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TESLA'S CONTRIBUTIONS TO MEDICINE

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Igor Salopek, Gordana Žauhar*

SUMMARY

*The major contribution of electrical engineer, scientist and inventor Nikola Tesla (Smiljan, Croatia, 1856 – New York, USA, 1943) to medicine was his high-frequency, high-voltage transformer known as the Tesla coil. High frequency currents are used in diathermy, as they, passing through the body, transform electrical energy into a therapeutic heat. Tesla himself spoke about this effect in an 1891 issue of **Electrical World**, reporting on an experiment in which he passed current through his own body. Even though he did not have medical training, he was interested in physiological effects of electricity and kept correspondence on electrotherapy with J. Dugan and SH Mahonell. In a 1896 issue of the **Electrical Review** Tesla published skull X-ray shots, beating Roentgen to it. Six years later he observed that placing an object before a photographic plate exposed to a high-frequency electrical field resulted in an image of the object surrounded by light. This phenomenon was later termed the **Kirlian effect**, and it refers to the aura, that is, the energy field produced by all living organisms. Tesla also designed an oscillator to relieve fatigue of the leg muscles. He experimented not only with the physiological effects of mechanical vibrations, but also with electrical narcosis.*

This review starts from museum materials, exhibits and literature, and continues with Tesla's biography, focusing on inventions that found application in medicine. It concludes with a brief description of the Tesla coil built in 1908 and kept at the Department of Physics of the Rijeka University Medical School. By inventing the coil and discovering the X-rays, Tesla made a significant contribution to medical diagnostics and therapy.

Key words: history of physics, history of medicine, 19th and 20th century, Nikola Tesla, Tesla's transformer, electrotherapy, X-rays.

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In the last part of this paper the authors summarize other Tesla's inventions which are not well known but are also interesting for medicine such as an ozone generator. Tesla patented his first ozone generator in 1896, and in 1900, he formed the Tesla Ozone Company. Tesla sold ozone machines to doctors for medical use. With inventions which are summarized and presented in this paper, Nikola Tesla gave a very important contribution to medicine although medicine was not his main field of research.

*Tesla, **Key words:** history of medicine, history of 19th and 20th century, Nikola physics, , Tesla's transformer, electrotherapy, X-rays.*

To delineate the entire work of Nikola Tesla (Smiljan, Croatia, 1856. - New York, USA, 1943), an electrical engineer who, with his versatility and inventions, made a strong contribution to many fields of science, including those that touch only or especially medicine, is almost impossible. Modern diagnostics and therapy are unimaginable without the electrotechnical inventions of the great genius (Fig. 1) – multiphase alternating current, transformer, alternating current electric motor, amplifier, arc lamp... However, in some segments of his activity, he came particularly close to medicine. The high-frequency and high-voltage currents that he produced with the help of a transformer that he patented as far back as 1891, and which today bears his name (popularly: Tesla's transformer or Tesla's HF-generator), are named after him. The Tesla transformer consists of an inductor and a high-voltage resonant transformer [1]. It produces high voltages of high frequencies through electromagnetic induction. The oscillating circuit of the Tesla transformer consists of a coil with several turns and a capacitor connected in parallel. In this circuit, an important role is played by the spark that breaks the circuit. The oscillating circuit is powered by an inductor. The capacitor is discharged through the spark gap through the coil, due to which a high-frequency magnetic field is created in it, which causes induction in the secondary.

