Nikola Tesla discovered „very special radiation“ or X-radiation

Vladimir Baltić[1], Milan Baltić[2]

SUMMARY

Nikola Tesla was an ingenious and briliant scintifist which contributed to the science and technology prosperity of the world. Nikola Tesla discovered high frequency oscillator 1891 year, and afterwards, single electrode X-ray tube without target electrode, electron („particles charged with electricity“), Bremsstrahlung or „breaking radiation“ or „very special radiation“ (X-radiation) in 1892 year, biological hazards of X-rays, and more about 700 inventions, and 112 patents. Tesla's research work in the field of X-rays was stoped in 1895 becouse burned in his laboratory. When W. C. Röntgen 1895, recognition X-rays, Tesla restored his work on this field and sent Röntgen a telegram with congratilations and Röntgen shows obtained with X-ray tubes which operated with high frequency currents. Tesla discovered many secret of nature.

Key words: *Nikola Tesla; X-Ray; Tesla's Oscillator; Vacuum Tubes; Biological Hazards*

Arch Oncol 2007;15(3-4):100-5.
UDC: 66.085.3:001.894
DOI: 2298/AOO0704100B

[1]Oncology Institute of Vojvodina, Sremska Kamenica, Serbia, [2]Medical faculty Novi Sad, Novi Sad, Serbia

Correspondence to:
Prof. dr. Vladimir Baltić, Oncology Institute of Vojvodina, Institutski put 4, 21204 Sremska Kamenica, Serbia
baltic.vladimir@onko.onk.ns.ac.yu

Received: 01.11.2007
Provisionally accepted: 21.11.2007
Accepted: 02.12.2007

„I think that the work of Nikola Tesla at that time and his great idea of rotating magnetic field is one of the greatest fields of human imagination in the history of human kind. That work of his enabled the discovery of x-rays, as well as all of work all over the world performed by J. J. Thompson and others, which brought to the concept of modern physics.“

Andre Blonden, French scientist

INTORODUCTION

Nikola Tesla (Name in Cyrillic alphabet, Никола Тесла, July 10,1856, Smiljan – January 7, 1943. New York) was an ingenious and brilliant American scientist of Serbian origin and a man of vision who lived and worked in XIX and XX centuries and greatly contributed to the science and technological prosperity of the world as an inventor of rotating magnetic field, induction motor, polyphase alternating current, generators and total system of transmission and distribution of elecrical energy (Figure 1).

Figure 1. Nikola Tesla, with Roger Boskovich's book „Theoria Philosophiae Naturalis“, in front of the spiral coil of his high-frequency transformer at East Houston St., New York, about 1893 year

Nikola Tesla dicovered high freqency oscillator in 1891, which was later called Tesla's oscillator. That invention marked the beginning of the second phase of development of the radio, wireless transmission of energy, discovery of very special rays and application of Tesla's currents in medicine, and numerous other inventions (1). Tesla was also a physicist, mechanical engineer and electrical engineer and he contributed to the fields of mechanical engineering, to the computer science, nuclear and theoretical physics, balistics, and to medicine (2). When we talk about nature of X-rays, it is interesting to know Tesla's opinion on matter and energy. Tesla regards that matter was created out of primeval and eternal energy which is known to us as light, and that it existed before matter (3). Tesla had, as a man of vision, expressed visual thinking which enabled him to represent his invention to the smallest detail. In studying light, he was of the opinion that the Sun was a paradigm, and that it was radiating heavenly body which from itself ejects particles which contain high velocity and energy, which bombard the earth, i.e. he discovered cosmical rays. In such a way Tesla philosophically considered the light to consist of waves and particles in nature. He thought that bundles of rays originate from matter in a primary or basic condition. The Sun, and perhaps some other sources of energy, probably emit similar bundles by radiation“ (N. Tesla, On Roentgen radiation, Electrical Review, April 8, 1896) (4). Such „projected lumps of matter act like non-elastic bodies, similar to small lead bullets... These lumps degrade in such small fragments that they totally lose some physical properties that they had prior to the stroke... Isn't it that we in fact witness the transformation of common matter into ether in case of roentgen phenomenon, or are we perhaps witnesses of decomposition of matter to some primary state...“ (N. Tesla, Roentgen rays or streams. Electrical Review, 1.12.1896) (5). Tesla proved that „the effects on sensitive plate depend on particles or vibrations of extremly high frequences“ (6). Today we know that X-rays are a form of invisible, high frequency electromagnetic radiation with wavelenght between 10 and 0.01 nanometres, corresponding to a frequency of 30 PHz to 3 E Hz. They are produced by accelerating electrons at a metal

