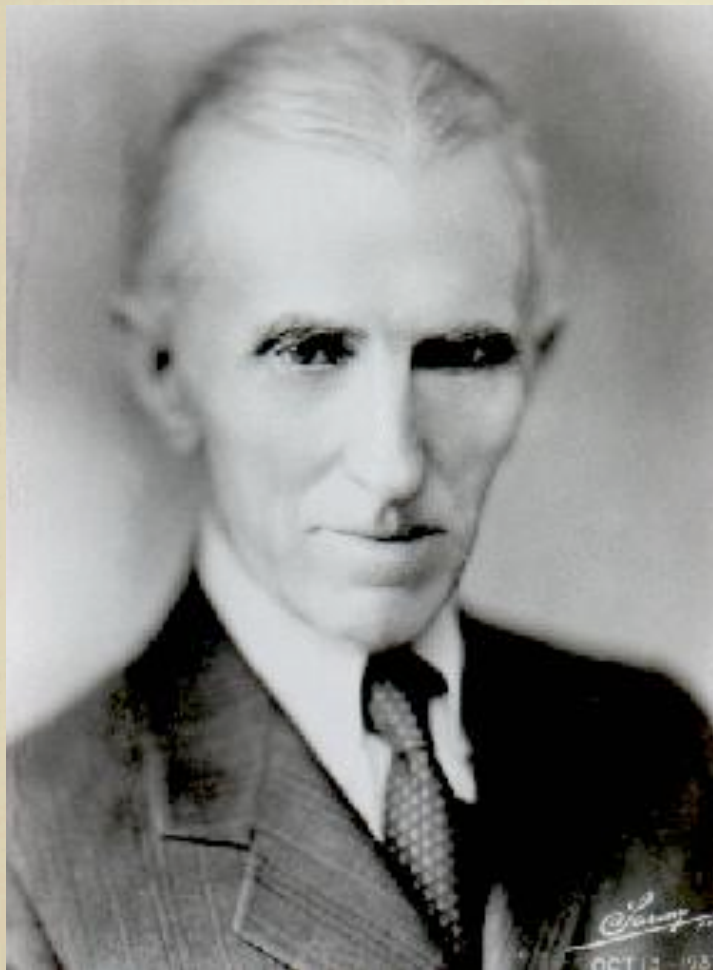


OMNIPRESENCE OF TESLA'S WORK AND IDEAS



“THE PRESENT IS THEIRS;
THE FUTURE, FOR WHICH
I REALLY WORKED, IS MINE.”

**NIKOLA TESLA
(1856-1943)**

**MILOŠ D. ERCEGOVAC
COMPUTER SCIENCE DEPARTMENT
UCLA**

- 1856 - 1943 NEW YORK
- BORN IN SMILJAN, LIKA PROVINCE (NOW CROATIA, THEN AUSTRIAN EMPIRE), SERB BY ORIGIN, YUGOSLAV BY CONVICTION, AMERICAN FOR LIFE, WORLD CITIZEN. US CITIZEN 1891.



6th International
Symposium Nikola Tesla

October 18-20, 2006
Belgrade, Serbia

On the Occasion of
150th Birth Anniversary
of Nikola Tesla

 **IEEE**

Serbian Academy of Science and Arts, Knez Mihailova 35, Belgrade, Serbia

■ BIBLIOGRAPHY AND SOURCES

Omnipresence of Tesla's Work and Ideas, M. ERCEGOVAC,
PROC. 6TH INTL. SYMPOSIUM NIKOLA TESLA, OCTOBER 2006,
BELGRADE, SERBIA.

Tesla's Visionary Ideas, M. ERCEGOVAC, FRESHMAN SEMINAR,
FALL 2000, UC BERKELEY.

M. CHENEY AND R. UTH, TESLA - MASTER OF LIGHTING,
BARNES & NOBLE, 1999.

M. J. SEIFER, WIZARD - THE LIFE AND TIMES OF NIKOLA TESLA
- BIOGRAPHY OF A GENIUS, BIRCH LANE PRESS BOOK, 1996.

[HTTP://EN.WIKIPEDIA.ORG/WIKI/NIKOLA TESLA](http://en.wikipedia.org/wiki/Nikola_Tesla)

[HTTP://WWW.PBS.ORG/TESLA/INS/INDEX.HTML](http://www.pbs.org/tesla/ins/index.html)

[HTTP://WWW.TESLA-MUSEUM.ORG/MENI SL.HTM](http://www.tesla-museum.org/meni_sl.htm)

TESLA DAY AT SFU 2006 (PRESENTATIONS BY PROFS. ARROTT, MARTI, AND MARINCIC)

NIKOLA TESLA MUSEUM, BELGRADE

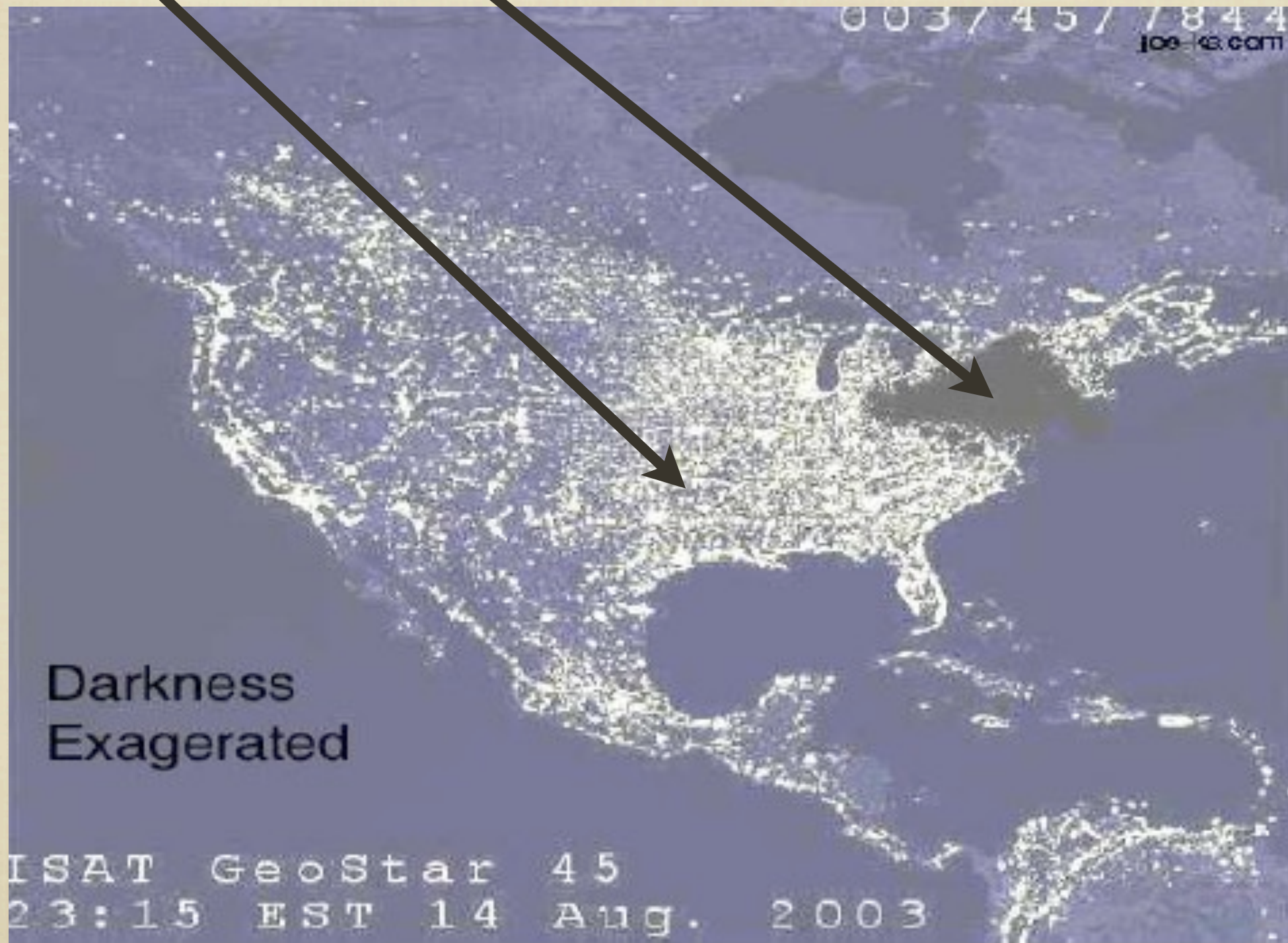


- TESLA? LARGELY NEGLECTED
- BRILLIANT INVENTOR, ELECTRICAL AND MECHANICAL ENGINEER
- INVENTOR AND SCIENTIST
- VISIONARY
- THINKER
- A MAN WITH CLASS AND INTEGRITY
- GENIUS - UNUSUAL, OF COURSE



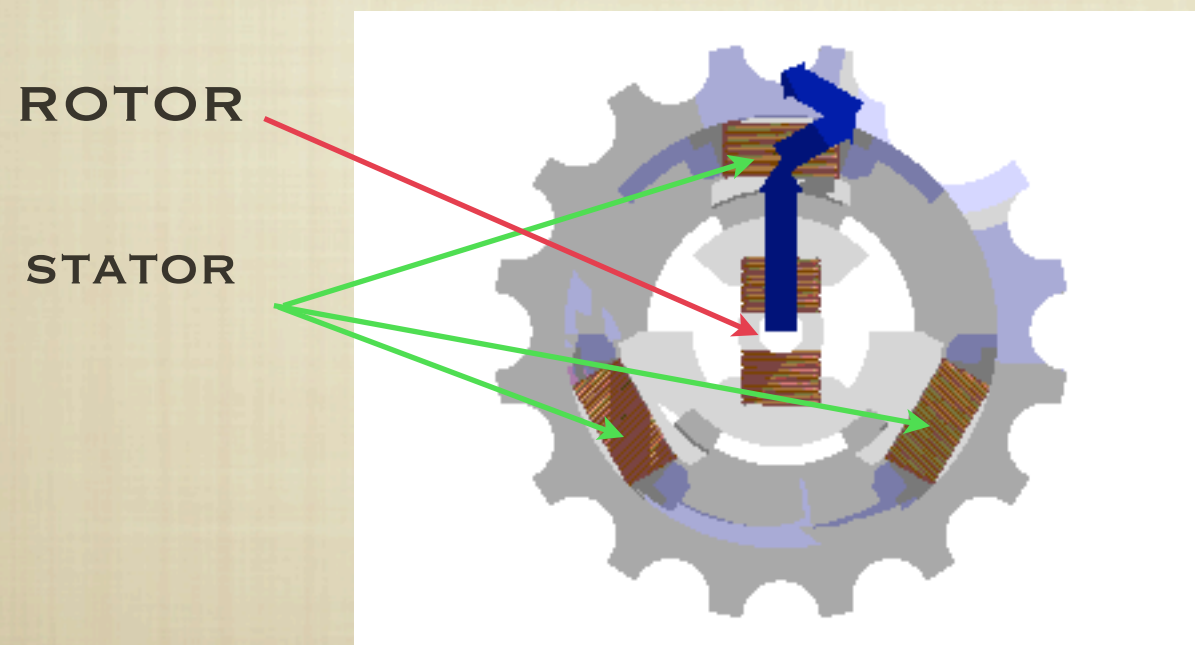
- WHAT DID HE DO? MANY THINGS BUT THESE ARE ENOUGH TO KEEP MANKIND IN ETERNAL DEBT TO TESLA
- **ELECTRIC POWER SYSTEMS**
(ALTERNATING CURRENT (AC) SYSTEM OF MOTORS, GENERATORS AND TRANSFORMERS) => 2ND INDUSTRIAL REVOLUTION
“THE MAN WHO LIT THE WORLD”
- **WIRELESS SIGNAL TRANSMISSION (RADIO)**
- **HIGH FREQUENCY CURRENTS, GENERATORS, COILS**
- THESE INVENTIONS ENABLED ENORMOUS ECONOMIC AND TECHNOLOGICAL PROGRESS OF MANKIND