Carrying out various experiments to solve the problems of lighting and long-distance transmission of electricity, Tesla noticed that high-frequency currents are not dangerous for humans. He published his observations as early as 1891 in the *Electrical World magazine*. By conducting experiments of passing high-frequency current through his own body, he came to the realization that the tissues inside the human body can be safely heated with the help of these currents. Therefore, in December of the same year, he published a special article on the possibilities of medical application of high-frequency currents. In the book *The Problem of Increasing Human Energy*, Tesla wrote [2]: "I still remember with pleasure how nine years ago I discharged the charge of a powerful induction coil through my body in order to demonstrate to the scientific public the comparative harmlessness of high-frequency electric currents, and still I reme

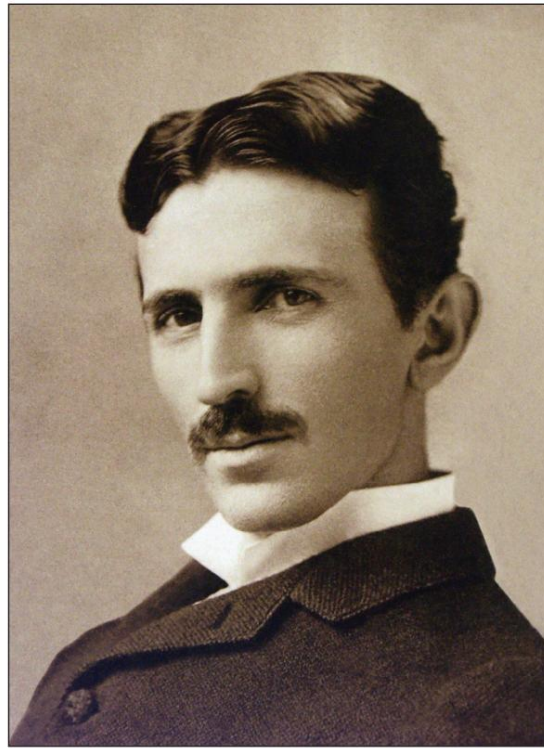


Figure 1. Nikola Tesla (1856–1943)

Figures 1 Nikola Tesla (1856–1943)

To-day, with much less apprehension than in that experiment, I would let currents flow through my body as strong as the electricity of all the dynes now working at Niagara—forty or fifty thousand horse-power. Although I produced electric oscillations of such intensity that circulating through my arms and chest melted the wires attached to my palms, I felt no discomfort."

Namely, although he had no medical education, he was interested in the physiological effects of electricity and corresponded with doctors WJ Dugan and SH Monellom on electrotherapy (Figure 2) [3]. Both of them send him their books on treatment with electric current, and Tesla corrects them on several occasions that the discoveries of high-frequency currents are wrongly attributed to WJ Morton, but the discovery of the therapeutic effect of currents to the French doctor A. d'Arsonval. He also constructed a special device for treatment with high-frequency currents. That device is kept in the Nikola Tesla Museum in Belgrade, and is shown in Figure 3. Today, high-frequency currents (

165 Broadway, New York,
June 15th, 1910.

My Dear Dr. Dugan;

N. TESLA

Please accept my thanks for your book on electro-therapeutics just received, and also for the expression of your appreciation.

I shall peruse your volume with great interest. In glancing over it casually, I notice that on page 119 you give credit to Dr. Wm. J. Morton for the discovery of the high frequency currents. He is a personal friend of mine and I have a high regard for him, though I think that his claim is untenable. He made the statement you quote in good faith, of course, but not being an electrician, the early records were probably not available to him. The so called "static induced current" was known for at least thirty years before. As to its use in medicine, it can be stated broadly that ever since Leyden, stored static electricity has been used, though the knowledge of the subject was very imperfect. With the advent of the frictional machine, it also became a familiar fact that by adjusting the capacity of the Leyden battery, spark discharges of any rapidity of succession could be obtained.

However, not until I published in the "EL.WORLD" in February 1891 some physiological effects of high frequency currents which I had observed, was the attention of physicians directed to the subject. P'Arsonval in France published more complete results two months later claiming, however, that he had made the discovery before.

Figure 2. Copy of the letter from Nikola Tesla to WJ Dugan, New York, June 15th, 1910 *Figure 2 Copy of the letter N. Tesla – WJ Dugan, New York, June 15th, 1910*

several hundreds of kilohertz) are used in medical diathermy procedures, where electrical energy is converted into thermal energy, and in this way the tissue inside the body is heated, acting therapeutically [4]. It treats rheumatic and other chronic diseases, inflammations, and is also used in gynecology and surgery. A similar procedure is called teslinization, whereby the human body is placed in the electric field of HF currents obtained by a Tesla transformer.

