

# HISTORY OF MEDICINE

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### NIKOLA TESLA AND MEDICINE: 160<sup>TH</sup> ANNIVERSARY OF THE BIRTH OF THE GENIUS WHO GAVE LIGHT TO THE WORLD - PART II

*NIKOLA TESLA I MEDICINA – 160 GODINA OD ROĐENJA GENIJA  
 KOJI JE SVETU PODARIO SVETLOST – II DEO*

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#### Summary

**Introduction.** Nikola Tesla (1856 - 1943) was a genius inventor and scientist, whose contribution to medicine is remarkable. Part I of this article reviewed special contributions of the world renowned scientist to the establishment of radiology as a new discipline in medicine. This paper deals with the use of Tesla currents in medicine. **Tesla Currents in Medicine.** Tesla's greatest impact on medicine is his invention of a transformer (*Tesla coil*) for producing high frequency and high voltage currents (*Tesla currents*). Tesla currents are used in diathermy, as they, while passing through the body, transform electrical energy into a therapeutic heat. In 1891, Tesla passed currents through his own body and was the first to experience their beneficial effects. He kept correspondence on electrotherapy with J. Dugan and S. H. Monell. In 1896, he used high frequency currents and designed an ozone generator for producing ozone, with powerful antiseptic and antibacterial properties. Tesla is famous for his extensive experiments with mechanical vibrations and resonance, examining their effects on the organism and pioneering their use for medical purposes. Tesla also designed an oscillator to relieve fatigue of the leg muscles. It is less known that Tesla's inventions (Tesla coil and wireless remote control) are widely used in modern medical equipment. Apart from this, wireless technology is nowadays widely applied in numerous diagnostic and therapeutic procedures. **Conclusion.** Nikola Tesla was the last Renaissance figure of the modern era. Tesla bridged three centuries and two millennia by his inventions, and permanently indebted humankind by his epochal discoveries.

**Key words:** History of Medicine; Famous Persons; Portraits as Topic; Electric Stimulation Therapy; Ozone; Radio Waves; Diathermy; Wireless Technology

#### Introduction

Nikola Tesla (1856 - 1943) was a genius inventor and scientist whose contribution to the development of medicine is outstanding. Part I of this paper reviewed

#### Sažetak

**Uvod.** Nikola Tesla (1856–1943) bio je genijalni pronalazač i naučnik koji je izuzetno doprineo razvoju medicine. U našem prethodnom radu opisan je poseban doprinos ovog naučnika svetskog glasa utemeljenju radiologije kao nove medicinske discipline. U ovom radu dat je osvrt na primenu Teslinih struja u medicini. **Primena Teslinih struja u medicini.** Teslin izum koji je najznačajnije doprineo medicini je transformator (Teslin kalem) za stvaranje visokofrekventnih i visokonaponskih struja (Teslinih struja). Tesline struje se koriste u postupcima medicinske dijatermije, pri čemu se prilikom njihovog prolaska kroz organizam električna energija pretvara u toplotnu, te se na taj način zagrevanjem tkiva u unutrašnjosti organizma postiže terapijski efekat. Poznato je da se Tesla dopisivao sa lekarima elektroterapeutima, Duganom i Monelom. Podstaknut korišćenjem visokofrekventnih struja, Tesla je 1896. godine konstruisao ozonski generator, koji služi za dobijanje ozona, agensa sa snažnim baktericidnim svojstvima. Nikola Tesla je ispitivao i uticaj mehaničkih vibracija i rezonancije na organizam i prvi ih primenio u medicinske svrhe. S tim u vezi, osmislio je oscilator koji je koristio za suzbijanje umora u nožnim mišićima. Malo je poznato da su Teslini pronalasci (transformator i sistem za bežično daljinsko upravljanje) nezaobilazni deo korišćenja medicinske opreme. Pored toga, bežična tehnologija u današnje vreme se takođe u potpunosti primenjuje u sklopu brojnih dijagnostičkih i terapijskih procedura. **Zaključak.** Nikola Tesla je poslednja renesansna ličnost modernog doba. Svojim grandioznim delom spojio je tri veka i dva milenijuma i večno zadužio čovečanstvo.

**Ključne reči:** istorija medicine; poznate ličnosti; portreti; elektroterapija; ozon; radio talasi; dijatermija; bežična tehnologija

his remarkable contribution to the establishment of radiology as a new discipline in medicine. Part II reviews the application of Tesla currents in medicine.

### Abbreviations

AIEE – American Institute of Electrical Engineers

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### Tesla Currents in Medicine

*A man is born to work, to suffer and to fight; he who doesn't, must perish. Of all the frictional resistance, the one that most retards human movement is ignorance. If you don't know how, observe the phenomena of nature, they will give you clear answers and inspiration. The progress and development of man essentially depends on ingenuity. The most important product of the creative mind is an invention. Its final goal is an overall mastering of the mind over the nature and the exploitation of all its forces for the needs of humankind. An inventor's endeavor is essentially life saving. Whether he harnesses forces, improves devices, or provides new comforts and conveniences, he is adding to the safety of our existence.*

