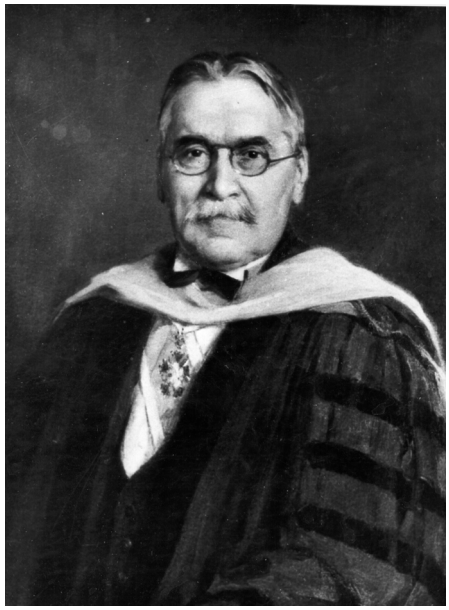
Michael Idvorsky Pupin (1854 - 1935)



Michael Idvorsky Pupin

Michael Pupin was born on October 9, 1854, in Idvor, "a little village that cannot be found on any map", as described in his biography *From Immigrant to Inventor*. When Pupin was a boy Idvor was part of so-called Military Frontier, belonged to Austria-Hungary, and later became a part of the kingdom of Serbs, Croats, and Slovenes. At the Paris peace conference, in 1919, the Rumanians claimed this province, but they could not overcome the fact that the population of Banat, particularly that where Idvor is located, is Serb. The settled Serbs were technically Austrian subjects but were allowed to retain their language and customs. The reason for establishing the Military Frontier can be traced back towards the end of the seventeenth century when the Austrian Empire was harassed by Turkish invasions that advanced as far as Vienna. Then the Polish king Sobiesky had come to the rescue of Vienna. It was at that time that Emperor Leopold I, of Austria, invited the Serb Patriarch of Pech, in old Serbia, to move with thirty-five thousand families of the old Serbia into the Austrian territory north of Sava and Danube rivers, to become guardians. In 1960 the Patriarch moved into Austria and settled the accompanying families on the northern banks of the two rivers. Upon this occasion an agreement with Emperor Leopold I was recorded in an Austrian document called Privilegia. According to this documents the Serbs of the military frontiers were to enjoy a spiritual, economic and political autonomy. Serbs maintained their own schools and their own churches, and each village elected its own local administration. Pupin's father was several times head of the administration called the Knez.

Michael's parents were illiterate but intelligent and well-respected peasants, who brought up their son in the spirit of the maintaining and cultivation of old Serbian traditions. The young Pupin acquired his basic knowledge in his mother tongue, reading, writing and arithmetic, at the elementary school in Idvor. His schooling was continued at Pancevo in 1869, where he was lucky to have good teachers, particularly in the natural sciences. For participating in a May-festival parade in honor of Svetozar Miletic, during which he was caught trampling upon the Austrian flag, Pupin barely avoided being expelled from school, so in the following year, 1872, he was sent for further schooling at Prague. He stayed there for a short period, and following his father's sudden death, he decides to travel to America. After two weeks of Atlantic crossing fraught with much hardship, he arrived in the United States at the end of March 1874. The immigrant ship, *Westphalia*, landed at Hoboken and a tug took them to Castle Garden. There the immigrants were carefully examined and cross-examined. As Pupin had not completed any school or apprenticeship, and without knowledge of the language, he experienced a very hard time in entering, and later in the first years of living in America.

His first job in America was on the Delaware farm where he taught some English, had to drive a team of mules in the work of hauling things to the field preparatory for spring planting. Next, similar job, he found in Philadelphia but stayed only a month and then went to New York. There he found a job to help in the loading of ships, in painting the ship, and later was wall painter and paperhanger, coal carrier from sidewalks to cellars and so on. A step forward in his education was when he found a job in a famous crack factory on Cortland Street, and started more seriously to study technical things, and begin to attend evening lectures at Cooper Union. There he was impressed by a great painting called "Men of Progress," representing a group of very learned-looking men.

After considerable efforts and hard studies of Greek and Latin Languages among other subjects, Pupin managed in the autumn of 1879 to pass the entrance examination and become enrolled at Columbia College. At the end of the freshman year he gained two prizes one in Greek and the other in mathematics, and become popular as a good sportsman by quick victory in wrestling-match against a "freshman giant". In the second year he established the reputation as a doctor of "lame ducks" – the name of those students who failed in their college examination. He continued to be brilliant student and supporting financially himself he graduated Columbia College in 1884.