■ WITH AND WITHOUT TESLA'S AC INVENTIONS

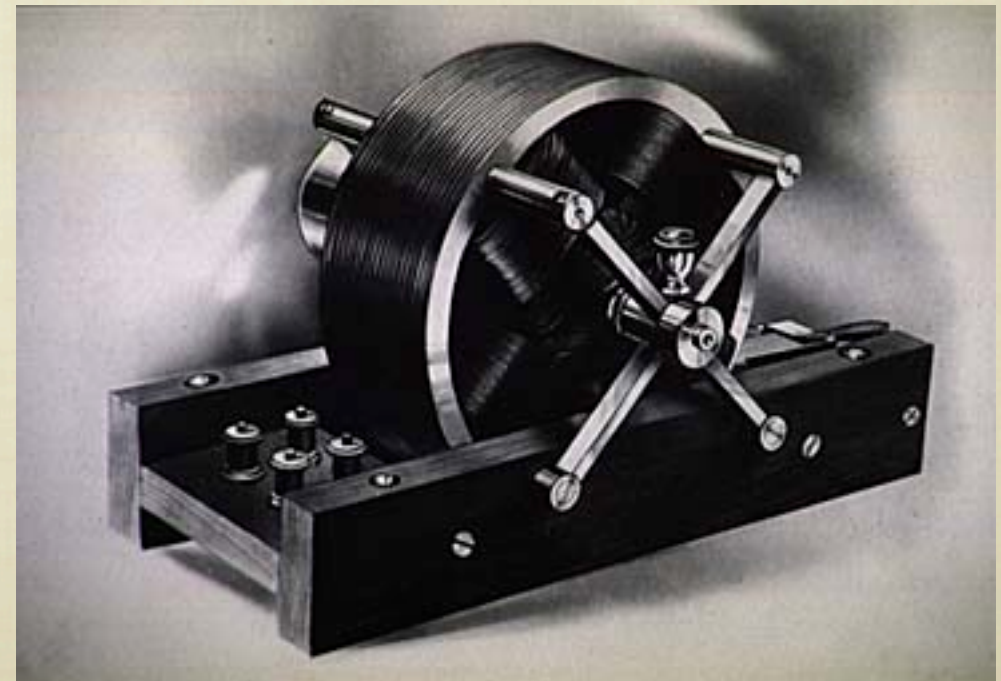


- TESLA'S KEY INSIGHT FOR TOTAL POWER SYSTEM
 - AC CURRENTS > **ROTATING MAGNETIC FIELD** > DRIVES INDUCTION MOTOR
 - ROTATING INDUCTION MOTOR > **ROTATING MAGNETIC FIELD** > AC CURRENTS
 - (HIGH AC CURRENT, LOW VOLTAGE) > STEP UP TRANSFORMER > (LOW AC CURRENT, HIGH VOLTAGE) -- **LOW TRANSMISSION LOSSES** > STEP-DOWN TRANSFORMER > (HIGH AC CURRENT, LOW VOLTAGE) > CONSUMER

INDUCTION MOTOR

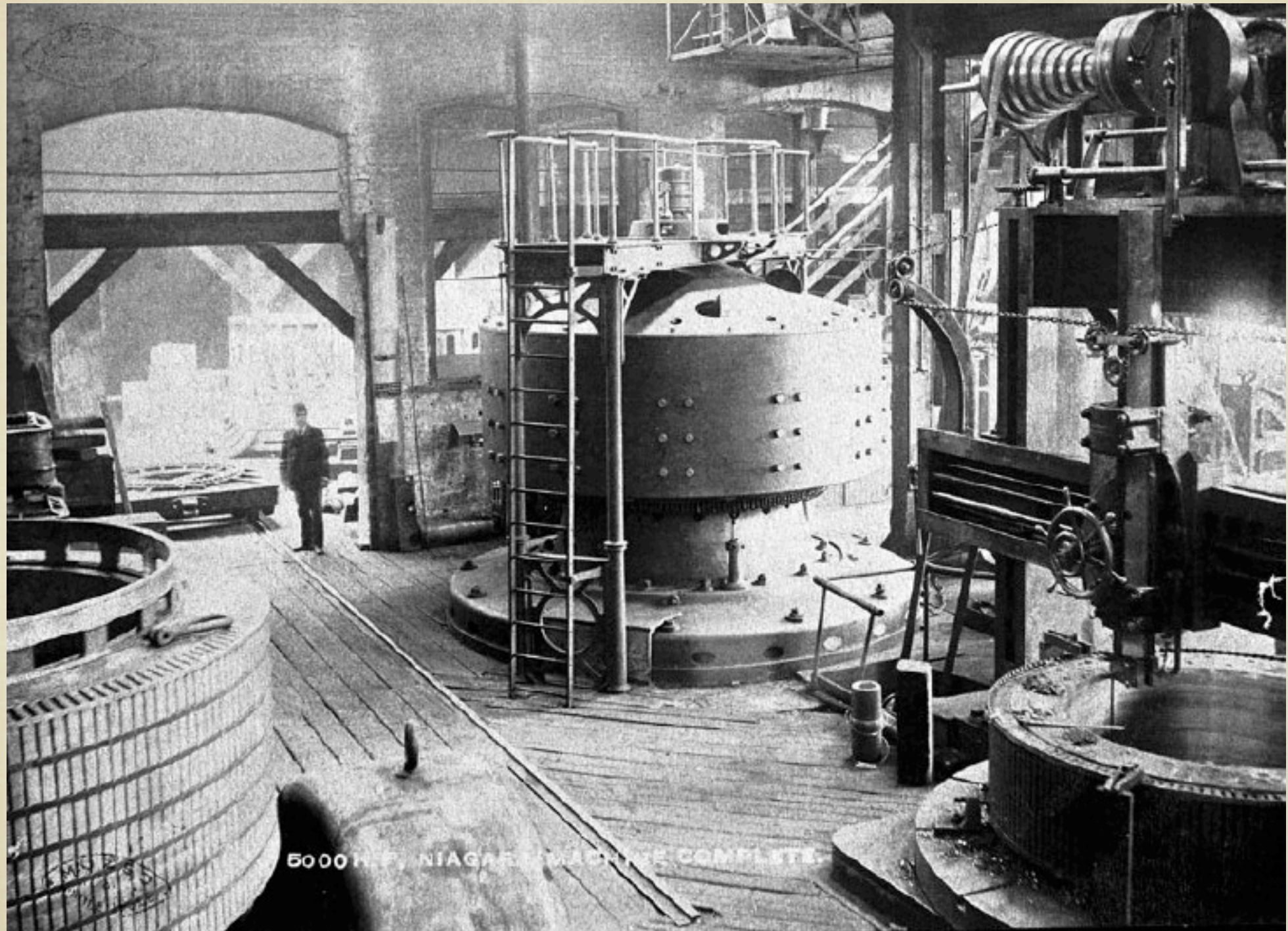


FROM WIKIPEDIA: ELECTRIC MOTORS



2-PHASE SYSTEM

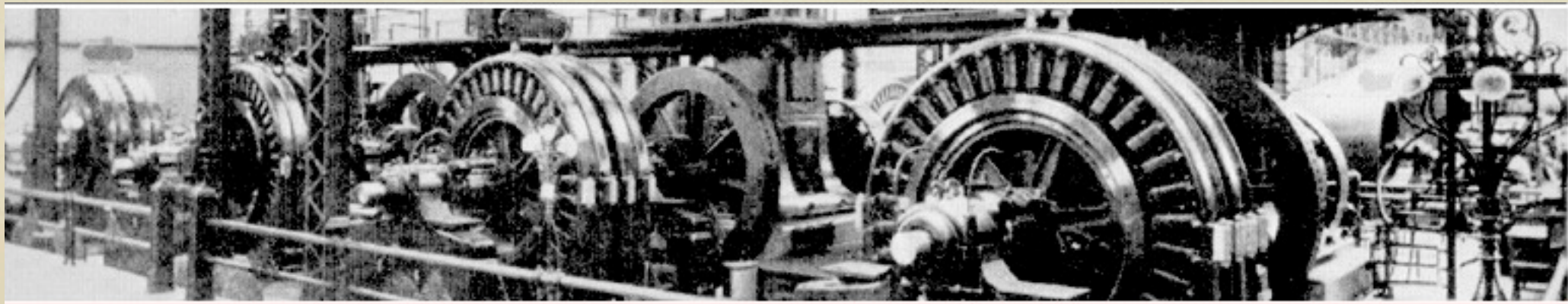
NIAGARA AC GENERATORS



NIAGARA POWER PLANT

"One of the boldest engineering and commercial feats of the past century, the successful development of the water-power of Niagara Falls, was the signal for the utilization of water powers all over the world. "

--William Andrews, "How Niagara Has Been Harnessed,"
The American Monthly Review of Reviews, June 1901.



THE POWER REACHED BUFFALO, 30KM AWAY, ON NOV 16, 1896: A BEGINNING OF MASSIVE (AC) ELECTRIFICATION ERA



LES DRYSDALE 2006

OTHER AREAS

- WIRELESS WORLD
- REMOTE CONTROL AND TELEPRESENCE
- RADIO-FREQUENCY LIGHTING
- IC MANUFACTURING
- NANOTECHNOLOGY
- SENSORS AND TRANSDUCERS
- ELECTRICITY IN MEDICINE - DIATHERMY
- MENTAL MODELS AND VISUALIZATION
- NEUROIMAGING
- BLADELESS TURBINES AND PUMPS
- ARTS

CLOSING REMARKS

VISION OF WIRELESS COMMUNICATION

“ ... A TELEPHONE SUBSCRIBER HERE MAY CALL UP AND TALK TO ANY OTHER SUBSCRIBER ON THE GLOBE. AN INEXPENSIVE RECEIVER, NO BIGGER THAN A WATCH, WILL ENABLE HIM TO LISTEN ANYWHERE, ON LAND OR SEA, TO A SPEECH DELIVERED, OR MUSIC PLAYED IN SOME OTHER PLACE, HOWEVER DISTANT.”

