

TESLIN TRANSFORMATOR SA TROFAZNYM NAPAANJEM

U Laboratoriji za atomsku fiziku razvijena je **"Nova tehnologija za čišćenje dimnih gasova od SO₂ i NO_x pomoću visoko frekventnog korona pražnjenja kada se kao izvor napajanja koristi Teslin transformator"** - ELFI TEHNOLOGIJA.

U prvim eksperimentima je korišćen konvencionalni Teslin transformator (umanjena verzija Teslinog transformatora kao u Muzeju "Nikola Tesla" u Beogradu). Medjutim, visoki napon konvencionalnog Teslinog transformatora nije konstantan - menja se sa vremenom, u zavisnosti od vremena pražnjenja visoko naponskog kondenzatora. Zbog toga eksperimentalni rezultati izučavanja ELFI tehnologije nisu reproducibilni.

Da bi se dobili reproducibilni eksperimentalni rezultati izučavanja nove tehnologije za čišćenje dimnih gasova od SO₂ i NO_x - ELFI tehnologije razvijen je **"Novi tip Teslinog transformatora sa trofaznim napajanjem"** -3PTC.

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3. Vujo Miljević, Teslin transformator sa trofaznim napajanjem, Republika Srbija, Zavod za intelektualnu svojinu, 10. april 2007., Broj patenta 49 563.

4. V. Miljevic and M. Davidovic, u knjizi **IDEJE NIKOLE TESLE: The Three Phase Tesla Coil; The technology for removal of SO₂ and NO_x from flue gases by high frequency discharge by using Tesla Coil**, AKADEMIJA NAUKA I UMJETNOSTI REPUBLIKE SRPSKE - NAUČNI SKUPOVI, Knjiga X, ODJELJENJE PRIRODNO-MATENATIČKIH I TEHNIČKIH NAUKA, Knjiga 6, strana 107, Banja Luka, 2006.

5. Vujo Miljević and Veljko Lučić, **APPLICATION OF THE THREE PHASE TESLA COIL FOR REMOVAL OF SO₂ AND NO_x FROM FLUE GASES BY HIGH FREQUENCY DISCHARGE**, INTERNATIONAL CONFERENCE, INNOVATIONS&HEALTH AND SAFE HUMAN ENVIROMENT, 29TH AND 30TH NOVEMBER, SANU, BELGRADE 2007, SECTION E-CLEAN HUMAN ENVIROMENT, BAI2007ED007.

6. POSTER

7. SLIDE SHOW

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**APPLICATION OF THE THREE PHASE TESLA COIL FOR REMOVAL OF SO₂
AND NO_x FROM FLUE GASES BY HIGH FREQUENCY DISCHARGE**

**PRIMENA TROFAZNOG TESLINOG TRANSFORMATORA ZA ČIŠĆENJE SO₂ I
NO_x IZ DIMNIH GASOVA POMOĆU VISOKOFREKVENTNOG KORONA
PRAŽNENJA**

Abstract

The new original electronic filtering technology (ELFI) using a plasma chemistry method is developed in "VINCA" Institute of Nuclear Sciences, on the basis of fundamental research of the original type of high frequency corona discharge energized by the new type of high-frequency and high voltage generator - "Three-phase Tesla Coil".

The ELFI module can be added to an existing plant as a by-pass, so it does not obstruct its function. SO₂ and NO_x are simultaneously removed from the flue gases by the ELFI technology and are converted into a useful artificial fertilizer. Waste materials are not produced by this technology, and the problem of permanent storage of undesired products does not exist.

Key words: SO₂, NO_x, flue gas treatment

1. INTRODUCTION

The emission of toxic gas, sulphur oxides and nitrogen oxides from industrial plants has become a serious problem in the World. SO₂ and NO_x are known to be converted to "acid rain" in the atmosphere and cause the environmental pollution. – Fig. 1

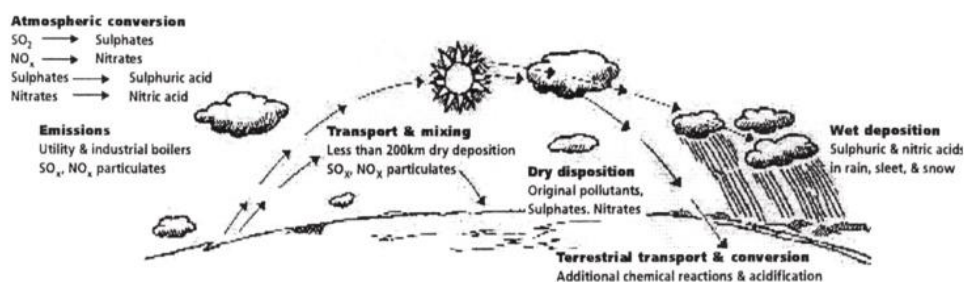


Fig. 1

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2. TECHNOLOGIES FOR CLEANING SO₂ AND NO_x FROM FLUE GASES

E-beam technology has the disadvantages of high capital cost and the need to shield potentially hazardous X-rays which are produced in the process. One possible alternative technology is the corona discharge, a comparatively recent entrant to the field of non-thermal waste treatment. The principle behind the corona discharge is the creation of plasma filaments – small bursts of plasma – generated when a high voltage is applied between a wire filament and a metal plate. High electric fields are created in the heads of those filaments, which produces largenumbers of free electrons, as in e-beam reactors.