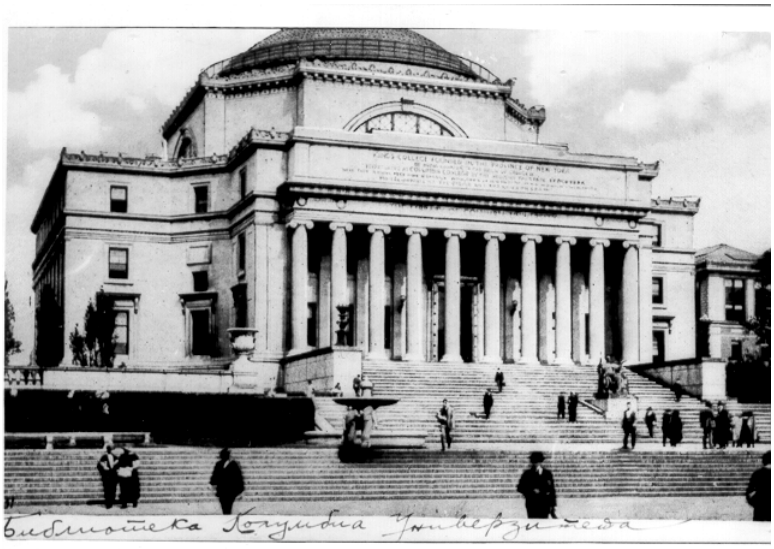
At the end of his senior year he was impressed by an experiment of his physics professor explaining Faraday's discovery of electromagnetic induction. That experiment helped him to decide whether to turn to science or letters. At that time he also received American citizenship. After graduation Pupin received scholarship for further scientific education at the Universities of Cambridge, England. After nine years in America he traveled for the first time back to Europe, stayed shortly in Cambridge expecting to meet Maxwell, but learned from Mr. Niven that this great man was dead for four years. Mr Niven suggested Pupin

that he could study at Cambridge under Lord Rayleigh, who had succeeded Maxwell as professor of physics. On the journey to Idvor, Pupin passed through Switzerland, Budapest and Pancevo and went to Idvor to see his mother and sisters. Pupin spent two months in Idvor talking to the Idvor's people about his life in America and with sadness realized that his people suffer under foreign rulers even more then when he had been here before.

When he returned to Cambridge from drowsy little Idvor, the ancient college buildings inspired a filling of wonder and veneration. He started work at Cambridge unattached to any college in the beginning, but later was attached to King's College. Ever since the time of Newton, Cambridge had become the nursery of the mathematical sciences in the British Empire. There were about five special honor groups and Pupin joined so-called tripos group with a coach to guide him. Although he succeeded in competing with the other students in the same group, he was not satisfied with such kind of mathematical physics training; it was not what he had expected to learn. In this matter Pupin was not alone. Sir William Thomson, known later as Lord Rayleigh was among the first who called for changes. Pupin realized that experimental work is essential in studying physics. After a year in Cambridge Pupin again went to Idvor. In passing through Paris he found a La Grange book on *Analytic mechanics*. Whole summer he studied this book together with the biography of Maxwell. On return to Cambridge he continued to specialize in mathematics and attended lectures of Lord Rayleigh and Stokes. Being interested in experimental work he thought of going to Cavendish laboratory. Meanwhile he obtained a letter from America informing him that he won a scholarship and he was directed to professor Tyndall for further advice. Professor Tyndall was invited in 1872 to deliver a course of lectures in several principal cities in the United States. The object of these lectures was "to show the uses of experiment in the cultivation of natural knowledge". Pupin met professor Tyndall twice and decided to study experimental physics in Berlin, with Hermann von Helmholtz, the famous professor of physics, the formulator of the principle of conservation of energy. Pupin was introduced to professor Helmholtz as John Tyndall fellow of physics of Columbia College with recommendations from professor Tyndall and Columbia College. In his doctor dissertation work Pupin concentrated on mathematical research in physical chemistry and in 1899 he successfully defended the thesis entitled "*Osmotic pressure and its relationship to free energy*".

