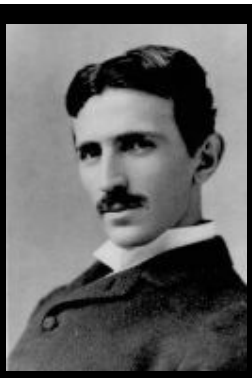


Nikola Tesla

And His Celebrated Tesla Coil

Nikola Tesla, Serbian-American inventor, remains shrouded in controversy and mystery sixty years after his death. *Establishment historians* try to sweep Tesla under the rug. *Cult* followers believe Tesla was centuries ahead of today's technology, inventing antimatter, antigravity, free energy, and that Tesla and his followers left Earth to live on another planet. *Coilers* just love to design and build versions of the famous Tesla Coil. By any measure Tesla was eccentric and brilliant, and his patents founded empires of industry and technology.

Yet other men rode to fame and fortune on Teslas inventions. Teslas AC generators and motors power the wheels of industry, while the name of Tesla was all but forgotten. Tesla died in poverty in a New York hotel in January 1943, his papers were quickly siezed by the FBI. For years after the death of Tesla, lawsuits raged over Tesla patents. Out of only eleven patent suits ever heard by the US Supreme Court in its history before 1960, two were suits over tesla inventions, and the Court found that Tesla was indeed the inventor of Polyphase AC, and of practical Radio Frequency Transmission.

Tesla's Avengers

John Wagner, school teacher, mobilized his third grade classes to raise thousands of dollars to create this commemorative bronze bust of Tesla. Wagner accuses the Smithsonian's National Museum of American History of presenting "a deliberate assault on factual history" and is crusading to set the record straight. Read how Tesla was Erased at the Smithsonian and get a kewul Tesla Tshirt while helping the class raise funds for more busts like this one at Yale University.

"In a single burst of invention he created the polyphase alternating current system of motors and generators that powers our world. He gave us every essential of radio, and laid the foundation for much of today's technology."
-- Epitath on bronze bust of Tesla, refused by the Smithsonian, now displayed at Yale University.

Tesla Coiling

While Teslas polyphase AC system spans the world today, a different invention, the Tesla Coil, never saw commercial use. The Tesla Coil however is the most awe inspiring electrical device, transforming ordinary power into high frequencies at tremendous voltages. During his brief peropd of poularity Tesla with his coil created spectacular displays of live electricity, such as the 1893 Worlds Fair in Chicago. Tesla coils are still individually hand made by intrepid Coilers following in Teslas footsteps.

I discovered the Tesla Coil in 1978 while reading a 19th century article by Tesla in a cracked, leather and wood bound volume from an obscure corner at Georgia Tech. Back in my dormitory, I began building a Tesla Coil. Several nights later, I powered up the coil. My terrified roomate fled in panic. The Tesla Coil was delightfully awe inspiring, with its shattering roar and streamers of purple fire writhing in the air. I was in love.

Call Me Sparky !

Mk II Coil in operation

Altairs Tesla Coils, Coil Plans, and How to Make a Tesla Coil

! ! WARNING ! !

This device involves extreme voltages, possibility of fire, explosion, violent ruptures of glass components and other risks.

Construction of such devices may be illegal in your area.
You could be hurt. You could die.
Take cover. Turn it on.
Fear what you have created.

High Voltage

Click Hazard Icon For More Info

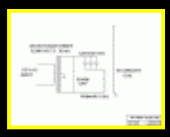
This device involves very high voltages.

PCBs

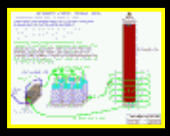
Click Hazard Icon For More Info

Don't Die Like a Poisoned Roach ! Test For PCBs in old High Voltage components !

Altair's First Tesla Coil, Mk I



Made in 1978 in Heffner dormitory at Gerogia Tech. Was wound on a 2-1/2 inch grey PVC pipe and was excited from a 15kV neon transformer, a spark gap made of coat hanger and a plastic cup liberated from the lunch room. My favorite capacitor bank was six 1 qt beer bottles, with brine and copper wire inside, wrapped in foil on a metal plate on a stack of computer paper. It was also fun to empty the bottles.

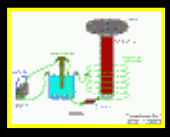


Status September 1978, purple corona at top, 12 in streamers. Eventually died by external arcing on the secondary.
Lessons Learned: use more top load (toroid or sphere electrode capacitance); dont use black or gray PVC pipe; secondary coil should not be very long and thin, aspect ratio should be 3 - 5 ; secondary should have heavier wire, lower resistance, higher resonance.

Altair's Mk II Tesla Coil

My second Tesla coil will drive 40 inch streamers, photos above. Its vital statistics are:
Sedcondary Coil : Cylindrical , 4.5 in dia, 30 in tall, PVC form, 880 turns of #20 copper wire.
Top Load : Toroid, stovepipe, 8 x 24 inches.
Primary Coil A: Cylindrical , 40 in dia, 18 in tall, on PVC posts, ten turns of 1/4 inch copper tubing.

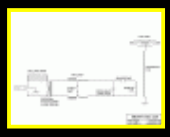
Primary Coil B: Cylindrical , 9 in dia, 18 in tall, on 8in PVC, 30 turns of #6 copper wire.
Primary Coil C: Conical Helix, 10 in to 48 in dia, 120 deg included, 23 turns of #6 copper wire.
Power: Potential Transformer, 14400 V AC, 1500 VA, External Ballast 1 to 4 hot water heater elements, 1500 W each.
Hawg Capacitor A: One plastic soda bottle, 0.008 uF
Hawg Capacitor B: One glass gallon cider jugg, 0.003 uF
Hawg Capacitor C: Seven glass gallon cider juggs, 0.017 uF
Surplus Capacitor: Old surplus GE capacitor, 50 kV, 0.022 uF
Progress to Date : see **Altair's Tesla Lab Notes**



Status Feb 1999:
Streamers 44 in, controlled strikes 10 in.
Switched to GE Capacitor, 22 nF. Primary Coil tunes at 6 1/2 turns.
Expanded 240 V ballast bank to 12 kW, for 1.5 kVA potential transformer.
Next: Construction of asynchronous tungsten rotary gap. Increase primary conductor size to 1/2 in dia or more.

Altair's Mk III Tesla Coil

My Mk III Tesla coil will drive 50 inch streamers. Dont get too close. Its vital statistics are:
Sedcondary Coil : Cylindrical , 9 in dia, 30 in tall, PVC form, 880 turns of #20 copper wire.

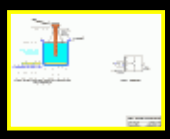


Top Load : Toroid, stovepipe, 8 x 24 inches.
Primary Coil D: Conical Helix, 10 in to 48 in dia, 120 deg included, 23 turns of 3/4 in copper tubing.
Power: Potential Transformer, 14400 V AC, 1500 VA, External Ballast 1 to 8 hot water heater elements, 1500 W each.
Hawg Capacitor C: Seven glass gallon cider juggs, 0.017 uF
Surplus Capacitor: Old surplus GE capacitor, 50 kV, 0.022 uF

Progress to Date : see Altair's Tesla Lab Notes

Status Feb 2000:
Streamers 54 in, controlled strikes 14 in.
Switched to GE Capacitor, 22 nF. Primary Coil tunes at 6 1/2 turns.
Rewound Primary Coil with 3/4 in Cu tubing.
Expanded 240 V ballast bank to 12 kW, for 1.5 kVA potential transformer.
Next: Fiber Optic Instrumentation System, Increase Toroid size. Construction of asynchronous tungsten rotary gap.

Hawg Capacitor



The HAWG CAPACITOR is a cheap way to home-grow a useable high voltage capacitor from a plastic soda pop bottle. These wont stand a lot of abuse, but a plastic soda bottle is cheap to replace.
Theory of Hawg Capacitor design.
Hawg Capacitor experiments to date.
Archive of HV capacitor email excerpts

The BOSS HAWG CAPACITOR is much more rugged and almost as cheap. This version uses glass gallon apple cider juggs, for construction details and a great recipe, see High Voltage Apple Cider.

Party Cup Capacitor

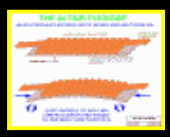
The PARTY CUP CAPACITOR, designed by Marc Metlicka, is the cheapest useable high voltage capacitor, made from plastic party cups. The prototype withstands 33kV AC in spark gap duty.

i pulled out about 5" by 18" strip, i rolled it around the cup at about 1" from the top holding the overlap of about 1" tightly, then tearing off the excess. holding the seam i started rubbing the foil tightly around the cup with the other hand, then folding it under the cup and pressing flat. then i put the cup inside another cup and putting my hand inside i pressed, squeezed, pushed, twisted, and rubbed the two cups together. when i pulled the cups apart i was surprised at how flat and form fitting the foil had become.

i then rubbed the foil even smoother with a sharpie marker, burnishing the bottom folds tightly against the cup. i took the foil cup and pushed it inside the other cup and did the rub, twist, push routine again then pulled them apart one more time, i took the torn off piece and folded it over twice to make the contact strip, i slid it under the foil about 1" then put the cups back together. this made one cell.

FlexiGap

The FLEXIGAP is a fully adjustible modification to the Richard Quick multiple spark gap. It is still Quick and Hawg cheap, but it includes a simple method of continuously and simultaneously varying the gap spacing in an (almost) uniform manner.



Multiple spark gaps are used to improve 'quenching' which is the gaps' ability to stop conducting after it has delivered the proper amount of charge. In high power Tesla coils, the RF energy in the primary may cause the gap to continue conducting RF after the capacitor is discharged, which depletes the energy from the primary-secondary system.

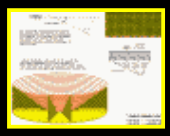
Multiple gaps are optimized by three main parameters: number of gaps, gap spacing, and airflow. Airflow is optimized by a blower, number of gaps is optimized by a selectable tap in a chain of gaps. In this version, the spacings are also adjustible by bowing a flexible substrate.

SuckerGap

The SuckerGap is an idea from. It is a static gap using two hollow tubular electrodes with air being sucked into the electrodes. The air promotes good quenching and cools the gap.

This gap is sucked by a ShopVac. The blower of the ShopVac is mounted onto a plastic bucket which has a two-horned PVC manifold. The electrodes are copper pipe fittings at the ends of the manifold facing each other.

Cone Primary Coil



Primary coils spirally wound in the shape of an inverted cone allow the coupling to be adjusted by raising or lowering the secondary. This inverted conical spiral primary uses coil supports cut from pegboard to form notches for the wire to be laid into. I use pegboard with 1/4 in holes which fits #6 copper ground wire. Later, I used 3/4 inch copper tubing on the same coil form.

Extending MOT Stacks

Many experimenters stack MOTs (Microwave Oven Transformers) with their primaries in parallel and secondaries in series to get several kV. Usually with more than 4 MOTs in series, the secondary to core insulation begins to fail. Those who have PLENTY of MOTs might try this hookup to extend their MOT stack farther before insulation failure.

This connection allows four MOTs to be stacked with only a 2x overstress of the insulation, even in one end of the stack is grounded.
Two such stacks oppositely phased will give eight MOTs in series with a grounded center tap with only 2x overstress.

This connection allows four MOTs to be stacked with NO overstress of the insulation.

Tesla Coil Design Data

Coiling Terms	A brief lexicon of TC terms and acronyms, you wanna bookmark this if you lurk on a Tesla Coil list server. Collections by Reinhard, Fritz, et al.
Tesla Coil Basics	A brief theory of operation of Tesla Coils, in FAQ form according to Bert Hickman. Excellent into for the coiler newbie, covers all the bases, including formulas for rolling your own.
Tesla Coil Design Data	A collection of data for TC designers and builders, including dielectric property tables, conductances of electrolytes, household leyden jars, etc. Data formulas for rolling your own capacitors, coils, etc.

Vic and Kip's Excellent Tesla Coil

Another Altair member, Kip Turner, W4KIP, built a fine coil. In his own words:

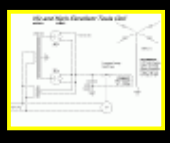
(Our 1,000 KV Tesla coil) was a pulsed device with a pulse input power of about 6.5 MW. (13 Kv @ 500 A.) Just the kind of toy you'd expect a teenager to build. (The average was about 1 KW). (We also built a "Jacob's ladder that was 10 feet high with a 2 foot gap...but that was one of our low voltage gadgets...160 KV). No pix of it.

How big a spark are these guys after ?

(Mine did about six feet ! ...Limited by distance to grounded objects.)

Heres more from Kip :

The tesla coil that I and Vic made used a rug core for the coil form. I still have some of the wire we used...I think it's #26. My memory is a little flaky, but I believe it was about 6 feet long and 6 in (more or less) diameter. The primary was about 2 feet in diameter. We operated with one end grounded and the freq was about 135 KHz. It used a tungsten rotary spark gap (homemade) and had a 13.5 KVDC , 500 watt power source. The arc was limited by the 6 foot distance to ground. I have a picture...somewhere. If I can find it, I'll send you a copy. I think Vic lost it during a move a few years ago. The cap was a very high voltage indeed WWII surplus unit.
Kip



Kip supplied the info to draw a schematic of Vic and Kip's unusual Tesla Coil. Note the high voltage supply is DC and the coil runs at a low rate of about 10 BPS. The 3B24 rectifiers and transformer required no RFI protection.

Please email Kip and bug him to dig up his old TC photo for this page.

Bert Behlow made an unusual secondary coil which was immersed in mineral oil. This secondary had LOTS of turns of very fine wire. A valiant effort, but fell short of our grand expectations. Bert, if you're out there somewhere, it would be really good to hear from you.

I have collected materials for a secondary coil about 60" tall and 9" in diameter. Would like to resonate it at 184.32 KHz so it could double as an output stage for Lowfer beacon YWK. Might be a fun group project for folks in the Atlanta area?

Lexicon

Nikola Tesla

Nikola Tesla (1856-1943) is perhaps the most controversial and mysterious inventor of the technical age, is also a cult icon of alternative science followers. A Serbian immigrant, he arrived in America a pauper, earned fame and fortune as an eccentric but flambouyant genius, and died in poverty. Nikola Tesla's patents still today are the core of our electrical power distribution and use. Royalties from his many inventions founded empires of industry and technology for those shrewd enough to have obtained them cheaply, such as Morgan, Westinghouse and Edison. The celebrated Tesla Coil has found little commercial use, but is still the hands down favorite for producing awesome and beautiful electrical displays.

Grote Reber

Grote Reber (1911-2???) a ham radio operator and engineer who founded the science of Radio Astronomy in his spare time. In 1937 he built a 31 ft parabolic dish antenna with a 20 ft focal length in his backyard in Wheaton, Illinois. With his third homemade radio receiver, he successfully recorded extraterrestrial signals at 160 MHz in 1938. Reber worked long into the night when interference was reduced. By aiming his dish in declination and using the rotation of the planet earth, Reber had completed the first radio map of the sky by 1943, clearly showing not only our own galactic core, but discovering new sources in Cygnus and Cassiopeia. When a delegation of distinguished scientists came to verify his accomplishment, he had to delay them because it was laundry day and his dish antenna was supporting one end of Mrs Reber's clothesline. When the movie Contact was filmed at the VLA Radio Astronomy Observatory, ham operators there contacted Reber, by then very aged but continuing research and living in Tasmania. Reber permitted his ham radio callsign to be used by Jodie Foster in the movie.

James Clerk Maxwell

James Clerk Maxwell (1831-1879) received much of his formal

technical education in London, but his heart continually drew him to poetry, and to his family home in the hills of Scotland. Maxwell was a child prodigy; his first paper, on the mathematics of arbitrary curved shapes in rolling contact, was published when he was sixteen years old. More mathematical treatises on an astonishing variety of subjects followed. Although famous for his equations of electromagnetics, they comprised a small part of his life works. His papers include the mathematics of human perception of colors, kinetic theory of gasses, the dynamics of a spinning top, thoeries of soap bubbles, and others. During his career, he would repeatedly discover scientists and experimenters wrestling with knotty theoretical problems, whereupon he would step in and set the math right, before moving on to some other problem which drew his interest. As astronomers argued over the physical composition of the newly discovered rings of Saturn, Maxwell deduced the answer by purely mathematical reasoning; nearly a hundred years after his death NASA space probes proved him right.

Classical Physics

Classical Physics is the physics up to the Thoery of Relativity. If you dont know what kind of physics you studied, it was classical physics. John Wheeler taught a freshman college physics course that started with the Theory of Relativity and commenced to describe the whole of classical physics as a condition of relativity. His wild approach was quickly suppressed.

Continuity conditions

Continuity conditions say that flux density is proportional to field strength. The constants of this proportionality are the permitivity (for electric force) and permeability (for magnetic force). These two constants represent the elasticity of spacetime. From these two numbers we get the impedance and velocity of a wave in space. The impedance is 377 ohms, the velocity is 186000 miles/second.

Scot

Q: Why did God create whiskey ?
A: So the Scots would not rule the world.

Vectors

Vectors are numbers that *point somewhere*. A vector has a direction and a magnitude. Example: Five is a *scalar* number. Five miles northwest is a *vector*.

Duality

definition here

Brine

definition here

Magnet Wire

definition here

Quench

definition here

The Illusion of Solidity

The Illusion of Solidity is the perception of matter as sensible and substantial. If we look into matter, we find it composed of molecules and atoms, which in turn are composed of protons, neutrons and electrons. Virtually everything our senses perceive are elaborate structures of protons, neutrons and electrons and the electromagnetic fields that bind them. These particles are quite small and have powerful electric and magnetic charges. Picture our solar system seen in the night sky; the planets are very small compared to the vast distances separating them. The structure of the solar system is held together by gravity as the structure of the atom is held together by electromagnetic forces. The same protons, neutrons and electrons combine in many possible patterns of electromagnetic fields creating multitudes of different physical properties. Protons in the hammer dont touch protons in the nail, it is the force fields of the electrons which absorb the force of impact.

Strong Nuclear Force

Short range force, the strongest known. If you ever figure out how to make a weapon from it, please say nothing about it, burn your notes, destroy the ashes and kill yourself.

Electromagnetic Force

Second strongest known force, obeys inverse square law. Much stronger than gravity. The earth would be held in its present orbit by electromagnetic force alone if the entire mass of the sun were replaced by 1/1000 of a gram of pure electrons removed from the earth. Sometimes electric and magnetic aspects of this force are perceived separately. X-rays, light, and radio waves are all electromagnetic energy in pure form.

Weak Nuclear Force

Short range force, third strongest known force, binds protons and neutrons in the nucleus of an atom. Makes nuclear bombs go boom.

Gravitational Force

Inverse square, weakest force. May be an aspect of the stronger forces but we cant prove it.

Back to Altair home page

EMail altair@altair.org

NIKOLA TESLA

1856 - 1943

FORGOTTEN AMERICAN SCIENTIST

ERASED AT THE SMITHSONIAN

OMITTED IN SCHOOL TEXTBOOKS

OMITTED IN TECHNICAL JOURNALS

UNKNOWN, EVEN TO SOME ENGINEERS

Revised September 20, 2002

NEVERTHELESS...

A unique class of Michigan Third and Fourth Grade children are honoring Tesla and preserving his memory in history at eleven major universities: Harvard, Yale, Princeton, MIT, Caltech, Univ. of Michigan, Univ. of Wisconsin, Univ. of Maryland, Univ. of Illinois, Univ. of Pennsylvania, and Purdue Univ.

THIS IS OUR SCHOOL

Summers-Knoll Elementary School

Ann Arbor, Michigan USA

S-K cares for the educational needs of bright, gifted, and creative children in Grades K-5.

I am John W. Wagner, teacher...and I have a story to tell you about my successive classes of third and fourth grade students whose efforts are focused on preserving Tesla's memory in history.

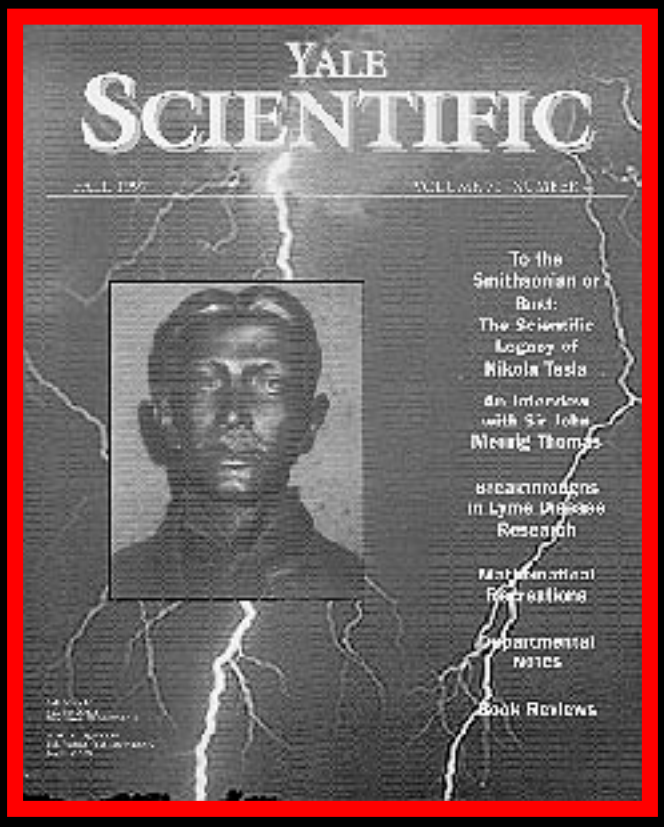
Along the way, my students somehow learn to write...and enjoy their newly acquired skill. Is this not one of the grand purposes of school?

Our class hero is Nikola Tesla because he is the underdog

of electrical history, yet his scientific discoveries brought us the prosperity we enjoy today.

I encourage you to continue reading our incredible story of how my students are making their mark on history for Nikola Tesla. Perhaps you will even want to give us a helping hand in some small way. We can certainly use all the help we can get.

I provide only one link to an outside web site; it is to Yale University. Yale also created a link to our web site. Please read Yale's short story before returning to this page.



Click HERE now. Then return here and continue as indicated.

Click HERE to continue (after having read the Yale page).

Click HERE to go to B-W page (without pictures) for print-out.

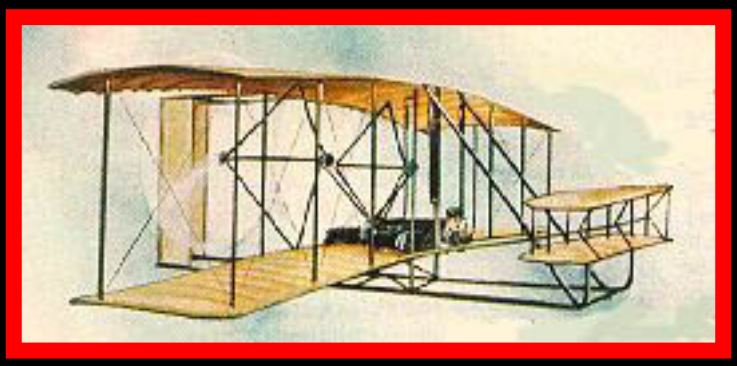
Click HERE to send me a message.

Click HERE to go directly to our T-shirt page.

Nikola Tesla--(Page 7)

Are you still unconvinced that our complaints are legitimate? Please consider the following information concerning the Wright Brothers...not willingly cited by our historians.

SMITHSONIAN SNUBS WRIGHT BROTHERS



When you visit the National Air and Space Museum at the Smithsonian you see this famous Wright Flyer which made man's first successful flight December 17, 1903. What Smithsonian officials do NOT tell you is that they snubbed the Wright brothers for 45 years, refusing to acknowledge their great accomplishment and install this famous plane in the museum. They did this because their own head of the Smithsonian, Samuel P. Langley, built an airplane shortly before the Wright brothers...but it could NOT fly! Forty-five years is a long time for the Smithsonian to deny the truth. Wilbur died Spring 1912, weakened by his nine-year dispute with the Smithsonian. Orville finally gave up the fight in 1928 and sent his famous plane to the Museum of

London as a gesture of contempt for the Smithsonian. American public pressure increased in the years that followed. Many people wondered why our famous Wright Flyer was in London instead of here in America. Orville died January 1948. Later that year the Smithsonian finally agreed to bring the plane back from London to be formally installed December 17, 1948. Unfortunately, neither of the Wright brothers lived long enough to know that their own country officially acknowledged their great accomplishment.

The Smithsonian is cheating the public from learning Tesla's history in much the same way as they did with the Wright Brothers, except that Tesla's banishment has lasted more than a century.

ARE YOU INCENSED ENOUGH TO WANT TO HELP US?

Education is the only way to combat the Smithsonian's wrongful depiction of electrical history, but we cannot hope to match the millions of dollars industry and the Edison Institute spend promoting Edison's name. Nevertheless, I believe we can make a significant impact on many of our country's future physics and engineering students by donating busts of Tesla to many of our major

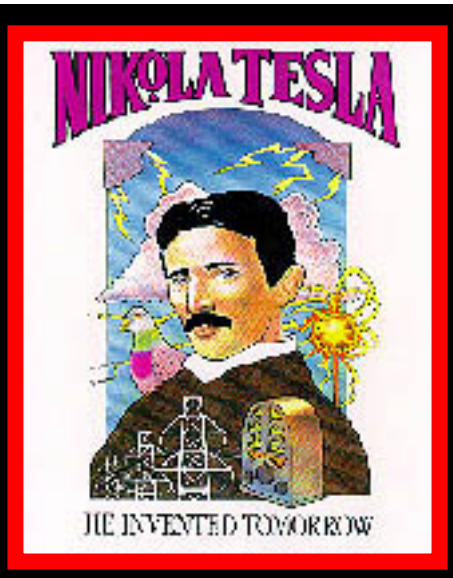
universities.

People universally recognize that a sculpture is an acknowledgment of one's greatness. Inasmuch as the academic community essentially forgot Tesla for a century, we believe a good first step is to reintroduce him to the students and faculty of our major universities.

OUR RECORD

We have already proved our ability to do the job, but we need everyone's help if we are to continue. In the past we received donations and sold promotional T-shirts to earn money for our busts. We have the mold and we want to have additional busts cast for other universities, but our coffer is empty. In short, we need to sell more T-shirts to earn money for our busts; we hope you will want to help us continue our quest.

THIS DRAWING IS ON THE FRONT OF OUR T-SHIRTS



We engaged a commercial artist to render this drawing for the front of our T-shirts, the symbolism representing Tesla's interests and accomplishments. It is 9 1/2 inches wide by 14 1/4 inches high and has six colors. Shirts are premium grade 100% white cotton.

T-SHIRT ORDERING INSTRUCTIONS

(1). Make your check payable to:

"SUMMERS-KNOLL ELEM. SCH.-(TESLA)." Shirt cost is $23. We pay the postage.

(2). Specify quantity and size desired. Shirts come in ADULT sizes S - M - L - XL- XXL.

(3). (IMPORTANT) Write your e-mail address clearly on your check (or on a separate piece of paper).

(4). Specify name and mailing address if it is different from that printed on your check.

(5). Mail your check or money order to:

John W. Wagner

3890 Tubbs Road

Ann Arbor, MI 48103-9437

All money goes into our school's tax-free account, making this a squeaky clean operation. We do not want any trouble with the IRS. 100% of the money is spent only on the busts (and possibly Tesla posters...for donation to schools), shirts, mailing envelopes, and postage. I pay for all other expenses without reimbursement.

Although we are a tax-free organization, it is NOT legal to claim the shirts as a deduction with the IRS.

Orders are always mailed either the same day received or the next day (if the mail arrives late in the afternoon).

We take overseas orders, but we must charge extra for postage. The cost varies from country to country. As I recall, $10 US dollars usually covers postage for one shirt. Check with me. Your bank or Western Union Office can convert your money to US Dollars.

Click HERE to continue.

Click HERE to go back one page.

Click HERE to send me a message.

Click HERE to go to B-W page (without pictures) for print-out.

DONT DIE !

Laboratory Hazards

Safety, Prevention, First Aid

Acid

PREVENTION

Aviod contact with skin and eyes, aviod exposure to fumes. Wear face protection and protective gloves and clothing. When diluting, always add Acid to water, Never add water to acid. Some acids when dissolving other substances produce enormous amounts of heat that can cause boiling and splattering.

Acids can be neutralized with Soduim Bicarbonate, $NaHCO_3$, beware of possible violent chemical reaction. Mixing strong acids and alkalis especially can cause violent chemical reactions.

IN CASE OF EXPOSURE

Acid Fumes

Remove source of contamination or move victim to fresh air.
Begin rescue breathing if breathing has stopped and CPR if heart action has stopped.
Transfer promptly to a medical facility.
Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed.

Acid On The Skin

Avoid direct contact with acid. Wear chemical resistant protective gloves, if necessary. As quickly as possible, flush contaminated area with lukewarm, gently running water for at least 20-30 minutes, by the clock. If irritation persists, repeat flushing. DO NOT INTERRUPT FLUSHING. If

necessary, keep emergency vehicle waiting. Under running water, remove contaminated clothing, shoes, and leather goods (e.g., watchbands, belts). Transport victim to an emergency care facility immediately. Completely decontaminate clothing, shoes and leather goods before re-use or discard.

Acid In The Eyes

Avoid direct contact with this chemical. Wear impervious protective gloves, if necessary. Immediately flush the contaminated eye(s) with lukewarm, gently flowing water for at least 20-30 minutes, by the clock, while holding the eyelid(s) open. Neutral saline solution may be used as soon as it is available. DO NOT INTERRUPT FLUSHING. If necessary, keep emergency vehicle waiting. Take care not to rinse contaminated water into the non-affected eye or onto the face. If irritation persists repeat flushing. Quickly transport victim to an emergency care facility.

Acid Swallowed

NEVER give anything by mouth if victim is rapidly losing consciousness, or is unconscious or convulsing. Have victim rinse mouth thoroughly with water. DO NOT INDUCE VOMITING. Have victim drink 240 to 300 mL (8 to 10 oz.) of water to dilute material in stomach. If milk is available, it may be administered AFTER the water has been given. If vomiting occurs naturally, repeat administration of water. Quickly transport victim to an emergency facility.

Other First Aid Provide general supportive measures (comfort, warmth, rest). Consult a doctor and/or the nearest Poison Control Center for all exposures except minor instances of inhalation or skin contact.

Alkali

PREVENTION

Aviod contact with skin and eyes, aviod exposure to fumes. Wear face protection and protective gloves and clothing. When diluting, always add Alkali to water, Never add water to alkali. Some caustic alkalis like Lye (Sodium Hydroxide, NaOH) when dissolving produce enormous amounts of heat that can cause boiling and splattering.

Alkalis can be neutralized with Vinegar (weak Acetic Acid), beware of possible violent chemical reaction. Mixing strong acids and alkalis especially can cause violent chemical reactions.

IN CASE OF EXPOSURE

Alkali Fumes

**Remove source of contamination or move victim to fresh air.
Begin rescue breathing if breathing has stopped and CPR if heart action has stopped.
Transfer promptly to a medical facility.
Medical observation is recommended for 24 to 48 hours after breathing overexposure, as pulmonary edema may be delayed.**

Alkali In The Eyes

Instantly flush with large amounts of water. Continue without stopping for at least 30 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately.

Alkali On The Skin

Quickly remove contaminated clothing. Immediately wash area with large amounts of water. Seek medical attention immediately.