Results so far have been encouraging, although the gas volumes treated to date have been considerably smaller than those using e-beams. Corona discharges have the potential advantages that fitting costs may be greatly reduced, since they use the same wire-plate electrode configuration as in the electric percipitators used in convetional “wet scrubbers” for flue gas control. If either of these methods is to replace conventional technology, they will need to use less than 3% of the total electrical power of the generator.

One of the major problems for both technologies is “scale-up” for application to the modern large power plants [1] .

3. IMPULSE CORONA DISCHARGE

Theoretical investigation of the phenomenon impulse corona energization of flue gases led to the assumption that the most suitable electron energy for producing the chemical radicals which are responsible for the oxidations of the sulphur and nitrogen oxides is in the range 5 to 20 eV and that a pulse corona discharge can provide a number of such electrons : Table 1 and Table 2 [3] .

Table I - Main reactions of the process

$e^*(5.1\text{eV}) + \text{H}_2\text{O} \rightarrow \text{H} + \text{OH}^-$
$e^*(7\text{eV}) + \text{O}_2 \rightarrow \text{O} + \text{O}^-$
$e^*(> 15,7\text{eV}) + \text{N}_2 \rightarrow \text{N}_2^+; e; \text{N}^+; \text{N}; \text{N}_2^*$
$e^*(> 12,1\text{eV}) + \text{O}_2 \rightarrow \text{O}_2^+; e; \text{O}^+; \text{O}; \text{O}_2^*$
$e(<5\text{eV}) + \text{O}_2 \rightarrow \text{O}_2^-$
$\text{O}_2^+ + \text{O}_2^- \rightarrow \text{O}_3 + \text{O}$
$\text{O}_2^+ + \text{H}_2\text{O} \rightarrow \text{O}_2^* \text{H}_2\text{O}$
$\text{O}_2^* \text{H}_2\text{O} + \text{H}_2\text{O} \rightarrow \text{H}_3\text{O}^+ \text{OH} + \text{O}_2$
$\text{H}_3\text{O}^+ \text{OH} + n \text{H}_2\text{O} \rightarrow \text{H}_3\text{O}^+ (\text{H}_2\text{O})_n + \text{OH}$
$\text{H}_3\text{O}^+ (\text{H}_2\text{O})_n + \text{O}_2^- \rightarrow (n+1)\text{H}_2\text{O} + \text{HO}_2$
$\text{NO} + \text{HO}_2 \rightarrow \text{NO}_2 + \text{OH}$
$\text{NO} + \text{O} \rightarrow \text{NO}_2$
$\text{NO}_2 + \text{OH} \rightarrow \text{HNO}_3$
$\text{NO}_2 + \text{O} \rightarrow \text{NO}_3$
$\text{NO}_2 + \text{NO}_3 \rightarrow \text{N}_2\text{O}_5$
$\text{N}_2\text{O}_5 + \text{H}_2\text{O} \rightarrow 2\text{HNO}_3$
$\text{SO}_2 + \text{OH} \rightarrow \text{HSO}_3$
$\text{HSO}_3 + \text{OH} \rightarrow \text{H}_2\text{SO}_4$
$\text{SO}_2 + \text{O} \rightarrow \text{SO}_3$
$\text{SO}_3 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_4$
$\text{HNO}_3 + \text{NH}_3 \rightarrow \text{NH}_4 \text{NO}_3$
$\text{H}_2\text{SO}_4 + 2\text{NH}_3 \rightarrow (\text{NH}_4)_2\text{SO}_4$