target. In medical application, this is Tungstran (95%), Rhenium (5%), or Molibden. X rays are used in various medical applications (7). Tesla is the author of almost 700 inventions, and he patented 112 patenats in the field of electrotechniques all over the world and today they represent a basis for studying and exploatation. In honour of contribution of Nikola Tesla to science, on June 30, 1956, International Electrotechnical Commission Committe of Action, decided to intoduce Tesla (T) as a unit of magnetic induction. Tesla, (T=W/m2 or T=N/(m x A)) is the unit of magnetic flux density, equal to the magnitude of the magnetic field vector necessary to produce a force of one newton on a charge of one coulomb moving perpendicular to the direction of the magnetic field vector with a velocity of one meter per second. It is equivalent of one weber per meter (8). Also, general Director UNESCO, Koichiro Matsumura, decided, on October 16th, 2003, to enter the active material from Tesla's inheritance into Register of UNESCO's Memory of the World Programe (9).

The aim of this paper is to remind the medical workers, biologists and others to remember more than hundred years later that Nikola Tesla discovered in1892 „unusual rays" and gave characteristics of breaking radiation (Bremssthrahlung) and its nature, which three yearslater were named Roentgen rays or X-rays. The discovery X-rays and uranium rays, and electron contributed to a profund transformation of physics in the 20th century. For more than 100 years, the use of X-rays has developed two separat paths in diagnostic imaging and scatering of X-rays for studing atomic and nuclear structure. The use of x-rays for medical purposes to develop into of radiation therapy.

THE WORK ON „UNUSUAL RADIATION"

In the second half of XIX century X radiation was studied by numerous scientists: Ivan Puelyui, William Crooks, Johan Wilhelm Hittrof, Eguen Goldstein, Henrich Hertz, Philipp Lenard, Herman von Helmholtz, Thomas Edison, Charle Glover Barkla, Max von Laue, Nikola Tesla, Mihajilo Pupin and Wilhelm Conrad Roentegen. Everyone of them gave significiant contribution to the discovery and to the description of X radiation. For example, Hittrof described „energy rays", Goldstain described „cathode rays", and Crooks developed cathode tube, which was named after him. He investigated electrical flow in gasses under low preassure in that tube. Hertz noticed that cathode rays pass through a thin metal layer, and Lenard developed his own tube in which he was able to follow the path of x rays and to induce fluorescence in it. Helmholtz formulated mathematical equations for X-rays. He postulated a dispersion of X-rays before Roentgen (10).

Nikola Tesla founded his own company in 1886 in New York: *Tesla Electric light & Manufacturing…* with an aim of implementing his invention in the field of polyphase alternating currents. In the newly erected laboratory Tesla constructed his first polyphase AC motor. After this discovery Tesla decided to solve Maxwell's and Hertz's theory of electromagnetic fields (1,11).

In April 1887, Nikola Tesla began to investigate X-rays using high voltages and vaccum tubes of his own design, as well as Crooks tubes. From his technical publications it is indicated that he invented and developed a special single electrode X-ray tube with one knee, which differed from other X-ray tubes in having no target electrode and which is very similar to his patent no. 514170 (http://www.google.com/patents?id=UpldAAAAEBAJ&dq=5147) (Figure 2) (1,10-12).