The procurement of teaching aids for teaching physics followed individual discoveries in physics, and was largely determined by the research orientation of individual professors. Tesla's transformer, which in the past was used in physics classes at the Faculty of Medicine in Rijeka, dates back to 1908 and is certainly one of the oldest of its kind, and according to the plate on it,

it can be seen that it was made in the well-known *Max Kohl* school production company from Chemnitz. It is not possible to say with certainty how this study came to Rijeka, but it is assumed that it was acquired for teaching physics at the Naval Academy, which existed in Rijeka at that time. Physics was then taught by Peter Salcher [5], a professor at the Naval Academy and an active member of the Natural Sciences Club (Naturwissenschaftliches Club, Club di Scienze naturali). This club was active in Rijeka from 1883 until the First World War and had considerable influence on the development and popularization of the natural sciences, especially on the development of physics [6]. After the establishment of the Faculty of Medicine in Rijeka, physics professor Aleksa Steiner used the aforementioned teaching to demonstrate experiments with high-frequency currents.

Tesla had other discoveries that later proved to be very important for medicine. Doing experiments with vacuum tubes, he discovered X-rays almost at the same time as WC Röntgen. Just a few months after Röntgen informed the public about the new discovery, Tesla published a series of articles about these new rays in the American journal *Electrical Review* in 1886 [7]. In the articles, he described in detail the technique of obtaining X-rays and attached X-rays of the human skull and chest, which he made himself (Figure 4). He is also responsible for improving the technique of x-ray devices, especially for maintaining and regulating the vacuum in x-rays.



Figure 3. Tesla's device for treatment with high-frequency currents, beginning of the 20th century. (Nikola Tesla Museum, Belgrade)

Figure 3 Tesla's apparatus for medical use (Nikola Tesla Museum, Belgrade)

skim pipes. Physicists attributed the discovery of X-rays exclusively to Röntgen, after whom they were named. Tesla never disputed this, and even corresponded with Röntgen (Figure 5).

Experimenting with high-frequency currents, Tesla noticed that these currents cause the formation of ozone in the air [8]. In very small concentrations, ozone has a refreshing effect and also has bactericidal properties. Tesla knew about the bactericidal effect of ozone, so he constructed one of the first ozone generators or ozonizers. He patented this invention in 1896 (Figure 6), and in 1900 he founded the *Tesla Ozone Company*, which produced ozone generators and sold them to doctors. Even today, ozonizers are used to purify and freshen the air in rooms with air conditioning.

In 1890, Tesla noticed the following phenomenon: if an object placed on a photographic plate is placed in a high-frequency electric field, an outline (image) of that object appears on the plate [9]. He called this phenomenon electrographic photography or electrography. Later, this method of painting was called



Figure 4. Photograph of the skull taken by Tesla, 1896.

Figure 4 An X-ray picture taken by Nikola Tesla, 1896

München 20 Juli 1901

Herrn Nicola Tesla : New York

Sehr geehrter Herr!

Sie haben mich ungemein über-
rascht mit den schönen Photographien
von den wunderbaren Entladungen, und
ich danke Ihnen vielen Dank dafür.

Wenn ich nur könnte, mit Sie solche
Sachen machen!

Mit dem Ausdruck besonderer Hochachtung
verbleibe ich.

Ihr ergebener
W. Röntgen

Figure 5. Röntgen's letter to
Tesla Figure 5 Copy of the Röntgen's letter to Tesla

Kirlian photo. A characteristic outline also appears on photographs of parts of the human body, which is interpreted as an "aura" or the energy field of a living organism, and attempts are made to connect the change of outline with pathological conditions, both biological and psychological, especially in alternative media does.