Table 1

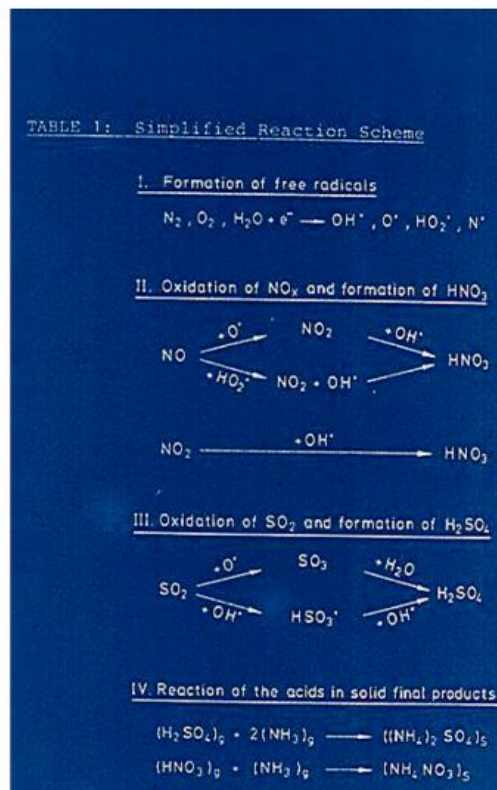


Table 2

4. HIGH FREQUENCY CORONA DISCHARGE BY THREE PHASE TESLA COIL

4.1. Double-Sided High-Frequency Corona Brush Discharge

Corona Brush Discharge (CBD) represents a new type of a high-frequency corona discharge . One of the principal characteristics of this discharge is that corona occupies a whole volume between a special brush-shaped electrodes in a discharge chamber .

The results of the study of the double-sided high-frequency corona brush discharge (DSCBD) when a new type of Tesla coil is used as a power supply – the Three-Phase Tesla coil (3PTC), which gives uniform output voltage in each operating pulse – are presented in this paper.

When 3PTC is energized, corona discharge is established and it completely occupies the space between the all electrodes and emits uniform light from the whole volume of double-sided corona brush discharge (DSCBD). So, for example, second positive system of N_2^* 337.1 nm and 357,7 nm are obtained [4] .

4.2. ELFI Technology Principal Characteristics

The ELFI technology is based on a new type of the high frequency corona discharge. As a consequence, the principal advantages of ELFI technology over other existing technologies for cleaning of flue gases (e.g. the electron beam technology) are:

- Plasma is created in the whole volume of a plasma chemical reactor (PCR);
- It is possible to scale-up a plasma chemical reactor, so that a large flow of flue gases from a thermal plant can be processed, which is significant for industrial application of the ELFI technology.

One may find about other existing methods for cleaning of flue gases from SO_2 and NO_x in the article: “Plasmas join the fight against acid rain “by Graeme Lister, Physics World, December 1992, p. 19.

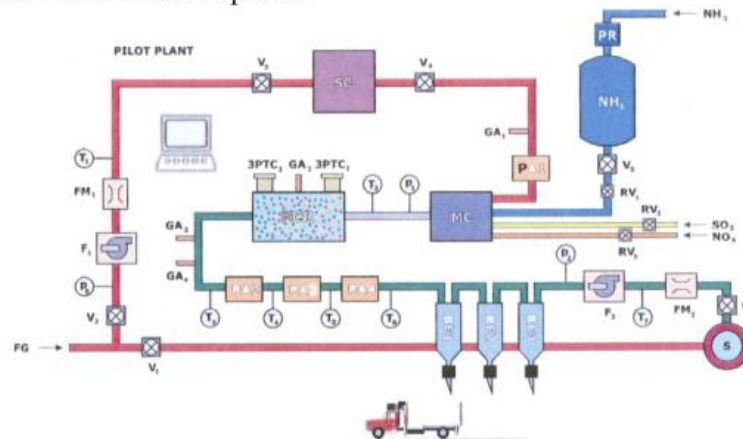
Some properties of the ELFI technology:

- this new, original technology using a plasma chemistry method is developed in the “VINCA” Institute of Nuclear Sciences on the basis of fundamental research of the original type of high frequency corona discharge.
- it is realized in the form of a special ELFI module which makes a part of a plant that burns fossil fuel.
- ELFI modules can be added to existing plants as a by-pass, so that it does not obstruct their function.
- SO_2 and NO_x are simultaneously removed from flue gas and by ammonia addition, converted into a useful, high quality and commercially valuable artificial fertilizer.
- waste materials are not produced by this technology, and the problem of permanent storage of undesired products does not exist.
- it consumes less electric energy for its functioning than other technologies.
- it is the only commercially efficient technology of this kind in the world.
- Removal of SO_2 and NO_x from flue gases contributes to the protection of human environment from these pollutants, and therefore directly improves health of human population ; it also prevents creation of acid rains, and protects buildings and metal constructions

- It can be used (installed) in all plants that burn fossil fuels: electric power plants, mills, chemical industry, oil industry, thermal plants, and other plants.

Principle of operation

A flue gas of known characteristics (temperature, gas flow rate, humidity) enters the plasma chemical reactor PCR, in which SO₂ and NO_x are being removed with addition of ammonia (NH₃) in stoichiometric ratio and converted into artificial fertilizer. Fertilizer is collected in bag filters BF1 – BF3, and flue gas without SO₂ and NO_x is passed through the stack S into the atmosphere.