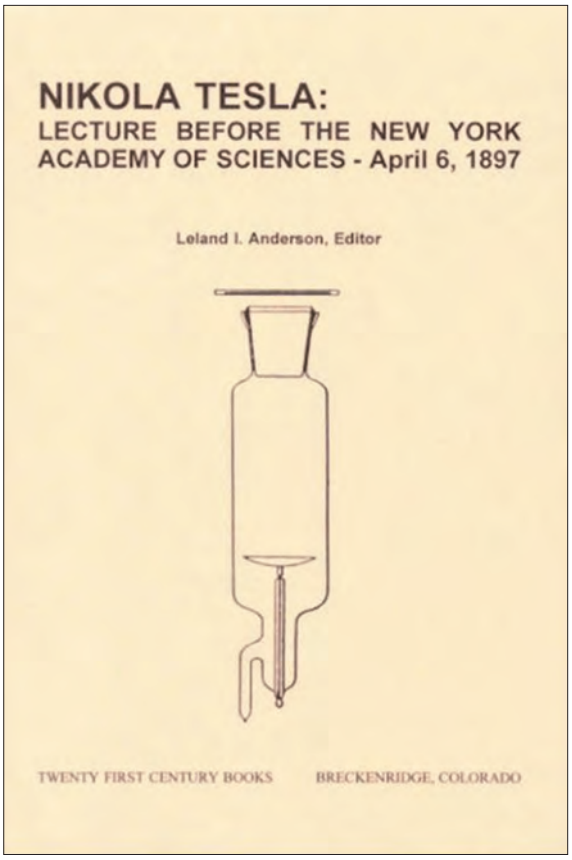

Figure 2. Sketch vacuum tube for production X-rays; Tesla's designe

He stated these facts in his unpublished 1897 X-ray lecture before The New York Academy of Sciences. Andersen had reconstructed the lecture a partial typescript and from two articles by Tesla in the May 5 and August 11, 1897, issues of Electrical Review (N.Y.) (1,11,12). In the beginning of 1889, Tesla constructed the first generator of high frequency and high voltage, and in 1891 he created Tesla's coils, which enabled experiments in vacuum tubes and which also enabled the obtaining of clear roentgen pictures. At the same time, X-rays were investigated in Europe using static apparatus and Rumkorf's inductor. Tesla was of the opinion that high frequency coils instead of them should be used in order to reduce dissipation of potential. In that way extreme voltages were possible to achieve of about 4.000.000 volts.

In July 1891, Tesla declared that during experimenting in vacuum tubes he proved the existence of electrostatic charge because of existence of elemental particles (13). J. J. Thomson reacted quickly on this claiming that this had nothing to do with the existence of electrically charged particles. However, in August Tesla answered to him that „electrostatic charging is the outcome of small, particles charged with electricity, which crash with the molecules of diluted gas" (14). Five years later, Thompson repeated the experiment and proved Tesla's claim, and he called the particles electrons. Thompson was awarded Nobel Prize, not even mentioning Tesla's name.

Tesla wrote in his paper on nature and reflexion of X rays: „Roentgen inclined to the convection that the rays he discovered were longitudinal waves of ethir….; From my experiments in reflection of the Roentgen rays… with powerful radiations, maybe shown to exist under all angles of incidence, it appears that the lumps or molecules are indeed shattered into fragments or