N. TESLA (~1900)

TESLA ENVISIONED GLOBAL SYSTEM OF MULTIMEDIA COMMUNICATION

- WORLD-WIDE WIRELESS TRANSMISSION OF SIGNALS AND MESSAGES
- INTEGRATION WITH EXISTING COMMUNICATION EQUIPMENT
- THE UNIVERSAL DISTRIBUTION OF GENERAL NEWS, BY TELEGRAPH OR TELEPHONE, IN CONNECTION WITH THE PRESS
- THE INTERCONNECTION AND OPERATION OF ALL STOCK TICKERS OF THE WORLD -

“WORLD-SYSTEM” FEATURES

- GLOBAL WEATHER WARNING
- THE ESTABLISHMENT OF INTELLIGENCE TRANSMISSION FOR EXCLUSIVE PRIVATE USE
- THE ESTABLISHMENT OF SECRET AND SECURE GOVERNMENT TELEGRAPH SERVICE
- THE SAME SYSTEM TO TRANSMIT ENERGY
>> MAKING IT A FREE RESOURCE

TESLA'S IDEAS ON WIRELESS TRANSMISSION

THREE GOALS:

- TO DEVELOP A TRANSMITTER OF GREAT POWER
- TO PERFECT MEANS FOR INDIVIDUALIZING AND ISOLATING THE ENERGY TRANSMITTED (E.G., SIGNALS)
- TO ESTABLISH THE LAWS OF PROPAGATION OF CURRENTS THROUGH THE EARTH AND THE ATMOSPHERE

N. Tesla , The Transmission of Electric Energy without Wires, Electrical World and Engineer, March 5, 1904.

ENERGY/SIGNAL TRANSMISSION METHOD AND SYSTEM

No. 649,621.

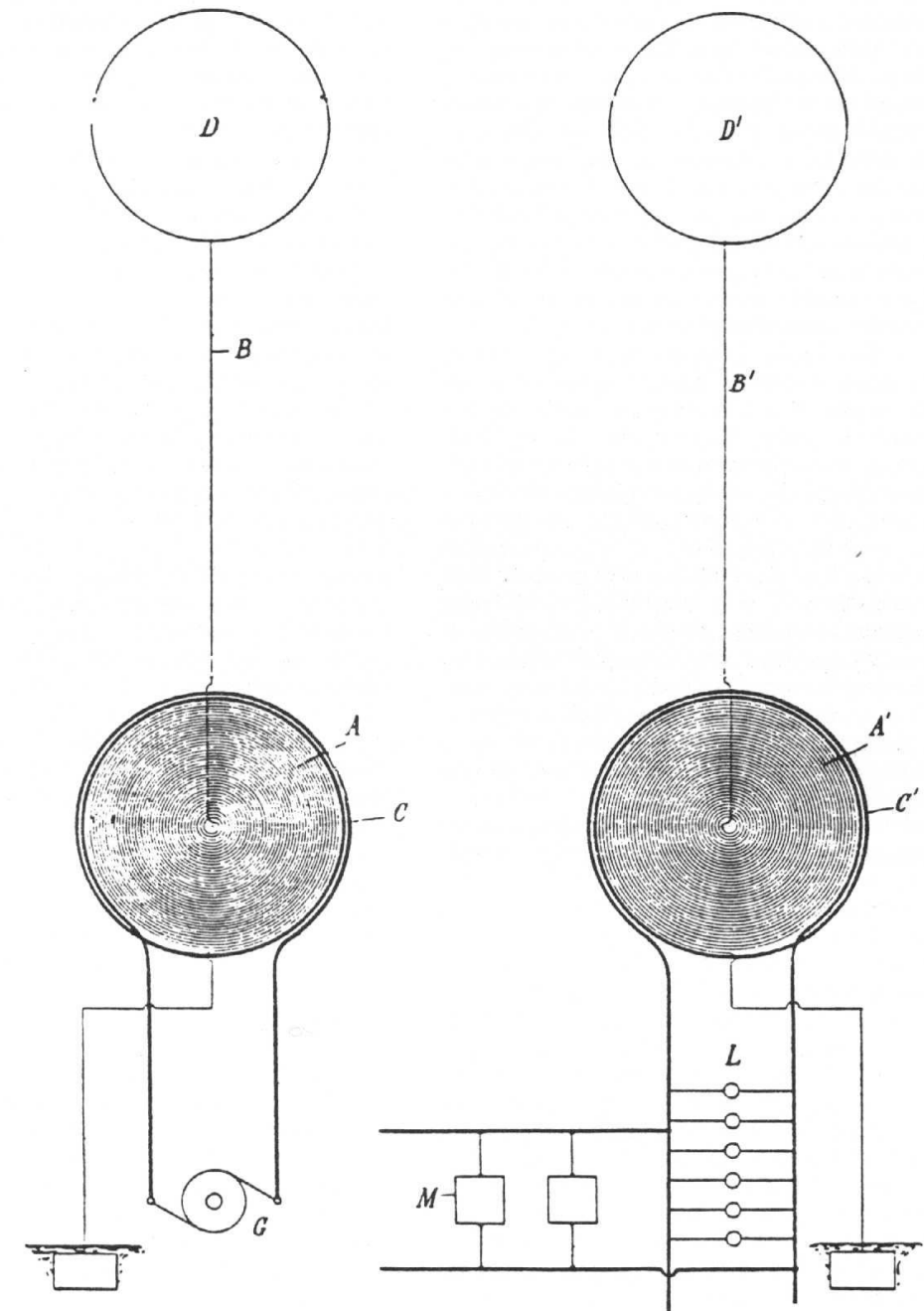
N. TESLA.

Patented May 15, 1900.

APPARATUS FOR TRANSMISSION OF ELECTRICAL ENERGY.

(Application filed Feb. 19, 1900.)

(No Model.)



Witnesses:
Benjamin Miller.
G. W. Marling.

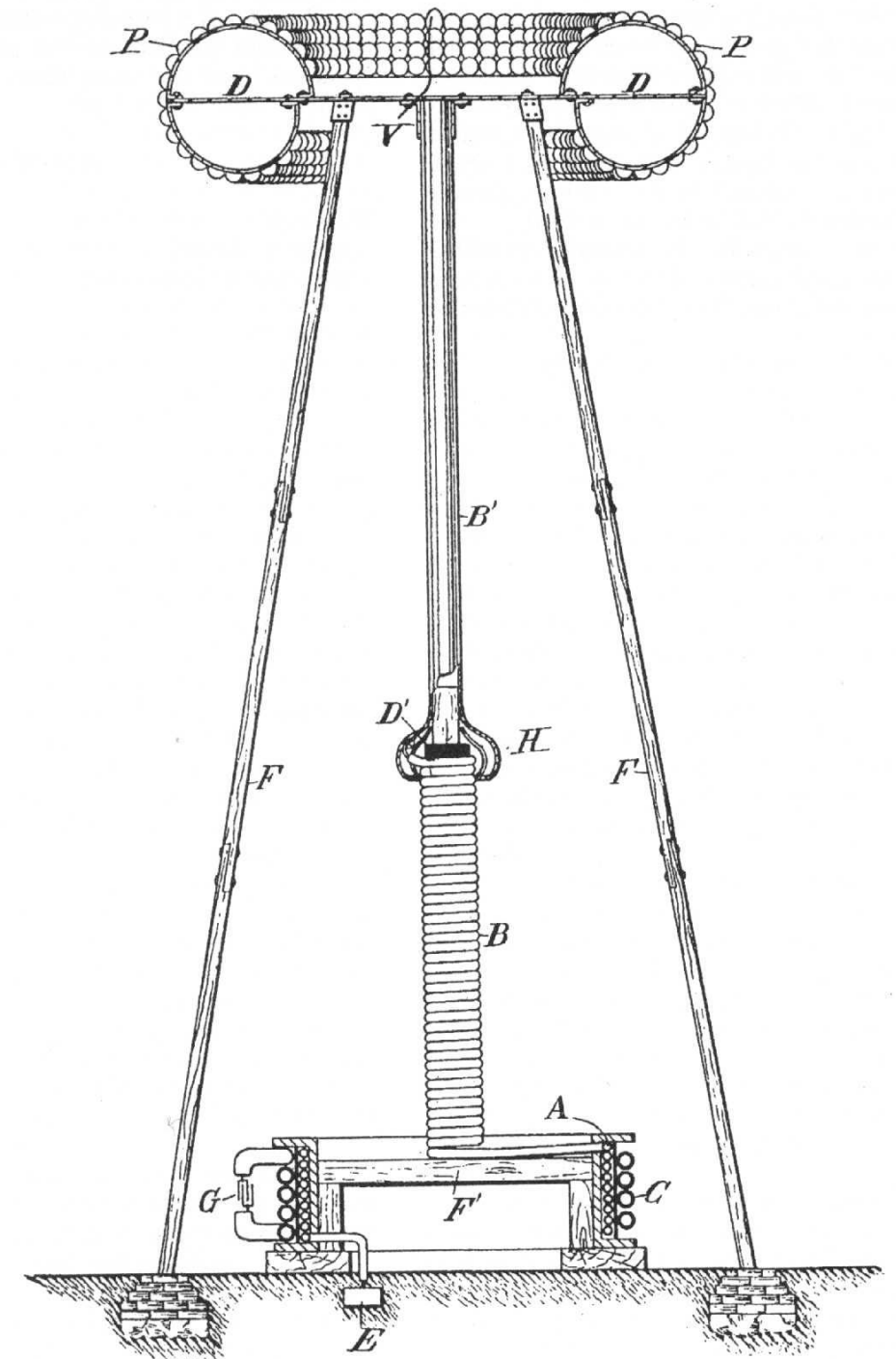
Nikola Tesla, Inventor
by *Ken. Page Cooper* Att'ys

KEY STEPS IN DEVELOPING WIRELESS TRANSMISSION

- MEASURES THE ELECTRIC POTENTIAL OF THE GLOBE AND ITS FLUCTUATIONS;
 - ESTIMATES RESONANCE FREQUENCY BETWEEN IONOSPHERE AND EARTH AT 6Hz. DETERMINED IN THE 50s TO BE 6.8Hz
 - CLAIMS THE FIRST EXPERIMENTAL EVIDENCE OF STATIONARY WAVES => THE PLANET BEHAVING LIKE A CONDUCTOR OF LIMITED DIMENSIONS =>
- SUGGESTS A POSSIBILITY OF WIRELESS TRANSMISSION OF SIGNALS AND POWER - A VISION OF INTERNET**
- PROPOSES **MAGNIFYING TRANSMITTER**
[Summer 1899, Colorado Springs Lab]

MAGNIFYING TRANSMITTER
- A WORLD ANTENNA
FIRST BASE STATION?
57M HIGH,
37M UNDERGROUND
- ATTEMPT TO BUILD
A “WORLD TELEGRAPHY
CENTER”
NEVER COMPLETED FOR
LACK OF FUNDS