Pupin academic career began in 1899 as a "Teacher of Mathematical Physics in the Department of Electrical Engineering," at the newly established Department of Electrical Engineering in the School of Mines of Columbia College in New York. He immediately began scientific research and establishment of new laboratories. Shortly afterwards he was appointed associate professor, and in 1901 professor of electro mechanics. At the Columbia College, Pupin first lectured in mathematical physics, then in thermodynamics and hydraulics. His first major success in scientific work was in the field of investigating the harmonics of sources of alternating currents by tuned circuits. He studied resonance phenomena in low frequency circuits with iron-cored inductances, in coupled transformer resonators, and so on. This work gave rise to Pupin's invention of multiplex telegraphy, which discovery he protected with several patents. This invention has application in today's communication systems, of course on a much larger scale.

Only two months following the discovery of X-rays, Pupin made successful photographs and applying a combination of phosphorescent screen and ordinary film he shortened exposure time inventing technique that is used today. After only three months of investigations, he succeeded in arriving at several original discoveries, which on April 6, 1896, were communicated to the New York Academy of Sciences. Among this was discovery that the primary X-rays produce the secondary X-rays upon reflection from different materials.



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Pupin's greatest success was the solution of the problem of long-distance telephone transmission by the use of special inductance coils distributed along the line. From the theoretical work of Heaviside it was known that ordinary transmission lines couldn't achieve the Heaviside's condition for ideal signal transmission, because they have small inductance. Attempts of many investigators to periodically load transmission lines with inductance coil were unsuccessful. It was not before Pupin derived new theory of periodically loaded transmission lines and experimentally verified it, first in his laboratory, and then in practice, that this important problem in signal transmission was solved. In this connection Pupin developed the toroidal form of inductance coil without which the theoretical results would have had small practical value, because otherwise coils belonging to different telephonic circuits would have mutual

inductance, and this would result in cross-talk. A toroidal inductance coil has no external circuits. The Western Electric Co., in New York, and by Siemens-Halske of Berlin, developed this type of telephone cable and it revolutionized telephonic transmission.

Over ninethy years ago the American Telephone and Telegraph Company, established telephonic communication between Boston - New York - Washington. Over a cable of this kind, and at that time this was the longest telephonic cable transmission in the world. It was 500 miles, or 800 kilometers long. Today the distance has been indefinitely increased by the interposition of vacuum tube amplifiers. But it is admitted that without the inductance coils introduced according to Pupin' s theory the vacuum tube amplifiers alone would make transmission over telephone cables impossible. The coils eliminate distortion, not only that due to unequal reduction of amplitude of different frequencies, but also that due to different velocities of propagation for different frequencies.
In the development of the inductance coils during at least twenty five years, Pupin was consulted by both the Western Electric Company and Siemens-Halske of Berlin.

Pupin and his co-workers

Pupin's discovery permitted transmission of telephone signals between cities, which were an enormous step forward in the development of telephony. After these discoveries, the name of Michael Pupin, who had been highly respected in the scientific world, became widely known to the public in the United States and in Europe. However, work on the practical problems of the application of the Pupin system in telephony absorbed him to such an extent that he dropped out of the mainstream of research in the fundamental problems of physics, the area in which he had begun his carrier. Dealing with many problems arising in the application of the Pupin system, Pupin speeded up its application on the World's scale and became rich. From 1901, when he received tenure as professor, Pupin's successful scientific and teaching career proceeded until 1929, when he retired. In his lifetime he guided many students who admired him. Several; of them are well known scientists as Edwin Armstrong, Langmuir, Morcroft and others. Some of them were Nobel prize winners.

During the World War I Pupin and his scientific committee were doing research work for the purpose of developing a system of submarine detection and a system of telephonic communication between aeroplanes. This work earned him a recognition from the late President Harding.

In recognition of his achievements, Pupin was selected president or vise-president of the highest scientific and technical institutions, such as the American Institute of Electrical Engineers, the New York Academy of Sciences, the Radio Institute of America, or the American Association for the Advancement of Science. For his inventions Pupin filed a total of 34 patents in the period 1894 to 1934. Almost all patents are from the field of telegraphy, telephony and radio. During his lifetime he received a large number of diplomas and medals in recognition of everything that he created. He published several books between 1894 and 1930.Of major interest is his *Thermodynamics* and his autobiography, published for the first time in the United States in 1923, under the title, *From Immigrant to Inventor.* He also wrote two other popular scientific books *The New Reformation* and the *Romance of Machines*.

Until the end of his life, Pupin maintained close contacts with his compatriots and helped them in various ways. He had set up a number of aid funds, built a special school in his Idvor, and made considerable contribution to the drawing of Yugoslavia's frontiers in 1919.