constituents so small us to make them lose entirely some physical properties possessed before the impact…; The first florescence when the current is turned on the wall produces in variabbly this first fluorescence, and the latter never takes place when the bulb has been exhausted under application of a high degree of heat or when the organic matter is otherwise destroyed. Upon the disappearance of the first fluorescence, the refraction increased slowly…; When taking impressions at a small distance tube giving very intense rays no shadow, unless a scarcely perceptible one, is obtained. Thus, for instance, the flesh, and bones of the hand appear equally transparent… The distance still increased the shadow of the flesh appears, while that of the bones grows deeper, and in this neighborhood a place can be found at which the definition of the shadow is clearest. …; We can show have one or other body might allow the rays to pass through, but such explanations are not applicable to all bodies without exception."… (15,16). „I am getting more and more convinced that we have to deal with a stream of material particles, which strike the sensitive plate with great velocities. Taking as a basis the estimates of Lord Kelvin on the speed of projected particles in a Crooks bulb, we arrive easily, by the employment of very high potentials, to speeds of as much as a hundred kilometers a second… Are the particles from electrode or from charged surface generally… projected through the glass or aluminium walls, or do they merely hit the inner surface and cause particles from the outside of the wall to fly off, acting in a purely mechanical way, as when a row of ivory balls is struck? So far, most of the phenomena indicate that they are projected through the wall of the bulb..." (4,15). A single electrode, in the form of a round disk of a diameter slight less than that of the tube, was placed about an inch below the narrow neck on the top. „A singe electrode *e*, consisting of a massive aluminium plate is mounted on a conductor *t*, provided with a glass wrapping *w*, a s usual, and selected in one of the ends of a straight tube *b*, about five centimeters in diameter and 30 centimeters long…, in such bulbs I have used a number of different metals for impact with a view of increasing the intensity of the rays and also for the purpose of reflecting and concentrating them." (17). The leading-in conductor's cracking, was provided along with wrapping, so as to prevent cracking, by the formation of sparks at the point where the wire enters the bulb… In the present instance the screen was preferably formed by a bronze paintings, slightly above the aluminium electrode and extending to just a little below the wrapping of the wire, so as to allow seeking constantly the end of the wrapping or else a small aluminium plate (Figure 2), was supported in the inside of the bulb above the electrode… I may remark, however, that while it may be generally stated the Crooks vacuum is not enough for the production of the Roentgen phenomena, this is not literally true. Nor are the Crooks phenomena produced at a particular degree of exhaustion, but manifest themselves even with poor vacuum, provided the potential is high enough. This likewise, is true of the Roentgen effects. In my experiments on reflection with apparatus shown in Figure 2…. the reflection of this stream is dependent upon some fundamental and electrical property of the metals. …For example, magnesium should be even a better reflector than zinc, and sodium still better than magnesium"… „In a number of experiments with rays reflected from any transmitted through a conducting of insulating plate, some that only a small part of the ray could be accounted for, for instance, through a zinc plate, one-sixteenth of one inch thick, under an instance angle of 45 degrees, about two and one-half percent where reflected and about three percent transmitted through the plate, hence over 94 percent of the total radiation remain to be accounted for." (18). Therefore, independently from Roentgen, in 1892 Tesla discovered „white light, dark light and very special radiation" or X rays, and performed a few experiments with these lights but he did not categorized them" (1,11). At that time he wrote: „electric bulb will in the beginning get warm and give violet light, but then the electrode will decompose and the bulb will get cold. It is useful to use a ventilator, from that moment the bulb is in very good condition for the production of roentgen shadows" (18,19). He did not publicity declare his findings nor did he make them widely known. Today, that kind of radiation is known as Bremssthrahlung or „breaking radiation" or „declaration radiation" (20). Apart from this, X rays may be generated by K-shell emission. Bremsstrahlung is emitted radiation when the velocity of the electron shot at the nucleus of a positively charged tungsten atom. This energy loss produces X radiation. Electrons are scattered elastically and non-elastically by the positively nucleus. The non-elastically scattered electron loses energy, which appears as Bremsstrahlung. Elastically scattered electrons are generally scattered through large angles (Figure 3). This process is extremely inefficient (-0,01%) (20).

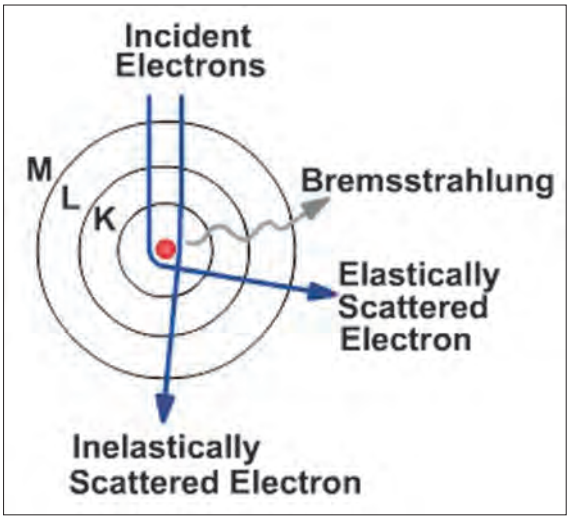

Figure 3. Scheme of X radiation or „braking radiation" (20)