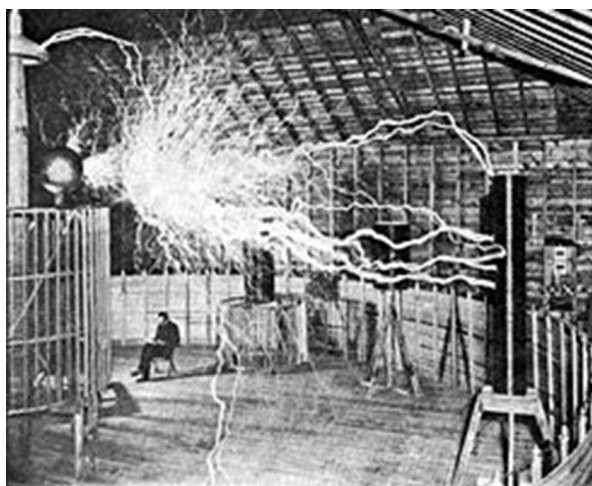
*Nikola Tesla*

#### *Nikola Tesla and Electrotherapy*

Historians of medicine consider high-frequency and high voltage currents to be the most important Tesla's contribution to medicine [1]. By the use of these currents, called *Tesla currents*, it is possible to produce heat in tissues of the human body (electrotherapy) [2, 3]. Today, Tesla currents are used in medical diathermy, where electrical energy is converted into heat and thus warms the tissue inside the body [2–6]. These currents are used to treat disorders of the locomotor system, inflammatory processes and chronic diseases, as well as in gynecology and surgery [3]. A similar procedure is called *teslization*, where the human body is subjected to a high frequency electric field of Tesla currents generated by a Tesla coil (“skin effect”) [2–7].

Before Tesla currents were used, direct current electrotherapy had been associated with painful muscle spasms, and even fatalities [8]. At that time, there were ways to generate extremely high-frequency damped oscillations [5]. However, Tesla was the first who succeeded, first using mechanical generators, and then oscillator coils, to produce continuous, undamped high-frequency currents [5, 6].

Tesla explained his decision to start researching high-frequency currents, previously completely unknown: “Some theoretical possibilities offered by currents of very high frequency and observations which I causally made while pursuing experiments with alternating currents, as well as the stimulating influence of the work of Hertz, determined me some time during



**Figure 1.** Nikola Tesla - master of lightning – produced by high frequency and high voltage currents in his lab in Colorado, 1899. Source: The Nikola Tesla Museum, document no. MNT, VI/II, 38

**Slika 1.** Nikola Tesla kao gospodar munja, odnosno visokofrekvencijskih i visokonaponskih struja proizvedenih u njegovoj laboratoriji u Koloradu 1899. godine  
Izvor: Muzej Nikole Tesle, dokument br. MNT, VI/II, 38

1889 to enter a systematic investigation of high frequency phenomena. This has proved itself so fruitful, since” [8]. During 1891 and 1892, Tesla designed and made several high-frequency electrical oscillators for medical purposes [8, 9]. As he said, the work was hard, and he struggled “to get from the Scylla to the Charybdis” [8]. Those were mainly high frequency generators (5-10000 cycles per second), operating at tens of thousands volts [3, 9]. Using these devices, Tesla performed amazing experiments [6]. Showers of sparks and lightning erupted around him in his laboratory, making some fascinating scenes [6, 10, 11]. On these occasions, Tesla transformers raised the potential to several million volts at a frequency of several million Hertz [6, 11]. Lightning bolts were flying around his lab a few meters in range [6]. Tesla liked sitting in a chair inside his lab taking notes while the air all around him was filled with such streamers from his giant coil [6, 12] (**Figure 1**).

In his experiments with his oscillating transformer, Tesla connected his coil to a Geissler tube and found it glowing intensely [6]. The luminescence appeared in these tubes without direct connection of conductors with the source of electrical energy [6, 13]. Therefore, in Tesla's hands, light bulbs lit like in hands of a magician, which was a real attraction for observers [1, 6, 12–15] (**Figure 2**).

Tesla conducted a number of experiments on himself using high-frequency and high-voltage currents, and he was the first to report about their beneficial effects on the body [1–3, 5, 6, 8, 9, 16]. In the winter of 1891, Tesla passed high-frequency and high-voltage current through his body without causing any muscle spasms or tissue damage [1]. The scientific world was soon informed of the fascinating properties of Tesla's currents [1, 16]. On February 21, 1891, Tesla pu-



**Figure 2.** Tesla demonstrating wireless electricity transmission Tesla holding a light bulb illuminating it by hand, without any wire connections. Source: [www.tesla-museum.org](http://www.tesla-museum.org)  
**Slika 2.** Tesla demonstrira bežični prenos električne energije. U njegovoj ruci svetli sijalica bez direktnog povezivanja sa strujnim izvorom. Izvor: [www.tesla-museum.org](http://www.tesla-museum.org)

blished the article “Phenomena of alternating currents of very high frequency” in the journal *Electrical World* [3, 5, 8, 16]. It was also the first paper on high-frequency currents in the world [8]. According to Tesla, his accidental experience with high-frequency currents led to the following conclusions on the physiological effects of these currents on the human body: “The discharge of even a very large coil cannot produce seriously injurious effects, whereas, if the same coil were operated with a current of lower frequency, though the electromotive force would be much smaller, the discharge would be most certainly injurious. This result, however, is due in part to the high frequency. The writer’s experiences tend to show that the higher the frequency the greater the amount of electrical energy which may be passed through the body without serious discomfort” [16]. This was a shocking discovery that disproved Edison’s claims that alternating currents were dangerous and harmful [8, 16]. On the other hand, no one could foresee the amazing effects of high-frequency currents [8]. Tesla’s explanation for this enigma was soon associated with the human body, emphasizing the following: “It seems certain that human tissues act as condensers” [5, 8].