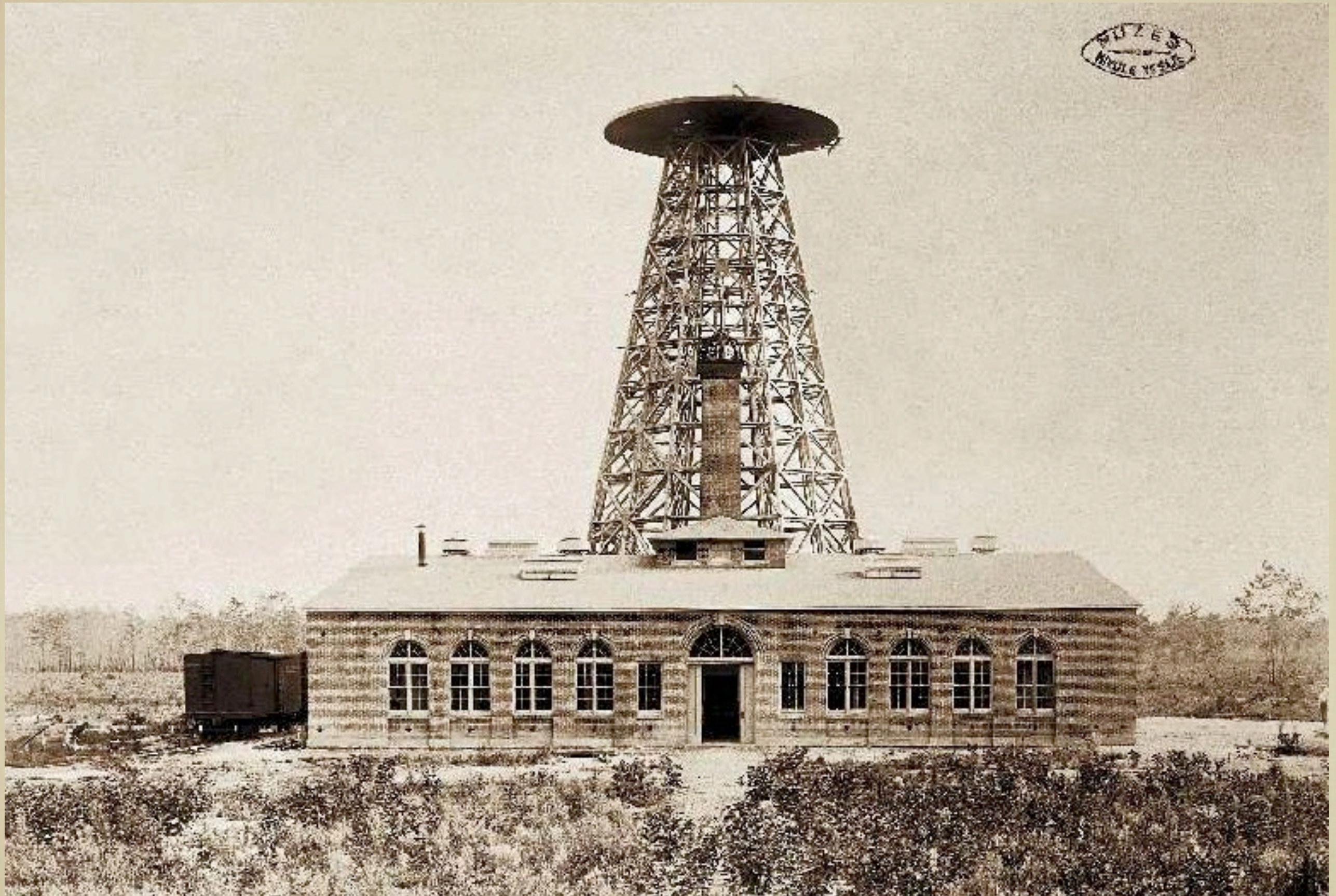
N. TESLA.
 APPARATUS FOR TRANSMITTING ELECTRICAL ENERGY.
 APPLICATION FILED JAN. 18, 1902. RENEWED MAY 4, 1907.
 1,119,732. Patented Dec. 1, 1914.



WITNESSES:
M. Lawson Dyer
Benjamin Miller.

Nikola Tesla, INVENTOR,
 BY *Kerr, Page & Cooper,*
 his ATTORNEYS.

LONG ISLAND LAB - WARDENCLYFFE



[BACK](#)

[CONCL](#)

MENTAL MODELS, VISUALIZATION, AND CREATIVE PROCESS

- *Mind's Eye* AS A PARADIGM OF CREATIVITY
- IN PRACTICE - ABSTRACTIONS AND 3D
VISUALIZATION
- ENABLED PROGRESS IN MANY VITAL AREAS SUCH
AS MOLECULAR BIOLOGY, DESIGN OF AIRCRAFT AND
COMPLEX MECHANICAL SYSTEMS, ... ARCHITECTURE
- ECONOMIC BENEFITS ENORMOUS: THE TESTS CAN BE
PERFORMED MUCH LATER IN THE PROCESS WITH MORE RELEVANT RESULTS

MENTAL MODELS, VISUALIZATION, AND CREATIVE PROCESS

- **“TESLA'S WAY OF VISUALIZING PROBLEMS AND DISCOVERING SOLUTIONS ANTICIPATES AMAZINGLY WELL THE MODERN APPROACH OF USING COMPUTER-BASED VISUALIZATION” [WEST 1997]**
- *“I needed no models, no drawings or experiments. I could picture them all in my mind” [Tesla 1919]*
- *A superhuman visionary - no team work for him. Could not fit into Edison lab model*

MENTAL MODELS, VISUALIZATION, AND CREATIVE PROCESS

- *“The moment one constructs a device to carry into practice a crude idea, he finds himself unavoidably engrossed with the details and defects of the apparatus My method is different. I do not rush into actual work. When I get an idea I start at once building it up in my imagination In this way I am able to rapidly develop and perfect a conception without touching anything. “ [Tesla]*

[BACK](#)

NEUROIMAGING - FUNCTIONAL

NEUROIMAGING - FUNCTIONAL

- VISUALIZING PROCESSING OF INFORMATION BY CENTERS IN THE BRAIN

NEUROIMAGING - FUNCTIONAL

- VISUALIZING PROCESSING OF INFORMATION BY CENTERS IN THE BRAIN
- COGNITIVE SCIENCE RESEARCH

NEUROIMAGING - FUNCTIONAL

- VISUALIZING PROCESSING OF INFORMATION BY CENTERS IN THE BRAIN
- COGNITIVE SCIENCE RESEARCH
- BRAIN-COMPUTER INTERFACE RESEARCH

NEUROIMAGING - FUNCTIONAL

- VISUALIZING PROCESSING OF INFORMATION BY CENTERS IN THE BRAIN
- COGNITIVE SCIENCE RESEARCH
- BRAIN-COMPUTER INTERFACE RESEARCH
- ONE OF THE GOALS: “READING THE MIND”

NEUROIMAGING AS TESLA SAW IT

[BACK](#)

NEUROIMAGING AS TESLA SAW IT

- *“I expect to photograph thoughts, ... In 1893...I became convinced that a definite image formed in thought must, by reflex action, produce a corresponding image on the retina, which can be read by suitable apparatus. This brought me to my system of television...”[Tesla 1933]*

[BACK](#)

NEUROIMAGING AS TESLA SAW IT

- *“I expect to photograph thoughts, ... In 1893...I became convinced that a definite image formed in thought must, by reflex action, produce a corresponding image on the retina, which can be read by suitable apparatus. This brought me to my system of television...”[Tesla 1933]*
- *“In a time not too distant it will be possible to flash any image formed in thought on a screen and render it visible at any place desired.”*

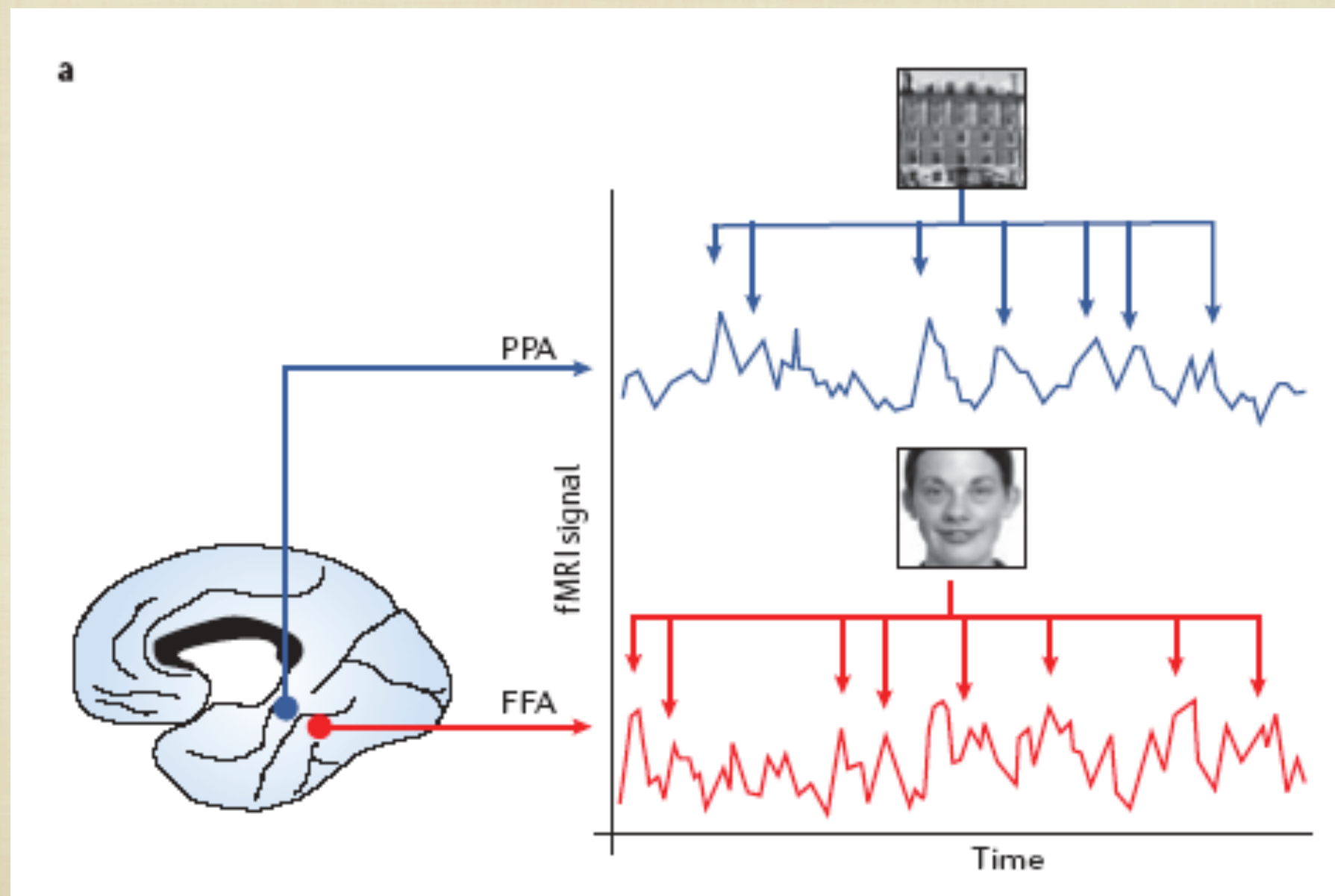
[BACK](#)

NEUROIMAGING

- TESLA'S FUTURISTIC IDEA OF A ``BRAIN READING DEVICE'' STILL IN THE REALM OF SCIENCE FICTION
- SIGNIFICANT PROGRESS MADE IN THE USE OF NON-INVASIVE NEUROIMAGING SIGNALS TO PARTIALLY ``DECODE'' THE MENTAL STATES OF A PERSON [HAYNES AND REES 2006]
- TESLA'S "BRAIN READING" DEVICE MAY EVENTUALLY BECOME A REALITY

DECODING CONTENTS OF VISUAL IMAGERY

BUILDING VS FACE: 85% SUCCESS



Haynes & Rees 2006

[BACK](#)

TELEPRESENCE AND REMOTELY CONTROLLED SYSTEMS

- TESLA [1898] INTRODUCED “ART OF TELEAUTOMATIC CONTROL” AND TELEROBOTICS
- DESIGNED AND BUILT A RADIO-CONTROLLED BOAT
- GAVE A MODERN VIEW OF A ROBOT: *“[it] will be able to follow a course laid out ...or obey commands given far in advance, it will be capable of knowing between what it ought and what it ought not to do ... and of recording impressions which will definitely affect its subsequent actions.”*

No. 613,809.