In those experiments Tesla… „A few weeks ago, when I observed a small screen of barium-platina-cyanide flare up to a great distance from the bulb, I fold some friends that it might be possible to obscure by the aid of such a screen objects passing through a street… I mention this odd idea only as an illustration of how these scientific developments my even affect our moral and customs"; „…obtained **shadows** with comparatively short exposures at distances of many feet, while at small distances and with thin objects, exposures of a few seconds are particle… A similar impression was obtained through the body experiments, a plate of glass; nearly three-sixteenth of an inch thick, a thickness of wood of fully two inches and through a distance of about four feet. The bones of human limbs were obtained by exposures ranging from a quarter of an hour to an hour, and some plates have shown such an amount of detail that it is almost impossible to believe that we have to deal with shadows only"… " An outline of the scull is easily obtained with an exposure of 20-40 minutes. In one instance an exposure of 40 minutes gave really not only the outline, but the cavity of the eye… nasal bones,… the vertebral column and connection to the scull, the flesh and even the hair. His now demonstrated

beyond any doubt that small metallic objects or bony or chalky deposits could be infallibly detected in any part of the body... „Or possible by the use of the X-rays to project a suitable chemical into any part of the body, which would wave it a valuable therapeutic agent...“ (4,17,19).

Figure 4. Radiograph of a chest and shoulder, Nikola Tesla (26)

The word „senograph“ Tesla took from philosophic paper by Sören Kiekeegaard called „Either or Or“. For Kierkegaard, senographs are the drafts that originate from the side of life, which is in the shade, …and cannot directly be seen… The picture, which I want to show to you here, is also an inner picture, which becomes visible when I watch it through the outer side. The outside may not have anything observable by itself, but only when I look at it from the outside, I am able to discover the inner picture, which is too delicate to be seen from outside…“ (11,21).

The word „skiagraph“ (from the Greek for a shadow) was introduced in 1896 for a picture obtained by X-rays and was used for a few years. Tesla was the first to make the photographs, the skeleton of a birds and rabbit, his own hand and knee (11).

Tesla's research work in the field of X rays was stopped in March 1895 when his laboratory in 5th. Avenue 46 E in New York was burned to the ground including all of his laboratory, equipment, documentation, as well as senographs of his hand and ankle. That event also stopped the development of some of Tesla's inventions or even disabled them (23).

When Wilhelm Conrad Roentgen published his paper titled „On a New Kind of Rays: A Preliminary Communication“ on December 28, 1895 in the Proceedings of the Physical Medical Society of Wurburg, it marked the first formal and public recognition of the categorization of X-rays. Roentgen referred to the radiation as „X“ to indicate that it was an unknown type of radiation“ (24). Tesla restored his work on this field. He immediately repeated his experiments and also repeated the research work of Roentgen. Tesla sent Roentgen a telegram with congratulations and with recordings of shoulders and chests, and with a fluorescent photograph of „Roentgen“, which were obtained with „very special radiation“ obtained with X ray tubes operated with high frequency currents. Roentgen replied, „The pictures are very interesting. If you would only be so kind as to close lose the manner in which you obtained them“ (8,25). Tesla did not considered that this situation gave him any priority in the discovery of X-rays, nor did he ever advanced any claim; but he immediately started an extensive series of investigations into their nature (Figure 4) (25).

After the discovery of Roentgen rays, Edwards R. Hewitt wrote: „On the morning when Nikola Tesla photographed Mark Twain using Geissler tube, it turned out that it wasn't the photo of Mark Twain, but of a screw for adjusting the lenses of the apparatus“ (25). In fact, it was the first senograph with X rays on the territory of USA (Figures 5 and 6).

Figure 5. Radiograph of a hand, Nikola Tesla (Muzej Nikole Tesle, Belgrade, Archive)

Figure 6. Radiograph of a foot, Nikola Tesla (27)

