necessary to contact one zinc plate with one copper or silver plate in order to exclude counter metal contact. This is done with the help of wet cloth circles that separate metal pairs and at the same time do not interfere with the movement of electricity.

In 1799 A. Volta, not understanding the true cause of the electric current, created an electrochemical source of direct electric current (galvanic battery) – "voltaic pile" (Figure 9), the principle of which was based on the conversion of chemical energy into electrical energy [8,16].

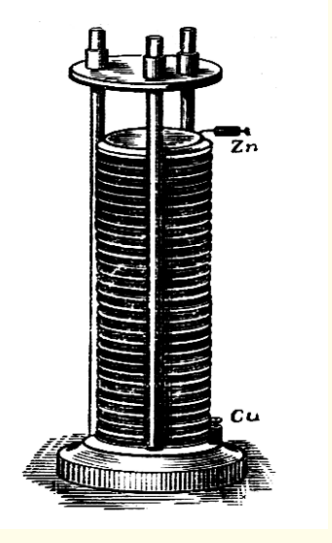

Figure 9: "Voltaic pile" А. Вольта [16].

The first "voltaic pile" consisted of 20 pairs of metal circles. One circle of the pair was made of copper, and the other was made of zinc. The metal mugs of the pairs were separated by cloth mugs soaked in salt water [2]. Volta called pairs of metal circles in the device conductors of the first class, and liquids - conductors of the second class [16].

In March 1800 A. Volta made a written communication to the Royal Society of London «On electricity excited by simple contact of simple conductive substances», in which he noted: «I have the pleasure to report some amazing results. The main of these results is the creation of a device that acts continuously, creates an indestructible charge, gives a continuous impulse to the electric fluid. Twenty, forty or sixty circles of copper or, even better, silver, stacked each with a circle of tin or better zinc, and the same number of layers of water or some other liquid better conductive than water, for example, brine, lye, etc., or pieces of cardboard, leather, etc. well moistened with these liquids, and these layers are located between both dissimilar metals of each pair. That's all that makes up my new tool". Volta originally called this instrument an "artificial electric organ", then an "electromotive pile". Later, the French gave the name "galvanic pile", or "voltaic pile". Presumably, the voltage of the "voltaic pile" was (40...50) V, and the current was less than 1 A [2].

Volta's invention of an electrochemical energy source in the form of a "voltaic pile" created prerequisites for the use of a new type of energy for various needs, gave a powerful impetus to the creation and further development of various branches of science and technology.

French chemist Jean-Baptiste Dumas (1800-1884) [17] (Figure 10) noted: "Not the old and noisy electricity of Nollet and Franklin, but Volta's electricity, which flows silently through a metal conductor" [8].

Figure 10: Jean-Baptiste Dumas [2].

French physicist and astronomer Dominique François Arago (1786-1853) [17] (Figure 11) wrote: "The famous professor came up with the idea of making a long pillar of copper, zinc and wet cloth circles. What to expect in advance from such a pillar? This structure, strange and apparently inactive, this column of dissimilar metals separated by a small amount of liquid, makes up a projectile, more wonderful than which man has never invented, not even excluding a telescope and a steam engine. I would dare to say that the voltaic pile is the most wonderful projectile of all human inventions" [2].

Figure 11: Dominique François Arago [2].

The classic of Marxism-Leninism Friedrich Engels (1820-1895) [18] noted: "The discovery of galvanic current has at least the same significance for the doctrine of electricity as the discovery of oxygen for chemistry" [19].

A little later, a number of scientists developed various batteries from galvanic cells.

Conclusions

Based on the facts presented in the report, we can conclude that despite the research carried out until the end of the XVIII century in the field of electric energy sources, the amount of theoretical and practical information was insufficient to use of electric energy to meet the needs of mankind.

The only source of electrical energy, where there was already "ready" electricity of large capacity, was then nature.

Bibliography

1. Burkov AF. "The main discoveries and research in the field of magnetism, electricity, mathematics and mechanics until the end of the XVII century". Vladivostok. Russia: Marine State University named after Adm. G. I. Nevelsky, (2007): 68.

2. Burkov AF. "History of domestic marine electric drives". Vladivostok. Russia: Far Eastern State Technical Fisheries University (2008): 380.

3. Kudryavtsev PS. "Physics History Course". 2nd ed. Moscow. Russia: Education, (1982): 448.

4. Kudryavtsev PS. "History of physics". Vol. 1: From ancient physics to Mendeleev. Edited by A. K. Timiryazev. Moscow. Russia: State Educational and Pedagogical Publishing House of the Ministry of Education (1948): 536.

5. Korotkov KG and Shustov MA. "Kirlian effect – past and present". St. Petersburg-Tomsk. Russia: Times Headset (2017): 144.

6. Khramov Yu A. "Physics: Biographical directory". 2nd ed. Moscow. Russia: Nauka (1983): 400.

7. Danilevsky VV. "Russian technique". 2nd ed. Leningrad. Russia: Lenizdat (1949): 548.

8. Chatel MA. "Russian electrical engineers of the XIX century". Moscow, Leningrad. Russia: Gosenergoizdat (1955): 432.

9. Ivanov BI., et al. "The history of the development of electrical engineering in St. Petersburg". Saint Petersburg. Russia: Nauka (2001): 208.

10. Belkind LD. "History of power engineering of the USSR". In 3 vol. Editorial Commission: Belkind L.D. et al. Vol. 2: Electrical Engineering. Alexandrov A.G. et al. Moscow, Leningrad. Russia: Gosenergoizdat (1957): 728.

11. Dorfman YaG. "Outstanding Russian physicist G.V. Richman and his role in the history of the science of electricity". *Electricity* 8(1953): 61-67.

12. "Mathematical encyclopedic dictionary". Editor-in-chief Prokhorov Yu.V. Moscow. Russia: Soviet Encyclopedia (1988): 848.

13. Euler L. Letters about various physical and philosophical matters written to a certain German princess, translated from French into Russian by Stepan Rumovsky, member of the Academy of Sciences, astronomer and professor. Saint Petersburg. Russia: at the Imperial Academy of Sciences. Pp. 1768-1774.

14. Peryshkin AV and Rodina NA. "Physics". Moscow. Russia: Prosveshenie (1986): 323.

15. Lvov AL. "Chemical sources of current". *Soros Educational Journal* 4(1998): 45-49.

16. Veselovsky ON and Shneiberg YaA. "Power engineering and its development". Moscow. Russia: Higher School (1976): 304.

17. Yarotsky AV. "Boris Semyonovich Yakobi". 1801-1874. Moscow. Russia: Nauka (1988): 240.

18. "The Great Soviet Encyclopedia". In 30 vol. 3rd ed. Vol. 30. Moscow. Russia: Soviet Encyclopedia (1978): 632.

19. Engels F. "Dialectics of nature". Electricity. Moscow. Russia: Politizdat (1982): 360.