N. TESLA.

Patented Nov. 8, 1898.

METHOD OF AND APPARATUS FOR CONTROLLING MECHANISM OF MOVING VESSELS
OR VEHICLES.

(No Model.)

5 Sheets—Sheet 3.

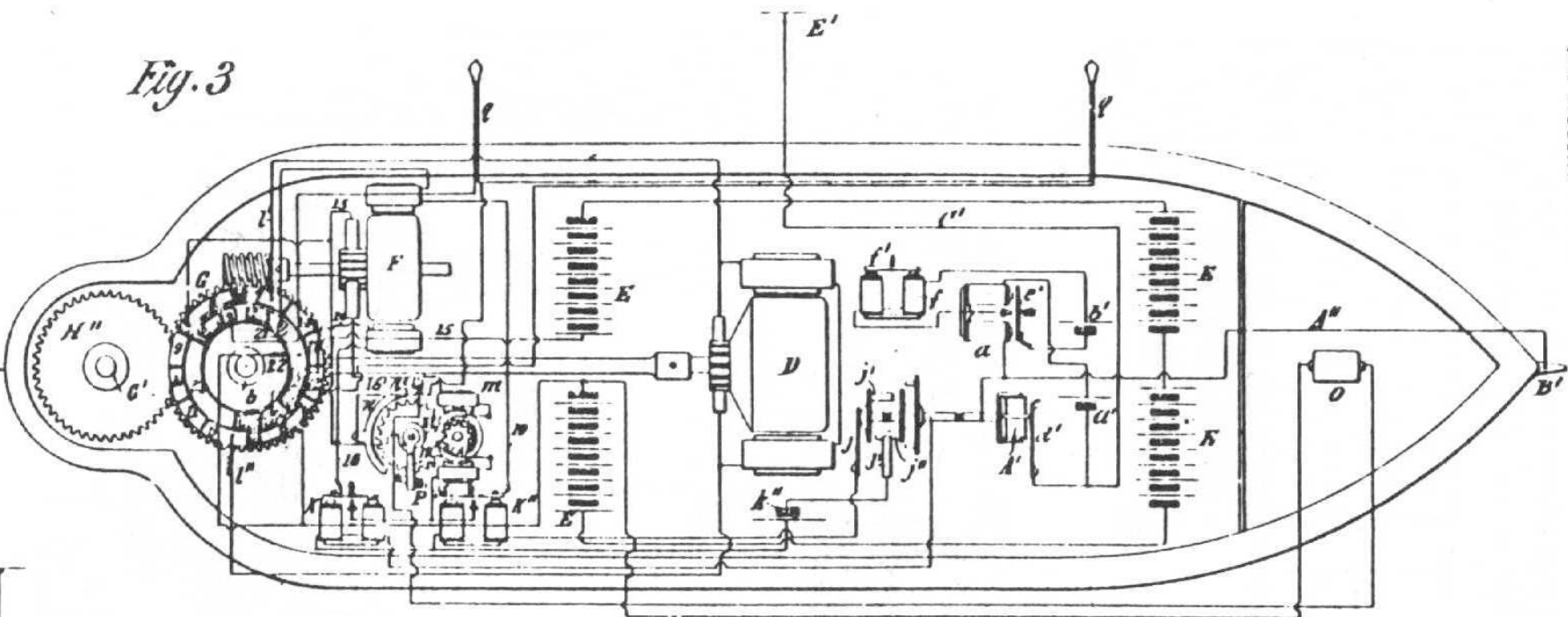


Fig. 3

Witnesses:
Michael Miller
George Schuyt

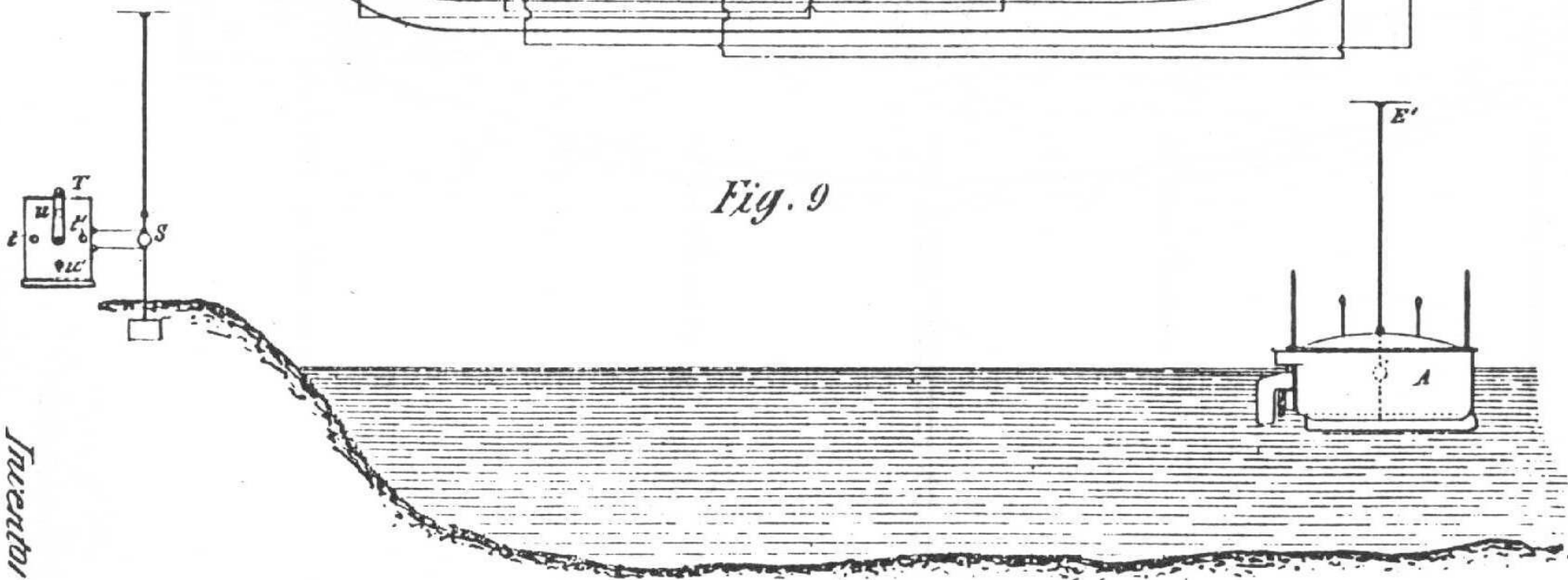


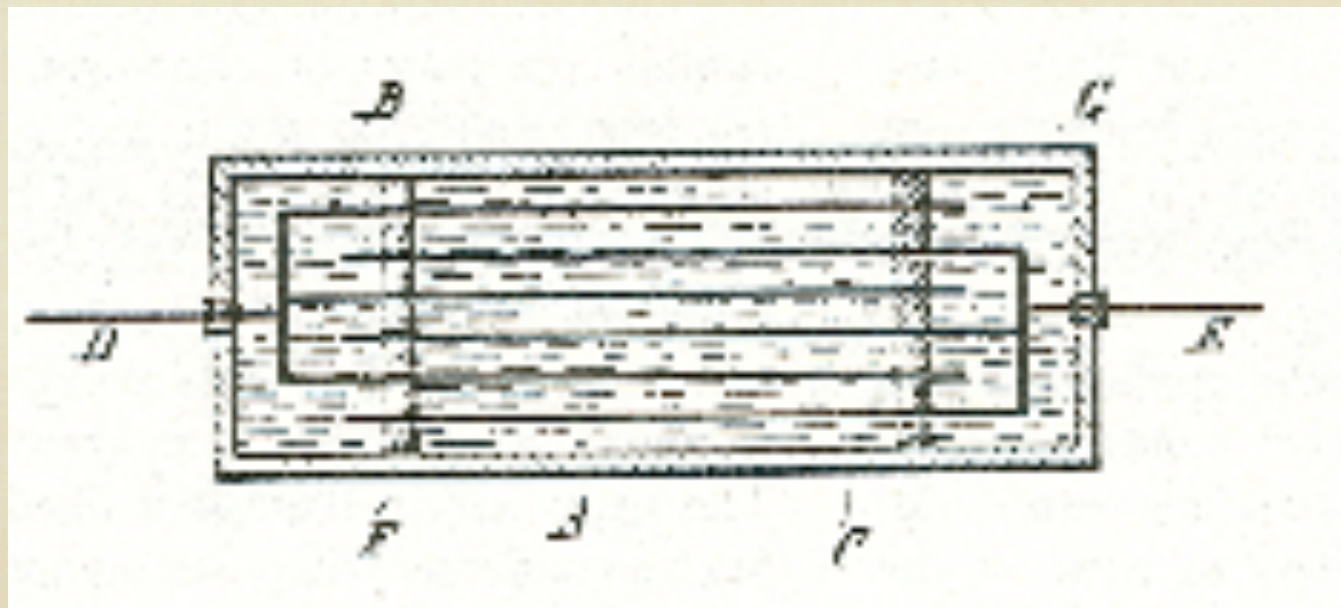
Fig. 9

Inventor:
N. Tesla

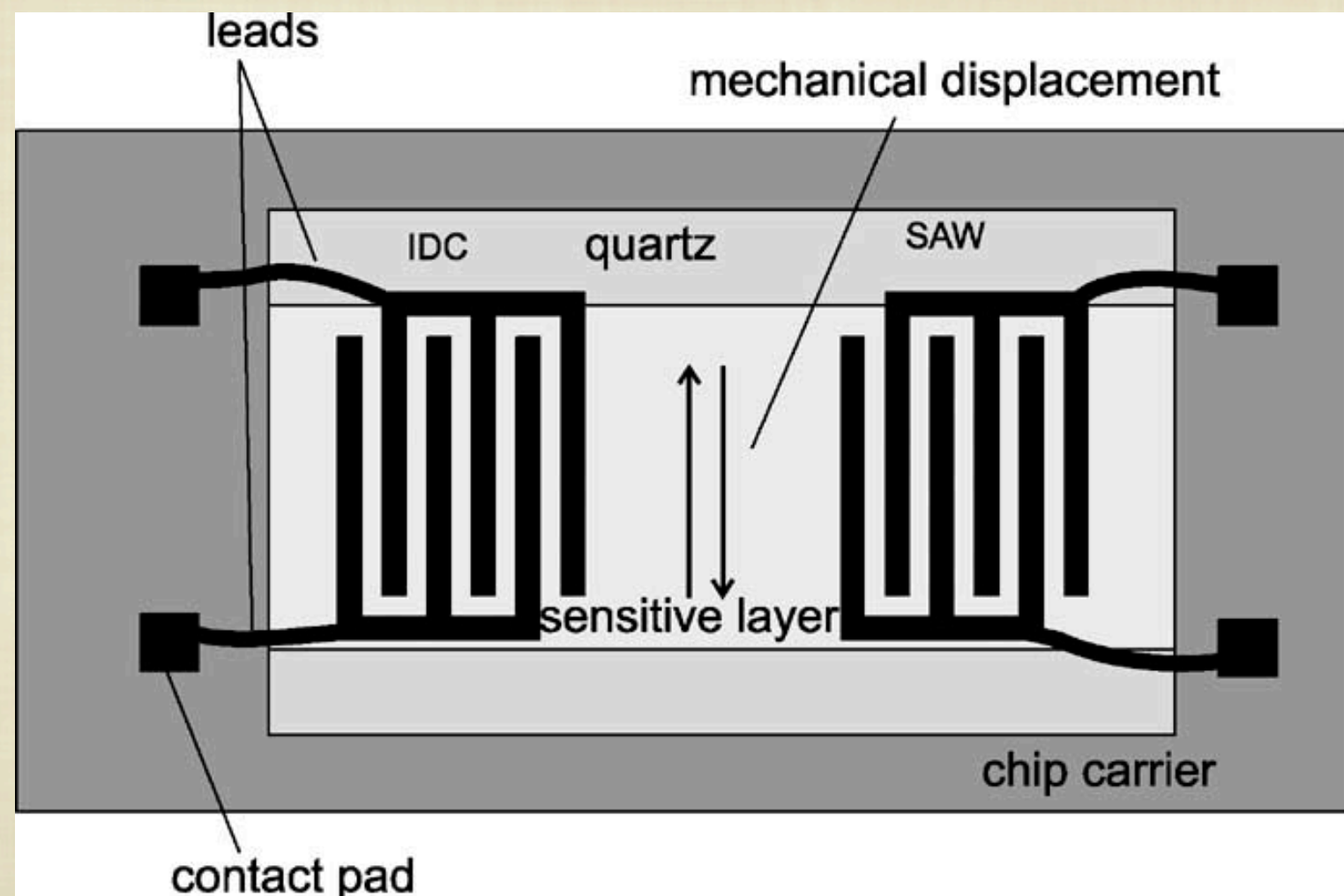
BACK

SENSORS AND TRANSDUCERS

- TESLA'S 1891 PATENT IS POSSIBLY THE EARLIEST EXAMPLE OF INTERDIGITAL ELECTRODE DESIGN -- MANY APPLICATIONS



- **PERVASIVE USE IN MICROMECHANICAL SYSTEMS (MEMS), CHEMICAL SENSING, PIEZOACOUSTICS, BIOTECHNOLOGY, ...**



Modern design [2004]

[BACK](#)