S – stack	MC – gasmixing chamber
FG – flue gas	PCR – plasma chemical reactor
V – valve	GA – gas analyzer
F – fan	PA – particle analyzer
P – pressure gauge	3PTC – 3 Phase Tesla coil
T – thermometer	BF – bag filter
SC – spray cooler	RV – regulation valve
FM – flow meter	PR – pressure regulator

Results achieved:

- New technology is the result of fundamental research on which ELFI is based and is presented on international scientific meetings.
- Laboratory studies show completely fulfilled foreseen expectations for flue gas filtering and gave numerous data necessary to project a pilot plant [6].
- The patents for ELFI technology were granted in : United States of America [7], following countries of the European Patent Union - Austria, Belgium, Switzerland and Luxemburg, France, Great Britain, Ireland, Italy, Holland, Germany and Sweden.[8], Japan [9], and Serbia [10].

4.3. V. Miljevic, ELFI – New original technology for simultaneous removal of sulphur dioxide (SO₂) and nitrogen oxides (NO_x) from flue gases in plants which burn fossil fuel - Fig. 3

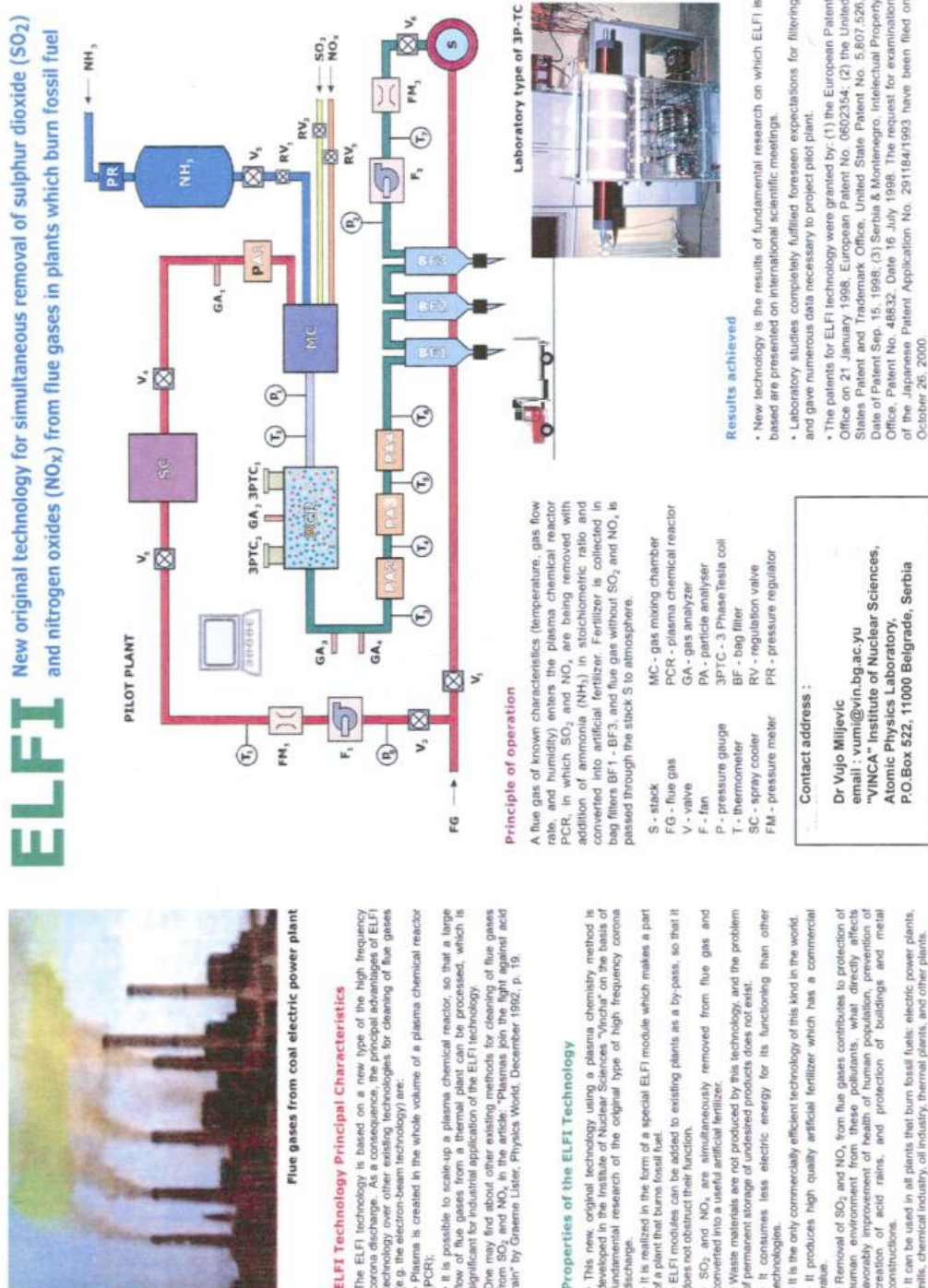


Fig. 3

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[4] V. Miljevic, Double-Sided High-Frequency Corona Brush Discharge, XVth Europhysics Conference on Atomic and Molecular Physics of Ionized Gases, *Europhysics Conference Abstracts*, Volume 24F, p.436 – 437.