Alkali Swallowed

NEVER give anything by mouth if victim is rapidly losing consciousness, or is unconscious or convulsing. Have victim rinse mouth thoroughly with water. DO NOT INDUCE VOMITING. Have victim drink 240 to 300 mL (8 to 10 oz.) of water to dilute material in stomach. If vomiting occurs naturally, repeat administration of water. Quickly transport victim to an emergency facility.

Other First Aid Provide general supportive measures (comfort, warmth, rest). Consult a doctor and/or the nearest Poison Control Center for all exposures except minor instances of inhalation or skin contact.

Biohazard

PREVENTION

Wear face protection and protective gloves and clothing.

Flush spills with a 1:10 solution of household bleach or Betadine.

Dispose of contaminated material as biohazardous waste.

IN CASE OF EXPOSURE

Biohazard In The Eyes

Instantly flush with large amounts of water. Continue without stopping for at least 5 minutes, occasionally lifting upper and lower lids.

Biohazard In The Mouth

Instantly flush with large amounts of water. Continue without stopping for at least 5 minutes.

Biohazard Puncture Of The Skin

Immediately MILK THE WOUND to induce bleeding. Wash area with soap and hot water for at least 5 minutes.

Biohazard On The Skin

Immediately remove contaminated clothing. Wash area with soap and hot water for at least 5 minutes.

Cryogenics

PREVENTION

Cryogenics such as Dry Ice or Liquid Nitrogen are hazardous. If misused they may cause, frostbite, eye damage, torn flesh, or asphyxiation.

SAFETY RULES FOR CRYOGENICS :
Keep away from children.
Always wear safety goggles at all times.
Use tweezers to handle superconductors, magnets, or other small, cold objects. Plastic tweezers are useful but should be tested for embrittlement (see last caution) before use in classroom.
Wear insulating gloves when handling liquid nitrogen or large, cold objects.
Use liquid nitrogen only in well ventilated places.
Do not allow any liquid nitrogen to touch any part of your body.
Item in contact with liquid nitrogen becomes Extremely Cold. Do not touch any item that has been immersed in liquid nitrogen until it has warmed to room temperature.
Do not store liquid nitrogen in any container with a tight fitting lid. A tightly sealed container will build up pressure as the liquid boils and may EXPLODE after a short time.
Many substances become brittle and may shatter when cold, sending pieces of the material flying. Avoid common glass and large, solid plastics.

IN CASE OF EXPOSURE

Thaw affected area with running tap water. (NOT HOT WATER !) If frostbite has occurred get medical attention.

ESD

Electrostatic Discharge can destroy circuits !

Explosive

PREVENTION

IN CASE OF EXPLOSION

Flammable

Fire can hurt or kill you !

Hot

Heat can hurt or kill you !

High Voltage

PREVENTION

Never work alone with high voltage. Have a partner who knows how to disconnect the power and who knows CPR. A healthy person can be easily restarted after electrocution. High voltages per se dont kill, but they cause dangerous currents to flow. Rule of thumb: 1 mA (milli Ampere, or 0.001 Amps) is startling, 10 mA is painful, 100 mA can cause the heart to go into fibrillation or stop. An old electricians trick to avoid accidental passage of electricity through the heart is to work with one hand and keep the other hand in a pocket.

IN CASE OF ELECTROCUTION

(1) REMOVE THE POWER ! Dont become an additional victim. Turn off or disconnect power source. If unable to reach a switch or plug, use an insulated tool such as a wooden broom handle or rolled up paper to separate the victim from the power source. If extremely high voltages are present, use only the best insulators, like a clean, dry PVC pipe.

(2) Check if the victim is conscious. IF victim is unconscious, check for breathing and pulse. Administer Standard CPR if indicated. A healthy person can be easily restarted after electrocution.

(3) Once consciousness is restored, check for burns. Administer Standard First Aid for burns if indicated.

Poison

PREVENTION

Poisons must be stored in a safe location and in a labeled container.
If you use poisons, find the number for your local poison control center and keep it handy. National Capital Poison Center 1-800-222-1222, or look up your local poison control center here.
Visit your local pharmacy and get Ipecac syrup for your home today.
Before using any poisons, read and understand warning labels and first aid procedures for that substance.

IN CASE OF POISONING

Keep Calm

Act quickly. Action is the most important factor in first aid if you suspect poisoning.

BEFORE CALLING FOR HELP:

Poisonous Fumes or Gases

Immediately carry or drag the person to fresh air. Minimize your exposure to the fumes. If the victim is not breathing, start artificial respiration immediately and continue it until the victim is breathing or help arrives. Send someone for help as quickly as possible.

Poisons on the skin

Brush off any dry poisons and flood the involved parts with large amounts of plain water. Then wash the skin with bar soap and water and rinse. Remove and discard all affected clothing.

Poisons in the Eye

Pour water from a glass on the bridge of the patient's eye and allow water to flood the eye gently for 15 minutes. Use plain lukewarm water. Do not allow the victim to rub his/her eyes.

Swallowed Poisons/Medications

Look into the victim's mouth and remove all tablets, powder or any material that is present. Examine the mouth for cuts, burns, swelling, unusual coloring or odor. Rinse and wipe out the mouth with a cloth.

CALLING FOR HELP:
Call the Poison Control Center or your doctor.
Identify yourself and give your phone number in case your call is disconnected.
Describe the patient by name, age and weight.
If Possible, have the container or poison in your hand and identify as best you can:
What was taken?
When was it taken?
How much was taken?
How is the patient acting?
Be prepared to answer any questions and follow medical advice.

How to Produce Vomiting

The most important item to have in your home when poisoning occurs is Ipecac syrup. Ipecac is a plant extract that when swallowed causes vomiting. Vomiting will remove the poison from the stomach. Your doctor or Poison Control Center may not always recommend using Ipecac syrup. Do not use Ipecac without the advice of a doctor or the Poison Control Center. Remember: Never produce vomiting unless instructed to do so!

Never produce vomiting if the patient:
Has swallowed petroleum products such as gasoline, cleaning fluids and lighter fluids.
Has swallowed a strong corrosive such as drain cleaner or acids. If this occurs, give liquids only.
Is drowsy or unconscious.

Is having convulsions (fits).

If you are instructed to use Ipecac Syrup to produce vomiting:

Give one tablespoonful (15cc) to young children 1 to 12 years of age, and two tablespoonfuls (30cc) to older children and adults. Always consult with your doctor or the Poison Control Center before giving Ipecac syrup to a child under the age of 1.
Follow the dose with a 4 to 8 ounce glass of water or juice. Encourage the patient to drink more fluids, if possible.
Do not allow the patient to lie down. Keep him/her active.
If the patient hasn't vomited within 15 to 20 minutes, give a second dose and another glass of liquid.
If you come to the hospital, bring the poison and the container with you. Bring any stomach contents you collect from vomiting.

Polychlorinated Biphenyls

PCB oils have excellent dielectric properties, stability and are non-flammable and were used in manufacture of certain high voltage transformers, capacitors and other devices. PCBs were developed in the late 1940s and since the mid 1970s manufacturers have phased them out due to toxicity. Newer oil filled High Voltage components will be labeled PCB-free.

PCB oils are TOXIC NASTY BAD STUFF for living beings. If you suspect an old component uses PCB oils, you can call the EPA or hire a test lab, or CAREFULLY do the following three simple tests for PCBs :

1 A droplet held in a flame on a piece of nichrome etc. will give a green color signalling the presence of chlorine.

2 PCB oils are much heavier than mineral oils. Specific gravity of PCBs is about 1.5, and they will sink in water.

3 PCB-based transformer oils have a pronounced sweet-solvent odor, like benzene.

Mineral oils lack the strong odor, will float in water, and burn yellow. If PCBs are present, the component, the oil, and anything they have touched should be considered TOXIC. Protect the skin from contact. Wrap the component in absorbent material and place in a plastic bag, along with any

waste wiping materials. Wash thoroughly.

Symptoms of PCB poisoning include fatigue, headache, cough, numbness in the arms and legs, discharge from the eyes, and unusual skin sores. Long term effects include liver and kidney damage and birth defects. Treatment is to avoid exposure. For more info see Safety Bulletin 37 from the University of North London

Magnetic

Magnets can hurt or kill credit cards and computer disks !

Do Not Touch

U Cant Tuch Dis !

Ionizing Radiation

Ionizing Radiation can hurt or kill you !

Non-Ionizing Radiation

Non-Ionizing Radiation can hurt or kill you !

LASER Radiation

LASER Radiation can hurt or kill you !

UV Radiation

UV Radiation can hurt or kill you !

Electrical Shock

Electrical Shock can hurt or kill you !

Warning

Ignoring this Warning can hurt or kill you !

You could be hurt. You could die. Do not attempt these experiments or projects unless you fully understand and accept all risks involved. Minors should not perform experiments on this web site without adult supervision.

No !

Dont do it !

No Body

No bodies allowed !

No Entry

Do Not Enter !

No Hands

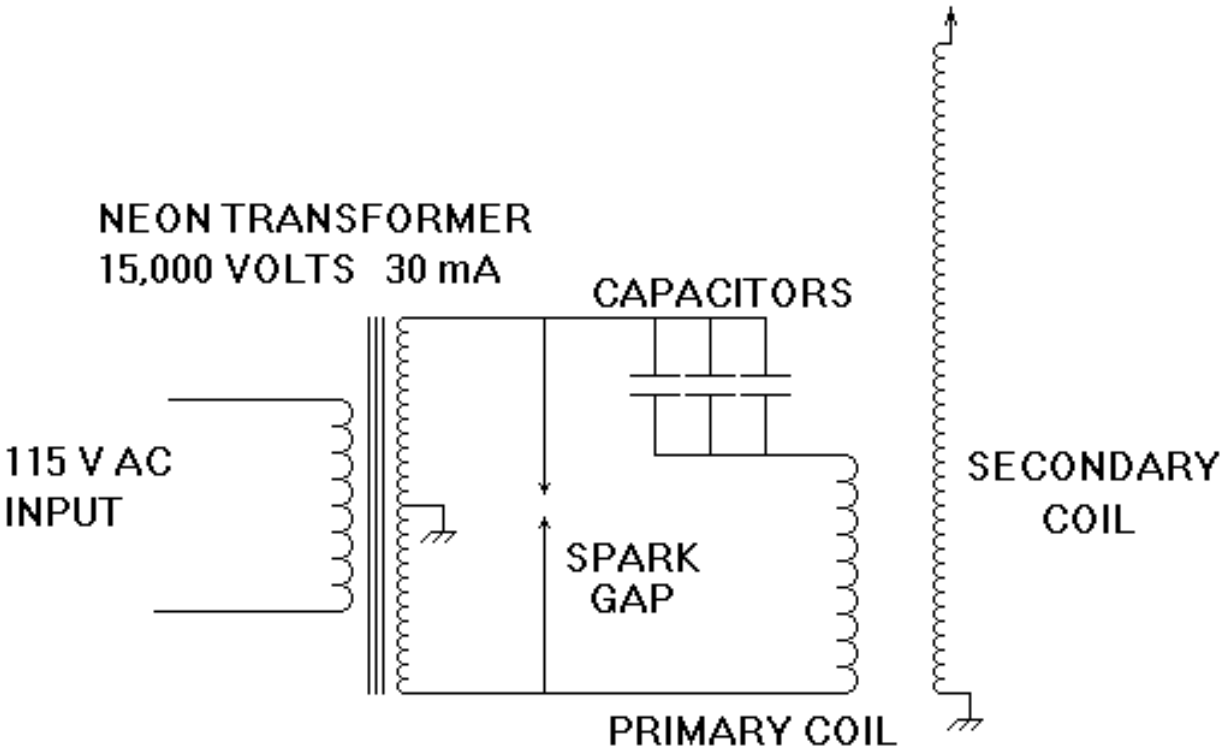
Do Not Use Hands !

No Smoking

No SMOKING !

Back to Altair home page

EMail *altair@altair.org*



MY FIRST TESLA COIL	
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1998 JUL 22	altair@altair.org

ALTAIR'S FIRST TESLA COIL

TRANSFORMER: NEON TYPE, 15,000 VOLTS 30 mA

SPARK GAP: COAT HANGER WIRE WITH 1/2 IN GAP, ENCLOSED IN CLEAR PLASTIC CUP FOR NOISE ABATEMENT.

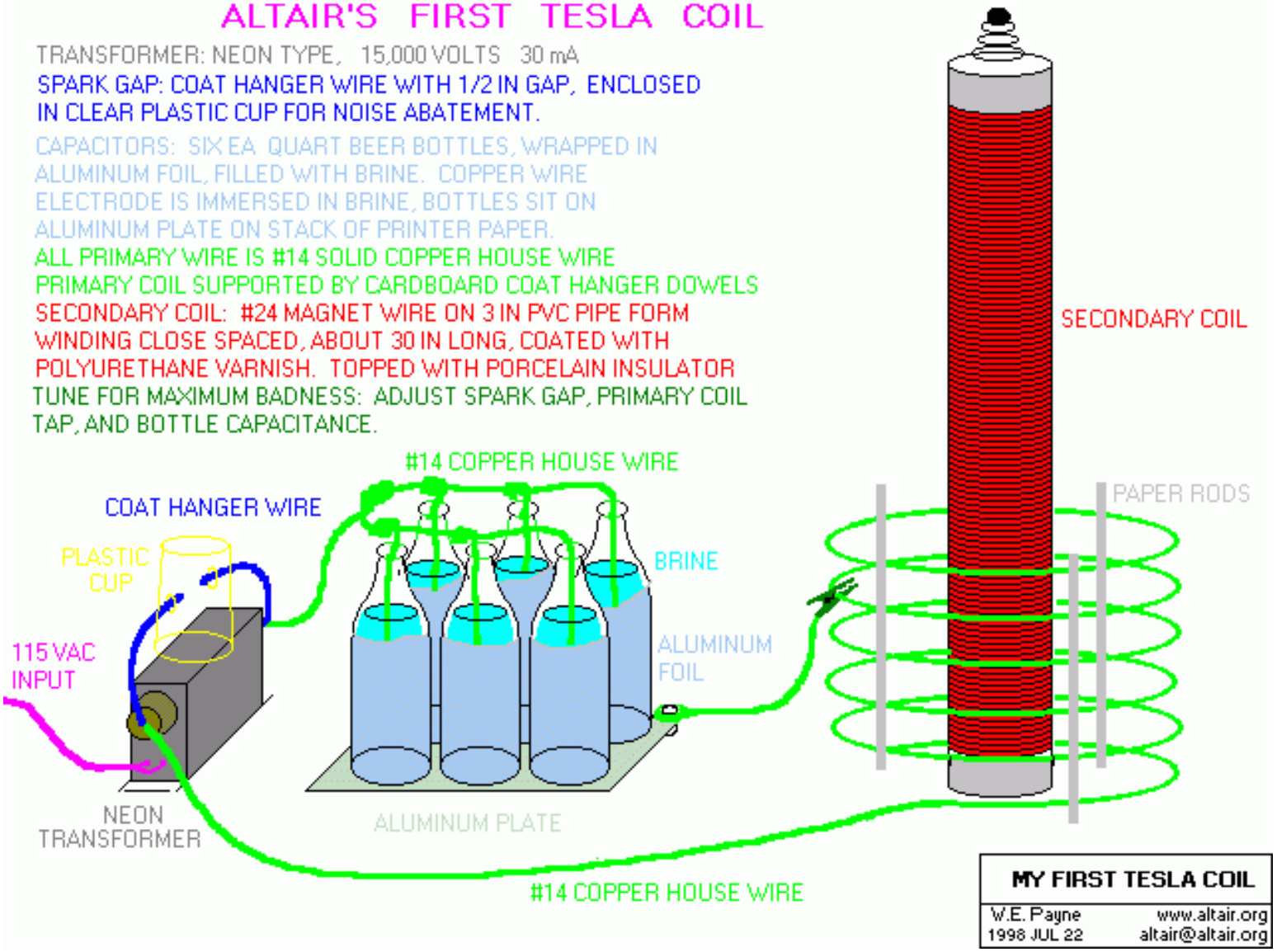
CAPACITORS: SIX EA QUART BEER BOTTLES, WRAPPED IN ALUMINUM FOIL, FILLED WITH BRINE. COPPER WIRE ELECTRODE IS IMMERSED IN BRINE, BOTTLES SIT ON ALUMINUM PLATE ON STACK OF PRINTER PAPER.

ALL PRIMARY WIRE IS #14 SOLID COPPER HOUSE WIRE

PRIMARY COIL SUPPORTED BY CARDBOARD COAT HANGER DOWELS

SECONDARY COIL: #24 MAGNET WIRE ON 3 IN PVC PIPE FORM WINDING CLOSE SPACED, ABOUT 30 IN LONG, COATED WITH POLYURETHANE VARNISH. TOPPED WITH PORCELAIN INSULATOR

TUNE FOR MAXIMUM BADNESS: ADJUST SPARK GAP, PRIMARY COIL TAP, AND BOTTLE CAPACITANCE.



MY FIRST TESLA COIL

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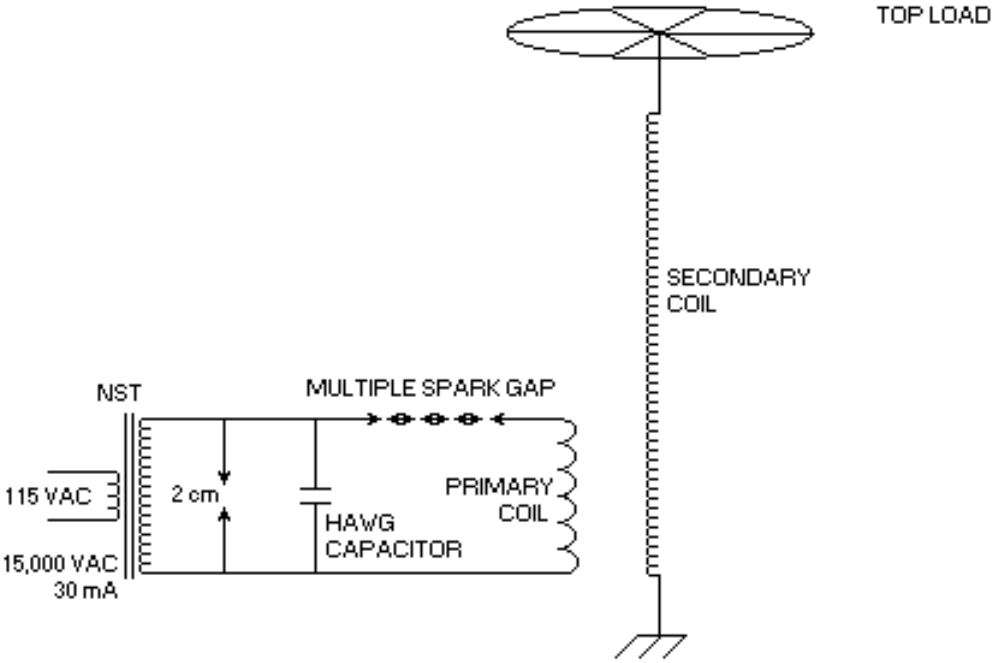

MY NEXT TESLA COIL

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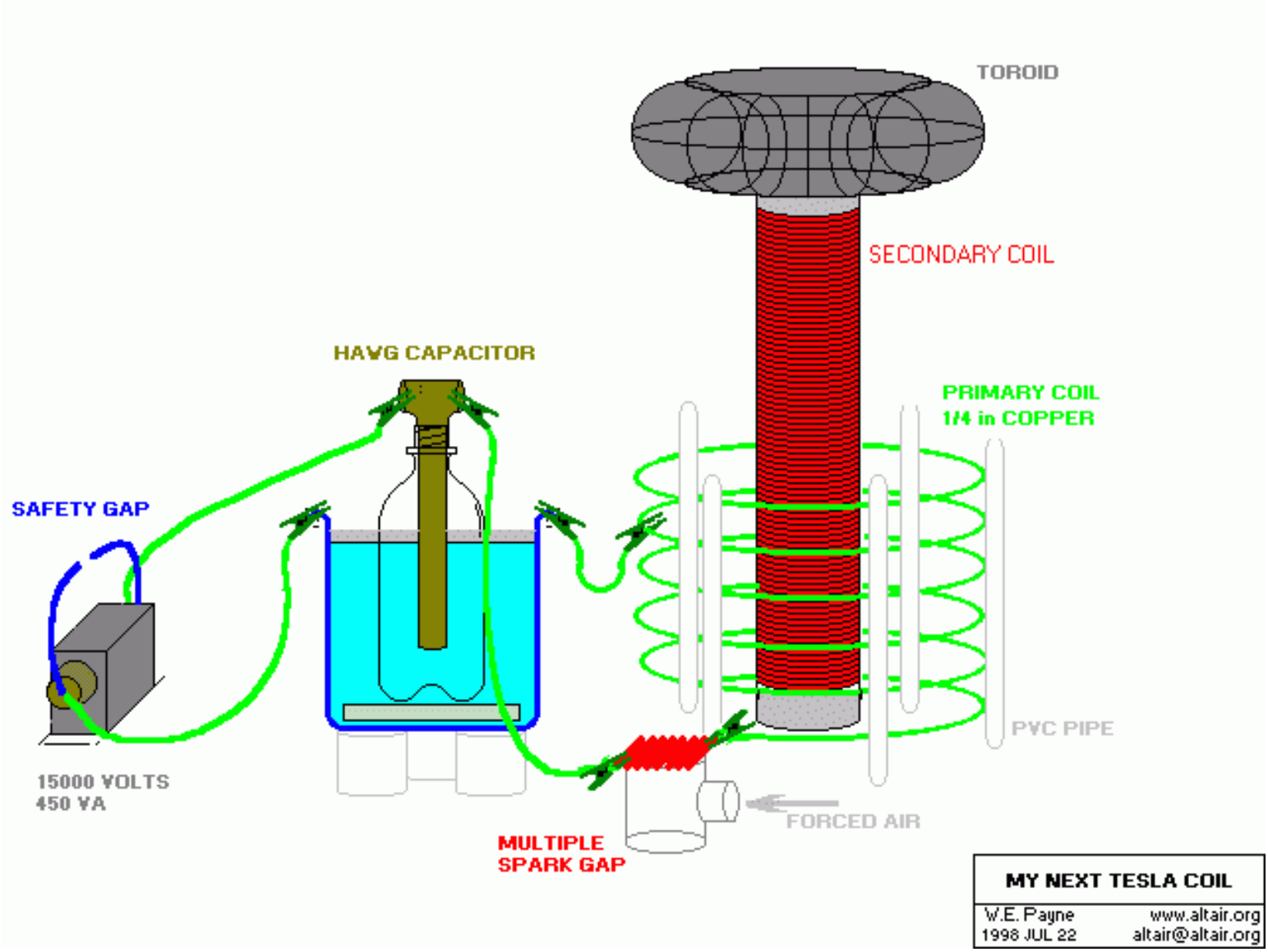
TOROID
SECONDARY COIL
HAVG CAPACITOR
PRIMARY COIL
1/4 in COPPER
SAFETY GAP
PVC PIPE
15000 VOLTS
450 VA
FORCED AIR
MULTIPLE
SPARK GAP
MY NEXT TESLA COIL
W.E. Payne
1998 JUL 22
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14 Sep 98
First light using NST and Plastic Hawg Capacitor. Sparks 3 inches. One NST and many plastic Hawg Caps died here.
PERFOMANCE: Controlled sparks 3 in, no breakout.
CONFIG:
Secondary : 880 t of #20 Cu wire on PVC pipe 4.5 in dia x 30 in long.
Top Load : Toroid, 8 x 24 in stovepipe
Primary A : 10 t of 1/4 in Cu tubing on six PVC posts 24 in high.
Power   : 15 kV, 30 mA NST
Capacitor : Hawg Capacitor, 2 l plastic soda bottle in 24 qt stainless steel pot.
Spark Gap : 13 segment Flexigap.

?? Sep 98
New tight coupled primary coil. Sec-Pri strike stopped operation until variac increased. NST subsequently degraded over next several runs.
PERFOMANCE: Controlled sparks 5 in, 1 in corona from #20 extended wire.
CONFIG: 14 Sep, plus :
Primary B : 30 t of #6 Cu wire on 10 in green PVC pipe 18 in high.

?? Sep 98
Installed inverted conical primary coil "Primary C"
PERFOMANCE: Controlled sparks 8 in, 3 in streamers #20 extended wire.
CONFIG: 14 Sep, plus
Primary C : Inverted cone, 30 deg, 10 in x 48 in, 23 t of #6 Cu wire on pegboard/plywood form.

03 Oct 98
Switched to 2.5 nF glass Hawg Capacitor with Primary Coil C, sparks 12 in. Added HV filter coils, PVC over EMT cores. No Hawg Cap deaths in over 20 runs, one more NST died.
PERFOMANCE: Controlled sparks 12 in, 6 in streamers from extended #20 wire.
CONFIG:
Primary C : Inverted cone, 30 deg, 10 in x 48 in, 23 t of #6 Cu wire on pegboard/plywood form.
Capacitor : Hawg Capacitor, gallon cider jug in 24 qt stainless steel pot.

10 Oct 98
Power control panel under construction. Features 240 V, 20 A service, 30 A disconnect, 4 switchable ballasts, variac w/ voltmeter. A.J. Smith helping construct rotary gap.

11 Oct 98
Control panel preliminary wiring and PT in service, for 120 VAC only using 7.5 A variac and two shorted NSTs for ballast. Nice Jacob's Ladder. Hooked up to previous TC circuit, controlled sparks 8 in.
PERFOMANCE: Controlled sparks 8 in, streamers 3 in from #20 extended wire.
CONFIG:
Secondary : 880 t of #20 Cu wire on PVC pipe 4.5 in dia x 30 in long.
Top Load : Toroid, 8 x 24 in stovepipe
Primary C : Inverted cone, 30 deg, 10 in x 48 in, 23 t of #6 Cu wire on pegboard/plywood form.
Power   : 70:1 PT, ballast = 2||NSTs 450 VA ea, 120 VAC in.
Capacitor : Hawg Capacitor, gallon cider jug in 24 qt stainless steel pot.
Spark Gap : 13 segment Flexigap.

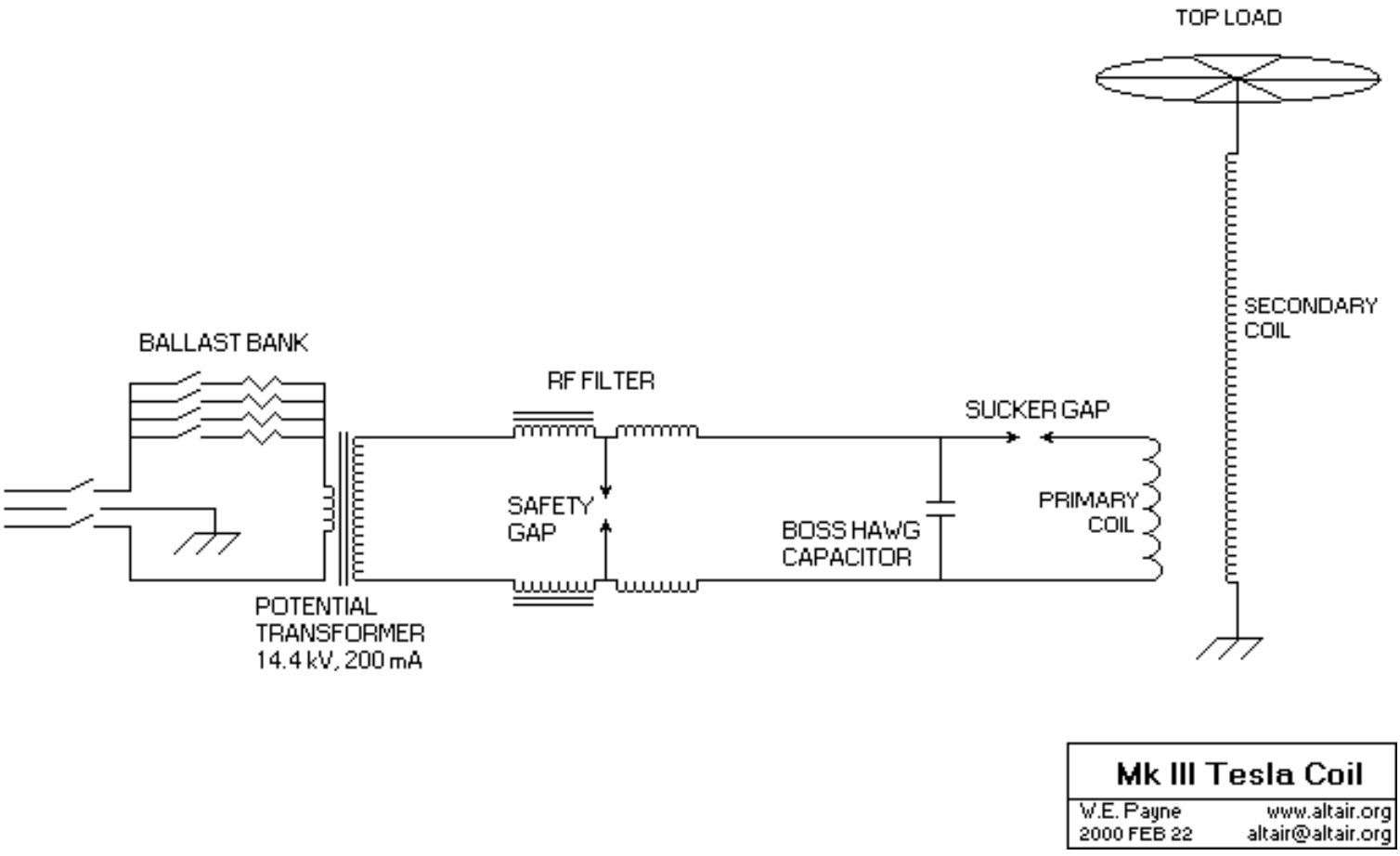
15 Oct 98
New aspirated spark gap, 1/2 in Cu pipe on PVC manifold, shop vac.
New Hawg Capacitor made from 3 Glass Gallon Cider Juggs, ? 5 nF.
Inner electrolyte, 1/2 can Red Devil Lye, electrodes 1/2 in Cu pipe.
Outer electrolyte, saturated brine, electrode/continment vessel #3 galvanized washtub.
PERFOMANCE: Controlled sparks 12 in, streamers 6 in from #20 extended wire.

18 Oct 98
New Hawg Capacitor made from 7 Glass Gallon Cider Juggs, 17 nF.
Inner electrolyte, 1/2 can Red Devil Lye. Outer electrolyte, saturated brine.
Disassembled, transported to Southern Tech for demo. Good demo until HV filter choke flameout.
PERFOMANCE: Controlled sparks 20 in, streamers 12 in from #20 extended wire.
CONFIG:
Secondary : 880 t of #20 Cu wire on PVC pipe 4.5 in dia x 30 in long.
Top Load : Toroid, 8 x 24 in stovepipe
Primary C : Inverted cone, 30 deg, 10 in x 48 in, 23 t of #6 Cu, wood form, tunes at 6 turns.

Power   : 70:1 PT, ballast = 2||NSTs 450 VA ea, 120 VAC in.
Capacitor : Hawg Capacitor, 7 gal cider juggs in #3 washtub.
Spark Gap : Aspirated, hollow electrode static gap.

Next : Elevate primary and secondary coils. Construct 240 V, 1500 VA ballast for 1.5 kVA potential transformer.