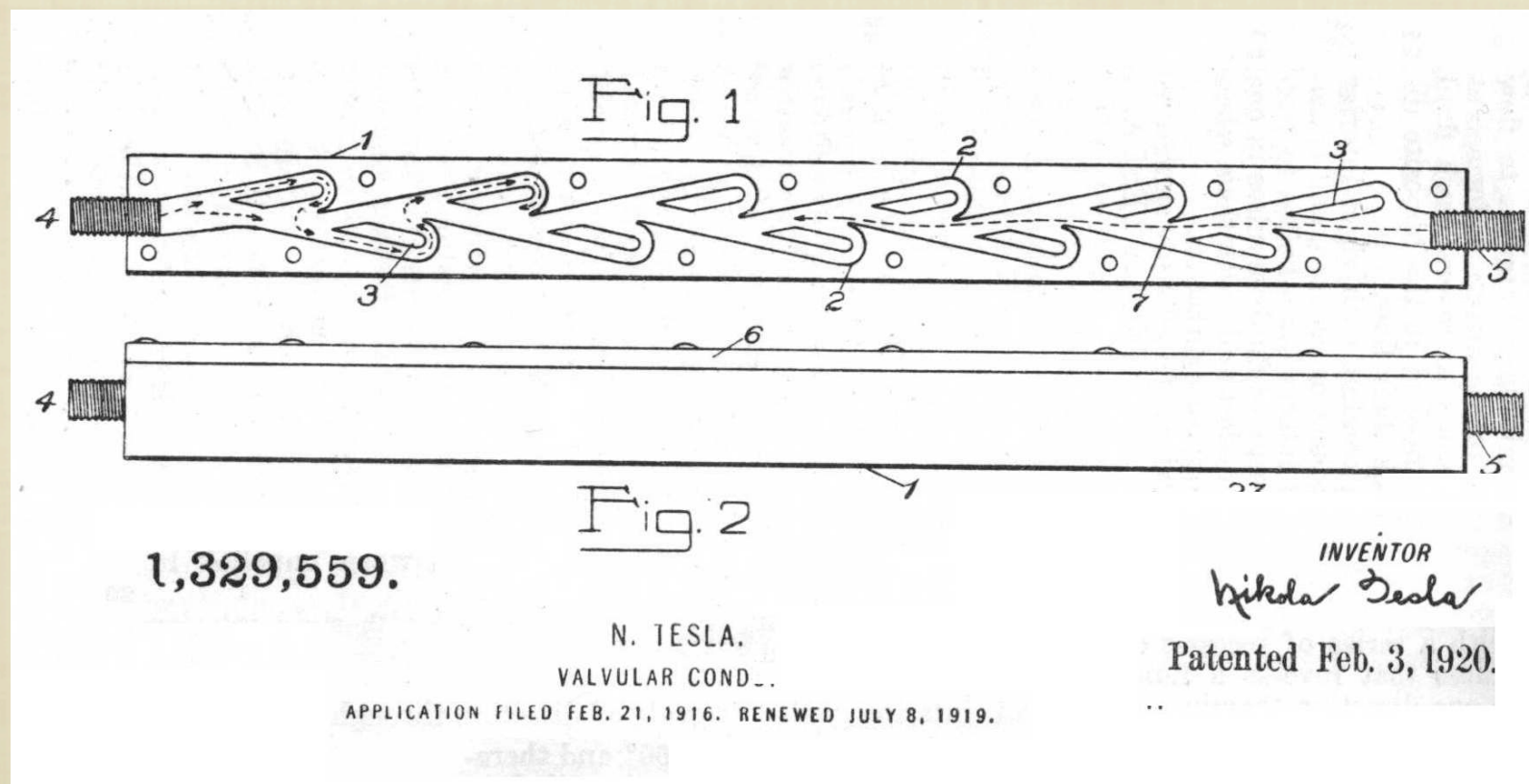
MOVING FLUIDS

- **TESLA'S VALVULAR CONDUIT [1920]**
- **APPLICABLE IN MICROMACHINES**
- **HIGHLY RELIABLE, NO INTERFERENCE WITH MOVING PARTS**
- **MEDICAL APPLICATIONS: DRUG DISPENSING IN THE BODY**

TESLA'S VALVULAR

2: BUCKET; 3: PARTITION; 4 & 5: INTAKES

- SMOOTH FLOW FROM INTAKE 5
- DISTURBED (BLOCKED) FLOW FROM INTAKE 4



HOW DOES IT WORK?

CONNECT N ELEMENTS TOGETHER;

IF P IS THE “LEAK” FROM THE FIRST ELEMENT,

THEN THE LEAK AFTER N ELEMENTS IS

$$P * P * \dots * P = P^N$$

=> RESISTANCE TO FLOW CAN BE MADE LARGE AT
WILL BY ADDING ELEMENTS

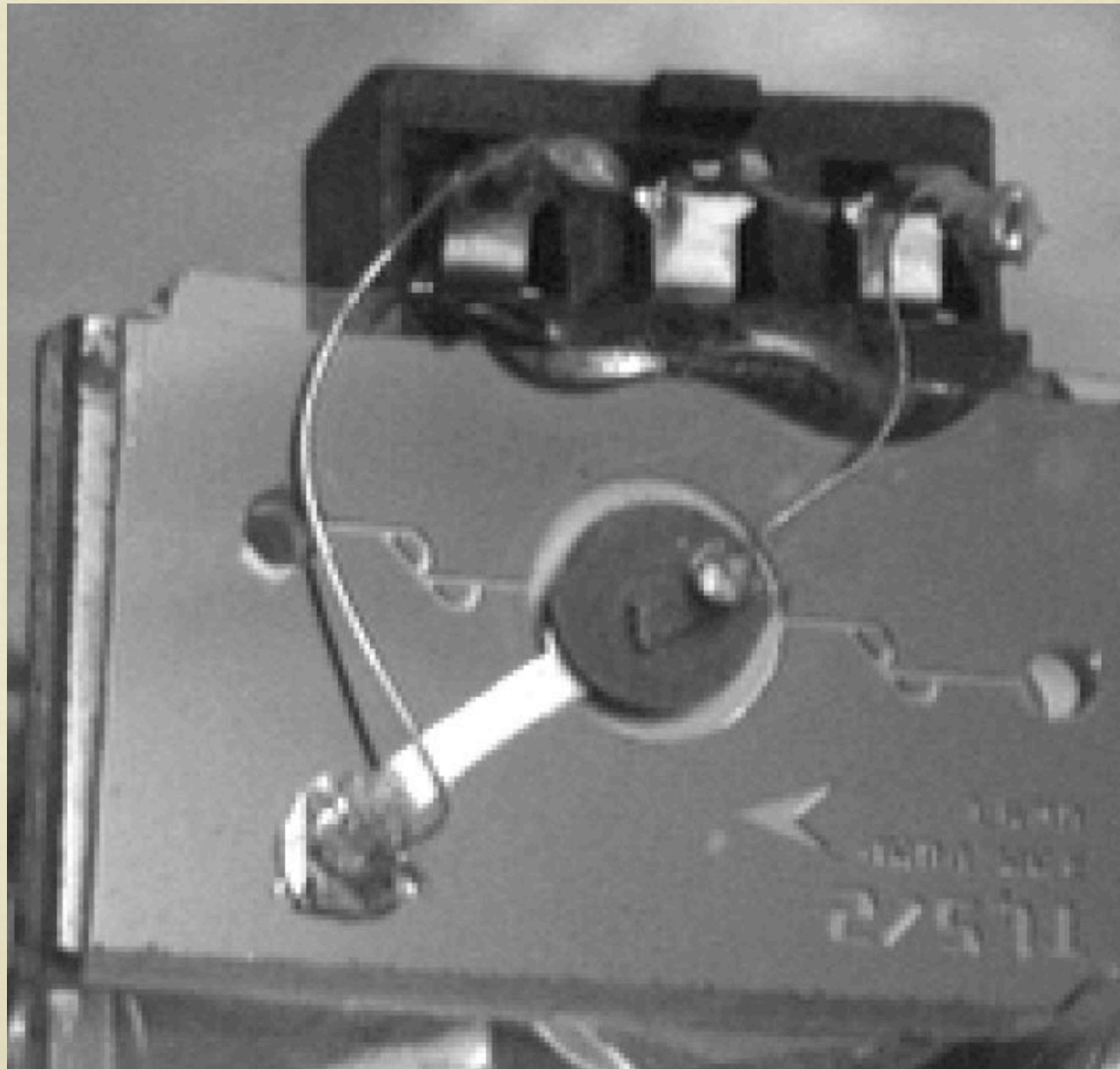
=> NO RESISTANCE IN THE NORMAL DIRECTION