On May 20, 1891, Tesla was invited to give a lecture before the members of *American Institute of Electrical Engineers* (AIEE), now the IEEE, at Columbia University in New York [5, 8, 9]. The lecture: “Experiments with Alternate Currents of Very High Frequency and Their Application to Methods of Artificial Illumination” was held before a large gathering [5]. On this occasion, Tesla amazed the audience, and demonstrated effects of alternating currents on the human body and intense smell of ozone [5, 9]. The lecture ended with the announcement that his future work would be directed towards finding new ways of using natural energy and thus “humanity will move forward with giant steps” [5, 17]. This lecture, published in *Electrical World* and the AIEE proceedings on July 11, 1891, was translated into many languages, and was many times cited both in our and in foreign scientific literature [5, 8].

It is known that Tesla corresponded with physicians and electrotherapists, Dugan William James and Samuel Howard Monell [2–4]. As a young physician, Dr. Monell, later a professor of electrotherapeutics, attended Tesla’s lecture at Columbia University in 1891 [5]. In his book “High-frequency electrical currents in medicine and dentistry”, published in 1910, he wrote about his impressions from the lecture: “On a memorable night in May, 1891, Nikola Tesla, the Slav, young and enthusiastic, with a poet’s mind and the aspirations of genius, stood before the “American Institute of Electrical Engineers” and lighted lamps with currents passing harmlessly through his own body and heated wires to incandescence by the touch of his conducting hand. With smiling countenance and without physical sensation, he placed himself in circuits, that by all the laws of alternating and direct currents should have brought the lecture to a close by the death of the daring lecturer! Yet he went sweeping on, astonishing his audience by demonstration after demonstration of unfamiliar discharges newborn into electrical science which were called “high frequency”. That lecture sent the fame of Tesla round the world” [5, 8, 9].

Nine years later, Nikola Tesla was examining the problem of increasing human energy, and in his eponymous paper: “The problem of increasing human energy”, he reflected on the lecture he gave at Columbia University: “I still remember with pleasure how, nine years ago, I passed the discharge of a powerful induction-coil through my body to demonstrate before a scientific society the comparative harmlessness of very rapidly vibrating electric currents, and I can still recall the astonishment of my audience. I would now undertake, with much less apprehension than I had in that experiment, to transmit through my body with such currents the entire electrical energy of the dynamo now working at Niagara – forty or fifty thousand horsepower. I have produced electrical oscillators which were of such intensity that when circulating through my arms and chest they have melted wires which joined my hands, and still I felt no inconvenience. I have energized with such oscillations a loop of heavy

copper wire so powerfully that masses of metal, and even objects of an electrical resistance specifically greater than that of human tissue, brought close to or placed within the loop, were heated to a high temperature and melted, often with the violence of an explosion, and yet into this very place in which this terribly destructive turmoil was going on I have repeatedly thrust my head without feeling anything or experienced any inconvenience” [18].

After this lecture, Tesla received many letters from eminent physicians from the United States of America, inquiring as to the physical effects of such currents of high frequency [8]. That is why Tesla wrote a separate article on the application of high frequency currents in medicine: “Massage with Currents of High Frequency”, which was published in the journal *Electrical Engineer* on December 23, 1891 [2, 3, 5, 8]. He provided specific instructions to doctors how to heat the skin of their patients using his currents [5]. Among other things, in this article Tesla wrote: “I have demonstrated in my lecture that a body perfectly well insulated in air can be heated by simply connecting it with a source of rapidly alternating high potential. The heating will, of course, be superficial, that is on the skin. With such apparatus properly prepared, wouldn’t it be possible for a skilled physician, to find in it a means for effective treatment of various types of diseases?” [8].

After his fascinating experiments at Columbia College in New York, where he passed 50,000 volts through his body, Tesla performed similar experiments in Europe, and captured the attention of the whole scientific world on developments in this area [1, 2, 5]. Thus, on February 3, 4, and 9, 1892, Tesla gave a lecture: “Experiments with Alternate Currents of High Potential and High Frequency” in the famous Royal Society in London before the members of the Institute of Electrical Engineers (IEE) [5, 7]. Then, on February 19, 1892, he delivered a lecture in Paris in the International Association for Electricity, and repeated it in the Association of Electrical Engineers [7]. There he met Jacques-Arsène d’Arsonval, a French physician, who conducted experiments with high-frequency currents, denying the fact that Tesla released observations of physiological effects of these current before him [5]. Both times Tesla’s experiments were considered to be sensational, and hinted at the possibility of therapeutic application of high frequency currents and voltage [1].

On September 13, 1898, Tesla gave a lecture: “High Frequency Oscillators for Electro-therapeutic and Other Purposes”, on the annual meeting of the American Electro-Therapeutic Association in Buffalo, combining all his work in this area [1, 2, 4, 8, 19]. So, Tesla gave a comprehensive overview of his eight oscillators that were already in use [8] and described the effects that high frequency currents caused in his system (heat effect, extreme fatigue, drowsiness, and disorders in breathing and blood circulation) [1]. In addition, Tesla clearly limited his research to living tissues, leaving therapy to doctors: “While it remained for the physician to investigate the specific actions on the orga-

nism and indicate proper methods of treatment, the various ways of applying these currents to the body of a patient suggested themselves readily to the electrician” [19]. In the final part of his lecture, Tesla stated the following: “Finally, though, I had the satisfaction of producing devices which are simple and reliable in their operation, which require practically no attention and which are capable of effecting a transformation of considerable amounts of energy with fair economy. The physician will now be able to obtain an instrument suitable to fulfill many requirements” [8]. Shortly after that, Tesla currents became the basis for diathermy and various other forms of high frequency electrotherapy [6, 8]. Tesla established a good cooperation with the New York doctor Carol, entrusting him one of his high-frequency transformers for therapeutic purposes and they were constantly in contact [5]. In addition, as already mentioned, he kept correspondence with physicians Monell and Dugan [2–4]. They both sent him their books on the treatment using high-frequency currents, but Tesla corrected them on several occasions that the discovery of these currents was wrongly attributed to William James Morton, and the discovery of their therapeutic activity to d’Arsonval [3]. Although Dugan’s “Handbook of Electrotherapeutics”, intended for medical students and doctors, contains a special dedication to Tesla, there is not much information about their relationship [16]. Since the letter in which Tesla thanks Dugan for sending him his book was sent via Tesla’s publisher, it can be concluded that Tesla and Dugan were not very close [3, 16].