Later: Continue construction of tungsten rotary gap.



Mk III Tesla Coil

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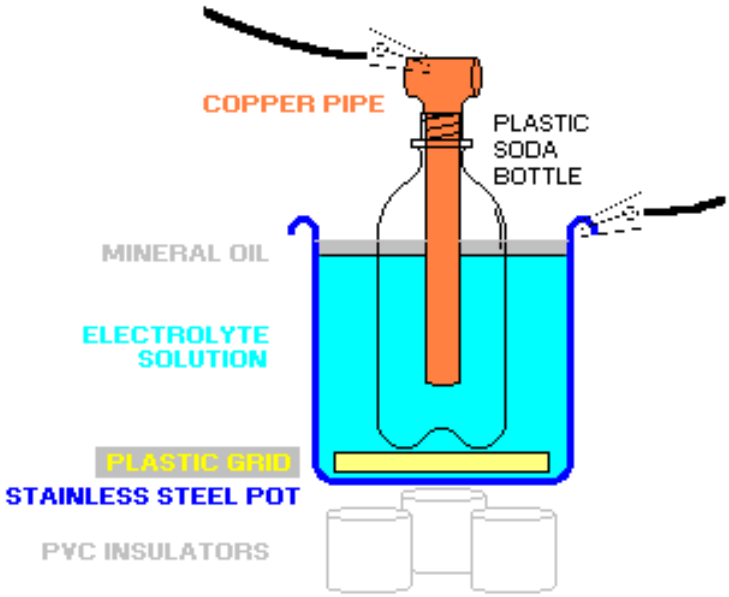
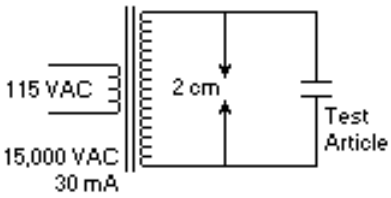


PLASTIC BOTTLE SALT WATER CAPACITOR TEST ARTICLE



TEST CIRCUIT

SALT WATER CAPACITOR	
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1998 AUG 27	altair@altair.org

THE HAWG CAPACITOR

Hawg products are homegrown Hi Tek Gadgets made from common materials. The first Hawg project, popularized by the illustrious Kip, is an 11 dB gain 1250 MHz antenna made from hardware cloth, or here in Georgia, "Hawg Fence Wire" In keeping with Hawg tradition, here is an investigation of high voltage capacitor banks suitable for use in small Tesla Coils. The high voltage dielectric of Hawg Capacitors are plastic soda pop bottles.

A capacitor is two conductors separated by an insulator (dielectric). In the Hawg capacitor, a plastic bottle separates two conductive salt solutions. Salt water capacitors are common among novice Tesla Coilers, although most experienced hands graduate to surplus capacitors or more sophisticated homegrown capacitors. The main problem with plastic soda bottles is they cannot withstand the electrical stress, and the dielectric will soon puncture, short-circuit, leak, etc.

The Dielectric :

The operating life of a capacitor is roughly inversely proportional to the 5th power of the applied voltage, and is halved for every 10 C temperature rise. Dielectric in thin layers will stand more voltage per mil than in thicker layers. Plastic soda pop bottles are usually made of Polyethylene Terpthalate (PET or Mylar) with a wall thickness of 0.010 +- 0.0005 inches.

"Reference Data for Radio Engineers, 4th Edition" (1957) list of Material Properties :

Polyethylene DE-3401 with 0.1% antioxidant additive :

Freq	K	TAN K
60 Hz	2.26	<.0002

1 kHz	2.26	<.0002
1 MHz	2.26	<.0002
100 MHz	2.26	<.0002
3 GHz	2.26	0.00031
25 GHz	2.26	0.0006

Dielectric Strength (0.033") is 1200 V/mil at 25C.
Softening point is 95 - 105 C
Moisture absorption 0.03%

Factors that promote failure of the dielectric are : concentration of E-field at sharp corners, corona discharge (bewaare of corona in trapped bubbles) and heating. PET bottles are blown into molds which 'orients' the molecules and improves the dielectric strength. Heating will cause the plastic to shrink and molecularly disorient, leading to dielectric rupture.

The Conductors :

A common technique using bottles is to wrap the outside with foil and put a condusctive liquid inside. With a foil wrapping, my 2 liter bottle measured 2.4 nF, I fully expected to get one or two nF more with electrolyte replacing the outer foil, but to my surprise the capacitance increased to 8.5 nF !! By putting liquid inside and out, a smooth, close contact is made, increasing capacitance, reducing field concentrations and corona. Corona is BAD NEWS for capacitors.

I dont know a lot about electrolyte conductivity, but ion concentration, ion mobility and valence will be important. However I suspect in this case the major portion of resistance is contact resistance. I normally use table salt (sodium chloride) and/or Epsom salt (magnesium sulfate). Jim Lux suggests copper sulfate for compatibility with copper electrodes. Watch out for generation of dangerous chemicals, for instance sodium chloride may decompose into chlorine. Floating a layer of oil over the top of the liquid, both inside and out, reduces corona discharge at the edges.

THE HAWG CAPACITOR EXPERIMENTS

TEST FIXTURE A: the Test Article is connected across a 450VA, 15 kV neon sign transformer (NST) in parallel with a 2cm fixed spark gap. PVC pipe caps support the victim.

TEST ARTICLE : a 2 liter coke bottle with saturated saline inside, set inside a cut off gallon of fermented gatorade and salt. A dead ant was allowed to remain in the electrolyte. #14 Cu wire was immersed in the interior and exterior electrolyte.

TEST 1 : When the PSWC was clip leaded across the gap, the arc became a very loud and satisfying roar. The internal electrolyte level was about 2 in above the external level, and streamers were observed over the exterior of the dielectric in a band between the inner and outer electrolyte levels. Especially bright discharges were seen on the dielectric close to the outer electrode wire, and the test was terminated.

TEST 2 : Extra dielectric was placed as a spacer between the outer electrode and the bottle dielectric, and high voltage was reapplied. Corona and surface streamers were seen in the band previously mentioned. After about one minute, the PSWC shorted out very suddenly. A small dielectric puncture was found several inch below the surface, under a fragment of the bottle label.

TEST 3 : Another PSWC was prepared with a well-stripped 2l coke bottle. This failed after about 3 minutes at the inner (upper) electrolyte level by arcing thru to the outer electrode wire.

Conclusions : Everybody is right. Polyethylene Terpthalate is a great dielectric. Soda pop bottle PSWCs are vulnerable to dielectric rupture, puncture and leak. Foil is not the way to go.

Recommendations : Try again using a metal outer vessel for more symmetric current distribution, probably with a spacer covering the bottom to prevent dielectric stress concentration. Equalize inner and outer electrolyte levels. Use an oil layer above the electrolyte. Cleanliness is next to Godliness and Saint Tesla, get bottles 'squeaky clean' before use. Keep electrodes clear of dielectric to allow current density to diffuse thru electrolyte. Symmetric current diffusion and smooth, clean dielectric seem to be essential. No failures were attributed to the dead ant, although bits of label and glue were suspected in several failures.

TEST ARTICLE : Outer electrode and vessel was a cheap K-mart stainless steel stock pot, the bottom of which was lined with disk cut from plastic ceiling light grille. The soda bottle was thoroughly stripped and all label adhesive removed with methanol. The inner electrolyte started out as carbonic acid, magnesium sulfate and sodium chloride. The outer electrolyte was magnesium sulfate and sodium chloride in a solution of water and fermented Gatorade. The inner electrode was 10 inch of 1/2 in copper pipe suspended in the bottle neck by a copper tee. The dead ant from last night was retired from duty. Electrolyte levels were equalized within a mm, and no oil layer was added.

TEST 4 : The test article was connected in parallel with a 450 VA, 15,000 Volt NST bridged by a 2 cm static arc gap. During the test, intermittent streamers were observed on the upper dielectric, which mostly appeared internal. Some condensation was also observed on the internal surface. After several minutes the streamers subsided although condensation remained. The plastic bottle dielectric failed at about t+30 min, with a small rupture at the electrolyte surface. All components had about a 10 C temperature rise. A narrow band of plastic at the liquid surface had shrunk during the run, making a smooth, symmetrical groove or constriction all the way aroud the bottle at the liquid line. The groove was

about one cm in width and depth. Crystalline deposits were also observed around the entire circumference.

This was the most reliable and longest lived plastic bottle capacitor tested.

RECOMMENDATIONS : Filter contaminants from electrolyte, use a mineral oil film on both electrolyte surfaces to reduce corona. This may aggravate heat accumulation at the top of the liquid level.

TEST ARTICLE : Same as test 4, but with 5mm mineral oil film on electrolyte surface inside and outside dielectric.

TEST 5 : The test article with oil layer was tested for 30 seconds. A slight foam of gas bubbles was generated around the dielectric at or near the surface. A milky cloud began spreading in the oil layer or interface which appeared to be composed of tiny gas bubbles. Two hours after the test, the milky layer had dissipated.

TEST FIXTURE B: The Test Article is connected in a standard TC circuit. The excitation is a 450VA, 15 kV NST in parallel with a 2cm fixed spark gap. A 40 in dia 10 turn solenoidal coil and a Flexigap complete the primary circuit. PVC pipe caps support the victim.

TEST 6 : Three test article with oil layer were each run in turn until failure. Input voltage and Flexigap settings were varied. In the first case the failure was near the electrolyte/oil interface, in the next two test articles failed beneath the surface. Failure typically induced by running more than 8 gap sections and/or more than 70 vac input to NST.

TEST 7 : A 2 quart polyethylene food storage bottle was run until failure, about 3 minutes under conditions above.

Selected email excerpts during THE HAWG CAPACITOR experiments

.. thin layers have higher dielectric strength (per unit thickness) than thick layers. A phenomenon that has surprised many. Ruby mica has such a high dielectric strength partly because it is composed of many very uniform very thin layers stuck together.

I would consider one hour as the minimum acceptable life of a disposable dielectric capacitor. I would still like to compare notes with any other folks who attempt to use plastic soda bottle SWCs, the more experience i can gather from others, the further/quicker I can progress. Rules of thumb: dielectric life goes as 1/e^5 with voltage and 1/2 with each 10 degree temperature rise. Any comment ?

From: Kip Turner[SMTP:kip@mindspring.com]

Your extrapolation is interesting but may not work. You have to look at the BIG picture. Capacitors are usually tested at twice working voltage to weed out obvious defects. In going to very high voltages, you may excite other failure modes, such as arcing other than through the dielectric. Also, using your 6x example, you will get 36 times the normal internal heating, and most dielectrics are poor thermal conductors.

Yes, but I control the construction to eliminate other modes. Your point about heat is well taken.

I have made PET (mylar film) capacitors for AC operation at 1 KVA per cubic inch. This produces about 10 watts of heat per cubic inch and the units would increase in temperature at a rate of several degrees C per second. The units were rated for 30 seconds on-time per 10 minutes and required a internal cooling arrangement to even survive that.

I consider min acceptable life = 1 hour. Active

cooling not desirable, mabe passive cooling.

Since you are operating at a higher frequency and very high fields, I would expect a much more rapid rise to the failure point (150-200 C). It is possible that, even with a cooling liquid for electrodes, the interior of the PET is overheating. The plastics are not very good thermal conductors.

My observations above point to localized heating at the liquid surface. Oil layer may/not help.

You might want to look it up, and calculate what happens to the internal temperature, assuming that the heat input is uniform and about 1 % of the reactive power in the capacitor. You should be able to integrate that and estimate the hot spot maximum temperature. You should keep PET well below 150 C, to avoid damage that weakens it and drastically increases the loss. You might want to check the "bottle" to be sure it does have the lower loss. It may not be as good as the film...which you can buy easily as "drafting mylar". Mylar (PET) is non-linear with voltage. It's resistance has a significant field intensity related effect, with the resistivity dropping at high voltages. This can help, in some cases, but you are above the fields which give long life.

Remember that there are several other causes for failure. Not just the voltage. You may reach gradients which produce field emission, especially at discontinuities.

Hey, I don't care if you pass along my "OPINIONS". Or you can take the credit (or blame) if you want to !

Kip

I'm probably running 2 to 3 kV per mil, but maybe this is still possible. So far I have blowed up two PSWCs, the first lasted 10 sec the second one survived 3 min. If I can cut the E-field in half

again, that would give a life of 1.5 hours. According to you, if I take a PET plastic dielectric capacitor with a rated life of 100,000 hours to 3x its design voltage, it should survive 400 hours. At six times over voltage, it should survive 10 hours. Corona problems are still my main concern, although none of the Tesla List responses specifically mentioned corona in their PSWC attempts.

Since the Tesla list is generally interested in high voltage caps and especially home grown ones, I'm forwarding your experience to the Tesla list server unless someone objects.

Will

ps : Mike Foster tells me the PET in soda bottles is molecularly oriented as a byproduct of the blowing process. My CRC handbook does not list the real part of the vector permittivity nor the dielectric strength. Yes, I know about teflon, but unfortunately have no source of cheap Teflon soda bottles ;-)

From: Kip Turner[SMTP:kip@mindspring.com]

As mentioned by one of your respondents, Mylar dielectric film is grain oriented PET. I don't know if the soda pop bottles are or not. The DF (Dissipation Factor) is about 1 % at low frequencies(the dielectric stuff). If heated above about 150 C, it will un-orient and the DF (DF= watts/VA... like power factor) will increase to 3 or 4 %. I never checked it at RF frequencies. Obviously, it's rather lossy for RF use. Teflon as a DF of about 0.01%...a factor of 100 lower.

I highly recommend the oil floating on the electrolyte, to reduce corona which is very damaging to the dielectric. You may have a higher than average field at the edge of the electrolyte. Life on a dielectric varies approximately as 1/(E^5) where E is the field intensity in the dielectric. Working fields, depending on life

requirements, are usually in the range of 600 to 1,000 V/mil for foil construction. Self healing types, such as electrolytic and metallized dielectric construction operate at somewhat higher fields, though a lot of the space saving is the lack of foil (typically about 6 micron thick).

Hope this helps you to estimate life. Remember...corona in a capacitor is a NO-NO !

Kip

Well, if 6u PET holds 600v then 9 mil PET should hold 900 kV, no? I should be able to get a pop bottle to stand up to a 15 kV Tesla coil, even with 15 kV of LF riding ont he 15 kV of 60 Hz. I notice the CRC handbook lists the dielectric constant of PET the same value for all three frequencies in their table. Thats gotta be a good sign for low dissipation. I dont have a microwave oven for dielectric loss testing right now.

Will

That does not confirm my experiences with PET. I have been able to get 6 micron PET coated with 0.025 micron aluminum to operate at 600 VDC, but that is a "self healing thickness of aluminum. (It will evaporate around a fault). Very small pieces of the material might withstand somewhat higher potentials, probably due to favorable variations in thickness and other random events.

I think he missed the decimal point somewhere. Suggest checking that hi-pot.

For the moment, at least, I'm a non-believer.

Kip

Last night I did a few experiments with a soda pop bottle PSWC (Plastic Salt Water Capacitor) . The wall of a 2l plastic coke bottle measured 0.010 +- 0.0005 inch wall thickness. With a foil wrapping the bottle had measured 2.4 nF, I fully expected to

get one or two nF more with electrolyte replacing the outer foil, but to my surprise the capacitance increased to 8.5 nF !! Mike you were right about my skill at the subtle art of bottle-foiling !

From: Payne, Will E [SMTP:will.e.payne@lmco.com]

My recent query on use of plastic soda pop bottles for SW caps reaped two sets of responses. Some folks warned me about their bad experiences with soda pop bottle SW caps, which perforate, arc thru and dribble SW on the floor. However, Mike Foster is a fount of useful knowledge on sucessful use of PET dielectric bottles at very high DC voltages.

From: Michael Foster[SMTP:michael.foster@mailexcite.com]

If your 2-liter Coke bottle only had a capacitance of a little over 2nf, then the bottle walls must be thicker than the mineral water bottles, or you are not as good as I am at applying the foil. Pop bottles have to withstand 6 atmospheres of pressure because of the carbonation, so they might be thicker than mineral water bottles. Why don't you try immersing the pop bottle in a larger container of salt water and see the both made of the same stuff, polyethylene terphthalate. PET has a dielectric constant of about 3.2. Both the dielectric constant and the dielectric strength vary a bit with the average molecular weight of the polymer and with the stress of molding, or how far the plastic is stretched when it is blown into the mold. Similar effects are taken into consideration when rating commercial metallized polyester caps as the film used is the same material as the pop bottles. In this case, the film is "biaxially oriented" meaning that it is stretched in two directions while it is hot. This increases both the mechanical and dielectric strength, which are really the same thing. I find that it is important to have the salt water at near saturation to work really well. In fact, one of my favorite tech- niques is to saturate the solution with both salt and

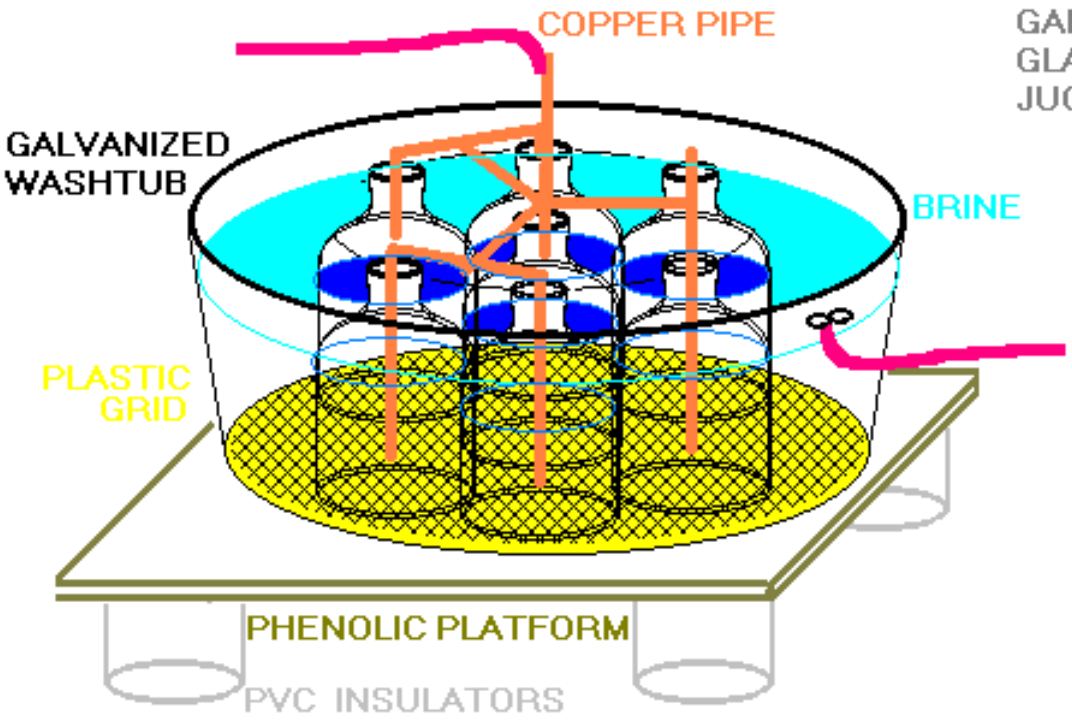
Epsom salts (magnesium sulfate.)

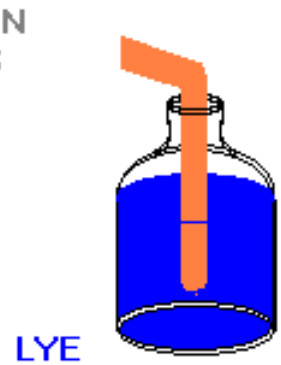
Just to see what would happen, I made a salt water cap which was two cells separated by PET film only .00048 inch thick (12 microns.) And no, that's not an extra zero. Anyway, I charged this up to 25kv repeatedly with no trouble at all.

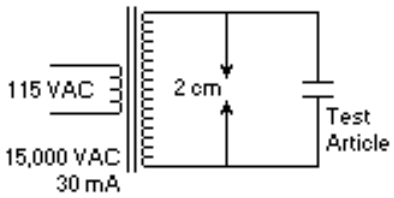
The reason I bring up all this stuff about the stress and orientation of PET, is that if you heat up a spot on this plastic, it tends shrink there and get a little thicker. I just thought that with the addition of water cooling on both sides of the polyester, this might constitute a "self-healing" dielectric.

I guess I'm just going to finally break down and build a coil myself to test it out. And by the way, I will cut apart some 2-liter Coke bottles and measure the wall thickness with a micrometer, which is how I know the thickness of the mineral water bottles. They are all amazingly consistent.

Michael S. Foster







TEST CIRCUIT

SALT WATER CAPACITOR	
W.E. Payne	www.altair.org
1998 AUG 27	altair@altair.org

High Voltage Apple Cider

Proper Procedure for Preparing Glass Gallon Cider Juggs for Service in High Voltage Capacitor Applications

Materials

Gallon Glass Juggs - Containing Pasteurized Apple Cider, No Preservatives
Yeast - 1/2 pkg per gallon, Wine or Champagne Yeast Preferred, Baker's Yeast OK
Cloves and/or Cinnamon to Taste
Sugar, to Proof the Yeast
Campden Tablets - 2 per gallon, available at Homebrew Supply along with Champagne Yeast
Kitchen Sink, Hot Water, Clorox or Chlorine Bleach, Paper Towels, Toothbrush, Measuring Cup
Warm, Dark Location

Procedure

Sterilize : Invert sealed gallon juggs in sinkful of HOT soapy water with a good splash of Clorox. Sterilize all tools in HOT soapy clorox solution. Scrub under threads of each jugg with old toothbrush.

Proof the Yeast : In sterile measuring cup, mix per gallon of cider : 1/4 cup of hot water and 1/2 tsp of sugar. Cover with sterile paper towel and let stand till blood temperature. Add 1/2 pkg yeast per gallon of cider. Mix well and cover. Check every 30 min until mixture begins to foam.

Add Yeast to Cider : Clean and rinse the top of each Jugg well. Open jugg, add 1/4 cup of working yeast, replace lid, screw down lightly and cover with sterile cloth or paper towel. Make sure the lids are not too tight or juggs may burst.

Wait : Stand in warm dark place like on top of water heater. Foam will overflow from lids while yeast is working. Internal pressure is judged by pressing on lid with thumb, adjust lids to pressurize for a firm but yielding pressure. Cider is ripe after a few days when yeast slows. Add two Campden tablets to each jugg and screw down cap as tightly as you dare !

Serve : Chill and serve cold, especially delicious if it turns out really fizzy. If cider is too flat, serve hot. Heat in a large pot, add cloves and cinnamon sticks to taste. Excellent by the fire on cold days. If a jugg goes sour, use the cider vinegar to make High Voltage Salad Dressing. Continue serving as requested until juggs are empty.

Assembling High Voltage Capacitor Bank

Materials

Gallon Juggs - Prepared as Above
Copper Pipe, 3/4 in or 1 in, Elbows and Tees to match
Large Galvanized Tub
Plastic Grid, open type from flourescent fixture
Sodium Chloride (Salt)
Sodium Hydroxide (Lye)

Procedure

Terminate Outer Electrode : Lug and bolt heavy wire to outside of tub using galvanized screws. Seal and cover screws with silicone or caulk.

Install Grid : Cut disk from plastic grid large enough to cover bottom of tub.

Set Jugs in Place : Arrange Juggs on grid in tub, leaving equal spaces around each.

Assemble Inner Electrode : Fabricate from copper pipe a buss with an electrode extending down into each Jugg. Pipe electrode should end 1 in above bottom of each Jugg.

Prepare Inner Electrolyte : Fill each Jugg halfway with cold water, add 16 oz of Sodium Hydroxide or 1 can of Red Devil Lye. Wait till lye dissolves and cools, then fill with water to 2 in below top.

Prepare Outer Electrolyte : Fill tub with hot water to 1 in below liquid level in juggs. Mix in as much salt as will dissolve. Fill to equalize level of inner and outer electrolytes, making sure to rinse off all salt on outside of juggs.

Final Assembly : Install inner electrode buss. Add 1/2 inch oil layer in top of each Jugg and on top of outer electrolyte.


2000 6. 29


2000. 6. 29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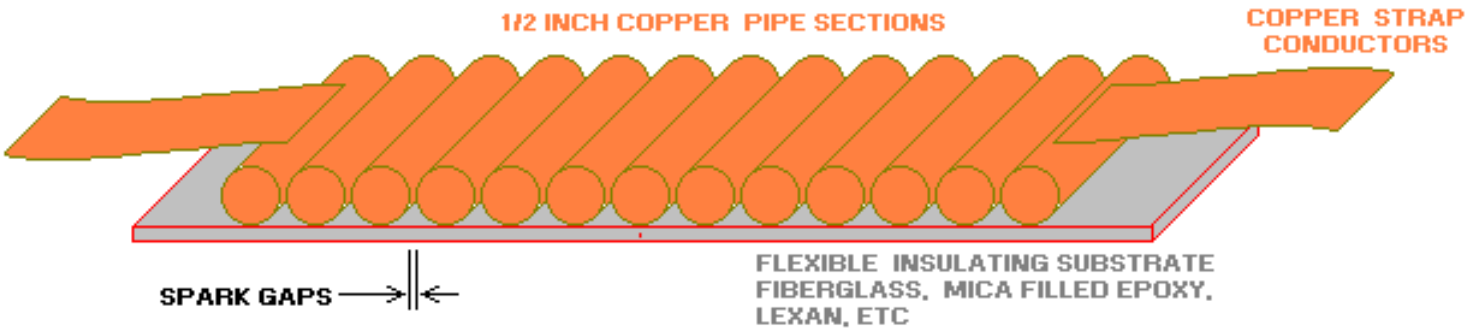
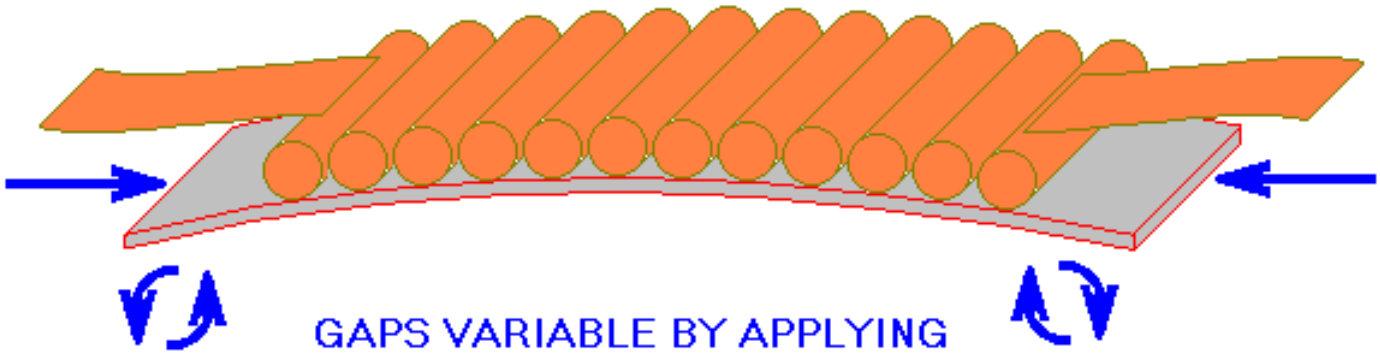
THE ALTAIR FLEXIGAP

AN ADJUSTIBLE MULTI-GAP BASED ON THE RICHARD QUICK MULTI SPARK GAP





GAPS VARIABLE BY APPLYING
COMPRESSION OR END TORQUE
TO UNIFORMLY BOW SUBSTRATE

ALTAIR FLEXIGAP	
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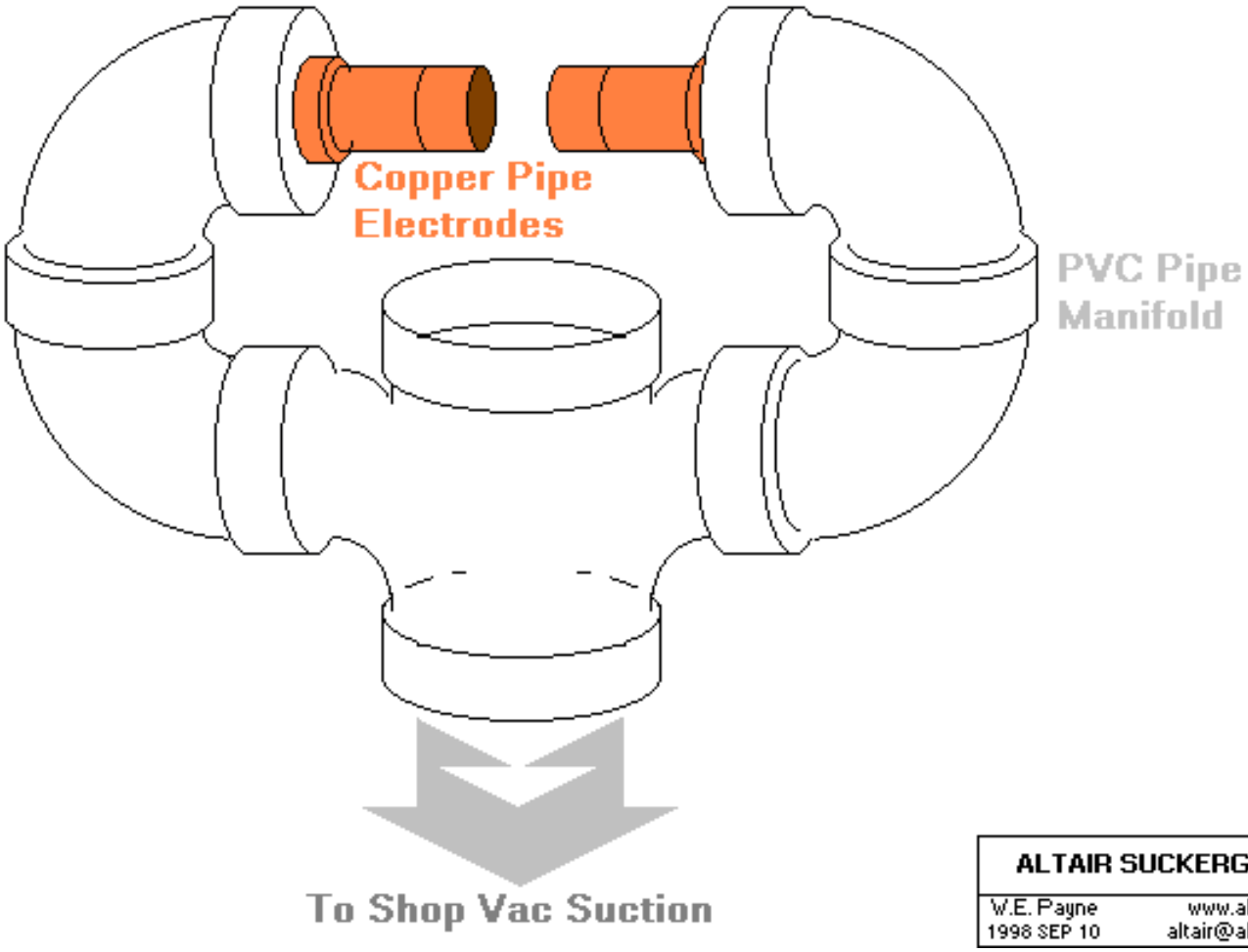
1998 SEP 10	altair@altair.org

SuckerGap Tesla Coil Aspirated Static Spark Gap



ALTAIR SUCKERGAP	
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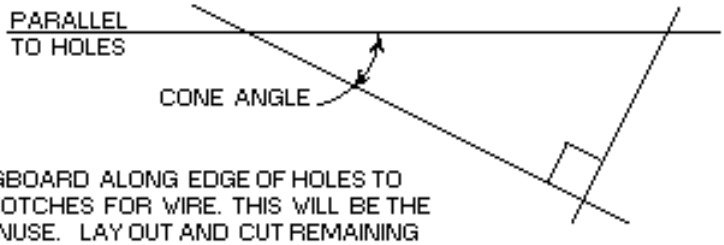
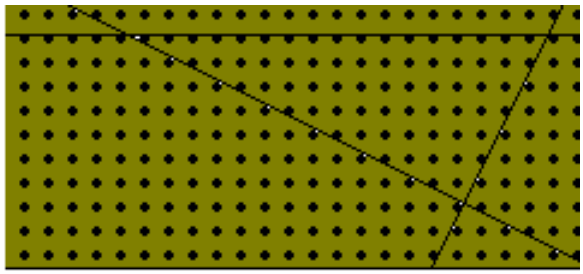
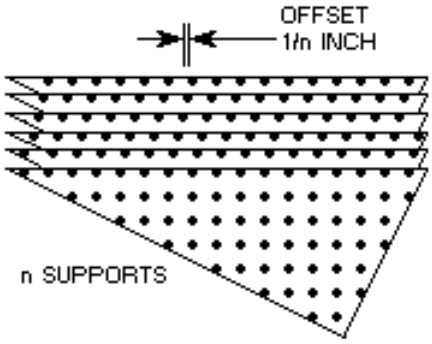
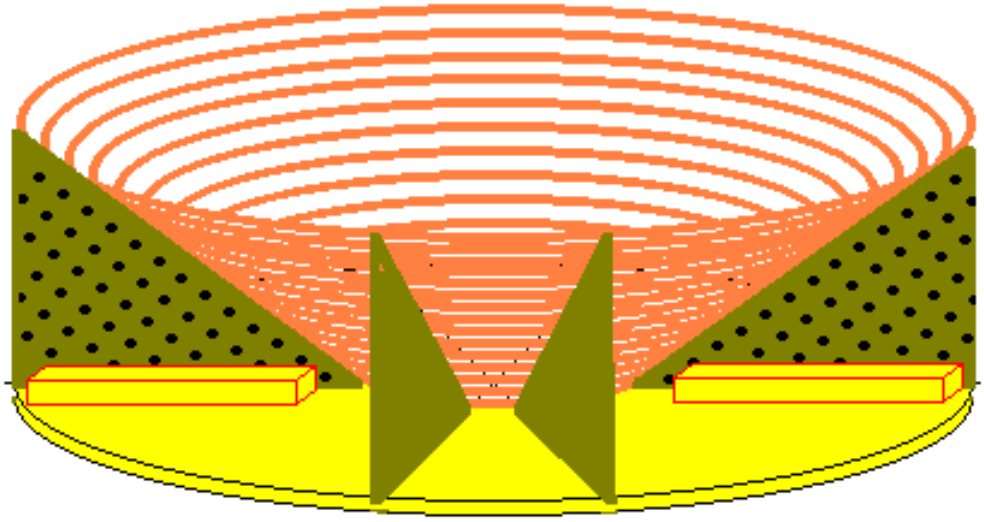




CUT PEGBOARD ALONG EDGE OF HOLES TO LEAVE NOTCHES FOR WIRE. THIS WILL BE THE HYPOTENUSE. LAY OUT AND CUT REMAINING TWO SIDES SUCH THAT NOTCHES ARE OFFSET BY 1/n INCH WHERE n IS NUMBER OF WIRE SUPPORTS.