Nikola Tesla also conducted experiments in which he examined the influence of mechanical vibrations on some physiological disorders. He constructed a "vibra tor" which he used to reduce the feeling of fatigue in the leg muscles [10]. He was a vital man and lived to a ripe old age. That is why it is in some of its own

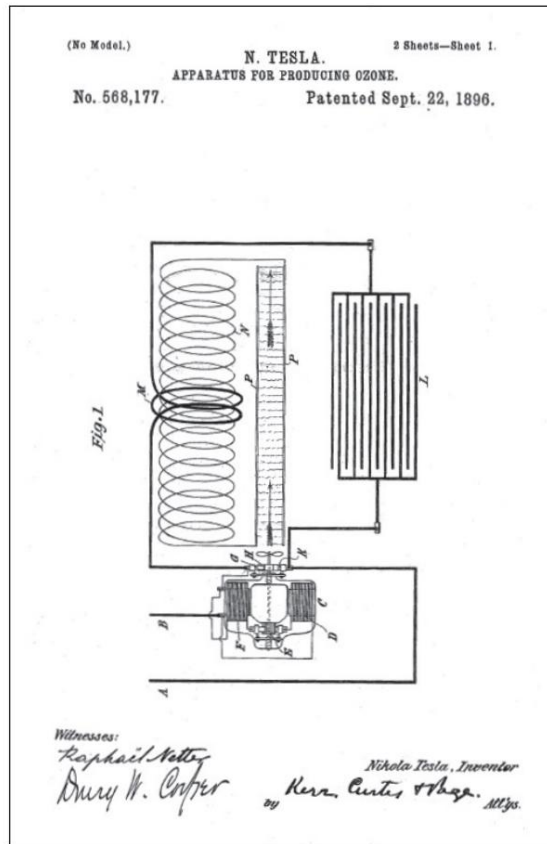


Figure 6. Patent application for ozone production apparatus, 1896.

Figure 6 Tesla's patent of the apparatus for producing ozone, 1896

spoke about proper nutrition and a healthy lifestyle in articles and lectures. Through his work and performances, he proved the humanist traits of his personality over and over again, wanting to make the world a better place.

Although medicine was not Tesla's main field of scientific interest, he contributed significantly to that scientific discipline with his discoveries, primarily by inventing transformers and experimenting with X-rays.

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ABSTRACT

Scientist, inventor, electrical engineer - Nikola Tesla (Smiljan, 1856 - New York, 1943), made a significant contribution to medicine by inventing a transformer for creating high-frequency and high-voltage "Tesla currents". High-frequency currents can be used in medical diathermy, where electrical energy is converted into heat and heats the tissue inside the organism, acting therapeutically. Tesla himself warned about this effect as early as 1891 in the **Electrical World** magazine, after the experiment of passing electricity through his own body. Namely, although he had no medical education, he was interested in the physiological effects of electricity, and corresponded with doctors WJ Dugan and SH Monella about electrotherapy. In 1896, he published in the journal **Electrical Review** the X-ray images of the skull that he managed to produce before Röntgen himself, but he could not explain the nature of their origin. Six years before, he noticed that by placing an object on a photographic plate in a visco-frequency electric field, an image of that object, bordered by light, remained on the plate. This phenomenon, called the "Kirlian effect", is interpreted as an "aura", that is, the energy field of living organisms. In 1896, he patented an ozonizer, a device for the production of ozone, which he produced in the **Tesla Ozone company** from 1900 and sold to doctors.

After researching museum materials, exhibits and literature, the article places special emphasis on the application of his inventions in medicine. With a brief review of Tesla's transformer of the Institute of Physics of the Faculty of Medicine of the University of Rijeka from 1908, it is finally concluded that Nikola Tesla, first of all through his invention

transformers and the discovery of X-rays, made a significant contribution to both medical diagnostics and therapy.

Keywords: *history of medicine, history of physics, XIX. and 20th century, Nikola Tesla, Tesla transformer, electrotherapy, X-rays*

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