In contrast, Tesla archives include a very rich correspondence with Prof. Monell [16]. In a letter dated December 16, 1908, Monell asked Tesla to send him photos and comments about his machines, about which he later wrote in his book on electrotherapeutics [9, 16]. In the same letter, Prof. Monell wrote about his concept for the book according to which his main objective was to stimulate interest of medical students, doctors and dentists in high frequency currents [9]. Their subsequent correspondence was about photographs Monell expected to get from Tesla for his book, as well as Tesla’s explanations for machines in the photos [16].

The Monell’s book, a part of the personal legacy of Nikola Tesla kept in his Museum in Belgrade, contains four photographs, although Tesla sent him more; the first is the well-known figure of Tesla sitting in front of one of his giant Tesla coils, the so-called high-frequency amplifiers, as stated in the legend [9]. The following two photographs present oscillators, a total of four, which have been applied for medical purposes [9, 16]. The fourth presents Tesla coils in resonance from Tesla’s laboratory [9]. Two of these photos have Tesla’s handwritten legends [16].

The first part of the Monell’s book, dedicated to electricity and its effects on the human body, includes a review on Tesla, as the inventor of these valuable therapeutic devices [9, 16]. In the preface of his book,

Monell points out the importance of high frequency currents in medical practice, both in rehabilitation of acute diseases, and in the treatment of chronic diseases, expressing his beliefs that those who read his book will most certainly be willing to use them in their work [16]. Monell also emphasizes that the main effect of high-frequency currents is based on their power to “modify the natural physiological processes in the body” [9, 16]. The improvement of the health status of patients subjected to these currents on daily basis was associated with: “induction of natural sleep, increase of strength, vital energy, joy of life, work capacity, walking capacity; it restored appetite, improved digestion, and provided progressive health improvement” [16].

This general improvement of the health status often manifested after the first session, even before signs of localized effects could be noticed [10, 16]. Apart from statements given by patients, the therapeutic efficacy also included blood and urine tests [16].

At the stage of drafting the book, in a letter dated June 4, 1909, Monell wrote to Tesla about his ideas on the cooperation related to the design, manufacture and marketing of devices based on Tesla’s high-frequency currents [16]. In his letter dated April 19, 1916, Monell proposed foundation of *Monell-Tesla Institute* [3, 16]. The aim this Institute would have been to expand the application of Tesla’s inventions in science and medicine [10, 16]. Tesla’s task was to design devices, and Monell’s to manage their use [16]. Unfortunately, Monell died in 1918, so this plan was never put into action.

In electrotherapy, Tesla used two types of oscillators [9]. The first type was a high frequency coil with two metal plates of considerable surface connected to its terminals [9, 10]. To enable strong currents to be passed through the tissues, the terminals should be large, and covered with cloth saturated with a solution of electrolyte harmless to the skin [9]. Another type of oscillator was connecting one terminal of the high frequency source to the ground and the other to a metal plate, which worked as a transmission antenna and it affected the whole body [9, 10]. Apart from this, the oscillators were huge and occupied a substantial part of doctors’ surgeries [8, 9]. Usually they were steam-powered electric generators producing high-frequency electricity [9].

After 1900, Tesla tried to exploit his inventions commercially in medicine [5]. He founded the *Tesla Electrotherapeutic Company* and designed a miniature transformer for home treatment using high frequency currents, but failed to commercialize his discovery [5]. However, his portable miniature oscillator (cylindrical in shape, about 30 cm long, 3 cm in diameter, 12 or 30 W, with frequency of 400.000 cps, 75 kV), known as “Mini Tesla” or “Pocket Tesla” had a remarkable success [3, 4, 8, 9]. A copy of this oscillator is in the *Nikola Tesla Museum* in Belgrade [8]. According to Margaret Cheney, this device was very popular [8, 20]. The famous French chanteuse Edith Piaf, for example, cured pharyngitis by means of Tesla cu-

rrents, specifically the oscillator “Mini Tesla” [9]. Over time, treatment using Tesla currents had become very effective and very popular [9, 10]. Monell listed various clinics in the United States which investigated effects of these currents and confirmed their beneficial effect on the organism [3, 9]. A similar thing happened in Europe, where d’Arsonval, academician Blondel, and a German doctor from Saarbrücken, Marsel Flug, made a great success with Tesla currents [9].

In his book “Nikola Tesla beneath Cobwebs”, Mario Filipi wrote about using Tesla currents for electro-anesthesia [4, 20]. According to this author, Tesla designed a device with high-frequency currents in a wardrobe of a New York theatre, for actors suffering from stage fright [21].