FASTEN PEGBOARD SUPPORTS TO PLYWOOD DISK
USE WOOD STRINGERS TO ATTACH SUPPORTS
KEEP SUPPORTS IN ORDER SO NOTCHES FORM SPIRAL
LAY WIRE INTO NOTCHES AND FASTEN WITH PLASTIC TIES



CONICAL PRIMARY COIL

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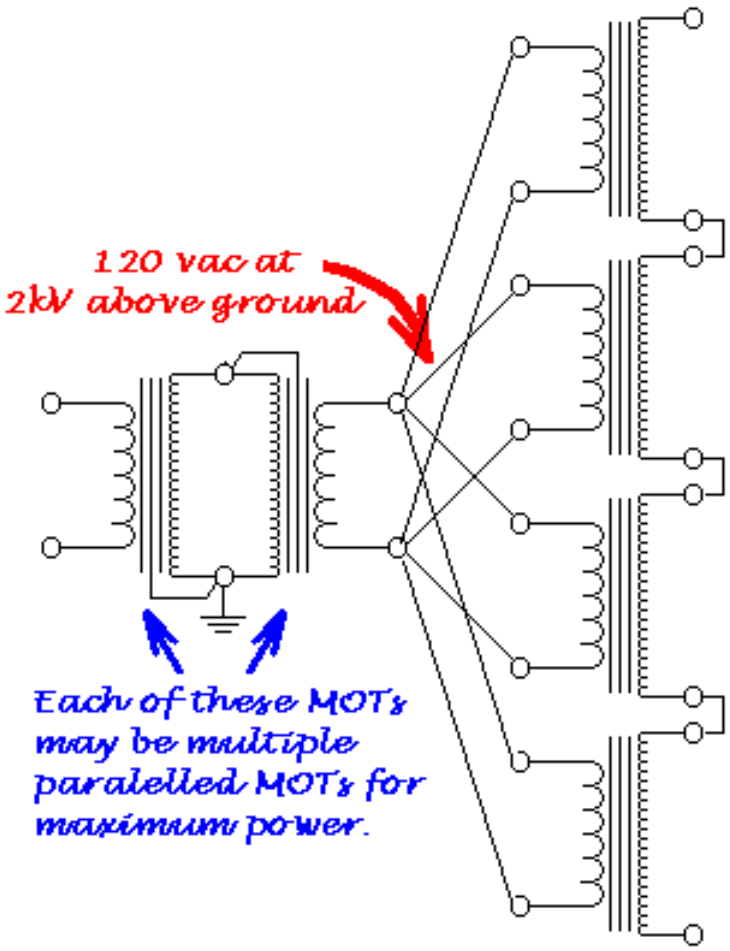
1998 SEP 25 altair@altair.org



Two MOTs may now be stacked without overrating any insulation..
Four MOTs may be stacked as previous experimenters have done.

A mirror image of the stack may be built for a total of eight MOTs in series with no insulation stressed more than 2x the rated operating voltage.

MOT EXTENDED STACK

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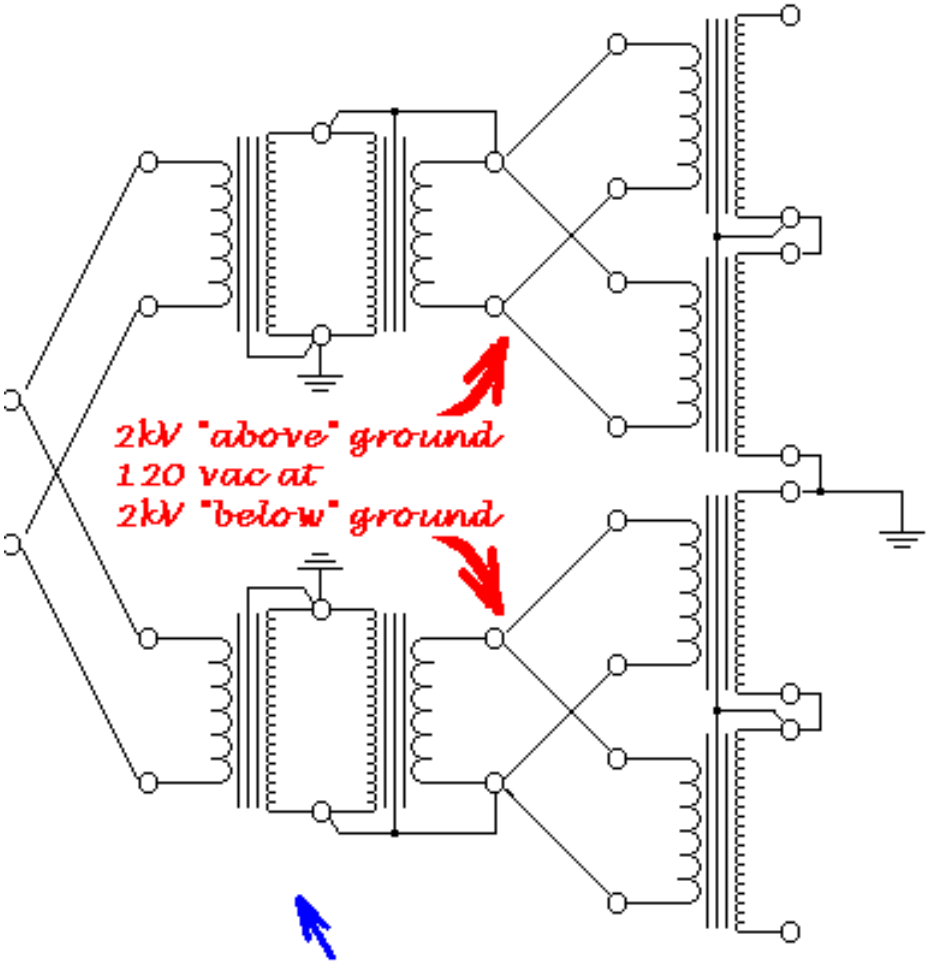
1998 SEP 25 altair@altair.org



Stacking four MOTs with no insulation overstress.
All HV windings are still connected to their respective cores, all LV windings are at the same potential as their respective cores.

Four MOTs may be stacked without overrating any insulation..
Eight MOTs may be stacked as previous experimenters have done.

Each of these MOTs may be multiple paralelled MOTs for maximum power.

MOT EXTENDED STACK 2	
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1998 SEP 25	altair@altair.org

This lexicon collected by Reinhard.

BTW:By The Way

IM(H)O: In My (Honest) Opinion

Coiler: One of us. A person who plays (works) with Tesla coils.

HFor RF: High Frequency or Radio Frequency. The operating frequency of a Tesla Coil. Usually from 60-700khz

HV: High Voltage

Variac: Variable AC Transformer, allows a gradual increase in voltage.

Former: The secondary coil form.

Toroid: A donut shaped top electrode. Its capacitance loads the secondary coil, drop its resonant frequency and it holds off the breakout. Energy stored in the toroid (~capacitor) gives us longer arcs.

Lossy: Material experiencing electrical losses (in the form of heat) at Tesla coil frequencies. PVC is a lossy material for cap construction (as dielectricum). Minimize use of lossy material to maximize output.

OBIT: Oil Burner Ignition Transformer

NST: Neon Sign Transformer

PT: Potiential Transformer (a mid sized version of a pig)

PIG or POLE PIG : A power line distribution transformer (also called POLE PIG)

MOT: Microwave Oven Transformer

DWC: Disruptive Wave Coil, a spark gap powered Tesla Coil.

CW(TC): Continuous Wave Tesla Coil: A TOOB or solid state (yuck) TC.

Resonant Charging: A condition where the primary capacitor resonates at the mains frequency with the power transformer. This allows the transformer to deliver more voltage than its faceplate rating.

Banjo Effect: A wavy streamer which looks like a swinging banjo string.

Streamer: A spark from the TC not hitting anything, just branching into air.

Arc or Strike or Hit: A streamer connecting to a grounded object.

Strike Rail: A conductor connected to RF ground to intercept hits. Often an open (!) turn above the primary coil.

Breakout: This is the voltage where a streamer or arc starts to form

Plasma Globe:
An semi-evacuated glass envelope powered by HF/HV exhibiting tesla like streamers inside of the glass.

PE: Polyethelene

Rolled Poly Cap: A (usually oil filled) cap made from PE sheets and AL foil and then rolled up.

SW Cap: Salt Water Capacitor. Very cheap and easy to build, but very lossy.

Flat Cap: A capacitor made from stacking flat plates on top of each other.

SF(S)G: Saftey Spark Gap

Multi Gap: A series arrangement of spark gaps

SG: Spark Gap (also called Static Gap)

RQ gap: Richard Quick Spark Gap

TF Gap: A modified type of RQ Gap from Terry Fritz (our moderator)

RSG: Rotary (moving electrode) Spark Gap

SRSG: Synchronos Rotary Spark Gap

ASRSG: ASynchronos Rotary Spark Gap

Q: Quality Factor of a resonant circuit, the ratio of its reactive to resistive parts. A high Q circuit rings like "diiinnngggg....." a low Q one rings like "donk"

Quench: Ability of a spark gap to shut off, cease conducting current.

1st or 2nd or 3rd or... notch quenching : (Terry's posted explanation)

After the gap fires, ringing energy couples from the primary system to the secondary system. If the gap continues to conduct, the energy in the secondary system will return to the primary system, and will continue to 'slosh' back and forth from primary to secondary until the gap either quenches or the system runs down due to losses.

When the gap quenches after the first energy transfer, it is first notch quenching. If it takes two or three complete transfers, it is second or third notch quenching. After that, it is usually considered as "no quenching" or "fails to quench". We usually want to quench on the first notch, before energy wasted to system losses.

From: Tesla List[SMTP:tesla@pupman.com]
Sent: Monday, September 07, 1998 17:53
To: tesla@pupman.com
Subject: Re: The very basics

Original Poster: Bert Hickman <bert.hickman@aquila.com>

Reinier (and other newer coilers),

I'll take a shot at doing a high-level summary for you. Veteran coilers can delete this now to save time! :^)

1. Why do we use high primary circuit voltages? And why the spark gap in the primary circuit?
Capacitor-discharge Tesla Coils use a high voltage transformer to charge up (temporarily store energy in) the primary (tank) capacitor (Cp). Once the voltage on the capacitor rises to a sufficient level to ionize the main spark gap (Vgap), the gap "fires", and acting as a switch, electrically closes the loop between the primary winding (Lp) and charged tank capacitor.

The gap's firing causes the primary LC circuit to oscillate, or "ring", much like a bell getting struck by a hammer, creating an oscillating electromagnetic field around the primary. The amount of energy available to "ring" the primary system is a function of the tank capacitance and voltage at the time the gap fired, and is typically called the "bang" size. Bang size represents the maximum amount of primary tank cap energy that's available for transfer to the secondary each time the gap initially fires. Mathematically, the bang size will be Ep = 0.5*Cp*(Vgap*Vgap) in Joules. Doubling the tank cap size doubles the bang size... BUT, doubling the main gap breakdown voltage QUADRUPLES the bang size. This is one reason why higher power systems tend to use higher operating/gap breakdown voltages and larger value tank caps.

Now, only a relatively small portion of the primary's electromagnetic field, typically 10-25%, interacts with the secondary. This fraction, called the coupling coefficient (k), is purely a function of the geometries and relative placement of the primary and secondary windings. The secondary and top terminal also form an LC circuit, made up of the secondary inductance (Ls), the self-capacitance of the secondary to ground (Cs), plus the effective capacitance of any top terminal we've added (Ct). The magnetic coupling betwwen the primary and secondary permit us to transfer energy between the two LC systems. A 2-coil Tesla Coil is properly tuned when the primary's ringing frequency is made equal to that of the secondary, forming a dual-tuned resonant transformer. This condition can be expressed mathematically as Lp*Cp = Ls*(Cs+Ct), and the natural ringing frequency Fo of each is approximately 1/(2*Pi*Sqrt(LpCp)).

2. Where does the high voltage output come from??
Here's where it gets a bit more complex...
When the main gap fires, the energy initially stored in the ringing primary LC circuit begins to electromagnetically couple into the secondary LC circuit, causing it to "ring". However, any energy which transfers to the secondary MUST reduce the amount of energy that remains in the primary, since Tesla Coils do NOT violate Conservation of Energy, and all we've got to play with is the initial "bang" energy stored in the primary tank cap at the instant the gap fired.

Because of the relatively loose coupling between the primary and secondary, it takes time for the primary's energy to fully transfer to the secondary. Called the secondary "ring-up" time, it is typically 2-4 cycles at Fo - the greater the coupling corefficient (k), the less time it takes. During this transfer time, we're also losing energy to gap resistance, skin effect, and other losses in the system, and the maximum

energy that we can practically transfer to the secondary is typically no more than 60-85% of the initial bang size. At some point near the completion of the secondary's "ring-up", we'll ideally get "breakout" of the top terminal, forming one or more streamer discharges. Once this occurs, we'll typically begin losing significant energy to the streamers (a very desirable loss!).

Once we've transferred all the available energy from the primary to the secondary, ALL the system's energy resides in the secondary's LC system. If we now "open up" the primary gap (called first notch quenching), we will prevent any of this energy from coming back into the primary LC circuit, and the secondary's remaining energy will hopefully dissipate into the streamers as it "rings down". However, if we are not successful in quenching the main gap, it reignites, and much of the secondary's energy then transfers back to the primary until all the remaining system energy again resides in the primary LC circuit.

This energy interchange process can repeat (often many times) until the gap finally does quench. Irrespective of when we quench, ALL the original bang energy will eventually be be dissipated, and the gap extinguished. The HV source then begins recharging the tank cap for the next bang. One important thing to remember: In a disruptive system, there is never any energy "carried over" from one bang to the next; secondary energy does NOT build up from one bang to the next.

The high output voltage that you see is actually due to the comparatively small capacitance in the secondary LC circuit compared to the primary and the Conservation of Energy. If there were no system losses, ALL of the bang energy would be transferred to the secondary. In practice, a well-constructed coil may deliver over 85% of this energy to the secondary. For now, let's call this fraction the energy transfer efficiency, or X.

Let's assume that we transfer X% of the primary bang energy to the secondary. The maximum energy in the secondary, and thus the maximum output voltage, will be directly limited to X*Ep. And we can thus find Vout as a function of the othter variables:

   Let Ep = Initial Primary Bang Energy = .5Cp*Vgap^2)
   Let Es = Energy transferred to the Secondary = 0.5*(Cp+Ct)*(Vout^2)
   And, let's assume Es = X*Ep.

   Solving for Vout:
   Vout = Vgap*SQRT(X*Cp/(Cs+Ct))

In typical 2-coil systems, Vout will be in the range of 10-30 times Vgap. Your mileage may vary! Notice that the turns ratio between the primary and secondary windings has no direct bearing on Vout! However, it CAN be shown that there is a relationship between the relative primary and secondary coil inductances:

   Vout = Vgap*SQRT(X*Ls/Lp)

And that's the BASIC theory behind a 2-coil system!

Reality-Check Time:
==========
In practice, the actual interrelationships that govern coil operation are considerably more complex thant implied above. Simply aiming for higher Vout will NOT generally deliver better performance! The actual efficiency of "incinerating the air" (that is, getting the LONGEST sparks for the MINIMAL input power or coil size) is a very complex, and still rather poorly understood, combination of bang-size, primary and secondary impedances, coupling coefficient, gap quenching, streamer loading, top-load capacitance, operating frequency, breakrate, charging circuit,... well, you get the picture!

The process of predetermining these interrelationships and tradeoffs to arrive at an optimal coil design is not yet fully understood. As an example, John Couture's recent post about sparklength INCREASING with reduced Vout (when we increase topload Capacitance) is one of those seemingly paradoxical relationships that classical coiling theory alone will not predict. A similar quandary is created by Terry Fritz's recent tests which imply that, under some conditions, 2nd-notch quenching may actually deliver longer sparklength than the more theoretically optimal 1st-Notch quench. Most experienced coilers end up developing a "feel" for what's optimal through hard-won experience...

In the final analysis, coiling is like peeling an onion... there's always another layer underneath! But isn't that part of what makes this hobby so interesting! :^)

Safe coiling to you!

-- Bert --

Reference Data for Design and Experiment

Conductances of Some Electrolytes

Aqueous Solutions of Infinite Dilution at 25°C
Conductance in $Ohm^{-1}cm^2equiv^{-1}$

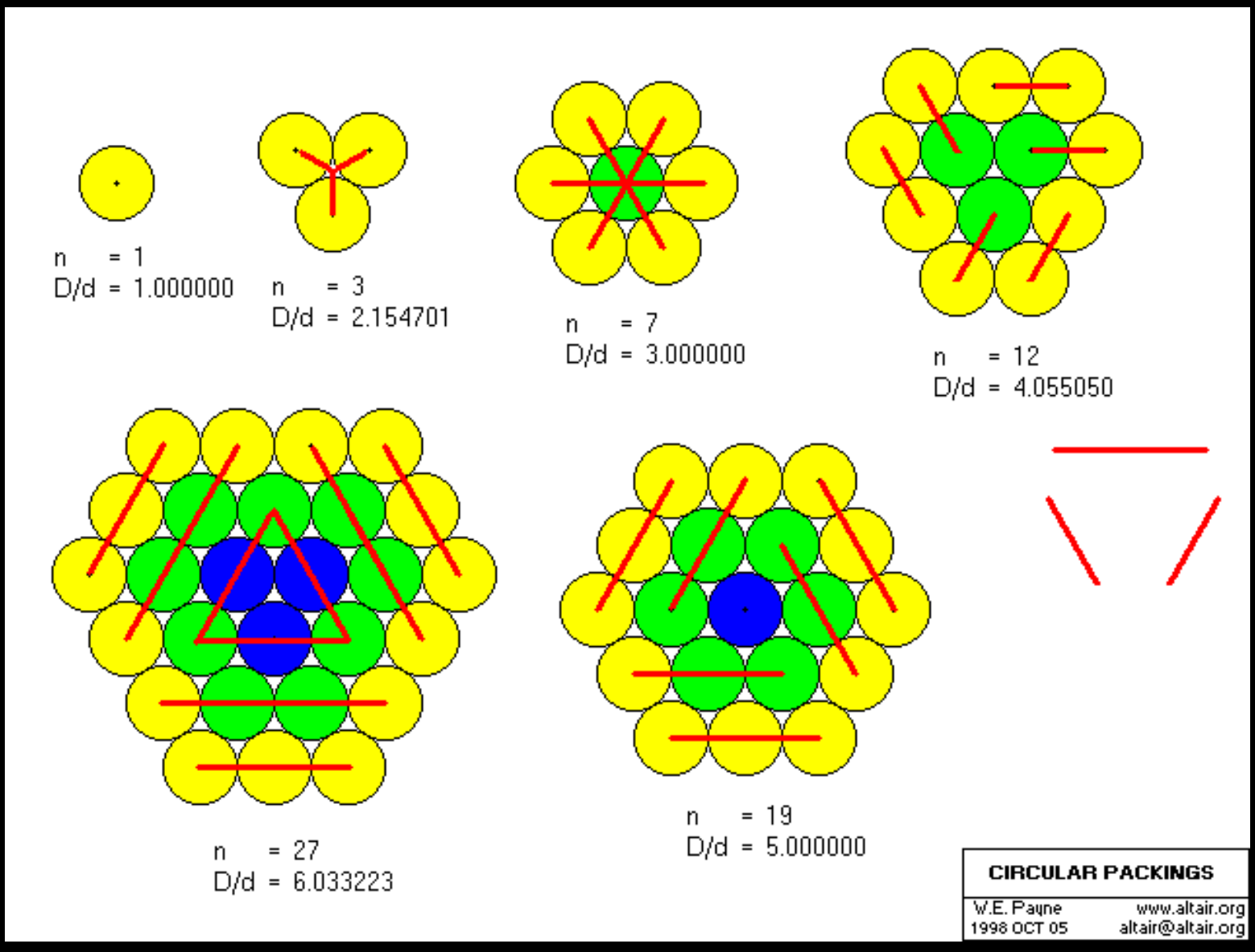
Formula	Name	Conductance	Formula	Name	Conductance
$AgNO_3$	Silver Chloride	133.36	$LaCl_3$	Lanthanum Chloride	145.8
$BaCl_2$	Barium Chloride	139.98	$LiCl$	Lithium Chloride	115.03
$CaCl_2$	Calcium Chloride	135.84	$LiClO_4$	Lithium Chlorate	105.98
$Ca(OH)_2$	Calcium Hydroxide	257.9	$MgCl_2$	Magnesium Chloride	129.4
$CuSO_4$	Copper Sulfate	133.6	NH_4Cl	Ammonium Chloride	149.7
HCl	Hydrochloric Acid	426.16	$NaCl$	Sodium Chloride	126.46
KBr	Potassium Bromide	151.9	$NaClO_4$	Sodium Hypochlorite	117.48
KCl	Potassium Chloride	149.86	NaI	Sodium Iodide	126.94
$KClO_4$	Potassium Chlorate	133.36	$NaOOCCH_3$	Sodium	91.0
$K_3Fe(CN)_6$	Potassium Ferrocyanide	174.5	$NaOOCC_2H_5$	Sodium	85.9
$K_4Fe(CN)_6$	Potassium Ferrocyanide	184.5	$NaOOCC_3H_7$	Sodium	82.7
$KHCO_3$	Potassium Hydrocarbonate	118.0	$NaOH$	Sodium Hydroxide	247.8
KI	Potassium Iodide	150.38	Na_2SO_4	Sodium Sulfate	129.9
KIO_4	Potassium Iodate	133.36	$SrCl_2$	Strontium Chloride	135.8
KNO_3	Silver Chloride	144.96	$ZnSO_4$	Zinc Sulfate	145.8
$KReO_4$		128.2			

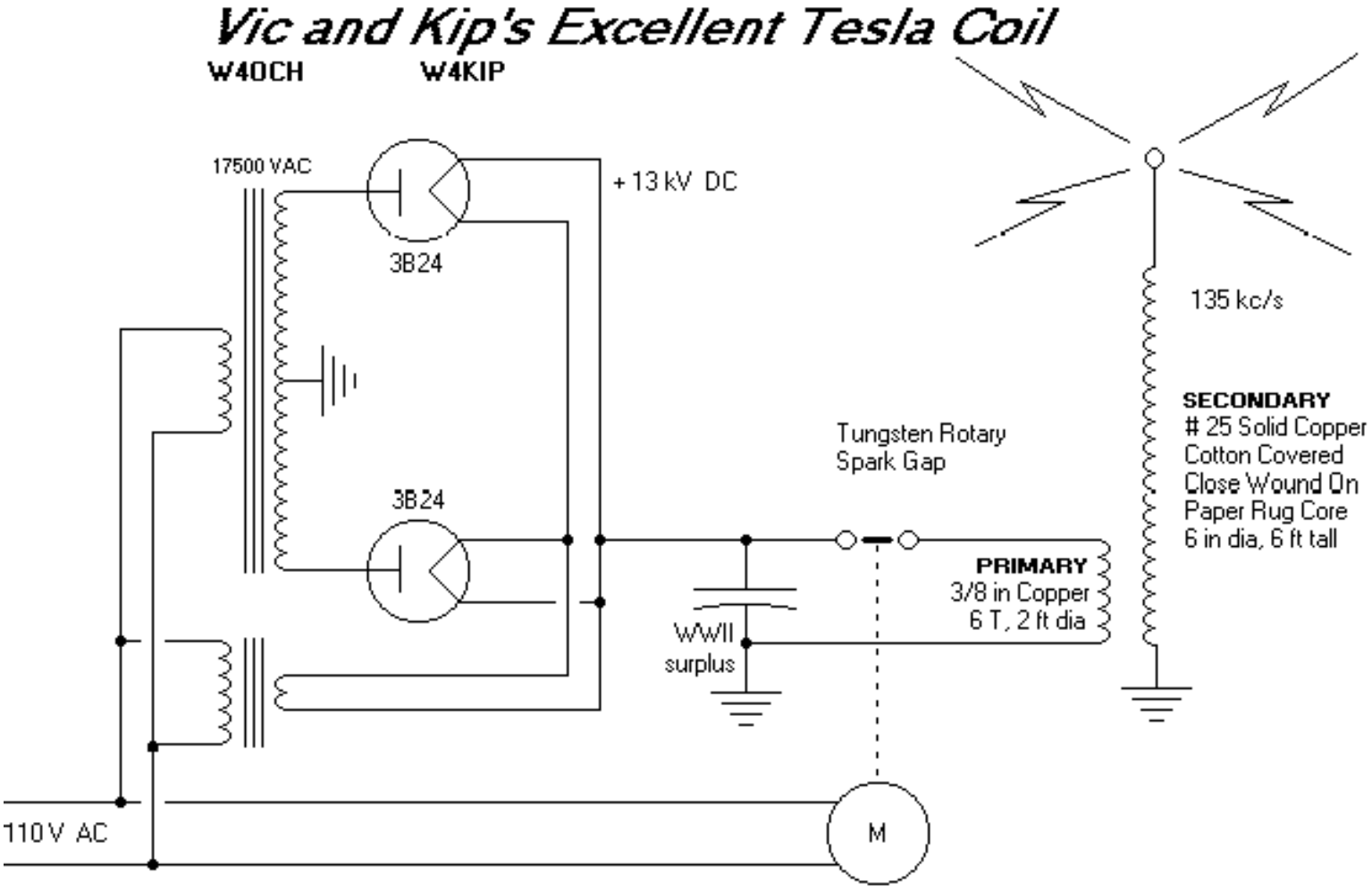
Electrical Capacitances of Some Common Containers

Typical Empirical Values of Household Items
Liquid Electrodes, With Voltage Standoff Clearances

Description	Material	Fluid Capacity	Thickness	Dielectric Constant	Loss Tangent	Capacitance	DC Rupture Voltage
Soda Pop Bottle	Oriented PET	1 liter	0.010 in	2.8	0.001	? nF	? 40 kV
Soda Pop Bottle	Oriented PET	2 liter	0.010 in	2.8	0.001	8 nF	? 40 kV
Soda Pop Bottle	Oriented PET	3 liter	? 0.010 in	2.8	0.001	? nF	? 40 kV
Cider Jug	Glass	1 gal	0.010 in	?	0.001	2.4 nF	? 50 kV
Beer Bottle	Glass (brown)	12 oz longneck	? in	?	?	? nF	? 40 kV
Beer Bottle	Glass (clear)	12 oz	? in	?	?	? nF	? 40 kV
Beer Bottle	Glass (brown)	12 oz	? in	?	?	? nF	? 40 kV
Beer Bottle	Glass (green)	12 oz	? in	?	?	? nF	? 40 kV
Beer Bottle	Glass (brown)	12 oz longneck	? in	?	?	? nF	? 40 kV
Beer Bottle	Glass (clear)	32 oz	? in	?	?	? nF	? 40 kV
Beer Bottle	Glass (brown)	12 oz longneck	? in	?	?	? nF	? 40 kV
Champagne Bottle	Glass	1 liter	? in	?	?	? nF	? 40 kV
Polyethylene Bucket	LDPE	5 gal	? in	?	?	? nF	? 40 kV

Packing Identical Circles in a Larger Circle

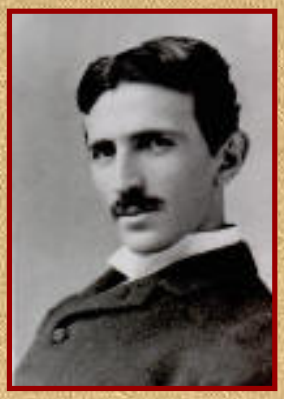



Vic and Kip's Excellent Tesla Coil
W4OCH
W4KIP
17500 VAC
3B24
+13 kV DC
3B24
Tungsten Rotary
Spark Gap
WWII
surplus
PRIMARY
3/8 in Copper
6 T, 2 ft dia
135 kc/s
SECONDARY
25 Solid Copper
Cotton Covered
Close Wound On
Paper Rug Core
6 in dia, 6 ft tall
110 V AC
M

Dr. Nikola Tesla

Tesla's Technology Today

"Were we,"* remarks B. A. Behrend, distinguished author and engineer, *"to seize and to eliminate the results of Mr. Tesla's work, the wheels of industry would cease to turn, our electric cars and trains would stop, our towns would be dark, and our mills would be dead and idle."