Around this time, Tesla was friendship with Mark Twain. They spent a lot of time together in Tesla's lab and elsewhere. „The news on the discovery of X rays was interesting for the scientific audience and many of them started studying that kind of penetrating radiation. Tesla's later X-ray experimentation by vacuum high field emission led him to alert the scientific community first to the biological hazards associated with X-ray exposure. Tesla wrote: „By expressing the head to a power full radiation strange have been noted. For instance, I find that there is a tendency to sleep and the time seems to pass away quickly. There is a general shooting effect, and I have: felt sensation of warmth in the upper part of the head. An assistant independently confirmed the tendency to sleep and quick lapse of time. When working with highly strained bulbs I frequently experienced a sudden, and sometimes even painful shock in the eye. Such shock may occur so often that the eye gets inflamed, and one cannot be considered over precautious if he obtains from watching the bulb too closely." In spring of 1897 Tesla suddenly got ill with all the clinical signs of the flu, but this was not connected with the harmful effects of X rays, or he was ill because of „shock of x-rays" for the eyes". Apart from that, Tesla observed „painful irritation on the skin, inflammation and appearance of blisters..., and in some spots there were open wounds". In the beginning he thought that the damages of the skin „are not due to the Roentgen rays, but merely to ozone generated in the contact with the skin. Nitrous acid may also be responsible, but to a small extent". „The action of the ozone on some substances, when placed near the bulb in such a way that the gas is generated on their surfaces, is so powerful that… the substances are practically destroyed in a few minutes… this powerful action of the ozone was observed by me first about two years ago, when performing an experiment which was shown to many persons in my laboratory." (17). Finally in the end of 1896 he wrote that „there are real dangers of Roentgen radiation... and that it is necessary to be aware of that dangers … so that they may not happen to somebody else" (1,25).

Apart from scientific testimonials, even the poets give evidence about the first senographs of Nikola Tesla. For example, Mrs. Catherine Johnson, the wife of well-known American poet Robert Johnson, who also was bearing the name of a well-known rebellion from the rising in Herzegovina, Luka Filipov, she wrote to Tesla on January 6, 1898 on the occasion of Robert's birthday: „When tomorrow evening you pay us a visit, we shall talk about the arm which is in front of me. That arm is doomed to be removed, because I cannon stand to look at it. It is too unusual, too strong, and whenever I occasionally enter the room, it frightens me immediately. That is one of its characteristics. But, that arm is not authentic, because it does not give the authentic idea of your hand, which is big and free, as you are. This arm looks thin, short; I know they call it shadows. You must try to make your arm just as big as it was and open again, as it really is." (28).

After publishing the news on the discovery of Roentgen rays, Oliver Lodz announced that he had made an apparatus that can see through a man. Few days after that news, Edison declared that he invented an apparatus by which he could see through two men, and that Tesla had invented the rays that are so mighty and that the rays penetrated through three men. When Lodz showed that to Edison, he smiled and said: „Good, let's stay with number three, what do you think? I think that three are enough and that they can prove as much as a regiment" (Phosphorescent light. New York. Mail and Express, May 22, 1896).

On January 2, 1896, Pupin made the first photograph of a patient who had his hand full of pellets of bullets in soft tissues, he had shortened the exposition for some 20 times and by putting a fluorescent blind in front of the film and found that primary rays produce secondary rays X rays. For example, Becqerel found in 1896 that the uranite salts emit X rays, which pass through thin leaves of aluminium and copper. Maria Sklodowska-Curie studied the nature of uranium radiation and suggested to introduce the term „radiation" for the ability of uranium to emit radiation." It was discovered that other radioactive elements produce other types of radiation, which influenced the discovery of inner structure of atom, and so on (29).

From 1887 till 1897 Tesla gave the mankind: electrical vacuum bulb, he discovered „very special radiation", electronic microscope, cosmic rays, electron. The Tesla coil invented in 1991, is still in use today. High frequencies allowed Tesla to develop the first neon and fluorescent illumination, and the first X rays photographs.

All of these inventions, which are „invented again" contributed to the fact that many were awarded Nobel prize, but Tesla himself is never mentioned in connection with them. However, it was the beginning of Tesla's creation. X-rays are not generated here on Earth: the universe has been full of X-ray satellite was launded to explore the structure and development of planets and stars oh the hearens. Tesla's monumental discovery made a considerable contrinution to the welfare of mankind. He is discovered many secret of nature!