#### *Nikola Tesla and the Ozone Generator*

Tesla’s genius was much more than unveiling the secrets of nature and it was evident in the variety of his interests as well [5]. He published several articles on general biological topics, as well as on proper diet and healthy lifestyle [2, 3]. For example, Tesla emphasized the importance of timely recognition of symptoms of the disease: “Incapacity of observing the first symptoms of an illness, and careless neglect of the same, are important factors of mortality. In noting carefully every new sign of approaching danger, and making conscientiously every possible effort to avert it, we are not only following wise laws of hygiene in the interest of our well-being and the success of our labors, but we are also complying with a higher moral duty. Everyone should consider his body as a priceless gift from one whom he loves above all, as a marvelous work of art, of indescribable beauty and mastery beyond human conception, and so delicate and frail that a word, a breath, a look, nay, a thought, may injure it. Uncleanliness, which breeds disease and death, is not only a self destructive but highly immoral habit. In keeping our bodies free from infection, healthful, and pure, we are expressing our reverence for the high principle with which they are endowed [18]. Like a real mechanical engineer, Tesla analyzed mechanisms for improving the automatism of living beings: “The human energy will be increased by careful attention to health, by substantial food, by moderation, by regularity of habits, by promotion of healthy life generally stated, by respecting ourselves and others as well” [2, 18]. According to him, success in life depends on hard work: “To be successful in this world one must perform the hardest kind of work. You must peg away night and day, and not stop a minute. There is no royal road. This has been the plan I have followed for years” [5]. “My health is good, “Tesla used to point out, “simply because I lived cautiously and moderately, and perhaps the most amazing thing is that I was seriously ill three times in my youth, physically hopelessly destroyed and abandoned by doctors”. At the time when Tesla finished high school, there was an

outbreak of cholera [22]. He contracted cholera and was bedridden for nine months and was near death multiple times [11, 14, 22, 23]. The doctors gave up on him almost completely [11, 14, 22]. Desperate parents watched their only son losing the battle with the illness [11]. Tesla's father, in a moment of despair, promised to send him to the best engineering school instead to seminary if he recovered [11, 12, 14, 22]. This dramatic life experience must be an additional reason for Tesla's commitment to invent something to contribute the fight against diseases, especially those caused by microorganisms. To this end, he experimented with high frequency alternating currents, and revealed their bactericidal properties: "My high frequency currents have bactericidal effects. So it has become a daily routine for the inventor to take off his clothes, stand in front of his coils and a prickly corona would envelop his body and restore his health" [24, 25]. In addition, Tesla noted that high-frequency currents produce ozone in the air, which acts refreshing and in very low concentrations has antibacterial properties [2, 3]. This urged him to use high voltage electrical discharge and design a device for ozone production (ozone generator/ozonizer) and patented it on June 17, 1896 [2, 3, 5]. In 1900, Tesla formed the "Tesla Ozone Company" for production of ozone generators, mostly bought by doctors [2, 3, 16]. One of the products of his company was called "Violet Ray" which was widely used for therapeutic purposes around 1910 and later [16]. In the late 19th and early 20th century, "Siemens" used this idea for water purification [5]. Today, ozonizers are used for air purification and refreshment in rooms with air-conditioning [3].

In May 1898, an *International Exhibition of Health* was held in New York, where Tesla presented his "electrical bath" [5, 10]. On this occasion, Tesla spoke about facts, discovered by famous scientists Louis Pasteur and Robert Koch stating that from 4,000 to 7,000 microbes fly in the air and fall on every square foot of a human body, where they remain [5]. Electric charge with positive or negative entropy creates a repulsive force between two charged bodies, one of which is the great mass of the human body, others are small microorganisms [5, 10]. The result of the electric charge is rejection of microorganisms from the body [5]. Tesla first applied this method himself, and then he described it in detail [5, 10]. The method included rubbing the body with a disinfectant, for example alcohol, the hair in particular, which especially retains microorganisms [5]. Then he used a special battery to electrify his body to reject microorganisms, and eventually the whole process was finished by mild rubbing of the body with alcohol again [5].

Speaking of good and useful electricity, Tesla used to say that one should protect himself from bad electricity, the so-called "evil spirit" [9]. Giving an interview to an amazed journalist of the "Sun" magazine he said: "One of the beneficial effects of water

is that it mechanically washes away the electricity from the skin. If you put some clay on the bottom of the bathtub, it will absorb all the harmful electricity from your body. Grounding is placing one's bare feet on the ground, grass, or sand, especially when it is humid or wet. Rinse your hands and/or feet under running water to remove any static electricity. Spending time by the water, like lakes, rivers, fountains, waterworks or streams, will fill you with natural electricity that will successfully fight the damaging one" [9].

#### *Nikola Tesla and Vibrational Medicine*

Nikola Tesla also examined the effects of mechanical vibration on the human body [3]. It is known that he made a "vibrator" for treating painful leg muscle spasms [2–4]. Here is how Tesla later recalled his work in this field of research: "Electrical oscillations of an extremely high rate act in an extraordinary manner upon the human organism. Thus, for instance, I demonstrated that powerful electrical discharges of several hundred thousand volts, which at that time were considered absolutely deadly, could be passed through the body without inconvenience or hurtful consequences. These oscillations produced other specific physiological effects, which, upon my announcement, were eagerly taken up by skilled physicians and further investigated. This new field has proved itself fruitful beyond expectation, and in the few years which have passed since, it has been developed to such an extent that it now forms a legitimate and important department of medical science [18]. On February 6, 1894, Tesla patented his mechanical oscillator called *Means for generating electric currents* [7].