Nikola Tesla: A Brief Bio: (1856-1943) - Nikola Tesla was born in Croatia, which at that time, lay within Austro-Hungary. It is interesting to note that he was a Serbian of "Valachian" descent. Tesla was proud of his Croatian motherland and Serbian descent. When his mother died in 1892, he paid a visit to Croatian capital Zagreb, and gave a lecture about alternating current. On that occasion Tesla said: ***"As a son of my homeland, I feel it is my duty to help the city of Zagreb in every respect with my advice and work"*** - (***"Smatram svojom duznoscu da kao rodeni sin svoje zemlje pomognem gradu Zagrebu u svakom pogledu savjetom i cinom"***). Nikola Tesla, besides being a great inventor and an outspoken Serbian patriot, had sincerely adored free Serb states, Serbia and Montenegro, and the rest of the Serbdom which pinched unliberated under Austro-Hungarian and Turkish yoke. He had never hidden his patriotic feelings, on the contrary-he stressed them!

On 1st of June 1892, Tesla arrived in Belgrade due to the call from Belgrade municipality. Several thousand people greeted him at the Belgrade train station. He addressed the gathered crowd, who saluted him: ***"There is something within me that might be illusion as it is often case with young delighted people, but if I would be fortunate to achieve some of my ideals, it would be on the behalf of the whole of humanity. If those hopes would become fulfilled, the most exiting thought would be that it is a deed of a Serb. Long live Serbdom!..."*** Tesla further said to the students of Belgrade University: ***"As you can see and hear, I have remained a Serb overseas where I have done some researches. You should do so and by your knowledge and hard work you should glorify Serbdom over the world."*** One of Tesla's proudest moments was when he was granted his United States citizenship; he never lost his love of his homeland, however. His monument, carved by Ivan Mestrovic (who knew Tesla personally), can be seen in Zagreb. Another monument, carved by Croatian sculptor Frano Krsinic, can be seen on "Goat Island", near the former Tesla Hydropower Plant on Niagara Falls, in the middle of the Niagara River, between the United States and Canada boarders. It is purposely left *un-illuminated* at night (for the effect, and, to provoke thought of what the world would be like without Tesla's contributions). A part of the Technical Museum in Zagreb is dedicated to Nikola Tesla. Even today, so many years after Tesla's death in 1943, his numerous manuscripts are kept as "top secret" by the US Ministry of Defense (see Margaret Cheney, "Tesla: Man Out of Time", Prentice Hall, 1981)

Nikola Tesla, an American inventor and engineer, whose mastery of electricity came at a time when electricity was changing American life. Tesla is the unsung creator of the electric age, without whom our radio, auto ignition, telephone, alternating current power generation, alternating current transmission, radio, and television, would all have been impossible. He discovered the rotating magnetic field, the basis of most alternating-current machinery, and held more than 700 patents. His inventions make him one of the foremost pioneers in the distribution of electric energy.

Born into a family of Serbian origin, Tesla's father was an Orthodox priest. He had several sisters and one older brother, Dane, who died when Nikola was five. In his autobiography ("My Inventions"), Tesla tells of the early workings of his mind in a description that we can only regard with amazement. He began seeing flashes of light that interfered with his physical vision. When a word was spoken, he would envision the object so

clearly that he had trouble distinguishing between the imagined (spoken) object and the real. In later years, he would build a machine in his mind, run it to see where it was flawed, and make whatever repairs and adjustments were needed, *before* he ever began his construction. At night and in solitude, Tesla had an inner world of personal vision where he made journeys to distant places, studies, carried on conversations and met people that seemed as real to him as his outer world. By the time he was a teenager he spoke four languages. At about age 17, he found to his delight that he could create things in his mind, picturing them as the finished product without models, drawings or experiments. He invented such things as a low friction finless waterwheel and a motor driven by June bugs.

He trained to be an engineer, attending the Technical University at Graz, Austria and the University of Prague. Beginning his studies in physics and mathematics at Graz Polytechnic, he then took philosophy at the University of Prague. After finishing the studies at the Polytechnic Institute, doing two years of study in one, working 19 hours a day and sleeping only two, he suffered a complete nervous breakdown. During the malady, he observed many phenomena, both strange and unbelievable. His vision and hearing intensified beyond any normal human capacity. He could sense objects in the dark in the same way as a bat. It was a period in which his sensitivities were so heightened that the flashes of light that he had seen from the time he was a youth now filled the air around him with tongues of living flame. Their intensity, instead of diminishing, *increased* with time, and seemingly attained a maximum when he was about twenty-five years old. His responses were so keenly tuned that a word would become an image that he could feel see and taste. It was during this time that he had one of his most famous ideas; the rotating magnetic field and alternating current induction motor.

Bringing himself back to the world as it is, Tesla began work as an electrical engineer with the Central Telegraph Office in Budapest, Hungary in 1881 and the following year, he went to work in Paris for the Continental Edison Company. In 1883 he constructed, after work hours, his first induction motor.

He sailed to America in 1884, arriving with four cents in his pocket. He found immediate employment with Thomas Edison - who quickly became a rival - Edison being an advocate of the inferior DC power transmission system. For the remainder of his life, Tesla would have, at times, difficulty getting his ideas and inventions funded because most financiers were in Edison’s corner. Even later in his life, many of his ideas and inventions could not get funding, and so remained in notebooks, which are still examined to this day, by engineers searching for clues from his brilliant scientific mind. Edison and Tesla parted company within a year due to a false promise made by Edison. Tesla was told (by Edison) that if he could repair all of the faulty and broken down motors and generators in the Edison plant that he would receive $50,000.00 for his effort. This Tesla did, and in record time, no less. At the completion of the repair work, Tesla approached Edison for the monies that were promised, at which time Edison replied that he was only "joking" about the money. Tesla did not find it very "funny" and left his employ.

Perhaps the lowest point in his life was in 1884-85 after he left Edison, and without recognition or a mentor, had to take manual labor to survive. He was digging ditches at $2.00 a day when he met Mr. A. K. Brown of the Western Union Telegraph Company who put up some of his own money and interested a friend in joining him in Tesla's project. Shortly thereafter, Tesla was commissioned with the design of the AC generators installed at Niagara Falls.

Tesla and Edison have often been represented as rivals. They were rivals, to a certain extent, in the battle between the alternating and direct current in which Tesla championed the former. He won; the great power plants at Niagara Falls and elsewhere are founded on the Tesla system. Otherwise the two men were merely opposites. Edison had a genius for practical inventions immediately applicable. Tesla, whose inventions were far ahead of the time, aroused antagonisms which delayed the fruition of his ideas for years. However, great physicists like Kelvin and Crookes spoke of his inventions as marvelous. ***"Tesla,"*** said Professor A. E. Kennelly, of Harvard University, when the Edison medal was presented to the inventor, ***"set wheels going round all over the world. . . . What he showed was a revelation to science and art unto all time."***

In May 1885, George Westinghouse purchased the patents to his induction motor, his polyphase system of

alternating-current dynamos, transformers and motors and made this the basis of the Westinghouse power system which still underlies the modern electrical power industry today. When Westinghouse found that they could not stay in business if they paid him his due of Twelve Million Dollars, Tesla tore up the contract. Tesla did this, quite simply, so people could have the benefit of financially attainable electricity. Tesla made his first million before he was 40, but gave up the royalties on his most profitable invention as a humanitarian gesture.

In April 1887, he established his own laboratory, where he experimented with shadowgraphs similar to those involved in the discovery of x-rays. In 1888 his discovery that a magnetic field could be made to rotate if two coils at right angles are supplied with AC current 90 degrees out of phase made possible the invention of the AC induction motor. The major advantage of this motor being its brushless operation, which many at the time was believed impossible.

By 1890, Tesla was a young, striking and desirable bachelor. Handsome, magnetic and elegant, he was the "catch" of New York society, yet remained unmarried and a misanthrope. He was wealthy, gifted, accomplished and recognized. He wore his clothes well and was quiet and modest. Many a designing matron with a marriageable daughter was eager to capture him for her salon. Social leaders and businessmen considered him a good contact and the intellectuals of his day found him an inspiration. However, Tesla proved to be impervious, an unattainable prize. Except at formal dinners he always dined alone, and never under any circumstances would he dine with a woman at a twosome dinner. At the Waldorf-Astoria and at the famous Delmonico's restaurant, he had picked out particular discrete tables, which were always reserved for him. In spite of all of the adulation that was heaped upon him, Tesla had but one desire – to continue his work. He lived the life of a celibate and a hermit. He enjoyed poetry and the opera and though he was not a drinker, he appreciated a glass of beer and advocated the limited consumption of liquor as an elixir of life.

In 1915 he was severely disappointed when a report that he and Edison were to *share* the Nobel Prize proved erroneous. Tesla was the recipient of the Edison Medal in 1917, the highest honor that the American Institute of Electrical Engineers could bestow. When others claimed credit for the revolutionary ideas that came from his extraordinary mind, he did not contest them.

Impractical in financial matters, eccentric and compulsive, Tesla had few friends, but those included Mark Twain, John J. O'Neill and Francis Marion Crawford. He never married, and cited on at least one occasion that marriage wasn't good for inventors. He was driven by compulsions and had a progressive germ phobia, washing his hands frequently and avoiding shaking hands and measuring the volume of his food before he ate it. He liked a fresh tablecloth with every meal. Always a fastidious dresser, he wore new gloves weekly and a new tie daily. He maintained the same weight through his lifetime, 142 pounds, and always slept only four hours per night.

The Inventions: Tesla believed that alternating current was vastly superior to (Edison's) direct current, but the problem was the lack of a practical motor. Alternating current is practical because of the fact that it can be altered, or converted, to suit a variety of situations. For example, if the voltage is made quite high, then the current necessary for a specific level of power is very low. This low current then becomes very efficient when sending electrical power over very long wires. (This is the reason why the power lines running across the countryside are at very high voltages.) Tesla also worked with radio-frequency electromagnetic waves, and, despite the claims made by Marconi, actually did invent the idea of Radio as we know it today. (There are numerous patents which bear this out. Even today, many texts still credit Marconi with the invention of radio, despite the Supreme Court decision which overruled the Marconi patent, awarding it to Tesla. Unfortunately, this decision came two years after Tesla's own death.) In working with radio waves, Tesla created the Tesla coil as a means to generate and receive this form of energy. Every time you start your automobile (or virtually any type of vehicle, for that matter) the device that provides "spark" to the spark plug, thus enabling the engine to start, is a unit either wholly or in part, a Tesla Coil.

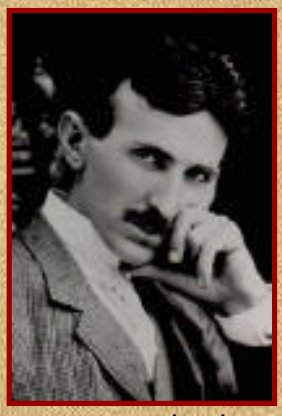
Tesla postulated the ability to locate objects in the air or in the ground by using radio waves. Today, we call it "RADAR", and when used to peer into the human body, "MRI". Tesla also created radio controlled devices., or

"Teli-autonomotons". His work with special gas filled lamps set the stage for the creation of fluorescent lighting, and neon lights.

Tesla patented dozens of devices ranging from speedometers to extremely efficient electrical generators. One unique device was his bladeless boundary disk turbine. Instead of using fan-type blades, Tesla's turbine utilized solid disks of metal, and relied on what is called the "boundary layer effect". His turbine ran on either compressed air or steam or gasoline explosions, and was so efficient that a device held in the hand could produce well over 10 horsepower!

One of the largest turbines that Tesla designed pumped out 10,000 Horse-power, and was about one fifth the size and weight of the engines of its day. Today, this bladeless technology is being used in a special type of non-clogging pump designed for the oil industry. The turbine is awaiting commercial use, and public acceptance., but developments are rapidly making it again seem attractive. Frank Germano, of ***International Turbine And Power,*** of Cody Wyoming, USA is pioneering the design of a special Tesla-Type turbine for the commercial power markets. This turbine can be run on any combustible fuel (propane, methane, gasoline, diesel, hydrogen), steam, or even water under pressure. Read an article appearing in **the "Bulletin of Atomic Scientists" January 2003** to see what Frank Germano is doing to bring this technology into commercial reality. To see how you - the reader - could actually HELP me bring this technology to commercial reality - click on this link - **How Can You Help Bring This Technology to The Commercial Market?!**

It has been said that Tesla is the "***Forgotten Father of Technology.***" It is hard to believe that a man who gave the world so much, received so little for his efforts. History books have been equally unkind.



In many parts of this country, people still refer to the electric utility as the 'Edison Company', even though they use the Tesla-Westinghouse alternating current system, not Edison's direct current. At the Niagara Falls power generating station, a small statue of Tesla is purposely left un-illuminated at night. I have visited this statue, and it is a quite stunning statement to witness the statue in complete darkness, with the surrounding area ablaze with lighting supplied from Tesla's own inventions.

Tesla also had a deep desire to provide wireless electricity across the globe. First, there was the patent infringement issue, which made millionaires of others, particularly the Marconi Company. But Tesla maintained a single-minded focus on developing global wireless communications and energy systems. Working in Colorado Springs in 1899, Tesla developed a transmitter to perfect a method by which transmitted energy could be channeled through natural media.

In Colorado Springs, Colorado, Tesla built a laboratory to develop this. The Colorado Springs lab contained the largest Tesla Coil ever built. Called the Magnifying Transmitter, it was capable of generating some 300,000 watts of power, and could produce a bolt of lightning over 130 feet long. According to local accounts, Tesla actually managed to successfully transmit about 30 to 50 thousand watts of power, without wires, using the Transmitter. There are detailed accounts of these feats, below.

Two years later, 1901, working on Long Island at Wardenclyffe, he set to work on his ultimate goal: construction of a "world telegraphy center" that was to have a lab, a wireless transmitter and production facilities for manufacturing oscillators and vacuum tubes. Constructed on the "model city's" 1,800 acres would be homes, stores and buildings to accommodate 2,500 workers... at least, that was the dream...

By that year's end, however, Marconi had usurped the inventor by transmitting an overseas signal. That left Tesla at the mercy of his financier, J.P. Morgan, who literally pulled the plug on his vision. Morgan, at the time the prime force behind General Electric Co., may have been unnerved by Tesla's claims that the technology

could transmit "unlimited power" by wireless means. The word "free" did not translate well to Morgan. Again, the money flow came to a halt.

Some Tesla devotees suspect he may have been a pioneer of the transistor. "Inventors of the modern computer have repeatedly been surprised, when seeking patents, to encounter Tesla's basic ones already on file," noted Tesla historian Leland Anderson, a former EE and a board member of the Wardenclyffe project. Indeed, two of Tesla's patents from 1903 contain the basic principles of the logical "AND" circuit element. Tesla went on to experiment with actual wireless transmission of electrical power.

Despite his accomplishments, by 1915, at age 60, Tesla was living on credit and drifting from one cheap hotel another, a victim of his own poor business decisions, underdeveloped ideas and inability to create another innovation as profound as the AC paradigm. In 1931, at the age of 75, Tesla received birthday greetings from Lee de Forest and Albert Einstein. In his later years he spent most of his time at the New York Public Library or feeding pigeons that he called- “my sincere friends".

By 1943, he had begun suffering heart trouble and fainting spells along with some mental confusion. On January 1st, 1943 he complained of chest pains during an experiment and returned to the hotel room where he lived. The last person to see him alive was a hotel maid on January 5th, 1943. It is assumed that he died January 7th, 1943 in New York City and his body was discovered on the following day. Over 2,000 people attended his funeral in Manhattan. So, at age 86, the great inventor died alone, nearly penniless and all but forgotten. Years earlier, however, Tesla had appeared to predict the posthumous recognition that today's scientific community would afford him when he wrote: ***"Let the future tell the truth, and evaluate each one according to his work and accomplishments."*** And what accomplishments they were, Dr. Tesla. The world would be a very dark place, without you.

"*The present is theirs ; the future, for which I really work , is mine.*"
Nikola Tesla

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Tesla's "Magnifying Transmitter"

Article: "The New York Times"...27 March, 1904

To gather in the latent electricity in the clouds and with the globe itself as a medium of transmission to convey telegraphic messages, power for commercial purposes, or even the sound of the human voice to the utmost confines of the earth is the latest dream of Nikola Tesla. In an article which appeared recently in The Electrical World Mr. Tesla explains the theories on which the world telegraphy system is founded and what he expects to accomplish by it.

His plans involve the establishment of stations for the transmission of messages and power, "preferably near important centers of civilization." Oddly enough, what Mr. Tesla proudly designates as the first of his commercial "world telegraphy" stations has been established at Wardenclyffe, L.I., which is not in any sense an important "centre of civilization," but a place described by train hands of the Long Island Railroad as a way station where "a passenger alights occasionally."

Tesla's "Magnifying Transmitter", at Wardenclyffe, Shoreham, LI (New York). The transmitting station is an octagonal tower, pyramidal in shape, and some 187 feet in height. It consists of huge wooden stilts, heavily braced, and reinforced, and surmounted by a cupola of interlaced steel wires, bent so as to form an arc. In the cupola there is a wooden platform occupying its entire width. Mr. Tesla began work on his transmitting station about eighteen months ago.

When he first came there, and it was understood that J. Pierpont Morgan had become interested in his odd enterprise and furnished him with financial assistance, a thrill of vague expectancy ran through the little settlement, The Wardenclyffe Land Company, which owns practically all the available ground in the vicinity, gave the inventor a free grant of some 175 acres of fine land, and then settled down to wait for the day when Wardenclyffe would become the centre of the universe.

Some of the farmers who come to Wardenclyffe to send their products to this city look at Mr. Tesla's tower, which is situated directly opposite the railroad station, and shake their heads sadly. They are inclined to take a skeptical view regarding the feasibility of the wireless "world telegraphy" idea, but yet Tesla's transmitting tower as it stands in lonely grandeur and boldly silhouetted against the sky on a wide clearing on the concession is a source or great satisfaction and of some mystification to them all.

"It is a mighty fine tower," said one food farmer to a visitor last week. "The breeze up there is something grand on a Summer evening, and you can see the Sound and all the steamers that go by. We are tired, though, trying to figure out why he put it here instead of at Coney Island. " While the tower itself is very "stagy" and picturesque, it is the wonders that are supposed to be hidden in the earth underneath it that excite the curiosity of the population in the little settlement.

In the centre of the wide concrete platform which serves as a base for the structure there is a wooden affair very much like the companionway on an ocean steamer. The tower and the enclosure in which it has been built are being carefully guarded these days, and no one except Mr. Tesla's own men are allowed to approach it. Only they have been allowed as much as the briefest peep down the companionway. Mr. Scherff, the private secretary of the inventor, told an inquirer that the companionway led to a small drainage passage built for the purpose of keeping the ground about the tower dry.

But such of the villagers as saw the tower constructed tell a different story. They declare that it leads to a well-like excavation as deep as the tower is high with walls of mason work and a circular stairway leading to the bottom.

From there, they say, tunnels have been built in all directions, until the entire ground below the little plain on which the tower is raised has been honeycombed with subterranean passages.

They tell with awe how Mr. Tesla, on his weekly visits to Wardenclyffe, spends as much time in the underground passages as he does on the tower or in the handsome laboratory and workshop erected beside it, and where the power plant for the world telegraph has been installed.

No instruments have been installed as yet in the transmitter, nor has Mr. Tesla given any description of what they will be like. But in his article he announces that he will transmit from the tower an electric wave of a total maximum activity of ten million horse power. This, he says, will be possible with a plant of but 100 horse power, by the use of a magnifying transmitter of his own invention and certain artifices which he promises to make known in due course. What he expects to accomplish is summed up in the closing paragraph as follows:

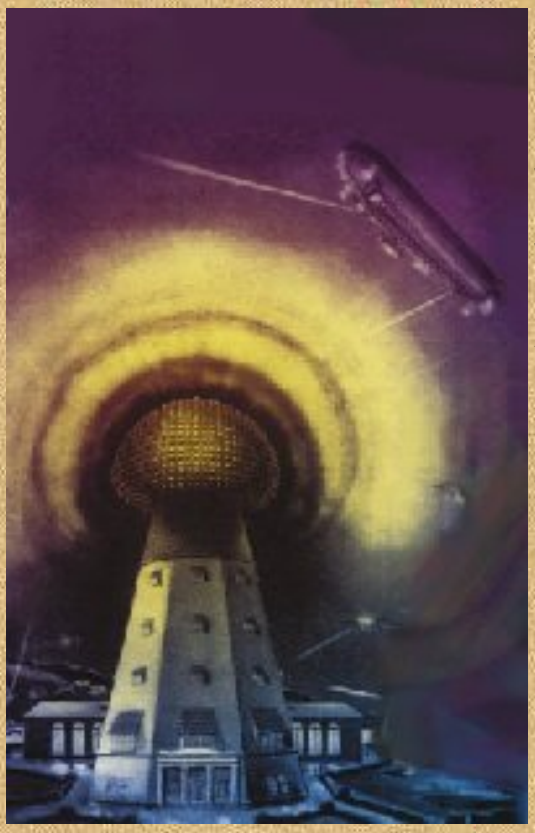
"When the great truth, accidentally revealed and experimentally confirmed, is fully recognized, that this planet, with all its appalling immensity, is to electric currents virtually no more than a small metal ball and that by virtue of this fact many possibilities, each baffling imagination and of incalculable consequence, are rendered absolutely sure of accomplishment; when the first plant is inaugurated and it is shown that a telegraphic message, almost as secret and non-interferable as a thought, can be transmitted to any terrestrial distance, the sound of the human voice, with all its intonations and inflections faithfully and instantly reproduced at any other point of the globe, the energy of a waterfall made available for supplying light, heat or motive power, anywhere...on sea, or land, or high in the air...humanity will be like an ant heap stirred up with a stick. See the excitement coming!" "Cloud born Electric Wavelets To Encircle the Globe: This Is Nicola Tesla's Latest Dream, and the Long Island Hamlet of Wardenclyffe Marvels Thereat," New York Times, 27 March 1904.

Let's continue:

As a young man, Nikola Tesla talked often of the possibility of interplanetary communication. Influenced by Buddhist philosophy and the thinking of Ernst Mach, Tesla began to develop a cosmology that tried to get at the heart of what life was and simultaneously discover electricity's role in the process. He believed in the concept of an all-pervasive aether and also believed that machines could be developed that would have the capability of thinking for themselves.

"The Problem of Increasing Human Energy", which was published 100 years ago (as of June 2000) in Century Magazine spells out Tesla's thoughts and visions for the future of mankind. This was written at the pinnacle of Tesla's life, when he was full of vigor, fresh from his startling accomplishments with the complete victory of his alternating current system over Edison's direct current system. In a radical departure from his previous writings which were of a technical nature, Tesla reveals his philosophy and hopes for humankind. In the article, Tesla expressed his belief that all of us are responsible for increasing the human mass, morally, intellectually, and physically. It was a radical article then... and in some circles... still be considered radical. Nonetheless it caught the eye of JP Morgan who financed Tesla's biggest dream... and most devastating disappointment.. Wardenclyffe! With the tower he had planned for the site, Tesla was going to power the world and light the oceans...A Fascinating Vision...However, powerful economic roadblocks stood in the way that drove Tesla deep into bankruptcy and culminated in the mindless destruction of the tower at Wardenclyffe.
CREDIT: The Electrical Experimenter, Dec. 1917.

Tesla's World Of Tomorrow



Tesla's life changed dramatically after Wardenclyffe. Initially his focus was on developing his bladeless turbine; but always his thoughts turned towards the revival of Wardenclyffe and his beloved Magnifying Transmitter. In 1925, his ideas on the wireless transmission of power were briefly entertained by the Bureau of Standards, but were abruptly rejected out of hand... due to the ignorance of how Tesla's system worked.

As an elderly man, Tesla discussed controversial topics such as free energy, particle beam weapons, cosmic rays that travel faster than light speed, a new magnifying transmitter which could harness these cosmic rays, interplanetary communication and also the claim that he could transmit energy at twice the speed of light. The identification of each separate invention became a somewhat confusing task for journalists and researchers because each of these ideas involve the transmission of energy to distant places: and the so called “death ray” apparently, in its final form, comprised features from some, if not all of the other inventions above.

It is these exotic inventions that interest and fuels the free energy researchers imagination. It was Tesla's claim that he could transmit energy at twice the speed of light that brought Tesla in direct conflict with Einstein's suggestion that space was curved--the conventional mode of thought at the time. Tesla's unique views on the nature of radioactivity also placed him out of the mainstream scientific world. Was Tesla simply delusional ... or did he indeed have a keen insight into the wheel work of Nature? Time will tell.

Tesla's World of Tomorrow :

We are an the threshold of a gigantic revolution, based on the commercialization of the wireless transmission of power.

Motion pictures will be flashed across limitless spaces.

The same energy (wireless transmission of power) will drive airplanes and dirigibles from one central base.

In rocket-propelled machines... it will be practicable to attain speeds of nearly a mile a second (3600 m.p.h.) through the rarefied medium above the stratosphere.

I have fame and untold wealth, more than this, and yet, how many articles have been written in which I was declared to be an impractical unsuccessful man, and how many poor, struggling writers have called me a visionary. Such is the folly and shortsightedness of the world! Nikola Tesla

We will be enabled to illuminate the whole sky at night...Eventually we will flash power in virtually unlimited amounts to planets... Nikola Tesla.

CREDIT: The Electrical Experimenter, Dec. 1917.

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THE WIRELESS TRANSMISSION OF ELECTRICAL POWER

It is possible that Nikola Tesla is best known for his remarkable statements regarding the wireless transmission of electrical power. His first efforts towards this end started in 1891 and were intended to simply "disturb the electrical equilibrium in the nearby portions of the earth... to bring into operation in any way some instrument." In other words the object of his experiments was simply to produce effects locally and detect them at a distance.

By 1899 the electrical potential of his transmitter had increased to the point that more room was needed for the sake of safety. This and other considerations led him to temporarily shift his wireless experiments to a location just outside of Colorado Springs. At this Colorado "Experimental Station" Tesla had some early success in wireless power transmission.

One photograph shows that "a small incandescent lamp was lighted by means of a resonant circuit grounded on one end, all the energy being drawn through the earth [from a nearby transmitter]."

In 1907 he even went as far as to make this statement: "... to make the little filament glow, the entire surface of the planet, two hundred million square miles, must be strongly electrified. This calls for peculiar electrical activities, hundreds of times greater than those involved in the lighting of an arc lamp through the human body [a far more spectacular demonstration]. What impresses him most, however, is the knowledge that the little lamp will spring into the same brilliancy anywhere on the globe, there being no appreciable diminution of the effect with the increase of distance from the transmitter." (One of Tesla's favorite pictures of himself- above, Left)

It is not at all clear that Tesla was referring to effects produced by his large Colorado transmitter. It is quite possible that he was writing about what could be done with an even bigger transmitter such as the one that he was developing in New York. If the Wardenclyffe communications facility had been finished, the 187 foot tall mushroom-shaped tower would have permanently housed a set of large coils including an immense helical resonator that would have served as the main transmitting element. Directly below the wooden tower there was a 120 foot shaft where deep underground Tesla had installed a radial array of iron pipes that served as a connection between the oscillator and the earth.

The Wardenclyffe plant was a major milestone in Tesla's researches into the application of alternating electrical currents to wireless communications and power transmission, an effort which drew a considerable amount of Tesla's attention during the period between 1891 and 1912. In the article "The Future of the Wireless Art" which appeared in Wireless Telegraphy & Telephony, 1908, Tesla made the following statement regarding the Wardenclyffe project on which he was then working: "As soon as completed, it will be possible for a business man in New York to dictate instructions, and have them instantly appear in type at his office in London or elsewhere. He will be able to call up, from his desk, and talk to any telephone subscriber on the globe, without any change whatever in the existing equipment. An inexpensive instrument, not bigger than a watch, will enable its bearer to hear anywhere, on sea or land, music or song, the speech of a political leader, the address of an eminent man of science, or the sermon of an eloquent clergyman, delivered in some other place, however distant.

In the same manner any picture, character, drawing, or print can be transferred from one to another place. Millions of such instruments can be operated from but one plant of this kind. More important than this, however, will be the transmission of power, without wires, which will be shown

on a scale large enough to carry conviction.

These few indications will be sufficient to show that the wireless art offers greater possibilities than any invention or discovery heretofore made, and if the conditions are favorable, we can expect with certitude that in the next few years wonders will be wrought by its application."

In the end, Tesla was never able to complete the Wardenclyffe plant, although he was able to conduct some performance tests. Nevertheless, if the above stated predictions were to be true, an interesting feature of Tesla's World System for global communications, had it gone into full operation, would have been its capacity to provide small but usable quantities of electrical power at the location of the receiving circuits.

A MUSEUM AT WARDENCLYFFE - THE CREATION OF A MONUMENT TO NIKOLA TESLA

The year was 1900 and following 9 productive months of wireless propagation research in Colorado, Nikola Tesla was anxious to put a mass of new found knowledge to work. His vision focused on the development of a prototype wireless communications station and research facility and he needed a site on which to build. In 1901 he cast his eyes some 60 miles eastward to the north shore village of Woodville Landing. Only six years before the north branch of the Long Island Railroad had opened, reducing travel time to the locality from a horse drawn five hours to less than two. Seeing an opportunity in land development a western lawyer and banker by the name of James S. Warden had purchased 1400 acres in the area and started building an exclusive summer resort community known as Wardenclyffe-On-Sound. With an opportunity for further development in mind, Warden offered Tesla a 200 acre section of this parcel lying directly to the south of the newly laid track. It was anticipated that implementation of Tesla's system would eventually lead to the establishment of a "Radio City" to house the thousands of employees needed for operation of the facility. The proximity to Manhattan and the fairly short travel time between the two, along with the site's closeness to a railway line must surely have been attractive features and Tesla accepted the offer.

The Wardenclyffe World Wireless facility as envisioned by Tesla was to have been quite different from present day radio broadcasting stations. While there was to be a great similarity in the apparatus employed, the method in which it was to be utilized would have been radically different. Conventional transmitters are designed so as to maximize the amount of power radiated from the antenna structure. Such equipment must process tremendous amounts of power in order to counteract the loss in field strength encountered as the signal radiates out from its point of origin. The transmitter at Wardenclyffe was being configured so as to minimize the radiated power. The energy of Tesla's steam driven Westinghouse 200 kW alternator was to be channeled instead into an extensive underground radial structure of iron pipe installed 120 feet beneath the tower's base. This was to be accomplished by superposing a low frequency baseband signal on the higher frequency signal coursing through the transmitter's helical resonator. The low frequency current in the presence of an enveloping corona-induced plasma of free charge carriers would have pumped the earth's charge. It is believed the resulting ground current and its associated wave complex would have allowed the propagation of wireless transmissions to any distance on the earth's surface with as little as 5% loss due to radiation. The terrestrial transmission line modes so excited would have supported a system with the following technical capabilities:

1. Establishment of a multi-channel global broadcasting system with programming including news, music, etc;
2. Interconnection of the world's telephone and telegraph exchanges, and stock tickers;
3. Transmission of written and printed matter, and data;
4. World wide reproduction of photographic images;
5. Establishment of a universal marine navigation and location system, including a means for the synchronization of precision timepieces;
6. Establishment of secure wireless communications services.