=> ACTS AS A *Fluid diode*

■ WORKS WITH A PUMP BY APPLYING PULSED

U OF WASHINGTON PUMP

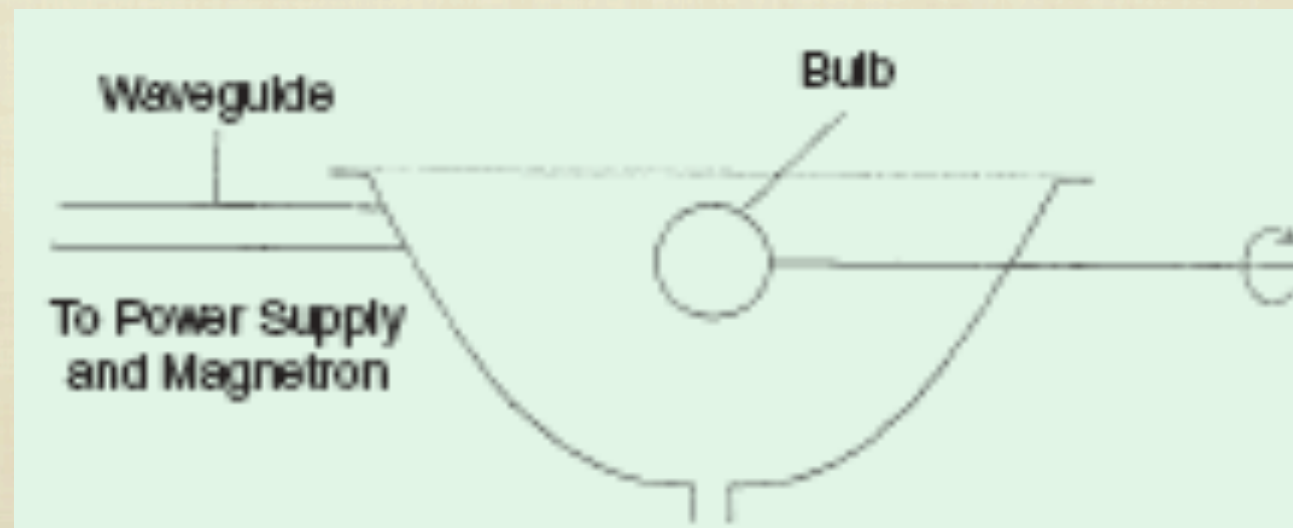
Morris and Foster 2003



[BACK](#)

RADIO-FREQUENCY (RF) LIGHTING

- TESLA'S 1891 WIRELESS LIGHT - **“A BRIGHT IDEA”**
- PRECURSOR OF MODERN ELECTRODE-LESS LAMPS
- REQUIRED PROGRESS IN TECHNOLOGY AND PLASMA PHYSICS TO BECOME PRACTICAL



HID sulfur lamp inspired by Tesla's design illuminates National Air and Space Museum, Washington, DC.



[BACK](#)

CONTRIBUTIONS TO PLASMA PHYSICS

- TESLA IS KNOWN AS THE FIRST PERSON TO PRODUCE AND STUDY RF GAS DISCHARGES AND PLASMAS.
- THESE ARE USED IN PHOTOLITHOGRAPHY, HIGH-RESOLUTION ETCHING, THIN FILM DEPOSITION AND IMPLANTATION - ALL NEEDED IN PRODUCING MODERN INTEGRATED CIRCUITS (IC).

BACK

NANOTECHNOLOGY

- **TESLA'S TRILAYERED (METAL-INSULATOR-METAL) COAXIAL CABLE [1894] IS THE BASIS FOR DESIGN AND FABRICATION OF COMPLEX NANOSTRUCTURES, NAMED "TESLIAN" COAXIAL NANOCABLES**

BACK

TESLA AND ELECTROTHERAPEUTICS

- FIRST TO RECOGNIZE PROPERTIES OF HIGH-FREQUENCY (HF) CURRENTS WHEN APPLIED TO HUMAN BODY AND HE PROCEEDED TO DEVELOP A VARIETY OF DEVICES FOR THEIR GENERATION.
- DIATHERMY AS A MOST SUCCESSFUL APPLICATION
- HISTORY NOT KIND TO TESLA - MOST CREDIT GIVEN TO D'ARSONVAL

[BACK](#)

THE “WONDER WORLD” TO BE CREATED

- TESLA’S IDEAS ABOUT “ELECTRICAL” WORLD OF THE FUTURE. HIS PREDICTION INCLUDE:
- THE WIDESPREAD USE OF HYDRO-ELECTRIC POWER GENERATION AND OF AC FOR POWER TRANSMISSION
- WIRELESS TRANSMISSION OF ELECTRICAL ENERGY
- ART OF INDIVIDUALIZATION: MULTI-FREQUENCY NON-INTERFERRING TRANSMISSION (SPREAD SPECTRUM IDEA)
- ELECTRICAL CONTROL OF ATMOSPHERIC MOISTURE: (NOT YET)

THE WONDER WORLD TO BE CREATED

- USE IN APPLIANCES (REFRIGERATION, ETC.), LIGHTING, AND PROPULSION
- USE IN AGRICULTURAL DOMAIN: PEST CONTROL, ELIMINATION OF MICROBES, ...
- COLLISION-PREVENTING INSTRUMENTS
- “IN A TIME NOT TOO DISTANT IT WILL BE POSSIBLE TO FLASH ANY IMAGE FORMED IN THOUGHT ON A SCREEN AND RENDER IT VISIBLE AT ANY PLACE DESIRED.”
- WORLD SYSTEM OF MUSIC DISTRIBUTION (iTesla?)

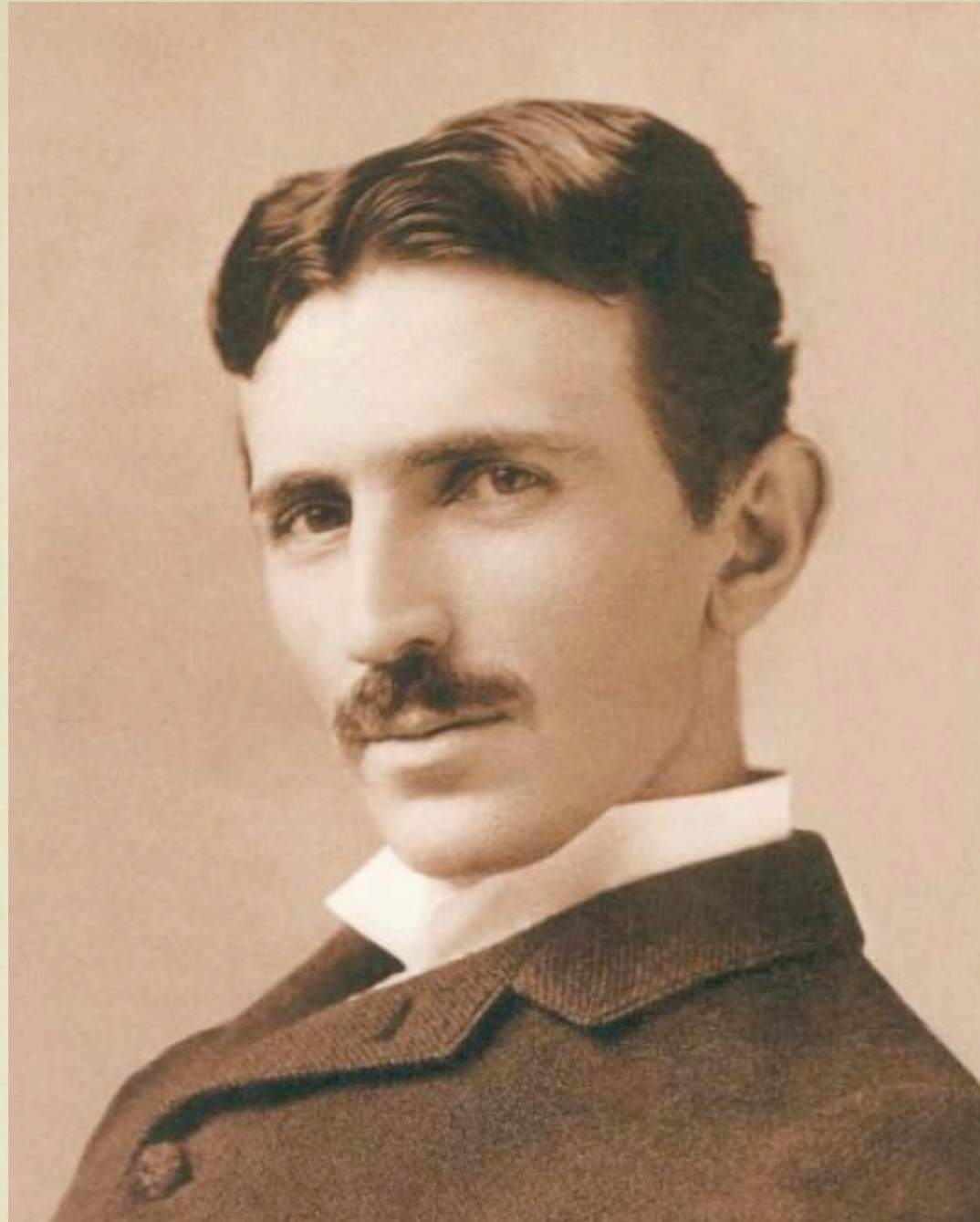
THE WONDER WORLD TO BE CREATED

- A VOICE-OPERATED TYPEWRITER
- PICTURE TRANSMISSION (FAX)
- PROPOSED THE USE OF GEOTHERMAL ENERGY
- EXPRESSED DOUBTS ABOUT SOLAR POWER GENERATION
- OPPOSED NUCLEAR ENERGY
- ELECTRIC GUNS AND TELEAUTOMATIC AERIAL TORPEDOES (CRUISE MISSILE?)