[5] V. Miljevic and Veljko Lucic, The Technology for Removal of SO₂ and NO_x from Flue Gases by High Frequency Discharge by Tesla Coil, *Proceedings, POWER PLANT 2006*, Serbia, Vrnjacka Banja (2006), 48 – 52.

[6] V. Miljevic, ELFI – New original technology for simultaneous removal of sulphur dioxide (SO₂) and nitrogen oxides (NO_x) from flue gases in plants which burn fossil fuel

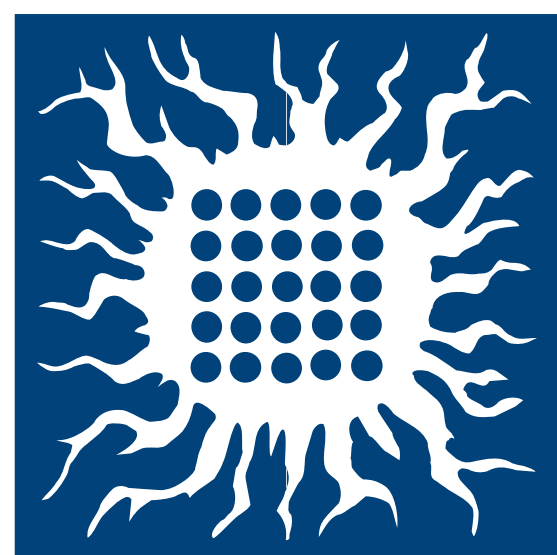
Patents :

[7] V. Miljević, Device for Simultaneous Removal of SO₂ and NO_x from Flue Gases by High - Frequency discharge, USA Pat. Office, Grant March (1998), USA pat. No. 5,807,526

[8] V. Miljević, Device for simultaneous removal of SO₂ and NO_x from flue gases by high frequency discharge, European Patent Specification EP 0 602 354 B1, Certificate 0602354, 21.01.1998. In Europe: Austria, Belgium, Switzerland and Luxemburg, France, Great Britain Ireland, Italy, The Netherlands, Germany and Sweden.

[9] V. Miljević, Device for simultaneous removal of SO₂ and NO_x from flue gases by high frequency discharge, Japanese Patent Application no. 291184 / 1993.

[10] V. Miljević, Uređaj za simultano čišćenje dimnih gasova od SO₂ i NO_x pomoću visokofrekventnog pražnjenja sa Teslinim transformatorom ili drugim generatorom visokog napona i visoke frekvencije, Rešenje Saveznog zavoda za intelektualnu svojinu, No. 48463, Beograd, 16. jul 1998.