The plan was to build the first of many installations to be located near major population centers around the world. If the program had moved forward without interruption, the Long Island prototype would have been followed by additional units the first of which being built somewhere along the coast of England. By the Summer of 1902 Tesla had shifted his laboratory operations from the Houston Street Laboratory to the rural Long Island setting and work began in earnest on development of the station and furthering of the propagation research. Construction had been made possible largely through the backing of financier J. Pierpont Morgan who had offered Tesla $150,000 towards the end of 1900. By July 1904, however, this support had run out and with a subsequent major down turn in the financial markets Tesla was compelled to pursue alternative methods of financing. With funds raised through an unrecorded mortgage against the property, additional venture capital, and the sale of X-ray tube power supplies to the medical profession he was able to make ends meet for another couple of years. In spite of valiant efforts to maintain the operation, income dwindled and his employees were eventually dropped from the payroll. Still, Tesla was certain that his wireless system would yield handsome rewards if it could only be set into operation and so the work continued as he was able. A second mortgage in 1908 acquired again from the Waldorf-Astoria proprietor George C. Boldt allowed some additional bills to be paid, but debt continued to mount and between 1912 and 1915 Tesla's financial condition disintegrated. The loss of ability to make additional payments was accompanied by the collapse of his plan for high capacity trans-Atlantic wireless communications. The property was foreclosed, Nikola Tesla honored the agreement with his debtor and title on the property was signed over to Mr. Boldt. The plant's abandonment sometime around 1911-1912 followed by demolition and salvaging of the tower in 1917 essentially brought an end to this era. Tesla's April 20, 1922 loss on appeal of the judgment completely closed the door to any further chance of his developing the site.

Note: ***Tesla had predicted that further advances would have permitted the wireless transmission of industrial amounts of electrical energy with minimal losses to any point on the earth's surface. Had he been able to complete the prototype station on Long Island and use it to demonstrate the feasibility of wireless power transmission then a plan would have been implemented for the construction of a pilot plant for this larger system at Niagara Falls, site of the world's first commercial three phase AC power plant.***

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"If ever we can ascertain at what period the earth's charge,
when disturbed, oscillates -
we shall know a fact, possibly of the greatest importance to the welfare of the human race." **; Nikola Tesla, 1893**

Two great articles in which Tesla predicts the future:
[A Machine To End War] and [The Wonder World To Be Created By Electricity]

TESLA COILS & THE WORLD SYSTEM

Nikola Tesla's Engineering Legacy

It was around the turn of the century, January 22, 1900, when Nikola Tesla sent his business associate George Westinghouse, Jr. some fascinating news. He wrote confidentially: "I have just returned from Colorado, where I have been carrying on some experiments since a few months past. The success has been even greater than I anticipated, and among other things I have absolutely demonstrated the practicability of the establishment of telegraphic communication to any point on the globe by the help of the machinery I have perfected."

The experiments Tesla referred to were preliminary steps taken toward the construction of a prototype global communications facility on eastern Long Island -- a place known as Wardenclyffe. They centered around a unique form of electrical oscillator that Tesla had developed for the production of high voltage, high frequency alternating electrical currents, an invention which his contemporaries dubbed the "Tesla Coil."

Also known as the disruptive discharge coil, these devices initially served as power supplies for various experimental high frequency electric lamps and other high frequency apparatus. The Tesla coil was subsequently adapted to the generation of radio frequency currents for Tesla's then decade long investigation into wireless transmission, offering a superior alternative to the high frequency electrical alternators that he had also constructed for the same purpose.

Nikola Tesla's historic laboratory and wireless communications facility (left) known as Wardenclyffe, located about 65 miles east of New York City on the North Shore of Long Island. It was here this creative genius worked out the final details related to his "World System" for ground-based global communications. The distinctive 187 foot tall tower was demolished in 1917, but the sturdy 94 foot square building still remains standing in silent testimony to Tesla's unfulfilled dream.

The main component of the classic Tesla coil is an air core electrical step-up transformer -- an assembly of two concentric wire coils positioned in fairly close proximity to each other. When an alternating current passes through the first coil or primary winding a time varying magnetic field is established which allows the transfer of energy by electromagnetic induction to the second coil or secondary winding.

The transformer's primary is excited by the rapid discharge of a high voltage capacitor through a high speed switching device known as a break or circuit controller . The potential which appears at the secondary's high voltage terminal is developed through a process known as resonant rise.

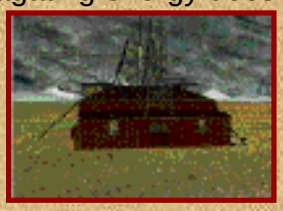
It can greatly exceed the voltage that would be expected from a conventional iron core transformer, using a simple calculation based upon the ratio of primary to secondary turns, that is to say, ratio of transformation. While in operation, the oscillator's primary capacitor is continuously recharged by a regular high voltage transformer, allowing for an uninterrupted flow of radio frequency current in the primary and secondary circuits.

The magnifying transmitter, which was the focus of Tesla's investigations in Colorado, is an advanced form of radio frequency oscillator specifically designed for wireless transmission. In addition to the primary and secondary inductors which made up the classic Tesla coil, Tesla added a third inductor, actually a helical resonator, known as the extra coil.
Power from the grounded primary / secondary combination, now known as the master oscillator, was fed to the lower end of the extra coil helical resonator through a heavy electrical conductor. This centrally located extra coil was separated by a wide space from the other two coils, which comprised the master oscillator section. Such spacing minimizes inductive coupling between the extra coil and the master oscillator, preventing, for the most part, a portion of the energy that is continuously flowing into the resonator from passing backward through the system and becoming lost. In addition to maximizing the efficiency of the system, allowing development of the highest possible power output for power consumed, the extra coil also served as the device's main transmitting element. (Operational Tesla Coils - Left and right))

While Tesla's wireless transmitter and present day radio transmitters are fundamentally the same, the method in which Tesla preferred to use his apparatus was radically different from that which is employed in present day radio systems. Conventional radio transmitters are set up so as to maximize the amount of power radiated from the antenna. When used

for long range transmission, such equipment must process tremendous amounts of power in order to counteract the reduction in field strength (P = 1/R2) encountered as the signal radiates outward from its point of origin. In contrast, Tesla's magnifying transmitter was configured so as to minimize the power which was radiated out into space. Instead of being directed into an elevated antenna, the electrical energy flowing through Tesla's transmitter was sent instead into the extra coil.

Rather than acting as a radiator, the large metallic spheroid, now known as an isotropic capacitance, which Tesla positioned above the extra coil was intended only as a reservoir for electrical charge. Another important component of Tesla's Long Island apparatus was an underground array of iron pipes which extended outward from the bottom of a deep shaft beneath the transmitter tower. When coupled with the transmitter these pipes provided a connection to the earth through which a powerful oscillating electrical current would flow. Unlike a conventional radio transmitter with an antenna that radiates dissipating electromagnetic waves out into space, the magnifying transmitter's extra coil excites a low-frequency ground wave called the Zenneck surface wave. In this case the propagating energy does not radiate into space but is concentrated near the earth's surface.



Furthermore, Tesla asserted that it is possible to periodically disturb the equilibrium of the earth's electrical charge and cause it to oscillate with his apparatus. This would be accomplished by superposing an extra low frequency baseband signal on the somewhat higher frequency signal coursing through the resonator -- the low frequency current in the presence of an enveloping corona-induced plasma of free charge carriers produced by the oscillator in effect "pumping" the earth's charge.

(Pike's Peak Power Station, in Colorado, left)

It is believed the resulting ground current with the associated Zenneck surface wave complex would have propagated wireless transmissions to any distance around the earth with as little as 5% loss due to radiation.

Using a global array of these magnifying transmitters, it was Tesla's plan to establish what he called the World System, providing multichannel global broadcasting, an array of secure wireless telecommunications services, and a long range aid to navigation, including means for the precise synchronization of clocks.

In a more highly developed state he envisioned the World System could expand to include the wireless transmission of electrical power. Telsa at work, left. The shot was taken without Tesla actually in the room with the coil in operation, and the images were combined using a technique similar to a "time delay", double exposure shot. No one could survive in the room with the voltage present, not even Tesla, himself. It does make for a great effect, though, which is exactly what the picture did, at the time.

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The World System of Power; "Wardenclyffe"

Shoreham, Long Island, New York

THE year 1900 marked to Tesla not only the opening of a new century but also the beginning of the world-superpower and radio-broadcasting era. With the encouragement of J. P. Morgan to spur him on--if he could accommodate any more spurring than his own inner drive furnished--and with $150,000 in cash from the same source, he was set to embark upon a gigantic venture, the building of a world wireless-power and a world broadcasting station.

The cash on hand would be totally inadequate to finance the project to completion, but this did not deter him

from making a start. He needed a laboratory both to replace the Houston Street establishment, which had become entirely inadequate, and to include equipment of the type employed at Colorado Springs, but designed for use in the actual world-broadcasting process. The location was determined as the result of an arrangement he made with James S. Warden, manager and director of the Suffolk County Land Company, a lawyer and banker from the West who had acquired two thousand acres of land at Shoreham, in Suffolk County, Long Island, about sixty miles from New York. The land was made the basis of a real-estate development under the name Wardenclyffe.

Tesla visualized a power-and-broadcasting station which would employ thousands of persons. He undertook the establishment, eventually, of a Radio City, something far more ambitious than the enterprise in Rockefeller Center in New York which bears this name today. Tesla planned to have all wavelength channels broadcast from a single station, a project which would have given him a complete monopoly of the radio-broadcasting business. What an opportunity nearsighted businessmen of his day overlooked in not getting in on his project! But in that day Tesla was about the only one who visualized modern broadcasting.

Everyone else visualized wireless as being useful only for sending telegraphic communications between ship and shore and across the ocean. Mr. Warden saw possibilities of a sort in Tesla's plan, however, and offered him a tract of two hundred acres, of which twenty acres were cleared, for his power station, with the expectation that the two thousand men who would shortly be employed in the station would build homes on convenient sites in the remainder of the 2,000-acre tract. Tesla accepted.

Stanford White, the famous designer of many churches and other architectural monuments throughout the country, was one of Tesla's friends. He now disclosed to the famous architect his vision of an industrial "city beautiful" and sought his cooperation in realizing his dream. Mr. White was enthusiastic about the idea and, as his contribution to Tesla's work, offered to underwrite the cost of designing the strange tower the inventor sketched, and all of the architectural work involved in the general plan for the city. The actual work was done by W. D. Crow, of East Orange, N. J., one of Mr. White's associates, who later became famous as a designer of hospitals and other institutional buildings.

It was a fantastic-looking tower, with strange structural limitations, which Mr. Crow found himself designing. Tesla required a tower, about 154 feet high, to support at its peak a giant copper electrode 100 feet in diameter and shaped like a gargantuan doughnut with a tubular diameter of twenty feet. (This was later changed to a hemispherical electrode.)

The tower would have to be a skeletonized structure, built almost entirely of wood, metal to be reduced to an utter minimum and any metal fixtures employed to be of copper. No engineering data were available on wood structures of this height and type. The structure Tesla required had a large amount of "sail area," or surface exposed to wind, concentrated at the top, creating stresses that had to be provided for in a tower that itself possessed only limited stability. Mr. Crow solved the engineering problems and then the equally difficult task of incorporating esthetic qualities in such an edifice.

When the design was completed another difficulty was encountered. None of the well-known builders could be induced to undertake the task of erecting the tower. A competent framer, associated with Norcross Bros., who were a large contracting firm in those days, finally took over the contract, although he, too, expressed fears that the winter gales might overturn the structure. (It stood, however, for a dozen years. When the Government, for military reasons decided it was necessary to remove this conspicuous landmark during the First World War, heavy charges of dynamite were necessary in order to topple it, and even then it remained intact on the ground like a fallen Martian invader out of Wells' War of the Worlds.)

The tower was completed in 1902, and with it a large low brick building more than 100 feet square which would provide quarters for the powerhouse and laboratory. While the structures were being built, Tesla commuted every day from the Waldorf-Astoria to Wardenclyffe, arriving at the nearby Shoreham station shortly after eleven am and remaining until three-thirty. He was always accompanied by a man servant, a Serbian, who

carried a heavy hamper filled with food. When the laboratory transferred from Houston Street was in full operation at Wardenclyffe, Tesla rented the Bailey cottage near the Long Island Sound shore and there made his home for a year.

The heavy equipment, the dynamos and motors, that Tesla desired for his plant were of an unusual design not produced by manufacturers, and he encountered many vexatious delays in securing such material. He was able to carry on a wide range of high-frequency current and other experiments in his new laboratory, but the principal project, that of setting up the worldwide broadcasting station, lagged. Meanwhile, he had a number of glass blowers making tubes for use in transmitting and receiving his broadcast programs. This was a dozen years before De Forest invented the form of radio tube now in general use. The secret of Tesla's tubes died with him.

Tesla seemed to be entirely fearless of his high-frequency currents of millions of volts. He had, nevertheless, the greatest respect for the electric current in all forms, and was extremely careful in working on his apparatus. When working on circuits that might come "alive," he always worked with one hand in his pocket, using the other to manipulate tools. He insisted that all of his workers do likewise when working on the 60-cycle low-frequency alternating-current circuits, whether the potential was 50,000 or 110 volts. This safeguard reduced the possibility of a dangerous current finding a circuit through the arms across the body, where there was chance that it might stop the action of the heart.

In spite of the great care which he manifested in all of his experimental work, he had a narrow escape from losing his life at the Wardenclyffe plant. He was making experiments on the properties of small-diameter jets of water moving at high velocity and under very high pressures, of the order of 10,000 pounds per square inch. Such a stream could be struck by a heavy iron bar without the stream being disrupted. The impinging bar would bounce back as if it had struck another solid iron bar...a strange property for a mechanically weak substance like water. The cylinder holding the water under high pressure was a heavy one made of wrought iron.

Tesla was unable to secure a wrought-iron cap for the upper surface, so he used a heavier one of cast iron, a more brittle metal. One day when he raised the pressure to a point higher than he had previously used, the cylinder exploded. The cast-iron cap broke and a large fragment shot within a few inches of his face as it went on a slanting path upward and finally crashed through the roof. The high-pressure stream of water had peculiar destructive effects on anything with which it came in contact, even tough, strong metals. Tesla never revealed the purpose or the results of these high-pressure experiments.

Tesla's insistence on the utmost neatness in his laboratory almost resulted in a tragedy through a case of thoughtlessness on the part of an assistant. Arrangements were being made for installing a heavy piece of machinery which was to be lag bolted to the thick concrete floor. Holes had been drilled in the concrete. The plan called for pouring molten lead into these holes and screwing the heavy bolts into the metal when it cooled. As soon as the holes were drilled, a young assistant starting cleaning up the debris. He not only swept up the stone chips and dust: he got a mop and thoroughly washed that area of the floor, thoughtlessly letting some of the water get into the holes. He then dried the floor. In the meantime Tesla and George Scherff, who was his financial secretary but also served in any way in which he could be helpful, were melting the lead which would hold the lag screws in the holes in the floor. Scherff took the first large ladleful of lead from the furnace and started across the laboratory to where the holes had been drilled, followed shortly by Tesla bearing another ladle.

Scherff bent down, and as he poured the hot liquid metal into one of the holes an explosion followed instantly. The molten lead was blown upward into his face in a shower of searing hot drops of liquid metal. The water which the assistant used to swab the floor had settled into the holes and, when the melted lead come in contact with it, it was changed to steam which shot the lead out of the hole like a bullet out of the barrel of a riffle. Both men were showered with drops of hot metal and dropped their ladles. Tesla, being several feet away, was only slightly injured; but Scherff was very seriously burned about the face and hands. Drops of the

metal had struck his eyes and so severely burned them that it was feared for a while that his sight could not be saved. However, despite the almost unlimited possibilities for accidents in connection with the vast variety of experiments which Tesla conducted in totally unexplored fields, using high voltages, high amperages, high pressures, high velocities and high temperatures, he went through his entire career with only one accident in which he suffered injury.

In that a sharp instrument slipped, entered his palm and penetrated through the hand. The accident to Scherff was the only one in which a member of his staff was injured, with the exception of a young assistant who developed X-ray burns. He had probably been exposed to the rays from one of Tesla's tubes which, unknown to Tesla and everyone else, had been producing them even before Roentgen announced their discovery. Tesla had given them another name and had not fully investigated their properties. This was probably the first case of X-ray burns on record.

Tesla was an indefatigable worker, and it was hard for him to understand why others were incapable of such feats of endurance as he was able to accomplish. He was willing to pay unusually high wages to workers who were willing to stick with him on protracted tasks but never demanded that anyone work beyond a reasonable day's labor. On one occasion a piece of long-awaited equipment arrived and Tesla was anxious to get it installed and operating as quickly as possible.

The electricians worked through twenty-four hours, stopping only for meals, and then for another twenty-four hours. The workers then dropped out, one by one, picking out nooks in the building in which to sleep. While they took from eight to twelve hours' sleep, Tesla continued to work; and when they came back to the job Tesla was still going strong and worked with them through his third sleepless twenty-four-hour period. The men were then given several days off in which to rest up; but Tesla, apparently none the worse for his seventy-two hours of toil, went through his next day of experiments, accomplishing a total of eighty-four hours without sleep or rest.

The plant at Wardenclyffe was intended primarily for demonstrating the radio-broadcasting phase of his "World System"; the power-distribution station was to be built at Niagara Falls. Tesla at this time published a brochure on his "World System" which indicates the remarkable state of advancement he had projected in the wireless art, now called radio, while other experimenters were struggling to acquire familiarity with rudimentary devices. At that time, however, his promises seemed fantastic. The brochure contained the following description of his system and his objectives:

The World System has resulted from a combination of several original discoveries made by the inventor in the course of long continued research and experimentation. It makes possible not only the instantaneous and precise wireless transmission of any kind of signals, messages or characters, to all parts of the world, but also the interconnection of the existing telegraph, telephone, and other signal stations without any change in their present equipment. By its means, for instance, a telephone subscriber here many call up any other subscriber on the Globe. An inexpensive receiver, not 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.

These examples are cited merely to give an idea of the possibilities of this great scientific advance, which annihilates distance and makes that perfect conductor, the Earth, available for all the innumerable purposes which human ingenuity has found for a line wire. One far reaching result of this is that any device capable of being operated through one or more wires (at a distance obviously restricted) can likewise be actuated, without artificial conductors and with the same facility and accuracy, at distances to which there are no limits other than those imposed by the physical dimensions of the Globe. Thus, not only will entirely new fields for commercial exploitation be opened up by this ideal method of transmission, but the old ones vastly extended.

The World System is based on the application of the following important inventions and discoveries:

1. The Tesla Transformer. This apparatus is, in the production of electrical vibrations, as revolutionary as

gunpowder was in warfare. Currents many times stronger than any ever generated in the usual ways, and sparks over 100 feet long have been produced by the inventor with an instrument of this kind.

2. The Magnifying Transmitter. This is Tesla's best invention--a peculiar transformer specially adapted to excite the Earth, which is in the transmission of electrical energy what the telescope is in astronomical observation. By the use of this marvelous device he has already set up electrical movements of greater intensity than those of lightning and passed a current, sufficient to light more than 200 incandescent lamps, around the Globe.

3. The Tesla Wireless System. This system comprises a number of improvements and is the only means known for transmitting economically electrical energy to a distance without wires. Careful tests and measurements in connection with an experimental station of great activity, erected by the inventor in Colorado, have demonstrated that power in any desired amount can be conveyed clear across the Globe if necessary, with a loss not exceeding a few per cent.

4. The Art of Individualization. This invention of Tesla is to primitive tuning what refined language is to unarticulated expression. It makes possible the transmission of signals or messages absolutely secret and exclusive both in active and passive aspect, that is, non-interfering as well as non-interferable. Each signal is like an individual of unmistakable identity and there is virtually no limit to the number of stations or instruments that can be simultaneously operated without the slightest mutual disturbance.

5. The Terrestrial Stationary Waves. This wonderful discovery, popularly explained, means that the Earth is responsive to electrical vibrations of definite pitch just as a tuning fork to certain waves of sound. These particular electrical vibrations, capable of powerfully exciting the Globe, lend themselves to innumerable uses of great importance commercially and in many other respects. The first World System power plant can be put in operation in nine months. With this power plant it will be practical to attain electrical activities up to ten million horsepower and it is designed to serve for as many technical achievements as are possible without undue expense. Among these the following may be mentioned:

1. Interconnection of the existing telegraph exchanges of offices all over the World;
2. Establishment of a secret and non-interferable government telegraph service;
3. Interconnection of all the present telephone exchanges or offices all over the Globe;
4. Universal distribution of general news, by telegraph or telephone, in connection with the Press;
5. Establishment of a World System of intelligence transmission for exclusive private use;
6. Interconnection and operation of all stock tickers of the world;
7. Establishment of a world system of musical distribution, etc.;
8. Universal registration of time by cheap clocks indicating the time with astronomical precision and requiring no attention whatever;
9. Facsimile transmission of typed or handwritten characters, letters, checks, etc.;
10. Establishment of a universal marine service enabling navigators of all ships to steer perfectly without compass, to determine the exact location, hour and speed, to prevent collisions and disasters, etc.;
11. Inauguration of a system of world printing on land and sea;
12. Reproduction anywhere in the world of photographic pictures and all kinds of drawings or records.

Thus, more than forty years ago, Tesla planned to inaugurate every feature of modern radio, and several facilities which have not yet been developed. He was to continue, for another twenty years, to be the only "wireless" inventor who had yet visualized a broadcasting service.

While at work on his Wardenclyffe radio-broadcasting plant, Tesla was also evolving plans for establishing his world power station at Niagara Falls. So sure was he of the successful outcome of his efforts that he stated in a newspaper interview in 1903 that he would light the lamps of the coming international exposition in Paris with power wirelessly transmitted from the Falls. Circumstances, however, prevented him from making good this promise. His difficulties and his plans were outlined in a statement published in the Electrical World and Engineer, March 5, 1904: (Below) Compliments: Gary Peterson of 21st Century Books, http://www.tfcbooks.com ; used by permission

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TRANSMISSION OF ELECTRICAL ENERGY WITHOUT WIRES

by Nikola Tesla
as communicated to the Thirtieth Anniversary of
the Electrical World and Engineer,
March 5, 1904

It is impossible to resist your courteous request extended on an occasion of such moment in the life of your journal. Your letter has vivified the memory of our beginning friendship, of the first imperfect attempts and undeserved successes, of kindness and misunderstandings. It has brought painfully to my mind the greatness of early expectations, the quick flight of time, and alas! the smallness of realizations. The following lines which, but for your initiative, might not have been given to the world for a long time yet, are an offering in the friendly spirit of old, and my best wishes for your future success accompany them.

Towards the close of 1898 a systematic research, carried on for a number of years with the object of perfecting a method of transmission of electrical energy through the natural medium, led me to recognize three important necessities: First, to develop a transmitter of great power; second, to perfect means for individualizing and isolating the energy transmitted; and, third, to ascertain the laws of propagation of currents through the earth and the atmosphere. Various reasons, not the least of which was the help proffered by my friend Leonard E. Curtis and the Colorado Springs Electric Company, determined me to select for my experimental investigations the large plateau, two thousand meters above sea-level, in the vicinity of that delightful resort, which I reached late in May, 1899. I had not been there but a few days when I congratulated myself on the happy choice and I began the task, for which I had long trained myself, with a grateful sense and full of inspiring hope. The perfect purity of the air, the unequaled beauty of the sky, the imposing sight of a high mountain range, the quiet and restfulness of the place--all around contributed to make the conditions for scientific observations ideal.

To this was added the exhilarating influence of a glorious climate and a singular sharpening of the senses. In those regions the organs undergo perceptible physical changes. The eyes assume an extraordinary limpidity, improving vision; the ears dry out and become more susceptible to sound. Objects can be clearly distinguished there at distances such that I prefer to have them told by someone else, and I have heard, this I can venture to vouch for, the claps of thunder seven and eight hundred kilometers away. I might have done better still, had it not been tedious to wait for the sounds to arrive, in definite intervals, as heralded precisely by an electrical indicating apparatus, nearly an hour before.

In the middle of June, while preparations for other work were going on, I arranged one of my receiving transformers with the view of determining in a novel manner, experimentally, the electric potential of the globe and studying its periodic and casual fluctuations. This formed part of a plan carefully mapped out in advance. A highly sensitive, self-restorative device, controlling a recording instrument, was included in the secondary circuit, while the primary was connected to the ground and an elevated terminal of adjustable capacity. The variations of potential gave rise to electric surging in the primary; these generated secondary currents, which in turn affected the sensitive device and recorder in proportion to their intensity. The earth was found to be, literally, alive with electrical vibrations, and soon I was deeply absorbed in the interesting investigation. No

better opportunities for such observations as I intended to make could be found anywhere.

Colorado is a country famous for the natural displays of electric force. In that dry and rarefied atmosphere the sun's rays beat the objects with fierce intensity. I raised steam, to a dangerous pressure, in barrels filled with concentrated salt solution, and the tinfoil coatings of some of my elevated terminals shriveled up in the fiery blaze. An experimental high-tension transformer, carelessly exposed to the rays of the setting sun, had most of its insulating compound melted out and was rendered useless. Aided by the dryness and rarefaction of the air, the water evaporates as in a boiler, and static electricity is developed in abundance. Lightning discharges are, accordingly, very frequent and sometimes of inconceivable violence. On one occasion approximately twelve thousand discharges occurred in two hours, and all in a radius of certainly less than fifty kilometers from the laboratory. Many of them resembled gigantic trees of fire with the trunks up or down. I never saw fire balls, but as compensation for my disappointment I succeeded later in determining the mode of their formation and producing them artificially.

In the latter part of the same month I noticed several times that my instruments were affected stronger by discharges taking place at great distances than by those near by. This puzzled me very much. What was the cause? A number of observations proved that it could not be due to the differences in the intensity of the individual discharges, and I readily ascertained that the phenomenon was not the result of a varying relation between the periods of my receiving circuits and those of the terrestrial disturbances. One night, as I was walking home with an assistant, meditating over these experiences, I was suddenly staggered by a thought. Years ago, when I wrote a chapter of my lecture before the Franklin Institute and the National Electric Light Association, it had presented itself to me, but I dismissed it as absurd and impossible. I banished it again. Nevertheless, my instinct was aroused and somehow I felt that I was nearing a great revelation.

It was on the third of July--the date I shall never forget--when I obtained the first decisive experimental evidence of a truth of overwhelming importance for the advancement of humanity. A dense mass of strongly charged clouds gathered in the west and towards the evening a violent storm broke loose which, after spending much of its fury in the mountains, was driven away with great velocity over the plains. Heavy and long persisting arcs formed almost in regular time intervals. My observations were now greatly facilitated and rendered more accurate by the experiences already gained. I was able to handle my instruments quickly and I was prepared. The recording apparatus being properly adjusted, its indications became fainter and fainter with the increasing distance of the storm, until they ceased altogether. I was watching in eager expectation. Surely enough, in a little while the indications again began, grew stronger and stronger and, after passing through a maximum, gradually decreased and ceased once more.

Many times, in regularly recurring intervals, the same actions were repeated until the storm which, as evident from simple computations, was moving with nearly constant speed, had retreated to a distance of about three hundred kilometers. Nor did these strange actions stop then, but continued to manifest themselves with undiminished force. Subsequently, similar observations were also made by my assistant, Mr. Fritz Lowenstein, and shortly afterward several admirable opportunities presented themselves which brought out, still more forcibly, and unmistakably, the true nature of the wonderful phenomenon. No doubt, whatever remained: I was observing stationary waves.

As the source of disturbances moved away the receiving circuit came successively upon their nodes and loops. Impossible as it seemed, this planet, despite its vast extent, behaved like a conductor of limited dimensions. The tremendous significance of this fact in the transmission of energy by my system had already become quite clear to me. Not only was it practicable to send telegraphic messages to any distance without wires, as I recognized long ago, but also to impress upon the entire globe the faint modulations of the human voice, far more still, to transmit power, in unlimited amounts, to any terrestrial distance and almost without loss.

With these stupendous possibilities in sight, and the experimental evidence before me that their realization was henceforth merely a question of expert knowledge, patience and skill, I attacked vigorously the development of my magnifying transmitter, now, however, not so much with the original intention of producing one of great

power, as with the object of learning how to construct the best one. This is, essentially, a circuit of very high self-induction and small resistance which in its arrangement, mode of excitation and action, may be said to be the diametrical opposite of a transmitting circuit typical of telegraphy by Hertzian or electromagnetic radiation.

It is difficult to form an adequate idea of the marvelous power of this unique appliance, by the aid of which the globe will be transformed. The electromagnetic radiation being reduced to an insignificant quantity, and proper conditions of resonance maintained, the circuit acts like an immense pendulum, storing indefinitely the energy of the primary exciting impulses and impressions upon the earth of the primary exciting impulses and impressions upon the earth and its conducting atmosphere uniform harmonic oscillations of intensities which, as actual tests have shown, may be pushed so far as to surpass those attained in the natural displays of static electricity.

Simultaneously with these endeavors, the means of individualization and isolation were gradually improved. Great importance was attached to this, for it was found that simple tuning was not sufficient to meet the vigorous practical requirements. The fundamental idea of employing a number of distinctive elements, cooperatively associated, for the purpose of isolating energy transmitted, I trace directly to my perusal of Spencer's clear and suggestive exposition of the human nerve mechanism. The influence of this principle on the transmission of intelligence, and electrical energy in general, cannot as yet be estimated, for the art is still in the embryonic stage; but many thousands of simultaneous telegraphic and telephonic messages, through one single conducting channel, natural or artificial, and without serious mutual interference, are certainly practicable, while millions are possible. On the other hand, any desired degree of individualization may be secured by the use of a great number of cooperative elements and arbitrary variation of their distinctive features and order of succession. For obvious reasons, the principle will also be valuable in the extension of the distance of transmission.

Progress though of necessity slow was steady and sure, for the objects aimed at were in a direction of my constant study and exercise. It is, therefore, not astonishing that before the end of 1899 I completed the task undertaken and reached the results which I have announced in my article in the Century Magazine of June, 1900, every word of which was carefully weighed.

Much has already been done towards making my system commercially available, in the transmission of energy in small amounts for specific purposes, as well as on an industrial scale. The results attained by me have made my scheme of intelligence transmission, for which the name of "World Telegraphy" has been suggested, easily realizable. It constitutes, I believe, in its principle of operation, means employed and capacities of application, a radical and fruitful departure from what has been done heretofore. I have no doubt that it will prove very efficient in enlightening the masses, particularly in still uncivilized countries and less accessible regions, and that it will add materially to general safety, comfort and convenience, and maintenance of peaceful relations.