Pupin died in New York in 1935.

written by
Prof. Dr. Aleksandar Marinčić
member of Serbian Academy of Science and Arts

APENDIX

Pupin's Patents

1)	519,346	Apparatus for telegraphic or telephonic transmission (1894)
2)	519,347	Transformer for telegraphic, telephonic, or other electrical systems(1894)
3)	640,515	Distributing electrical energy by alternating currents (1900)
4)	640,516	Electrical transmission by resonance-circuits (1900)
5)	652,230	Reducing attenuation of electrical waves and apparatus (1900)
6)	652,231	Reducing attenuation of electrical waves (1900)
7)	697,660	Winding-machine (1902)
8)	707,007	Multiple telegraphy (1902)
9)	707,008	Multiple telegraphy (1902)
10)	713,044	Producing asymmetrical currents from symmetrical alternating electromotive forces (1902)
11)	713,045	Apparatus for producing asymmetrical currents from symmetrical alternating electromotive forces (1902)
12)	761,995	Apparatus for reducing alternation of electrical waves (1904)
13)	768,301	Wireless electrical signalling (1904)
14)	821,741	Telegraphy (1906)
15)	1,334,165	Electric wave transmission (1920)
16)	1,399,877	Antenna with distributed positive resistance (1920)
17)	1,388,441	Multiple antenna for electric wave transmission (1921)
18)	1,399,877	Sound generator (1921)
19)	1,415,845	Selectively opposing impedance to received electrical oscillations (1922)
20)	1,416,061	Radio-receiving system having high selectivity (1922)
21)	1,446,769	Aperiodic pilot conductor (1923)
22)	1,456,909	Wave conductor (1923)
23)	1,452,833	Selective amplifying apparatus (1923)
24)	1,488,514	Selective amplifying apparatus (1924)
25)	1,494,803	Electrical tuning (1924)
26)	1,502,875	Tone-producing radio receiver (1924)
27)	1,541,845	Electrical wave transmission (1925)
28)	1,561,278	Wave signalling system (1925)
29)	1,561,279	Equalizing vacuum-tube amplifier (1925)
30)	1,571,488	Electromagnetic production of direct current without fluctuations (1926)
31)	1,657,587	Electrical pulse generator (1928)
32)	1,834,735	Inductive artificial line (1931)
33)	1,811,368	Telegraph system (1931)
34)	1,983,774	Supply system for vacuum tubes (1934)

Ref. National Academy of Sciences of the United States of America

Awards and Decorations given to Pupin

The Elliot Cresson Medal of the Franklin Institute (1902)
The Herbert Prix of the French Academy (1916)
The Edison Medal of the American Institute of Electrical Engineers (1919)
Honor Medal of the Radio Institute of America (1924)
Honor Medal of the Institute of Social Sciences (1924)
The John Fritz Medal of the Four National Engineering Societes (1931)
George Washington Award of the Western Society of Engineers (1928)
White Eagle, First Order of Yugoslavia (1929)
White Lion, First Order of Czechoslovakia (1929)

Pupin's Membership in Societies

National Academy of Sciences
American Mathematical Society
American Philosophical Society
American Physical Society
Honorary Member, American Institute of Electrical Engineers
Honorary Member, German Electrical Society
Corresponding Member, Royal Serbian Academy, Belgrade

Pupin was the president of the folowing institutions:

New York Academy of Sciences
Radio Institute of America
American Institute of Electrical Engineers
American Association for the Advancement of Science
University Club of New York
Engineering Foundation (Chairman)

Pupin's Honorary Degrees

Year	*Degree*	*Institution*
1904	Sc.D.	Columbia University
1915	LL.D.	Johns Hopkins University
1924	Sc.D.	Princeton University
1924	LL.D.	New York University
1924	LL.D.	Muhlenberg College
1925	D.Eng.	Case School of Applied Science
1925	L.H.D.	George Washington University
1925	Sc.D.	Union College
1926	LL.D.	Marietta College
1926	LL.D.	University of California
1926	Sc.D.	Rutgers University
1926	LL.D.	Delaware University
1926	LL.D.	Kenyon College
1927	Sc.D..	Brown University
1927	Sc.D.	Rochester University
1928	L.D.	Middlebury College
1929	Sc.D.	University of Belgrade, Yugoslavia
1929	Sc.D.	University of Prague, Czechoslovakia