Tesla left a record about how he accidentally came to the discovery of mechanical treatment while using the mechanical oscillator: "I had installed at the laboratory one of my mechanical oscillators with the object of using it in the exact determination of various physical constants. The machine was bolted in vertical position to a platform supported on elastic cushions and, one day, as I was making some observations, I stepped on the platform and the vibrations imparted to it by the machine were transmitted to my body. The sensation experienced was as strange as agreeable, and I asked my assistants to try. They did so and were mystified and pleased like myself. But a few minutes later some of us, who had stayed longer on the platform, felt an unspeakable and pressing necessity which had to be promptly satisfied, and then the stupendous truth dawned upon me". It was a discovery of laxative effects of mechanical oscillators, or technical therapy in a broader sense, about which Tesla said: "When I began to practice with my assistants mechanical therapy we used to finish our meals quickly and rush back to the laboratory. We suffered from dyspepsia and various stomach troubles, biliousness, constipation, flatulence and other disturbances, all natural results of such irregular habit. But only after a week of application, during which I improved the technique and my assistants learned how to take the treatment to their best

advantage, all these forms of sickness disappeared as by enchantment and for nearly four years, while the machine was in use, we were all in excellent health" [12, 26, 27].

Apart from his assistants, Tesla gladly offered his visitors the opportunity to try out the mechanical treatment [12]. One of them was the famous writer and Tesla's friend, Mark Twain [12, 14]. Tesla described it like this: "He came to the laboratory in the worst shape suffering from a variety of distressing and dangerous ailments but in less than two months he regained his old vigor and ability of enjoying life to the fullest extent" [12, 26].

In 1896, Tesla informed the public about the possibilities of mechanical therapy in the *Detroit Free Press* [7]. He had high expectations for his invention and was very optimistic regarding the future of mechanical therapy [5]. Tesla began experimenting more and more with medicinal properties of his oscillators, and good reports were coming from across the country about their extraordinary possibilities of treatment [5, 24]. "These high-frequency "vitality boosters" would generate a "universal healing agent" and enable the body to "throw off all diseases," said Finch Strong [24]. The gathered results included "improvement of mood, sleep, appetite, and bowel functions" [24].

Nikola Tesla and Dr. Georges Lakhovsky achieved amazing results with application of their high-frequency oscillators and vortex antennas on a large number of patients with a variety of health problems (locomotor diseases and injuries, hypothyroidism, sleep disorders, urogenital infections, hemorrhoids, prostate function disorders, osteoporosis, dyspepsia, constipation, cardiovascular disease, hormonal imbalances, etc.) [28]. Some doctors reported that mechanical therapy could treat tuberculosis [24].

At the end of his life, Tesla emphasized the importance of this discovery, calling it, at one moment, his greatest contribution to human well-being [5]. He pointed out that combination of proper diet and mechanical vibrations were a key to maintaining health and prolonging life [5].

#### *Nikola Tesla and Robotics in Medicine*

Nikola Tesla was a pioneer in robotics [5]. He used to say: "Every living being is an engine geared to the wheel-work of the universe". Interestingly, especially from our perspective, the Socialist Federal Republic of Yugoslavia (SFRY) was one of the few developing countries with its own medical electronics industry based on Tesla's ideas [8].

In modern medicine, Tesla's ideas have been used for wireless power transfer for medical implants in the human body [10]. Wireless remote control is most often used for nerve functions in people suffering from Parkinson's disease and in patients with essential tremor [8, 10]. These devices are charged by remote transmission of energy [10, 12]. Today, for these purposes, most experiments include microwaves [12]. In the same way, experimental studies are done for implants controlling urination, respiration, vision

and hearing [8, 10]. In addition, wireless implant technology today is also used to control pumps for a gradual drug dosage, as part of the treatment of some chronic diseases and cancer, regulation of insulin levels, managing the work of the diaphragm, heart muscle, artificial hearts, cochlear prostheses, neuroprostheses, etc. [10].

Tesla's idea of wireless transmission of energy provided a significant progress in fostering immobile patients [10]. Using Tesla's invention of wireless control of patients' chairs and beds, patients are less dependent on other people who take care of them, whereas relatives, doctors and other medical staff are more efficient, and the care itself is much easier and simpler [10].

When asked who, in his opinion, were great people, Tesla replied: "Great is a man who overarches others with his gifts of mind and intellectuality, the one that like a bee does with the honey gathers knowledge and reveals new truths, but crowns his efforts with love for humanity, which in return helps him evade the burden of miseries that fear, famine, ignorance, present disease. Not those who humiliate a man, but those who elevate him, who enrich his spiritual heritage, helping his spiritual happiness in process. Those are great". [18]. Living with this belief till the end of his life, this great man kept on working on developing a system of telemechanics and remote control, intuitively heralding the age of humanoid robotics: "Long ago I conceived the idea of constructing an automaton which would mechanically represent me" [10]. He did it in 1896, and designed a teleautomatic and automatic machine, which he patented in November 1898 [7]. Using Tesla's discovery, robotic control systems were introduced into the medical practice [8, 10]. Numerous medical robots, as well as multi-purpose machines that meet modern requirements of flexible automation, eliminate manual work in the course of surgical intervention [10].

Medical practice today uses all kinds of robotic sensors (ambient, tactile, ultrasonic, laser sensors, etc.) as well as all kinds of robotic systems for visualization (cameras, etc.) [10].

One of the ideas Tesla had no time to realize was artificial blood circulation [5]. He started thinking about it due to the illness of his close relative [5]. In a letter written to the inventor George Comstock Baker, on April 11, 1899, he requested an opinion about one of his medical devices. Tesla wrote about his idea: "A few years ago I came up with the idea to put a whole body into a chamber, only the face would be exposed to air. The chamber should have a door through which the person would enter, and it would be hermetically sealed. For the same reason, the window through which the face would be put through should be lined with rubber. If the chamber was made like this, the air inside it could be diluted or compressed. Now, if the air is diluted, I believe that the blood of a person inside the chamber would be drawn to the surface of the skin. If the air is put back into the chamber under compre-

ssion, the blood would rush back and we would get a powerful pump that dilutes the air with each cycle to a certain degree and that can be adjusted to dilute the air as many times as the heart beats per minute. I also thought about a device where the person's pulse would control the pump, so that it would pump the blood in accordance with the heart rate" [5].