THE THREE-PHASE TESLA COIL

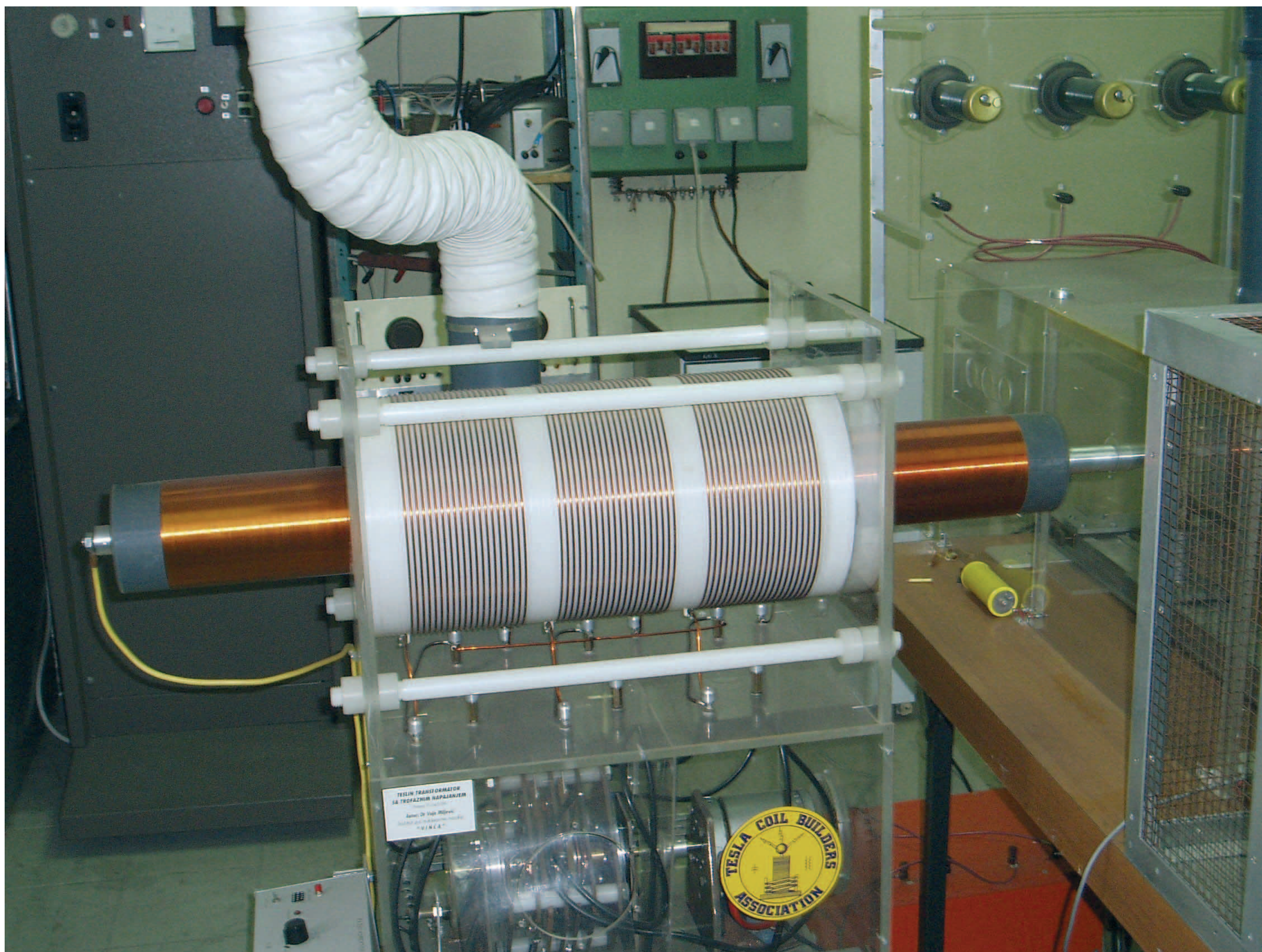
Vujo Miljevic

Vinca Institute of Nuclear Sciences

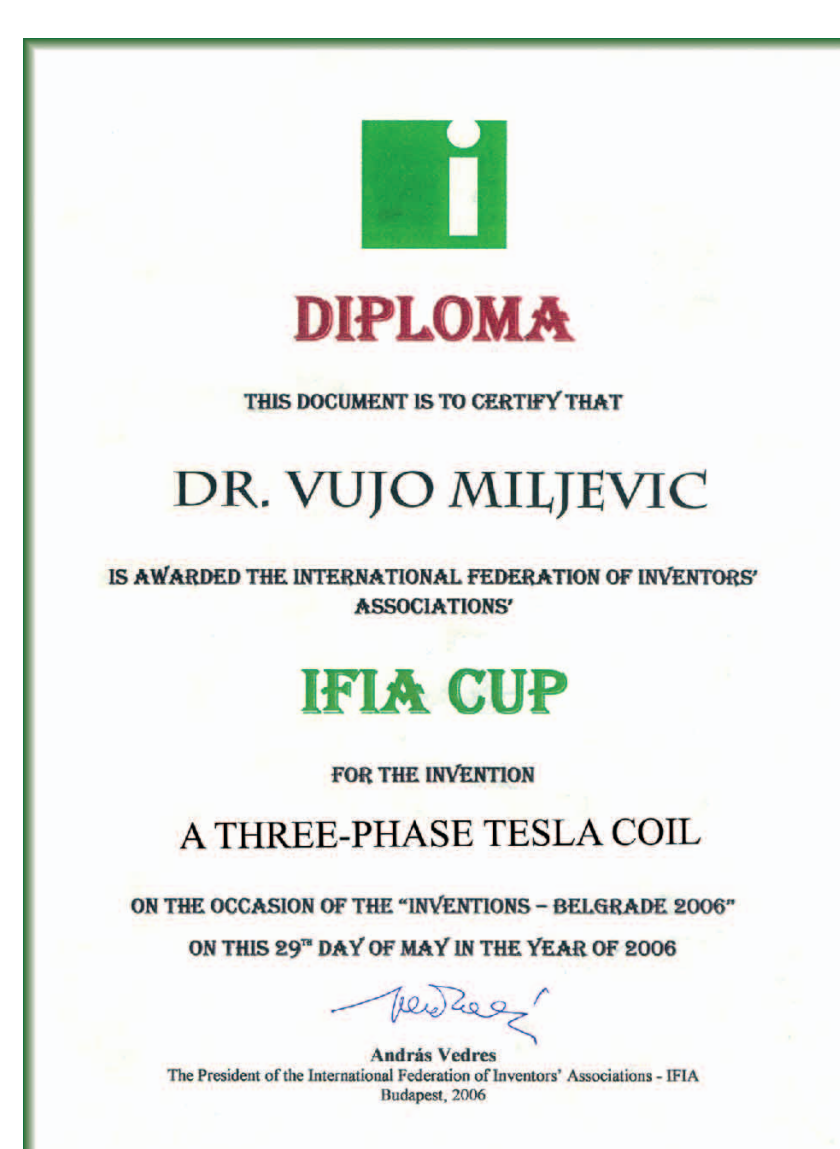
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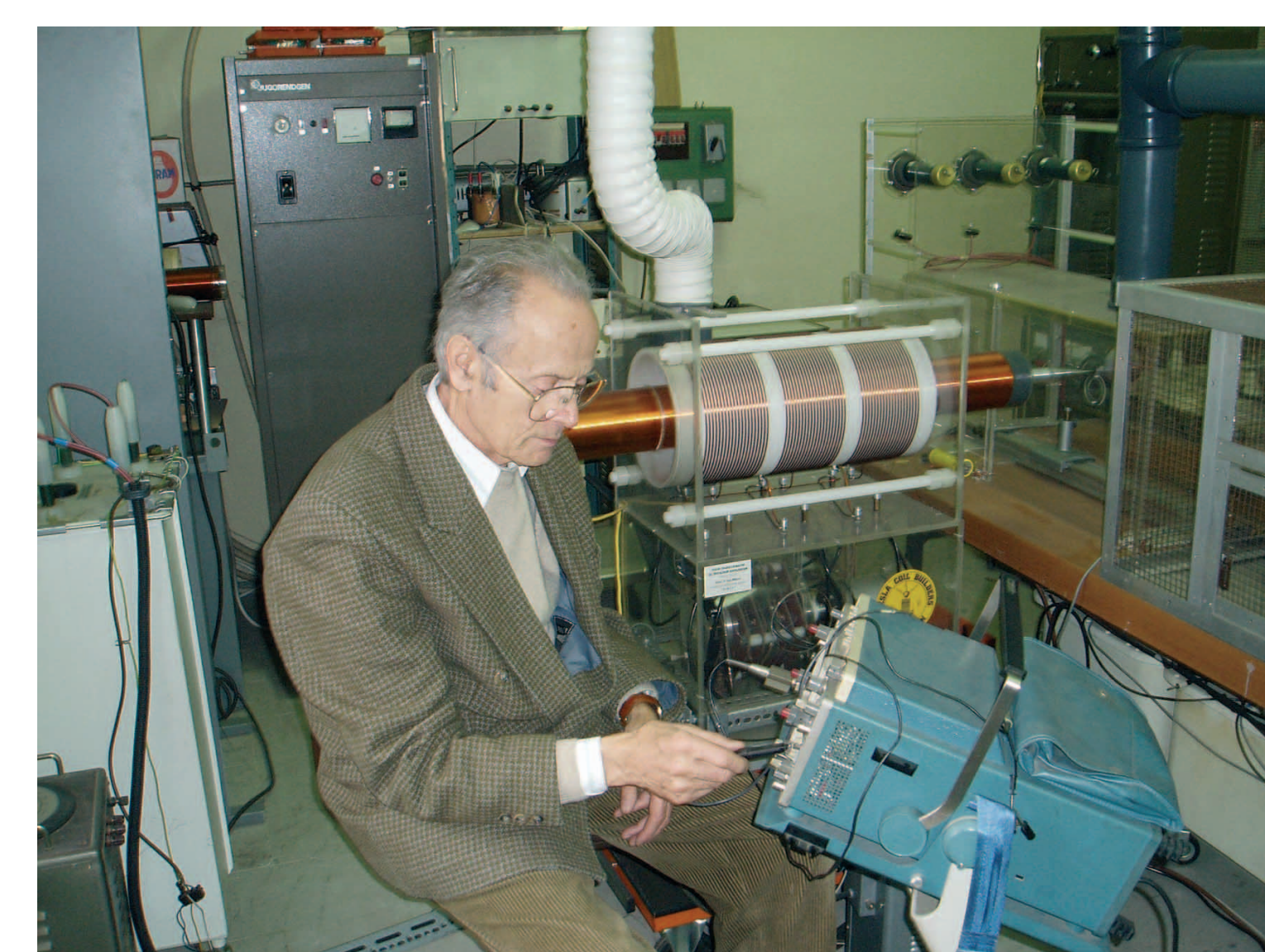
A special Tesla coil that is fed from the three-phase AC mains power supply is described. Such Tesla coil gives uniform output voltage in each operating pulse, as it is fed from each phase of the mains with 120 degrees out of phase.



The primary coils are wound on a tube made of an insulator providing a very high voltage breakdown, and distances between adjacent primary coils and between primary and secondary coils ensure that no voltage breakdown occurs between them. The geometry of the primary and secondary coils is chosen in order to provide maximal coupling. Each primary coil has its own capacitor and two-electrode rotating spark gap. All three spark gaps are placed on the same shaft of a synchronous motor at relative angles of 120 degrees. The motor rotates with 3000 rpm synchronously with the AC mains power supply. The relative angular position of spark gaps can be adjusted with respect to the shaft during its rotation to ensure a discharge of each of three capacitors at the instant of its maximal charge voltage. The angular adjustment can be done automatically by electronic device - the phase corrector.