BACK

CLOSING REMARKS

- THE SCOPE, DEPTH, AND TIMELINESS OF TESLA'S WORK MAKE HIM A UNIQUE FIGURE IN THE HISTORY OF ENGINEERING
- HIS IDEAS OF AC MOTORS AND POLYPHASE SYSTEMS ARE THE FOUNDATION OF ELECTRICAL POWER SYSTEMS IN MODERN WORLD
- PROVIDED CRITICAL IDEAS IN DIVERSE AREAS
- THE OMNIPRESENCE OF HIS IDEAS SHOWS THAT THEY HAVE WITHSTOOD THE TEST OF TIME



**"THE WORLD, I THINK, WILL WAIT A LONG TIME
FOR NIKOLA TESLA'S EQUAL IN ACHIEVEMENT AND
IMAGINATION."**

E.H. ARMSTRONG, FM RADIO PIONEER

THE ENGINEER-GENTLEMAN



BACK

272 PATENTS WORLD-WIDE



BACK

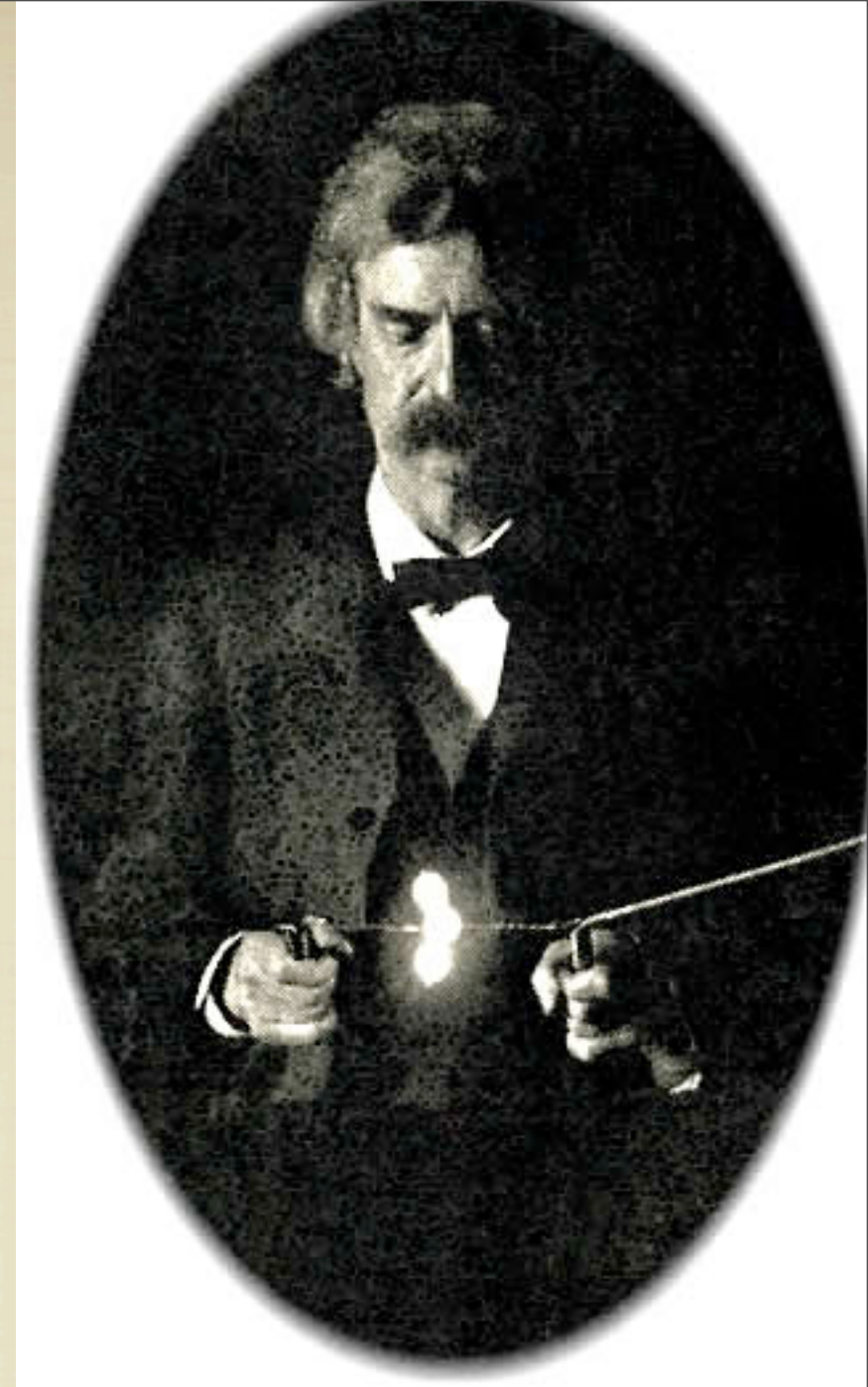
SCIENTIST

- IN COMPANY OF VOLTA, AMPERE, FARADAY, KELVIN
THE UNIT OF MAGNETIC INDUCTION [TESLA]
 $T = \text{WB}/\text{M}^2$
- HON. DOCTORATES COLUMBIA, PRAGUE, GRAZ,...
- EDISON MEDAL
- VICEPRESIDENT AIEE
- CLOSE TO KELVIN, LODGE, CROOKES, THOMPSON
- ADMIRED BY EINSTEIN
- THE TIMES MAGAZINE MAN OF THE YEAR
- ON POSTAL STAMPS AROUND THE WORLD
- STRONG VIEW ON RESEARCH

[BACK](#)

TESLA, LIFE AND PEOPLE

- LITERATE, WORLDLY, INTERESTING, WITTY - FRIEND WITH MARK TWAIN, UNDERWOOD JOHNSON, JACOB ASTOR, GEORGE WESTINGHOUSE, JP MORGAN, A DVORAK, SARAH BERNHARDT, GEORG VIERECK... THEIR WIVES ADORED HIM AND HE IGNORED THEM.
- DELMONICO'S AND WALDORF-ASTORIA SUITED HIS TASTE
- LOVED POETRY, GOOD WRITER
- IMPECCABLY DRESSED



[BACK](#)

NT MUSEUM, BELGRADE: INDUCTION MOTOR VIDEO (TESLA'S ORIGINAL DESIGN)



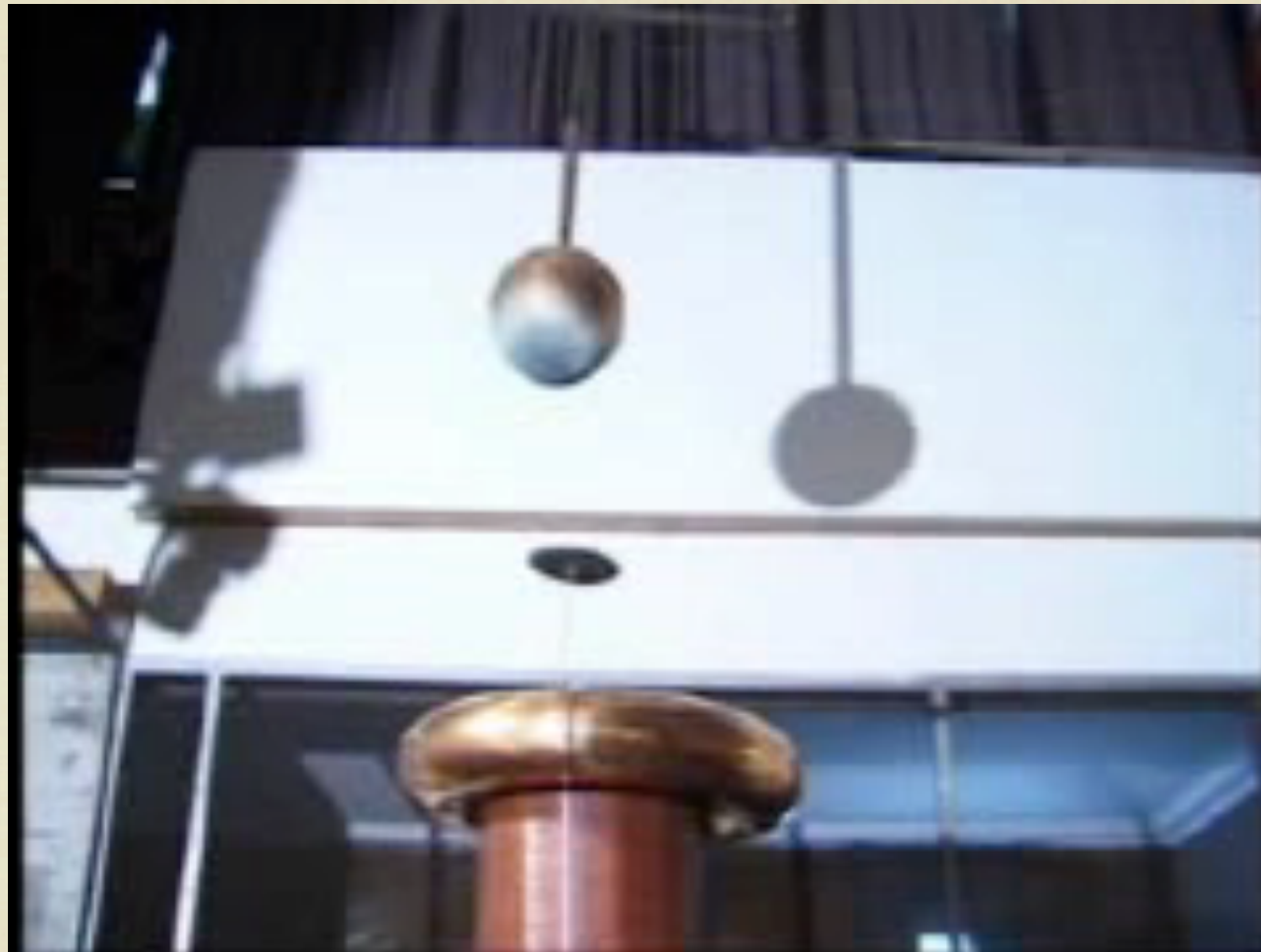
BACK

NT MUSEUM, BELGRADE: TESLA'S 2-PHASE GENERATOR

QuickTime™ and a
decompressor
are needed to see this picture.

BACK

NT MUSEUM, BELGRADE: TESLA'S TRANSFORMER



BACK

TESLA'S VIEW ON RESEARCH

“Today’s scientists have substituted mathematics for experiments, and they wander off through equation after equation, and eventually build a structure which has no relation to reality.”

THANKS TO LEN KLEINROCK, TESLA'S FAN AND TESLA COIL BUILDER

BACK

TESLA THINKER



READING BOSKOVIC'S
Theoria Philosophiae Naturalis
[in front of his high-frequency transformer]

BACK