#### *Medicine and Tesla's Inventions in the Light of Current Electromagnetic Culture*

While interpreting problems of energy and mankind, Nikola Tesla asked himself: "Of all the endless variety of phenomena which nature presents to our senses, there is none that fills our minds with greater wonder than that inconceivably complex movement which, in its entirety, we designate as human life. Its mysterious origin is veiled in the forever impenetrable mist of the past, its character is rendered incomprehensible by its infinite intricacy, and its destination is hidden in the unfathomable depths of the future. Whence does it come? What is it? Whither does it tend? are the great questions which the sages of all times have endeavored to answer" [18]. The central topic of Tesla's research was how to obtain energy from nature [5]. After extensive exploration of natural phenomena, Tesla concluded: "If you want to find the secrets of the universe, think in terms of energy, frequency and vibration. When I think of all the inventions, including those in which I took part, I am fully convinced that our Creator built this planet on the basis of electromagnetics" [29] (**Figure 3**).

All Tesla's inventions in physics and electrical engineering were the result of the kind of intuition that René Descartes described around 1628 in his philosophical work "Rules for the Direction of the Natural Intelligence" (Latin - *Regulae ad Directionem ingenii*) [7, 30]. Attempting to explain intuition as precisely as possible, Descartes defined it as an innate light of reason (Latin - *Ratione luce*, French - *Innée lumière*) [30]. Tesla was closest to Descartes ideal in his fundamental discoveries in the field of electromagnetism and related technologies [7]. In 1904, in "Note on Cabanellas Patent, No. 164995" Tesla wrote about his inventive talent: "From time to time, in rare intervals, Great Spirit of discovery comes to the Earth to announce a secret that should improve humanity. It selects the best prepared and most honorable one, and whispers a secret to his ear. Valuable knowledge comes like a flash of light. When he understands its hidden meaning, he is happy to see a miraculous change: a new world appears in front of his eyes and he barely recognizes any similarity with the old one. This is not a passing illusion, a mere game of his playful imagination or a phantom of the mist that will disappear. The miracles he sees, although far in time, will happen. He knows that, with no shadow of doubt in his mind, and feels it with every part of his body: It is a great idea" [5] (**Figure 4**).



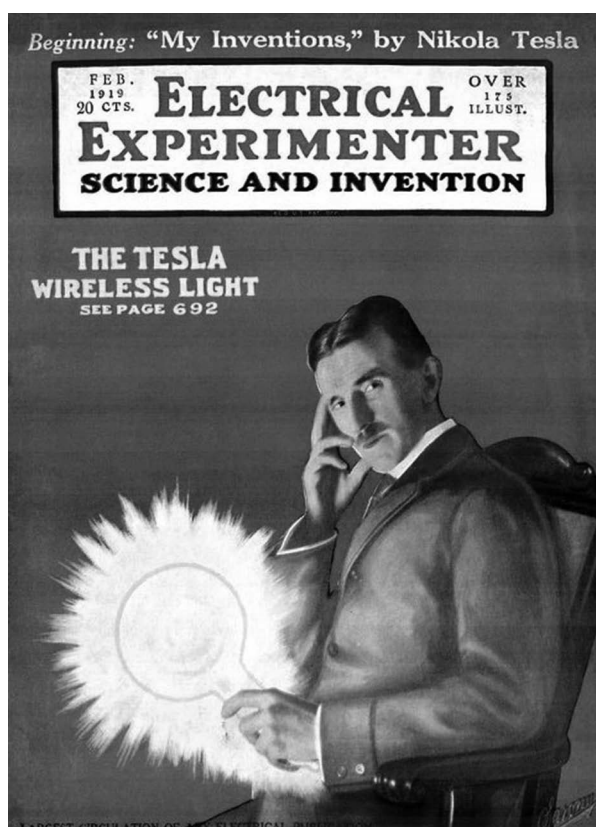
**Figure 3.** Tesla's famous electric motor (induction motor) constructed in 1887. It is the best machine for converting electrical energy into mechanical energy ever. A rotating magnetic field invented by Tesla in 1888, is a key principle in the operation of this "wheel of modern age". It is almost noiseless device with high efficiency (95 %). Source: [www.wikipedia.org](http://www.wikipedia.org)

**Slika 3.** Teslin čuveni elektromotor (indukcioni motor) konstruisan 1887. godine. To je do sada najbolja mašina koja pretvara električnu energiju u mehaničku. Radi na principu obrtnog elektromagnetnog polja, koji je Tesla otkrio 1882. godine. Popularno je nazvan „točak modernog doba“. Gotovo je bešuman. Ima stepen korisnog dejstva 95 posto. Izvor: [www.wikipedia.org](http://www.wikipedia.org)

The four fundamental forces in the nature are gravity, electromagnetism, weak, and strong nuclear forces [7]. Electromagnetic force is of crucial importance for the Second Industrial Revolution, and Nikola Tesla, the main character of our story, was often credited with starting it [7]. The background of the modern process of globalization and global networking is the information/communication technology, philosophically known as "electromagnetic culture" [7]. Tesla's work is within the foundations of modern electromagnetic culture [7]. Its main feature is high-speed flow of information that corresponds with Descartes ideal [7].