The Three phase Tesla coil has been awarded by the International Federation of Inventors' Associations' IFIA CUP on the occasion of the "INVENTIONS - BELGRADE 2006".





стваралаштво генија
НИКОЛА ТЕСЛА

поводом 150 година рођења

Галерија САНУ, Кнез Михаилова 35, Београд
18. октобар – 25. новембар 2006.

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18. октобар – 1. децембар 2006.

5. фебруар – 31. март 2007.

ГАЛЕРИЈА СРПСКЕ АКАДЕМИЈЕ НАУКА И УМЕТНОСТИ

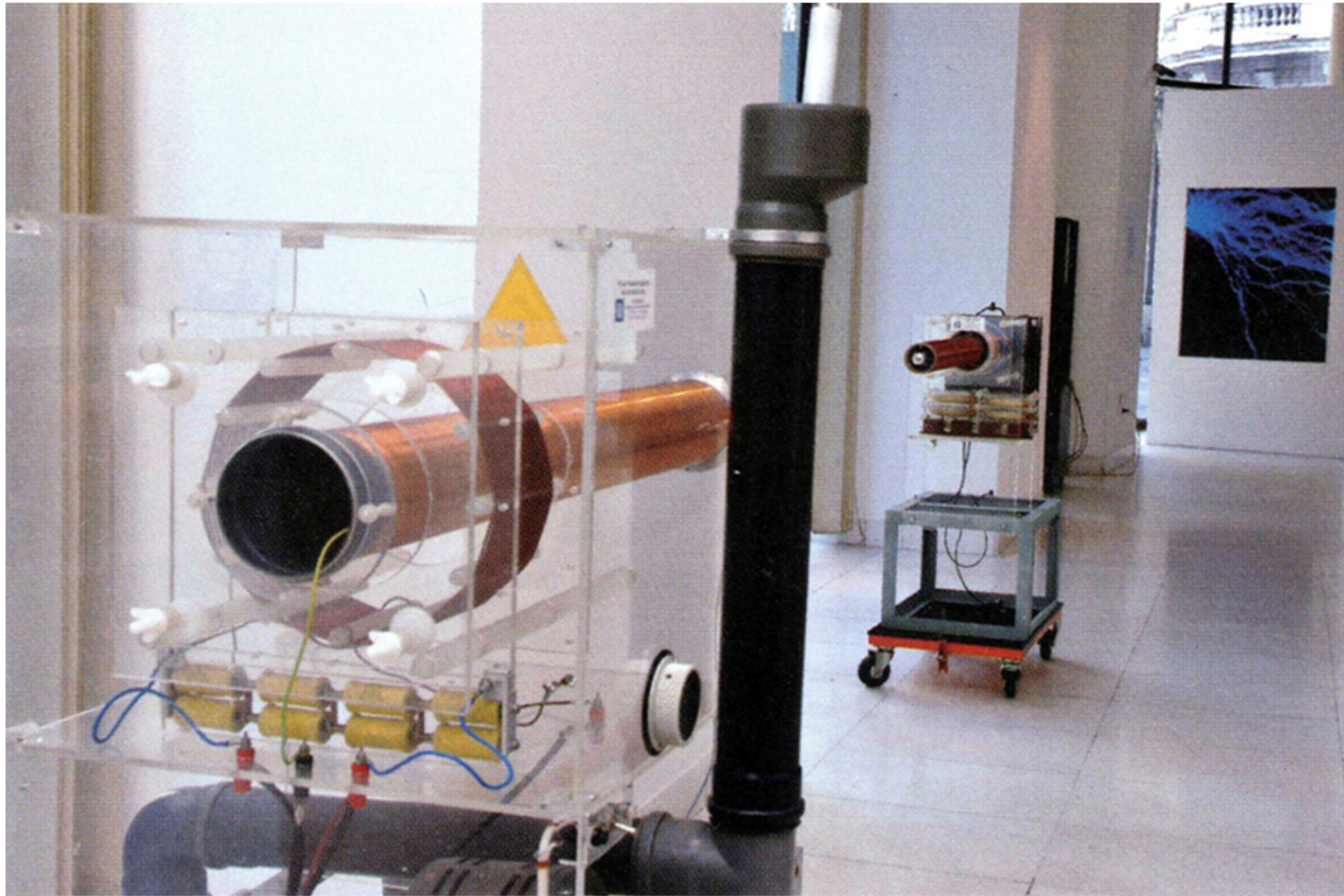
Александар Маринчић

НИКОЛА ТЕСЛА

стваралаштво генија

Београд 2006

НИКОЛА ТЕСЛА стваралаштво генија



1. Конвенционални Теслин трансформатор

НИКОЛА ТЕСЛА стваралаштво генија



2. Теслин трансформатор са електронском цеви

НИКОЛА ТЕСЛА стваралаштво генија



3.Теслин трансформатор са трофазним напајањем





Tesla's Tribute - "Earth at Night"