References

1 O'Nil Dž. Nenadmašni genije. Život Nikole Tesle. Beograd: Metaphisica; 2006.
2 Powerpedia: Nikola Tesla. Available from http://peswiki.com/energy/PowerPedia:Nikola-Tesla (27.11.2007)
3 Jelača S. Nikola Tesla. Available from: http://www.vojvodina.com/prilozi/Tesla.htm (27.11.2007)
4 Tesla N. On Roentgen radiations. Electrical Rewievs, April 8,1896; Available from www.rastko.org.yu/projekti/tesla/delo/10779 (24.10.2007)
5 Tesla N. Roentgen ray investigations. Electrical Review April 22, 1896. Available from www.rastko.org.yu/projekti/tesla/delo/10779 (24.10.2007)
6 Tesla N. An interesting feature of X-ray radiation. Electrical Review July 8,1896. Available from www.rastko.org.yu/projekti/tesla/delo/10779 (24.10.2007)
7 X-ray. Wikipedia, the Free Encyclopedia. Available from: http://en.wikipedia.org/wiki/x-ray (24.10.2007)
8 Vujović Lj. Tesla Memorial Society of New York. Available from www.teslasociety.com (26.10.2007)
9 Civrić Z. Nikola Tesla i njegov muzej. *Tesla*. 2006:1;6-13.
10 Nikola Tesla. Wikipedia, the Free Encyclopedia. Wikimedia Foundation. Available from: http://en.wikipedia.org (26.10.2007)
11 Sajfer MDz. Carobnjak. Zivot i vreme Nikole Tesle. Biografija jednog genija.19. Senograf (1896). Novi Sad: Stilos; 2006. p. 178.
12 Anderson IL. Nikola Tesla: Lecture before the New York Academy of Science, April 6, 1897. Breckenridge, Colorado: Twenty First Century Books.
13 Tesla N. Electric disclorge in vacuum tube. The Electrical Engineer; New York, July 1, 1896:A-16.
14 Tesla N. Reply to J.J. Thomson's note. The Electrical Engineer; New York, August 26, 1891.
15 N. Tesla Roentegn rays or streams. Electrical Review, 12.8..1896; Available from www.rastko.org.yu/projekti/tesla/delo/10779 (25.10.2007)
16 Tesla N. On reflection Roentgen rays. Electrical Review. Aprile 1, 1896. Available from www.rastko.org.yu/projekti/tesla/delo/10779 (25.10.2007)
17 Tesla N. On the roentgen streams. Electrical Review December 1, 1896; Available from www.rastko.org.yu/projekti/tesla/delo/10779 (25.10.2007)
18 Tesla N. On apparatus for cathography. Electrical Review May 9, 1896. Available from www.rastko.org.yu/projekti/tesla/delo/10779 (24.10.2007)
19 Tesla N. On Roentgen radiations. Electrical Review, March 11, 1896; Available from www.rastko.org.yu/projekti/tesla/delo/10779 (24.10.2007)

20 Tesla N. On Roentgen rays: latest results. Electrical Review March 18, 1896, Available from www.rastko.org.yu/projekti/tesla/delo/10779 (24.10.2007)

21 Bremsstrahlung, Wikipedia, the Free Encyclopedia. Available from www.en.wikipedia.org/wiki/ bremstrahlung (24.10.2007)

22 Kierkegaard S. Eiter or Or. 1848, (preveli na engl. Dejvid i Lilijan Svenson). New York: Oxford University Press; 1944.

23 Nikola Tesla. Available from http://www.theblackvault.com/wiki/index.php/Nikola-Tesla (8.12.2007)

24 Wilhelm Conrad Rontgen, Wikipedia, the Free Encyclopedia. Available from: http://en.wikipedia.org/wiki/Wilhelm-Conrad-R%C3%B6ntgen (11.11.2007)

25 Babić R. Nikola Tesla i X zraci. *Acta Medica Medianae*. 2004:43(4);81-2.

26 Nikola Tesla. Available from http://freesrpska.org/en/index.php?option=com=content-&taskview&id=688itemid=30 (1.12.2007)

27 Nikola Tesla. Available from http://www.reformation.org/nikola-tesla.html (02.12.2007)

28 Potočan B. Njujork peva srpski. Available from http://tesla:ld.o.net/page.php?2 (02.12.2007)

29 X-radiation. Available from http://www.ndt-ed.org/EducationalResources/CommunityCollege/Radiography/Physics/xrays.htm (21.11.2007)