According to Tesla himself, he discovered a new type of electromagnetic waves more than a century ago, and called them non-Hertzian waves in order to differentiate them from conventional, so-called Hertzian electromagnetic waves [31]. Non-Hertzian waves, called Tesla waves, have properties that cannot yet be measured, as they are still beyond observations and measurements [31]. However, science only recognizes electromagnetic waves, experimentally proven in 1888 by Hertz [31]. In his Canadian





**Figure 4.** Tesla on the cover of the American journal “Electrical Experimenter”, in 1919, which published a series of Tesla’s articles that constitute a unique autobiography “My inventions” Source: <http://electricalexperimenter.com/n10electricalexperi06gern.pdf>

**Slika 4.** Tesla na naslovnoj strani američkog časopisa *Electrical Experimenter* 1919. godine. U ovom časopisu Nikola Tesla je u nastavcima objavio svoju autobiografiju „Moji izumi“. Izvor: <http://electricalexperimenter.com/n10electricalexperi06gern.pdf>

patent 142,352 “Art of transmitting electrical energy through the natural mediums”, Tesla wrote the following: “It is necessary to employ oscillations in which the rate of radiation of energy into space in the form of Hertzian or electromagnetic waves is very small. To give an idea, I would say that the frequency should be smaller than twenty thousand per second, though shorter waves might be practicable. The lowest frequency would appear to be six per second, in which case there will be but one node, at or near the ground-mate. and, paradoxical as it may seem, the effect will increase with the distance and will be greatest in a region diametrically opposite the transmitter” [25]. In addition, Tesla predicted an extremely fast progress of science in the future: “The day science begins to study non-physical phenomena, it will make more progress in one decade than in all the previous centuries of its existence” [32].

In 1900, Nikola Tesla announced the connection between the human body and electromagnetism [33]. This realization has led to the creation of magnetic resonance imaging devices of invaluable importance, because they can detect diseases at an early stage and thus extend the human life [33]. Tesla’s numerous inventions in the field of electromagnetism in the late 19th and early 20th century have also opened the door to the development and implementation of other modern technologies in medicine [5, 7, 10, 31, 34]. Tesla’s views that the entire Cosmos acts on the principle of vibration and resonance are the basis of the modern theory of strings [34] and the backbone of microwave resonance therapy [28, 33, 35, 36]. That is one of the reasons why Tesla has been considered the founder of quantum medicine, bearing in mind that he was the first to use high-frequency waves to improve health. His holistic approach to scientific research has constantly attracted great interest of the scientific community. Thus, inspired by Tesla’s inventions, an American physician, Dr. Raymond Rife, found that cells exposed to some form of energy of appropriate frequency, absorb the energy through the resonant elements of their structure. If the absorbed energy exceeds a certain limit, the cells are destroyed. This was also a motive to design and implement the “frequency generator”, which became very popular in a short time [37].

Tesla realized that human body is a complex electromagnetic network [8]. He thought that if we affected the biological flow within our body, we could increase our energy potentials or take care of some “short circuits” [8]. The same principle goes for acupuncture [8]. However, although acupuncture and other kinds of energy treatment were known to ancient civilizations, and changed forms and types of application through centuries, energy healing becomes a subject of scientific research in the 20th century, through electroacupuncture, quantum physics and cyber technology [29]. Thus, it has been established that disharmony in the human energy field precedes pathological changes at the cellular and organ levels [29].

Before beginning the treatment, it is necessary to start changing one’s consciousness, which in practice means changing habits at the conscious level [29]. Nikola Tesla was a forerunner in researching the phenomenon of consciousness [38–41]. He argued that memory in the classical sense does not exist and that the information is “causing” a strong visual, thought and language associations [40–42]. He also pointed out that the ability of the brain to “translate” the senses in the real world, observations of numerous frequencies from the environment (light, sound, heat and physical vibrations), would be more logical if the brain was a hologram [40]. Not many researchers know that Tesla had never written down a single formula in electrical engineering [43]. All his discoveries were made after meditation and altered state of consciousness [43]. Tesla was actually focused on specified addresses on the level of collective consciousness [43, 44]. He

received extrasensory information directly from the consciousness [43–47]. The information is then transferred from the level of consciousness, or acupuncture system, to the nervous system crossing the barrier of neural synapses of some eighty milli electron volts [43]. Most people have insufficient energy at the acupuncture system [43]. It is interesting to point out that his motivation for inventions was so enormous that he enhanced information on the invention in regard to all the other information he received in the aforementioned manner, at the level of sensory consciousness [43]. In addition, Tesla hoped to be able to photograph a thought by detecting neural feedback to the retina and emission of light [1].

The aim of the increasingly popular electrotherapy is to detect disharmony in the human bioenergy field and to restore the natural balance and harmony [29]. This means maintaining the human body and maximizing its potential, increase one's energy, mental clarity, support immunity to stress and infections, emotional balance and good physical condition [29]. Today scientists are “rediscovering“

the power of words, thoughts and mind, confirming that words and thoughts can program the human body [40–42].

### Conclusion

Nikola Tesla was the last Renaissance figure of the modern era. His outstanding inventions bridged three centuries and two millennia, and the mankind owes a huge debt of gratitude to Tesla. His extraordinary enthusiasm and refined sense of beauty and measure showed that all the noble ideas of the mind can be realized only if the scientific and professional truth seekers have the knowledge, endless patience, dignified and curious spirit, professional responsibility and unlimited intellectual honesty. *“The world will long have to wait for a mind equal to Tesla's, a mind of such creative possibilities and such wealth of imagination. What is created is great, and, as time passes, it becomes even greater“*. Tesla's life, enthusiasm, humanism and principles will remain a lasting legacy for future generations around the world.

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