It involves the employment of a number of plants, all of which are capable of transmitting individualized signals to the uttermost confines of the earth. Each of them will be preferably located near some important center of civilization and the news it receives through any channel will be flashed to all points of the globe. A cheap and simple device, which might be carried in one's pocket, may then be set up somewhere on sea or land, and it will record the world's news or such special messages as may be intended for it. Thus the entire earth will be converted into a huge brain, as it were, capable of response in every one of its parts. Since a single plant of but one hundred horsepower can operate hundreds of millions of instruments, the system will have a virtually infinite working capacity, and it must needs immensely facilitate and cheapen the transmission of intelligence.

"The first of these central plants would have been already completed had it not been for unforeseen delays which, fortunately, have nothing to do with its purely technical features. But this loss of time, while vexatious, may, after all, prove to be a blessing in disguise. The best design of which I know has been adopted, and the transmitter will emit a wave complex of a total maximum activity of 10,000,000 horsepower, one percent of which is amply sufficient to "girdle the globe." This enormous rate of energy delivery, approximately twice that of the combined falls of Niagara, is obtainable only by the use of certain artifices, which I shall make known in

due course.

For a large part of the work which I have done so far I am indebted to the noble generosity of Mr. J. Pierpont Morgan, which was all the more welcome and stimulating, as it was extended at a time when those, who have since promised most, were the greatest of doubters. I have also to thank my friend Stanford White, for much unselfish and valuable assistance. This work is now far advanced, and though the results may be tardy, they are sure to come. Meanwhile, the transmission of energy on an industrial scale is not being neglected. The Canadian Niagara Power Company have offered me a splendid inducement, and next to achieving success for the sake of the art, it will give me the greatest satisfaction to make their concession financially profitable to them. In this first power plant, which I have been designing for a long time, I propose to distribute 10,000 horsepower under a tension of 10,000,000 volts, which I am now able to produce and handle with safety.

This energy will be collected all over the globe preferably in small amounts, ranging from a fraction of one to a few horsepower. One of the chief uses will be the illumination of isolated homes. It takes very little power to light a dwelling with vacuum tubes operated by high frequency currents and in each instance a terminal a little above the roof will be sufficient. Another valuable application will be the driving of clocks and other such apparatus. These clocks will be exceedingly simple, will require absolutely no attention and will indicate rigorously correct time. The idea of impressing upon the earth American time is fascinating and very likely to become popular.

There are innumerable devices of all kinds which are either now employed or can be supplied and by operating them in this manner I may be able to offer a great convenience to the whole world with a plant of no more than 10,000 horsepower. The introduction of this system will give opportunities for invention and manufacture such as have never presented themselves before. Knowing the far reaching importance of this first attempt and its effect upon future development, I shall proceed slowly and carefully. Experience has taught me not to assign a term to enterprises the consummation of which is not wholly dependent on my own abilities and exertions. But I am hopeful that these great realizations are not far off and I know that when this first work is completed they will follow with mathematical certitude.

When the great truth accidentally revealed and experimentally confirmed is fully recognized, that this planet, with all its appalling immensity, is to electric current virtually no more than a small metal ball and that by this fact many possibilities, each baffling the imagination and of incalculable consequence, are rendered absolutely sure of accomplishment; when the first plant is inaugurated, and it is shown that a telegraphic message, almost as secret and non-interferable as a thought, can be transmitted to any terrestrial distance, the sound of the human voice, with all its intonations and injections, faithfully and instantly reproduced at any point of the globe, the energy of a waterfall made available for supplying light, heat or motive power, anywhere on sea, or land, or high in the air...humanity will be like an ant heap stirred up with a stick: See the excitement coming. "
-End-

Summation:

The Niagara Falls plant was never built; and difficulties, soon enough, were encountered at the Wardenclyffe plant not only in securing desired equipment but also finances. Tesla's greatest oversight was that he neglected to invent, so to speak, a device for making the unlimited quantities of money that were necessary to develop his other inventions. As we have seen, he was utterly lacking in the phase of personality that made possible the securing of financial returns directly from his inventions. An individual with his ability could have made millions out of each of a number of Tesla's minor inventions.

If he had taken the trouble, for example, to collect annual royalties on twenty or more different kinds of devices put out by as many manufacturers employing his Tesla coil for medical treatments, he would have had ample income to finance his World Wireless System.

His mind, however, was too fully occupied with fascinating scientific problems. He had, at times, nearly a score of highly skilled workmen constantly employed in his laboratory developing the electrical inventions he was continuing to make at a rapid rate. Armed guards were always stationed around the laboratory to prevent spying on his inventions. His payroll was heavy, his bank balance became dangerously low, but he was so immersed in his experimental work that he continuously put off the task of making an effort to repair his finances.

He soon found himself facing judgments obtained by creditors on accounts upon which he could not make payments. He was forced, in 1905, to close the Wardenclyffe laboratory... The fantastic tower in front of the laboratory was never completed. The doughnut-shaped copper electrode was never built because Tesla changed his mind and decided to have a copper hemisphere 100 feet in diameter and 50 feet high built on top of the 154-foot cone-shaped tower.

A skeleton framework for holding the hemispherical plates was built, but the copper sheeting was never applied to it. The 300-horsepower dynamos and the apparatus for operating the broadcasting station were left intact, but they were eventually removed by the engineering firm that installed them and had not been paid. "Prodigal Genius. by, John O'Neil" excerpt.

WIRELESS TRANSMISSION OF ELECTRICITY to ANY point on earth...To see what would happen if we were to build, and "operate" one of Tesla's Magnifying Transmitters...click here:

Two choices - Yes, it could be built: Tesla's Magnifying Transmitter - A historical Prospective.

Or...no, we probably shouldn't...Tesla- The Greatest "Hacker" Of All Time?!

Wardenclyffe today: located in Shoreham, LI right on Route 25A, at the intersection with Tesla St., the Wardenclyffe lab building is in good shape and looks much as it did a century ago (minus the dramatic tower), though it has become a bit overgrown.

Want to DRIVE to Wardenclyffe? It's pretty easy to get to, being just off Route 25 on Long Island, NY. **Click here for a link to a printable map from Yahoo.com**

Owned today by "Agfa", there are movements afoot to turn it into a museum. Check with Gary Peterson of 21st Century Books to see how you can assist in this historic building becoming a Nikola Tesla Museum, learning center, library, and R&D Laboratory.

Tesla was depending on high earth conductivity to contain any energy that was not immediately used by subscribers. His proof of this was the existence of standing waves in the earth. Too darn bad no one listened. But, here's a promise - International Turbine And Power, LLC, with my direction, and the Tesla Wardenclyffe Project, will bring this building "back to life" if at all possible. Period. FDG.

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Let's see what other fantastic stories we can uncover, shall we? We're a long way from concluding this

amazing journey into the life of Nikola Tesla!

Tesla's Earthquake Machine

Excerpt from the New York World
Telegram, July 11, 1935 -

Nikola Tesla revealed that an earthquake which drew police and ambulances to the region of his laboratory at 48 E. Houston St., New York, in 1898, was the result of a little machine he was experimenting with at the time which "you could put in your overcoat pocket."

The bewildered newspapermen pounced upon this as at least one thing they could understand and "the father of modern electricity" told what had happened as follows:

"I was experimenting with vibrations. I had one of my machines going and I wanted to see if I could get it in tune with the vibration of the building. I put it up notch after notch. There was a peculiar cracking sound.

"I asked my assistants where did the sound come from. They did not know. I put the machine up a few more notches. There was a louder cracking sound. I knew I was approaching the vibration of the steel building. I pushed the machine a little higher. "Suddenly all the heavy machinery in the place was flying around. I grabbed a hammer and broke the machine. The building would have been about our ears in another few minutes. Outside in the street there was pandemonium.

"The police and ambulances arrived. I told my assistants to say nothing. We told the police it must have been an earthquake. That's all they ever knew about it."

Some shrewd reporter asked Dr. Tesla at this point what he would need to destroy the Empire State Building and the doctor replied: "Vibration will do anything. It would only be necessary to step up the vibrations of the machine to fit the natural vibration of the building and the building would come crashing down. That's why soldiers break step crossing a bridge."

His early experiments in vibration, he explained, led to his invention of his "earth vibrating" machine. (For more detailed information on this device, please check out a fantastic book, by Dale Pond - "Tesla's Earthquake Machine." Pick one up from Amazon.com, below)

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NIKOLA TESLA'S RADIANT ENERGY SYSTEM

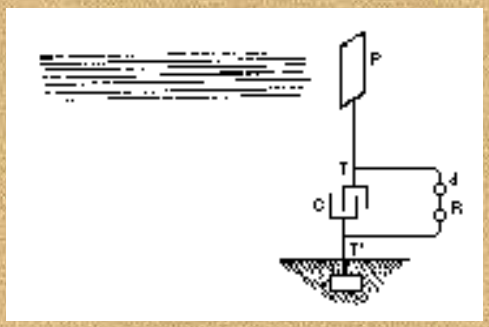
Brooklyn Eagle July 10, 1932

Nikola Tesla states: I have harnessed the cosmic rays and caused them to operate a motive device. Cosmic ray investigation is a subject that is very close to me. I was the first to discover these rays and I naturally feel toward them as I would toward my own flesh and blood. I have advanced a theory of the cosmic rays and at every step of my investigations I have found it completely justified. The attractive features of the cosmic rays is their constancy. They shower down on us throughout the whole 24 hours, and if a plant is developed to use their power it will not require devices for storing energy as would be necessary with devices using wind, tide or sunlight. All of my investigations seem to point to the conclusion that they are small particles, each carrying so small a charge that we are justified in calling them neutrons. They move with great velocity, exceeding that of light. More than 25 years ago I began my efforts to harness the cosmic rays and I can now state that I have

succeeded in operating a motive device by means of them. I will tell you in the most general way, the cosmic ray ionizes the air, setting free many charges ions and electrons. These charges are captured in a condenser which is made to discharge through the circuit of the motor. I have hopes of building my motor on a large scale, but circumstances have not been favorable to carrying out my plan.

Device to Harness Cosmic Energy Claimed by Tesla: New York American November 1st, 1933

"This new power for the driving of the world's machinery will be derived from the energy which operates the universe, the cosmic energy, whose central source for the earth is the sun and which is everywhere present in unlimited quantities."



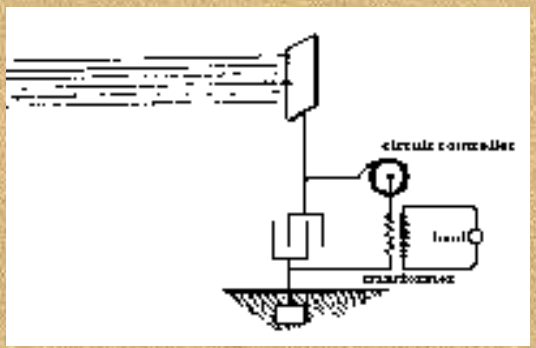
This is a diagram of Tesla's first radiant energy receiver. It stored static electricity obtained from the air and converted it to a usable form. Tesla's invention is a simple version of T.H. Moray's device. Moray's device used a unique rectifier (RE-valve) to efficiently capture the static electricity from the surrounding air. Moray's oscillator tubes (magnetron transducers) utilized this high-voltage energy to generate an internal secondary "cold" fusion reaction.

Stick an antenna up in the air, the higher the better, and wire it to one side of a capacitor, the other going to a good earth ground, and the potential difference will then charge the capacitor. Connect across the capacitor some sort of switching device so that it can be discharged at rhythmic intervals, and you have an oscillating electric output. T.H. Moray simply expanded on Tesla's idea to use high-voltage to create ionic oscillation.

Tesla's free-energy concept was patented in 1901 as an "Apparatus for the Utilization of Radiant Energy." The patent refers to "the sun, as well as other sources of radiant energy, like cosmic rays," that the device works at night is explained in terms of the nighttime availability of cosmic rays. Tesla also refers to the ground as "a vast reservoir of negative electricity."

Tesla was fascinated by radiant energy and its free-energy possibilities. He called the Crooke's radiometer, a device which has vanes that spin in a vacuum when exposed to radiant energy "a beautiful invention." He believed that it would become possible to harness energy directly by "connecting to the very wheel-work of nature." On his 76th birthday at his yearly ritual press conference, Tesla announced a "cosmic-ray motor" when asked if it was more powerful than the Crooke's radiometer, he answered, "thousands of times more powerful."

In 1901 Nikola Tesla was one the first to identify "radiant energy." Tesla says that the source of this energy is our Sun. He concluded that the Sun emits small particles, each carrying so small of a charge, that they move with great velocity, exceeding that of light. Tesla further states that these particles are the neutron particles. Tesla believed that these neutron particles were responsible for all radioactive reactions. Radiant matter is in tune with these neutron particles. Radiant matter is simply a re-transmitter of energy from one state to another.



How his radiant energy receiver worked:

From the electric Potential that exists between the elevated plate (plus) and the ground (minus), energy builds up in the capacitor, and, after

"a suitable time interval," the accumulated energy will "manifest itself in a powerful discharge" that can do work. The capacitor, says Tesla, should be "of considerable electrostatic capacity," and its dielectric made of "the best quality mica, for it has to withstand potentials that could rupture a weaker dielectric."

Tesla gives various options for the switching device. One is a rotary switch that resembles a Tesla circuit controller, another is an electrostatic device consisting of two very light, membranous conductors suspended in a vacuum. These sense the energy buildup in the capacitor, one charging positive, the other negative, and, at a certain charge level, are attracted, touch, and thus fire the capacitor. Tesla also mentions another switching device consisting of a minute air gap or weak dielectric film that breaks down suddenly when a certain potential is reached.

Tesla received two patents for this radiant energy device, "Apparatus for the Utilization of Radiant Energy," number 685,957, that was filed for on March 21, 1901 and granted on November 5, 1901. The other, "Apparatus for the Utilization of Radiant Energy," number 685,957, that was filed for on March 21, 1901 and was granted on November 5, 1901. In these patents he explains:

"The sun, as well as other sources of radiant energy throw off minute particles of matter positively electrified, which, impinging upon the upper plate, communicate continuously an electrical charge to the same. The opposite terminal of the condenser being connected to ground, which may be considered as a vast reservoir of negative electricity, a feeble current flows continuously into the condenser and inasmuch as the particles are charged to a very high potential, this charging of the condenser may continue, as I have actually observed, almost indefinitely, even to the point of rupturing the dielectric."

The Earth's Electrostatic Charge

Tesla's intent was to condense the energy trapped between the earth and its upper atmosphere and to transform it into an electric current. He pictured the sun as an immense ball of electricity, positively charged with a potential of some 200 billion volts. The earth, on the other hand, is charged with negative electricity. The tremendous electrical force between these two bodies constituted, at least in part, what he called cosmic energy. It varied from night to day and from season to season but it is always present.

The positive particles are stopped at the ionosphere and between it and the negative charges in the ground, a distance of 60 miles, there is a large difference of voltage - something on the order of 360,000 volts. With the gases of the atmosphere acting as an insulator between these two opposite stores of electrical charges, the region between the ground and the edge of space traps a great deal of energy. Despite the large size of the planet, it is electrically like a capacitor which keeps positive and negative charges apart by using the air as a non-conducting material as an insulator.

The earth has a charge of 96,500 coulombs. With a potential of 360,000 volts, the earth constitutes a capacitor of .25 farads (farads = coulombs/volts). If the formula for calculating the energy stored in a capacitor (E =1/2CV2) is applied to the earth, it turns out that the ambient medium contains 1.6 x 1011 joules or 4.5 megawatt-hours of electrical energy. In order to utilize this high-voltage energy you must do two things -- make an energy sink and then devise a way of making the "sink" oscillate.

"Zero-Point Energy?"

Such a "sink" has to be at a lower energy state than the surrounding medium and, for the energy to continually flow into it, the energy must be continually pumped out of it. Additionally, this "sink" must maintain a lower energy state while meeting the power requirements of the load attached to it. Electrical energy, watt-seconds, is a product of volts x amps x seconds. Because the period of oscillation does not change, either voltage or current has to be the variable in this system's energy equation. Bifilar wound coils are used in the system because a bifilar wound coil maximizes the voltage difference between its turns, the current is then minimized.

A coil in our system, then, will be set into oscillation at its resonant frequency by an external power source. During the "zero-point" portion of its cycle the coil will appear as one plate of a capacitor. As the voltage across the coil increases, the amount of charge it can siphon will increase. The energy that is taken into the coil

through the small energy window (zero-point), call it what you will, appears to be the key to the success of this system. It is at this zero-point where energy is condensed into positive and negative components of current. When energy escapes from the "sink" the magnetic field collapses and a strong magnetic quake is created in it's wake. A properly tuned system can capture and convert radiant energy in such a prescribed arrangement.

Energy Directly from the Atom

The radiant energy system is a self-oscillating capacitive system. Once it is set into oscillation, very little power is expended in keeping it going. Because it is an electrostatic oscillating system, only a small amount of charge moves through the system per cycle, that is, the coulomb per seconds = amps are low. If the charge is used at a low rate, the energy stored in the system will be turned into heat at a slow rate enabling the oscillations to continue for a long period of time.

Tesla's "COIL FOR ELECTRO MAGNETS," patent #512,340 is a very special coil design because, unlike an ordinary coil made by turning wire on a tube form, this one uses two wires laid next to each other on a form but with the end of the first one connected to the beginning of the second one. In this patent Tesla explains that the double coil will store many times the energy of a conventional coil.[1] Measurements of two coils of the same size and with the same number of turns, one with a single, the other with a bifilar winding, show differences in voltage gain. These bifilar Tesla's coils can be explained solely on the basis of their electrical activity. A bifilar coil is capable of holding more charge than a single wound coil. When operated at resonance, the distributed capacitance of the bifilar coil is able to overcome the counter - electromotive force (e.m.f.) normal to coils, inductive reactance.

Because of the electrical activity, a bifilar coil does not work against itself in the form of a counter - e.m.f., the potential across the coil quickly builds to a high value. The difference between the turns becomes great enough that the energy is practically all potential, at this point, the system becomes an electrostatic oscillator.

Minimal work is done in my radiant energy system due to the absence of wasted displacement currents. As small heat losses occur, oscillations are maintained by surplus charge generated by atomic catalytic reactions, energy is siphoned from the kinetic moments of these charges. Very low energy expenditure allows power delivery to an electrical load over an extended time period without an external fuel supply. After an initial input of energy from an outside source, the radiant energy electrical generator will operate as a very efficient device.

By reviewing history it is understandable why some inventions are not commercialized. It is economics, not science, that is the main factor. It will be remembered that alternating current was opposed by powerful financiers in Tesla's time.

Michael Pupin, noted in his autobiography: "...captains of industry...who were afraid that they would have to scrap some of their direct current apparatus and the plants for manufacturing it, if the alternating current system received any support. A most un-American attitude...but ignorance and false notions prevailed in the early nineties, because the captains of electrical industries paid small attention to highly trained scientists."[2]

Philadelphia Public Ledger November 2, 1933: Tesla 'Harnesses' Cosmic Energy

Inventor announces discovery to displace fuel in driving machinery. Calls Sun main source. A principle by which power for driving machinery of the world may be developed from the cosmic energy which operates the universe, has been discovered by Nikola Tesla, noted physicist and inventor of scientific devices, he announced today. This principle, which taps a source of power described as "everywhere present in unlimited quantities" and which may be transmitted by wire or wireless from central plants to any part of the globe, will eliminate the need of coal, oil, gas or any other of the common fuels, he said.

Dr. Tesla in a statement today at his hotel indicated the time was not far distant when the principle would be

ready for practical commercial development. Asked whether the sudden introduction of his principle would upset the present economic system, Dr. Tesla replied, "It is badly upset already." He added that now as never before was the time ripe for the development of new resources. While in its present form, the theory calls for the development of energy in central plants requiring vast machinery. Dr. Tesla said he might be able to work out a plan for its use by individuals. The central source of cosmic energy for the earth is the Sun, Dr. Tesla said, but "night will not interrupt the flow of new power supply."

Clearly Tesla is not talking about an atomic reactor. He is directly converting ionized particles generated by radiant matter. It is not nuclear energy as we know it today. Radiant Energy is directly converted to electrical power! Tesla believed that the Sun generates highly charged particles and that radiant matter is a re-transmitter of energy, it is this transfer of energy that could be used for practical purposes.

To continue the journey through the amazing life of Nikola Tesla, let's see what Tesla himself had predicted for our time: Please click on these links

[The Wonder World To Be Created By Electricity] and [A Machine To End War]

[The Lost Inventions of Nikola Tesla]

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Help Frank Germano

References :
[1] Nikola Tesla, U.S. Patent #512,340, "COIL FOR ELECTRO MAGNETS," he explains that a standard coil of 1000 turns with a potential of 100 volts across it will have a difference of .1 volt between turns. A similar bifilar coil will have a potential of 50 volts between turns. In that the stored energy is a function of the square of the voltages the energy in the bifilar will be 502/.12 = 2500/.01 = 250,000 times greater than the standard coil.
[2] Michael Pupin, From Immigrant to Inventor, Charles Scribner's Sons, N.Y., pages 285-286, 1923.

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Quotes from Tesla:

On Invention: ***It is the most important product of man's creative brain. The ultimate purpose is the complete mastery of mind over the material world, the harnessing of human nature to human needs.***

Of all the frictional resistance, the one that most retards human movement is ignorance, what Buddha called "the greatest evil in the world." The friction which results from ignorance can be reduced only by the spread of knowledge and the unification of the heterogeneous elements of humanity. No effort could be better spent.

Universal peace as a result of cumulative effort through centuries past might come into existence quickly -- not unlike a crystal that suddenly forms in a solution which has been slowly prepared.

George Westinghouse was a man with tremendous potential energy of which only part had taken kinetic form. Like a lion in the forest, he breathed deep and with delight the smoky air of his Pittsburgh

factories. Always affable and polite, he stood in marked contrast to the small-minded financiers I had been trying to negotiate with before I met him. Yet, no fiercer adversary could have been found when aroused. Westinghouse welcomed the struggle and never lost confidence. When others would give up in despair, he triumphed.

The last 29 days of the month [are] the hardest.

No matter what we attempt to do, no matter to what fields we turn our efforts, we are dependent on power. We have to evolve means of obtaining energy from stores which are forever inexhaustible, to perfect methods which do not imply consumption and waste of any material whatever. If we use fuel to get our power, we are living on our capital and exhausting it rapidly. This method is barbarous and wantonly wasteful and will have to be stopped in the interest of coming generations.

The scientific man does not aim at an immediate result. He does not expect that his advanced ideas will be readily taken up. His work is like that of a planter -- for the future. His duty is to lay foundation of those who are to come and point the way.

Even matter called inorganic, believed to be dead, responds to irritants and gives unmistakable evidence of a living principle within. Everything that exists, organic or inorganic, animated or inert, is susceptible to stimulus from the outside.

Science is but a perversion of itself unless it has as its ultimate goal the betterment of humanity.

We are confronted with portentous problems which can not be solved just by providing for our material existence, however abundantly. On the contrary, progress in this direction is fraught with hazards and perils not less menacing than those born from want and suffering. If we were to release the energy of the atoms or discover some other way of developing cheap and unlimited power at any point of the globe this accomplishment, instead of being a blessing, might bring disaster to mankind... The greatest good will come from the technical improvements tending to unification and harmony, and my wireless transmitter is preeminently such. By its means the human voice and likeness will be reproduced everywhere and factories driven thousands of miles from waterfalls furnishing the power; aerial machines will be propelled around the earth without a stop and the sun's energy controlled to create lakes and rivers for motive purposes and transformation of arid deserts into fertile land... (Nikola Tesla, "My Inventions: the autobiography of Nikola Tesla", Hart Bros., 1982. Originally appeared in the Electrical experimenter magazine in 1919.)

War cannot be avoided until the physical cause for its recurrence is removed and this, in the last analysis, is the vast extent of the planet on which we live. Only through annihilation of distance in every respect, as the conveyance of intelligence, transport of passengers and supplies and transmission of energy will conditions be brought about some day, insuring permanency of friendly relations. What we now want is closer contact and better understanding between individuals and communities all over the earth, and the elimination of egoism and pride which is always prone to plunge the world into primeval barbarism and strife... Peace can only come as a natural consequence of universal enlightenment... (Nikola Tesla, "My Inventions: the autobiography of Nikola Tesla", Hart Bros., 1982. Originally appeared in the Electrical experimenter magazine in 1919.)

In our dynamo machines, it is well known, we generate alternate currents which we direct by means of a commutator, a complicated device and, it may be justly said, the source of most of the troubles experienced in the operation of the machines. Now, the currents, so directed cannot be utilized in the motor, but must - again by means of a similar unreliable device - be reconverted into their original state of alternate currents. The function of the commutator is entirely external, and in no way does it affect the internal workings of the machines. In reality, therefore, all machines are alternate current machines, the currents appearing as continuous only in the external circuit during the transfer from

generator to motor. In view simply of this fact, alternate currents would commend themselves as a more direct application of electrical energy, and the employment of continuous currents would only be justified if we had dynamos which would primarily generate, and motors which would be directly actuated by, such currents. (Adopted from T.C. Martin, "The Inventions, Researches and Writings of Nikola Tesla," New Work: Electrical Engineer, 1894, pp. 9-11.)

On George Westinghouse: ***George Westinghouse was, in my opinion, the only man on this globe who could take my alternating-current system under the circumstances then existing and win the battle against prejudice and money power. He was a pioneer of imposing stature, one of the world's true nobleman of whom America may well be proud and to whom humanity owes an immense debt of gratitude. (Speech, Institute of Immigrant Welfare, Hotel Baltimore, New York, May 12, 1938, read in absentia.)***

On Edison: ***If Edison had a needle to find in a haystack, he would proceed at once with the diligence of the bee to examine straw after straw until he found the object of his search. ...***

I was a sorry witness of such doings, knowing that a little theory and calculation would have saved him ninety per cent of his labor. (New York Times, October 19, 1931.)

On Voltaire: ***I had a veritable mania for finishing whatever I began, which often got me into difficulties. On one occasion I started to read the works of Voltaire when I learned, to my dismay, that there were close on one hundred large volumes in small print which that monster had written while drinking seventy-two cups of black coffee per diem. It had to be done, but when I laid aside the last book I was very glad, and said, "Never more!*** (Nikola Tesla, "My Inventions: the autobiography of Nikola Tesla", Hart Bros., 1982. Originally appeared in the Electrical experimenter magazine in 1919.)

On Mark Twain: ***I had hardly completed my course at the Real Gymnasium when I was prostrated with a dangerous illness or rather, a score of them, and my condition became so desperate that I was given up by physicians. During this period I was permitted to read constantly, obtaining books from the Public Library which had been neglected and entrusted to me for classification of the works and preparation of the catalogues. One day I was handed a few volumes of new literature unlike anything I had ever read before and so captivating as to make me utterly forget my hopeless state. They were the earlier works of Mark Twain and to them might have been due the miraculous recovery which followed. Twenty-five years later, when I met Mr. Clemens and we formed a friendship between us, I told him of the experience and was amazed to see that great man of laughter burst into tears.*** (Nikola Tesla, "My Inventions: the autobiography of Nikola Tesla", Hart Bros., 1982. Originally appeared in the Electrical experimenter magazine in 1919.)

I hope you have enjoyed the information presented on this page. I also hope that you will take something away with you - knowledge. Nikola Tesla was perhaps the most important figure in the twentieth century. Think of the world today, and what it would be like without the contributions Tesla gave us. Thank You for visiting the site,

Frank Dominic Germano, President, International Turbine And Power

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Suggested Books:

Wizard : The Life and Times of Nikola Tesla : Biography of a Genius Marc J. Seifer / Hardcover / Published 1996 (Publisher Out Of Stock) WIZARD: THE LIFE & TIMES OF NIKOLA TESLA has taken me 20 years to write. My key reasons for writing the book were to try and answer many of the questions left unanswered by the other authors, such as why Tesla's name dropped into obscurity, whether or not he really received signals from Mars, how his magnifying transmitter really worked, what exactly happened to cause his failure with JP Morgan, what happened to his secret particle beam weaponry papers, and would his particle beam weapon have really worked. The book is set up completely chronologically, and begins with a quote for each chapter. It also differs from the other biographies in a number of other ways mainly because I had access to hundreds of documents which had never been published before, many received through the Freedom of Information Act. For instance, for the first time ever, WIZARD explains why Tesla stopped working for Edison, why Steinmetz dropped Tesla's name from his textbooks on AC power, why Michael Pupin never mentioned Tesla's name in his physics courses at Columbia University, how Tesla pre-dated Rutherford, Bohr and Einstein in theories on the structure of the atom and on what came to be called Quantum physics, how Marconi pirated Tesla's apparatus, why Tesla had a falling out with his editor TC Martin, John Jacob Astor, JP Morgan and John Hayes Hammond Jr, what Tesla's link to the Navy was, how Franklin Roosevelt used the Tesla patents to block payments on wireless apparatus to Marconi, yet at the same time cut Tesla out of the Marconi/Sarnoff/Westinghouse deal to create RCA, how Tesla interacted with Telefunken, the German wireless concern during WWI and the US War Department during WWII to help them design a particle beam weapon, and how and why Tesla's name has been picked up by cult circles.
This new trade paperback edition has a new illustration of Tesla's flying wing VTOL which was a forerunner of Lockheed Martin's X-33 which will replace the shuttle, and also a new section on the June 1908 explosion at Tunguska Siberia. The book contains over 1400 endnotes including references to 250 documents never published before, a full bibliography and index, and 16 pages of photos. Best wishes, Marc J. Seifer, Ph.D. Author .

Nikola Tesla's Earthquake Machine ~ Usually ships in 24 hours Dale Pond, et al / Paperback / Published 1995 Our Price: $16.95Reviews : Book Description In 1935, Nikola Tesla revealed that an earthquake in the region of his New York laboratory in 1898 was the result of a machine he had been experimenting with. This book presents his technology based on sonic vibrations. Now for the first time the secrets of the Tesla Oscillator are available to both the layman and advanced researcher. INTRODUCTION: ,This manual presents a new technology. It is based on SONIC VIBRATIONS which can be produced by a comparatively simple apparatus. Although sonic vibrations can be similar in their effects and in their wave mechanics like electro-magnetic oscillations, the writer has good reason to believe that this proposed system is fundamentally different in so far as the MANNER OF PRODUCTION of sonic vibrations is concerned. There is much sonic equipment available now on the market for different purposes. It all has nothing to do with the system in this manual. In the oscillators or transmitters described in this report, a RESONANCE EFFECT can be observed. Since resonance appears to be an ever expanding, magnifying effect with these transmitters, to the extent that they would self destruct the apparatus if uncontrolled, it can be deduced that there must be a great source of energy available to them. The very opposite is the truth of the matter however - very little input energy is required to set the device in motion and build that motion to tremendous levels of useable energy. The principle employed is called "Amplitude Modulation Additive Synthesis" by the music industry engineers. We have included a full chapter on the vibration physics to explain what happens and how. With a few simple formulas and a few basic concepts the writers propose to show why certain resonance effects concerning this type of apparatus go on ever increasing in amplitude. Many measurements have yet to be performed by qualified and competent engineers in their different fields of expertise to derive a complete understand of the

device and its attendant phenomena... Much experimentation has been done with the sonic transmitters by Nikola Tesla from whom some of the basic principles have been taken by the writers and further elaborated on. Many of Tesla's earlier experiments have been repeated and we believe that it is he who deserves the credit for having discovered these very fundamental principles of the device and its functions. Further elaboration has been brought in from John Keely's work with the fundamental principles of vibration physics and from a number of conventional sources dealing with vibration, sound and noise fundamentals. In modern times sound and vibration are being used more and more. The physics of these forces are becoming more known and useable. Sound is a rich source of energies and forces not completely understood and harnessed yet.

Buy from amazon.com **Secrets of Cold War Technology: Project HAARP and Beyond**, by Gerry Vassilatos, Our Price: $15.95 Now, Free Shipping!

Editorial Reviews

Book Description : In Secrets of Cold War Technology, Gerry Vassilatos reveals that "Death Ray" technology has been secretly researched and developed since the turn of the century. Included are chapters on H. C. Vion, the developer of auroral energy receivers; Dr. Selim Lemstrom's pre-Tesla experiments; the early beam weapons of Grindell-Mathews; John Hettenger and his early beam power systems; Ulivi Turpain and others. Learn about Project Argus, Project Teak and Project Orange; EMP experiments back in the '60s; why the Air Force directed the construction of a huge ionospheric "backscatter" telemetry system across the Pacific just after World War II; why Raytheon has collected every patent relevant to HAARP over the past few years; and much more pertinent information on hidden Cold War technology.

About the Author : Gerry Vassilatos is a high school science teacher who lives in New York City. He is the author of The Lost Science, another forthcoming book from Adventures Unlimited.

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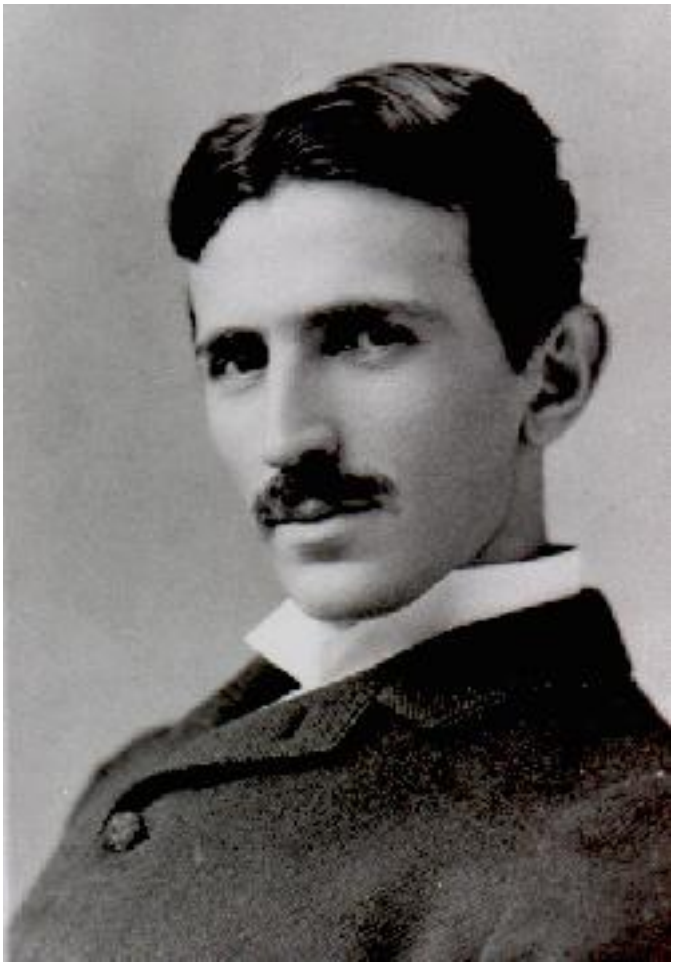

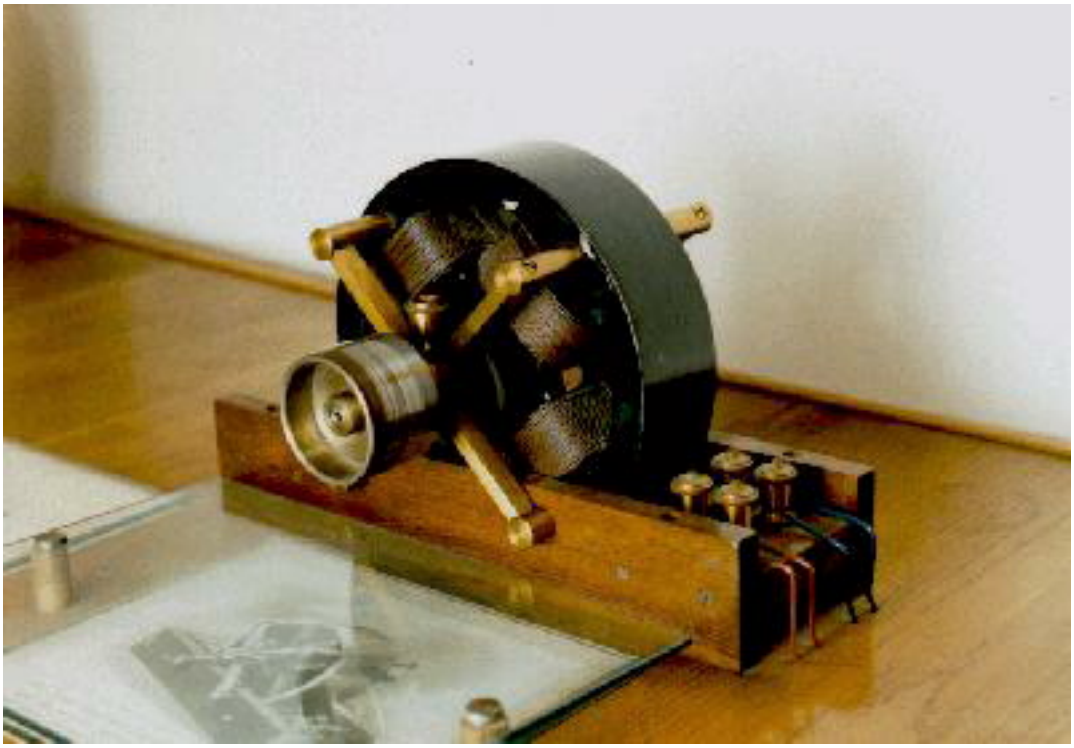

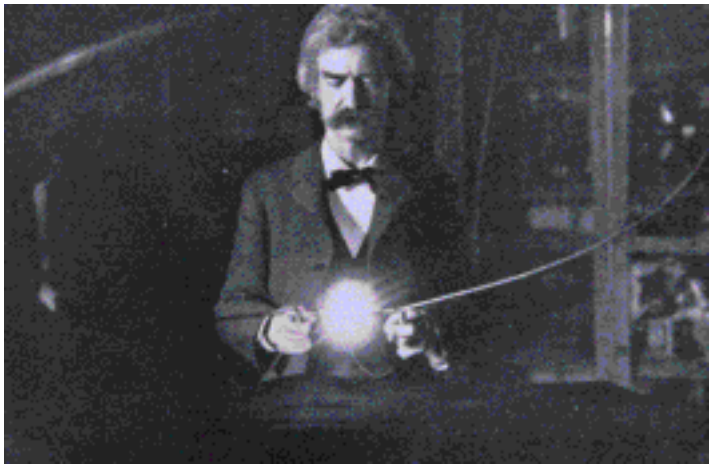

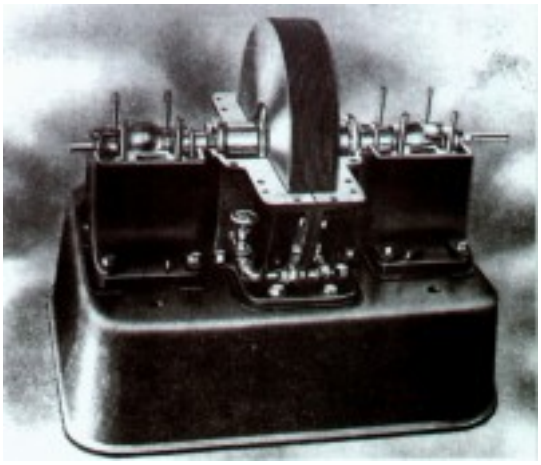

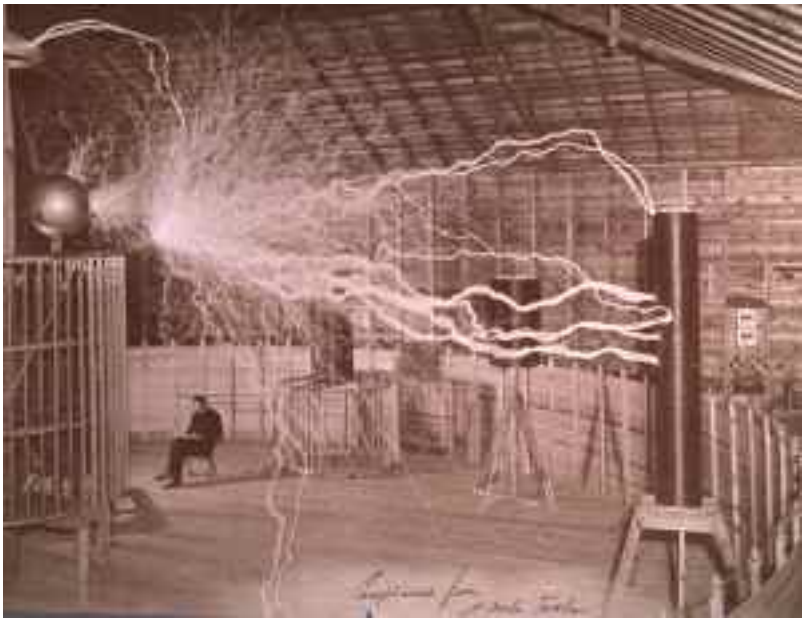

The Lost Inventions of Nikola Tesla

"Short-winded" bio: TESLA, Nikola (1856-1943), electrical inventor. Tesla was famous at the turn of the century for inventing the alternating current system still in use today. But his later inventions, documented in some 30 U.S. patents between 1890 and 1921, have never been utilized as Tesla intended despite their obvious potential for advancing in fundamental ways the technology of modern civilization. Among these lost inventions: the disk-turbine rotary engine, the Tesla coil, electric energy magnifier, high-frequency lighting systems, the magnifying transmitter, wireless power, and the free-energy receiver. Born Yugoslavia, 1956. Educated at the polytechnic school at Graz and at University of Prague. Worked as telephone engineer in Prague and Paris. Conceived new type of electric motor having no commutator, as direct current. motors have, but works on principle of rotating magnetic field produced by poly phase alternating currents. Constructed prototype. Found nobody interested in Europe. Emigrated to U.S. (1884). Worked briefly and unhappily with Thomas Edison.

Established own lab and obtained patents on poly phase motors, dynamos, transformers for a complete alternating current power system. Formed alliance with George Westinghouse, who bought poly phase patents for $1 million plus royalty. With Westinghouse, engaged in struggle against Edison to convince public of efficiency and safety of AC over DC, and succeeded in getting Alternating Current accepted as the electric power system worldwide.

Also with Westinghouse, lit the Chicago World's Fair, built Niagara Falls hydropower plant, and installed AC - Alternating Current - systems at Colorado silver mines, and other industries. By turn of the century was lifted to celebrity status comparable to Edison's as media promoted him along with the expanding electric power industry. Experimenting independently in Manhattan lab, developed and patented electric devices based on superior capabilities of high-potential, high-frequency currents: Tesla coil, radio, high-frequency lighting, x-rays, electrotherapy. Suffered lab fire. Rebuilt, and continued. Moved lab to Colorado Springs for about one year (1899). Built huge magnifying transmitter. Experimented with wireless power, radio, and earth resonance. Studied lightning. Created lightning. Returned to New York. With encouragement of financier J.P. Morgan, promoted a World System of radio broadcasting utilizing magnifying transmitters. Built huge tower for magnifying transmitter at Wardenclyffe, Long Island as first station in World System. Received enough from Morgan to bring station within sight of completion, then funds cut off, project collapsed.

Continued to invent into the 1920's, but flow of patents meager compared to earlier torrent, which amounted to some 700 patents worldwide. High-frequency inventions ignored by established technology, as were disk turbine, free energy receiver, and other inventions. Shut out by media except for birthday press conferences. At these conferences, predicted microwaves, TV, beam technologies, cosmic-ray motor, interplanetary communications, and wave-interference devices that since have been named the Tesla howitzer and the Tesla shield. In the 1930's, he was involved in wireless power projects in Quebec. Last birthday media appearance in 1940.

Died privately and peacefully at 87 in New York hotel room from no apparent cause in particular. Personal papers, including copious lab notes, impounded by U.S. Government, surfaced many years later at the "Tesla Museum", in Belgrade, Yugoslavia. Of these notes, only a fragment, "Colorado Springs Notes", has been published by the Museum.

the inventions:

1. Disk-Turbine Rotary Engine

Tesla called it a powerhouse in a hat. One version developed 110 h.p. at 5000 RPM and was less than ten inches in diameter. Tesla believed larger turbines could achieve 1000 HP. The disk-turbine rotary engine runs vibration free. It is cheap to manufacture because nothing but the rotor bearings needs to be fitted to close tolerances. It requires little maintenance. If necessary, the rotor can be replaced with ease. The turbine can run on steam, compressed air, gasoline, or oil.

How it works

Unlike conventional turbines that use blades or buckets to catch the flow, Tesla's uses a set of rigid metal disks that, instead of battling the propelling stream at steep angles, runs with smooth efficiency in parallel with the flow. What drives the disks is a peculiar adhesion that exists between the surface of a body and any moving fluid. This adhesion, is, in Tesla's words, caused by the shock of the fluid against the asperities of the solid substance (simple resistance) and from internal forces opposing molecular separation (a sticking phenomenon).

The propellant enters the intake and is directed through a nozzle onto the disks at their perimeter. It travels over the spinning disks in a spiral fashion, exiting at the disks' central openings and is exhausted from the casing. Tesla notes in his patent that, in an engine driven by a fluid, changes in the velocity and direction of movement of the fluid should be as gradual as possible. This, he observes, is not the case, though, in existing engines where sudden changes, shocks, and vibrations are unavoidable. The use of pistons, paddles, vanes and blades, notes Tesla, necessarily introduces numerous defects and limitations and adds to the complication, cost of production, and maintenance of the machines.

We who are stuck with the piston engine know this all too well. The Tesla turbine is vibration-free because the propelling fluid moves in natural paths or stream lines of least resistance, free from constraint and disturbance. Conducting the propellant through the intake valve on the other side easily reverses the turbine.

Internal combustion

A hollow casting is bolted to the top of the turbine for the internal combustion mode. A glow plug or spark plug screws into the top of this chamber. Sticking out of the sides are the intake valves. Interesting thing about these valves, there are no moving parts. They work on a fluidic principle. The Tesla turbines' only moving part is its rotor. Imagine, a powerful internal combustion engine with only one moving part.

Fluidics

The fluidic valve, which Tesla calls a valvular conduit, allows easy flow in one direction but in the other the flow gets hung up in dead-end chambers (buckets) where it gets spun around 360 degrees, thus forming eddies, or countercurrents that stop the flow as surely as if a mechanical valve were moved into the shut position. The spinning rotor creates plenty of suction to pull fuel and air into the combustion chamber. Tesla notes that after a short lapse of time the chamber becomes heated to such a degree that the ignition device may be shut off without disturbing the established regime. In other words; it diesels. The disk-turbine motor principle in reverse becomes a very efficient pump. (Tesla's Patent No. 1,061,142)

Fluid drive

The disk turbine principle is employed in the speedometer, which presents the problem of having to turn the rotary motion of a vehicles wheels to angular motion in order to push a spring-loaded indicator needle over a short arc. Tesla's solution: the speedometer cable connects to a disk which spins in interface with a second disk, imparting spin to the fluid in between and, hence, to the second disk which moves the needle. Interface two disks of different sizes in a fluid medium and any desired ratio between speeds of rotation may be obtained

by proper selection of the diameters of the disks, observes Tesla in his patent, thus anticipating in 1911 the fluid-drive automatic transmission.

Tesla First worked on his turbine early in his career, believing it would be a good prime mover for his alternating-current dynamos, far superior to the reciprocal steam engines that were the workhorses of that era. But he did not get down to perfecting and patenting it until after the collapse of his global broadcasting scheme (1909). By this time the internal-combustion piston engine was firmly rooted in Western power mechanics. Tesla referred to organized opposition to his attempts to introduce the superior engine, and so have others who have made the attempt since. But Tesla still saw a glorious future for his turbine. To his friend, Yale engineering professor Charles Scott, Tesla predicted, "My turbine will scrap all the heat engines in the world." Replied Scott, "That would make quite a pile of scrap."

2. Spark-Gap Oscillator:

Tesla was central in establishing the 60 cycle alternating current power system still in use today. Yet he suspected that the more striking phenomena resided in the higher frequencies of electric vibration. To reach these heights, he first tried dynamos spun at higher speeds and having a greater number of poles than any that had existed before. One having as an armature a flat, radially grooved copper disk achieved 30,000 cycles, but Tesla wanted to go into the millions of cycles.

It occurred to him that this vibratory capability was to be found in the capacitor. With a capacitor circuit, the spark-gap oscillator, he did indeed achieve the higher frequencies, and he did so by non mechanical means. The circuit was promising enough for him to patent it as A Method of and Apparatus for Electrical Conversion and Distribution, for Tesla saw in it the possibility of a whole new system of electric lighting by means of high frequencies. Though it was quickly succeeded by the Tesla coil and is not numbered among the more famous of the lost inventions, the spark-gap oscillator is pivotal for Tesla as the invention that launched him into his career in high frequencies.

How it works

The capacitor. There are only a few basic building blocks of electrical circuitry. The capacitor is one of them. Tesla didn't invent it, it had been around for some time, arguably for millennia, but he did improve upon it in three of his patents. Also called condenser, the common capacitor is just a sandwich of conductive and nonconductive layers that serves the purpose of storing electrical charge. The simplest capacitor has just two conductive sheets separated by a single sheet of insulation. In the capacitor shown, the conductive elements are two metal plates.

The insulation between them is oil. In the official vocabulary, the plates are indeed called plates and the insulative layer (oil, glass, mica, or whatever) is called the dielectric. Connect the two terminals of a capacitor into a circuit where there is plus-minus electrical potential, and charge builds on the plates, positive on one, negative on the other. Let this charge build for a while, and then connect the two plates through some resistance, a coil, say, and the capacitor discharges very suddenly. Tesla said, The explosion of dynamite is only the breath of a consumptive compared with its discharge. He went on to say that the capacitor is the means of producing the strongest current, the highest electrical pressure, the greatest commotion in the medium.

The capacitor's discharge is not necessarily a single event. If it discharges into a suitable resistance, there is a rush of current outward, then back again, as if it were bouncing off the resistance, then out, and back and so forth until it peters out. The discharge is oscillatory, a vibration. The vibration can be sustained by recharging the capacitor at appropriate intervals. When Tesla talks of the capacitor's discharge causing commotion in the medium, he means a vibration or mix of vibrations. The character of this vibration is determined in part by the capacity of the capacitor, that is, how much charge it will hold. This is a function of it size, the distance between plates, and the composition of the dielectric. Upon discharge there would be, typically, a fundamental vibration,

some harmonics, and perhaps other commotion, maybe musical, maybe not. Additional circuitry can tame the vibration to a pure tone.

The medium

When Tesla speaks of commotion in the medium, what is the medium? In Tesla's time it was an article of faith that there existed a unified field that permeated all being called the ether. The ether as the electric medium still is an article of faith in some circles, but in official science its existence is presumed to have been disproved in the laboratory. Nevertheless, this conviction about an ether ran very deep, not only among scientists but among all thinkers, until only about forty-some years ago when particle theory, $E=MC^2$, and, finally Hiroshima firmly established the new faith. Tesla said the electron did not exist.

The materialistic concept of these little particles running through conductors is alien to Tesla electric theory. Here is the Quaker writer Rufus Jones on the ether in 1920: An intangible substance which we call ether - luminiferous (light-bearing) aether - fills all space, even the space occupied by visible objects, and this ether which is capable of amazing vibrations, billions of times a second, is set vibrating at different velocities by different objects. These vibrations bombard the minute rods of the retina... It is responsible also for all the immensely varied phenomena of electricity, probably, too of cohesion and gravitation...

The dynamo and the other electrical mechanisms, which we have invented do not make or create electricity. They merely let it come through, showing itself now as light, now as heat, now again as motive power. But always it was there before, unnoted, merely potential, and yet a vast surrounding ocean of energy there behind, ready to break into active operation when the medium was at hand for it. Jones, who was not a scientist but a religious thinker and communicator, was making a point about the nearness of God's power and could do so by invoking the physics of his time. This would be difficult using the Einsteinian physics in fashion today, which W. Gordon Allen has called atheistic science.

Although the ether is intangible, it is assumed to have elastic properties, so that Tesla can say a circuit with a large capacity behaves as a slack spring, whereas one with a small capacity acts as a stiff spring vibrating more vigorously. This elastic character of the ether, which you experience palpably when you play with a pair of magnets, is due to the medium's lust for equilibrium. Distorted by electrical charge (or by magnetism or by the gravity of a material body), the ether seeks to restore a perfect balance between the polarities of positive-negative, plus/minus, yang/yin.

Voltage is the measure of ether strain or imbalance, called potential difference, or just potential. Balance is not restored from this strained condition in one swing-back. As we have seen with the capacitor, the disturbed electric medium, like a plucked guitar string, over-swings the centerline of equilibrium to one side, then to the other, again and again, and this we know as vibration. In this way of looking at nature, vibration is energy; energy is vibration. So you could say that the commotion in the medium caused by the capacitors discharge is energy itself.

Thus, you can speak of the capacitor as an energy magnifier. Even though a feeble potential may charge it, the sudden blast of the capacitor's release plucks the medium mightily. The capacitor is common in modern circuitry, but Tesla used it with much greater emphasis on its capability as an energy magnifier and on a scale almost unheard of today. It's difficult to find commercial capacitors that meet Tesla specifications. Builders of tesla coils and other high-voltage devices usually must construct their own capacitors. Fortunately, this can be done using readily available materials.

How it works

The spark gap: A simple way to discharge a capacitor is through a spark gap. The spark-gap oscillator is just a capacitor firing into a circuit load (lamps or whatever) through the spark gap. The opening between the spark-

gap electrodes determines when the capacitor will fire. This setting is one determinant of the frequency of the circuit.

The others are capacity and the reactance, or bounce characteristics, of the load. The potential needed to bridge the gap is in the tens of thousands of volts. It takes a potential of about 20,000 volts to break down the resistance of just a quarter of an inch of air. The gap doesn't necessarily have to be air. Tesla has referred to a gap consisting of a film of insulation. A spark gap is a switching device, a semiconductor in fact. But the spark gap is problematic, particularly the common two-electrode air-gap version. Heating and ionizing of the air cause irregularities in conduction and premature firing.

This arcing must be quenched. It can be to a great degree by using a series of small gaps instead of one larger one, or by using a rotary gap. Tesla also immersed the gap in flowing oil, used an air blowout, and even found that a magnetic field helps to quench. For the gap Tesla substituted high-speed rotary switches, which he called circuit controllers. One has a rotor that dips into a pool of mercury, and another uses mercury jets to make contact. You can operate a spark gap without a capacitor by connecting it directly to a source of sufficient voltage.

This is, of course, how our automotive spark plugs work, directly off the coil. (The capacitor in that circuit is used to juice the ignition coil primary.) The auto distributor, incidentally, is a rotary gap, pure Tesla. Early radio amateurs used spark-gap oscillators as transmitters. The capacitor was, more often than not, left out of the circuit, but with it the transmitter could create a greater commotion in the medium.

3. Tesla Coil

Tesla's best-known invention takes the spark-gap oscillator and uses it to vibrate vigorously a coil consisting of few turns of heavy conductor. Inside of this primary coil sits another secondary coil with hundreds of turns of slender wire. In the Tesla coil there is no iron core as in the conventional step-up transformer, and this air-core transformer differs radically in other ways. Recounting the birth of this invention, Tesla wrote, Each time the condenser was discharged the current would quiver in the primary wire and induce corresponding oscillations in the secondary. Thus, a transformer or induction coil on new principles was evolved Electrical effects of any desired character and of intensities undreamed of before are now easily producible by perfected apparatus of this kind. Elsewhere Tesla wrote, There is practically no limit to the power of an oscillator.

The conventional step-up transformer (short primary winding, long secondary on an iron core) boosts voltage at the expense of amperage. This is not true of Tesla's transformer. There is a real gain in power. Writing of the powerful coils he experimented with at his Colorado Springs lab, coils with outputs in excess of 12 million volts, Tesla wrote, It was a revelation to myself to find out that ... a single powerful streamer breaking out from a well insulated terminal may easily convey a current of several hundred amperes! The general impression is that the current in such a streamer is small.

How it works

A Tesla coil secondary has its own particular electrical character determined in part by the length of that slender coiled wire. Like a guitar string of a particular length, it wants to vibrate at a particular frequency. The secondary is inductively plucked by the primary coil. The primary circuit consists of a pulsating high-voltage source (a generator or conventional step-up transformer), a capacitor, a spark gap, and the primary coil itself. This circuit must be designed so that it vibrates at a frequency compatible with the frequency at which the secondary wants to vibrate.

The primary circuit's frequency is determined by the frequency and voltage of the source, the capacity of the capacitor, the setting of the spark gap, and the character of the primary coil, determined in part by the length of its winding. Now when all these primary-circuit components are tuned to work in harmony with each other, and

the circuit's resulting frequency is right for plucking the secondary in a compatible rhythmic manner, the secondary becomes at its terminal end maximally excited and develops huge electrical potentials, which if not put to work, boil off as a corona of bluish light or as sparks and streamers that jump to nearby conductors with crackling reports.

Unlike the conventional iron-core step-up transformer, whose core has the effect of damping vibrations, the secondary of the Tesla transformer is relatively free to swing unchecked. The pulsing from the primary coil has the effect of pushing a child in a swing. If it's done in a rhythmic manner at just the right moment at the end of a cycle, the swing will oscillate up to great heights. Similarly, with the right timing, the electrical vibration of the secondary can be made to swing up to tremendous amplitudes, voltages in the millions. This is the power of resonance.

Manmade earthquake

Tesla was fascinated with the power of resonance and experimented with it not only electrically but on the mechanical plane as well. In his Manhattan lab he built mechanical vibrators and tested their powers. One experiment got out of hand.

Tesla attached a powerful little vibrator driven by compressed air to a steel pillar. Leaving it there, he went about his business. Meanwhile, down the street, a violent quaking built up, shaking down plaster, bursting plumbing, cracking widows, and breaking heavy machinery off its anchorage. Tesla's vibrator had found the resonant frequency of a deep sandy layer of subsoil beneath his building, setting up an earthquake.

Soon Tesla's own building began to quake, and, just at the moment the police burst into the lab, Tesla was seen smashing the device with a sledgehammer, the only way he could promptly stop it. In a similar experiment, on an evening walk through the city, Tesla attached a battery-powered vibrator, described as being the size of an alarm clock, to the steel framework of a building under construction and, adjusting it to a suitable frequency, set the structure into resonant vibration. The structure shook, and so did the earth under his feet.

Later Tesla boasted that he could shake down the Empire State Building with such a device, and, as if this claim were not extravagant enough, he went on to state that a large-scale resonant vibration was capable of splitting the Earth in half. No details of Tesla's vibrators are available, but they probably resembled one of Tesla's reciprocating engines (such as Patent No. 511,916). These exploited the elasticity of gases, just as his electrical vibrators, like the Tesla coil, exploit the elasticity of the electric medium.

A new power system

Tesla invented his resonant transformer, as the Tesla coil is sometimes called, to power a new type of high-frequency lighting system, as his 1891 patent drawing shows. This was the first Tesla coil patent. There followed a series of other patents developing the device. All of these are for bipolar coils: both ends of the secondary are connected to the working circuit (usually lamps), as opposed to the mono polar format favored by today's basement builders in which the top is connected to a ball or other terminal capacitor, the bottom to ground. The mono polar format emerges later in patents for radio and wireless power, including Tesla's magnifying transmitter.

The 1896 patent drawing shows an evolved bipolar coil using tandem chokes to store energy for sudden release into the capacitor, enabling the device to be powered by relatively modest inputs. Chokes are coils wound on iron cores. They store energy as magnetism. When the charging current is interrupted, the magnetic field collapses inducing current in the coils, which rushes in to charge the capacitors.

Superconductivity

Alternating currents can be sent over long distances with relatively low losses. This is why Tesla's early 60-cycle system triumphed over Edison's direct current. The high frequency, high-potential output of a Tesla coil can travel over relatively light conductors for vastly greater distances than conventional 60-cycle AC Losses occur to some degree from corona discharge but hardly at all from ohmic resistance. This type of current also renders conductive materials that are normally nonconductive, rarefied gases, for example. You might say these currents make a medium superconductive.

Although super-magnetism is not in the picture because high-frequency vibrations would be severely damped by an electromagnet's iron core, it is revealing to reflect upon the unexploited superconductivity of Tesla energy these days when science is congratulating itself on new advances in the field. Prior to recent breakthroughs, superconductivity and super magnetism were low-temperature (cryogenic) phenomena, occurring when circuits were cooled down to near absolute zero. The new superconductivity at less drastically reduced temperatures developed out of the cryogenic work of the last twenty years, and this may be in debt to Tesla, who patented a similar idea way back in 1901.

Tesla's patent shows that the deep cooling of conductors with agents like liquid air results in an extraordinary magnification of the oscillation in the resonating circuit. Imagine the performance of a super cooled Tesla coil. No electrocution. Since we tend to associate high voltage with possibly fatal electric shock it may be puzzling to learn that the output of a well-tuned Tesla coil, though in the millions of volts, is harmless. This is customarily thought to be because the amperage is low (it's not) or it's explained in terms of something called the skin effect, which means that the current travels over you instead of through. But the real reason is a matter of human frequency response. Just as your ears cannot respond to vibrations over about 30,000 cycles, or the eyes to light vibrations at or above ultra violet, your nervous system cannot be shocked by frequencies over about 2,000 cycles.

Electrotherapy

Now that you know it's harmless, would you believe these currents are even good for you? Fact is that a whole branch of medicine was founded on the healing effects of certain Tesla coil frequencies. Tesla understood the therapeutic value of high-frequency vibrations. He never patented in the area but did announce his findings to the medical community, and a number of devices were patented and marketed by others.

Patients, by focusing certain frequencies on afflicted areas, or, in some cases, just sitting in the vicinity of vibrations from a device like the Lakhovsky Multi wave Oscillator, which produced a blend of specific frequencies, were said to have experienced relief from rheumatism and other painful conditions. It was even considered a cure for certain types of paralysis. Such radiation's increase the supply of blood to the area with a warming effect (diathermy). They enhance the oxygenation and nutritive value of the blood, increase various secretions, and accelerate the elimination of waste products in the blood. All this promotes healing. Electrotherapists even spoke of broadcasting vitamins to the body. Reversals of cancer tumor growths have been documented. Lakhovsky predicated science will discover, some day, not only the nature of microbes by the radiation they produce, but also a method of killing disease within the body by radiation.

Electrotherapy devices were sold directly to the public via ads in popular magazines and in the Sears catalogs. Self-treatment was widespread. This easy access to treatment of all sorts of conditions led to the eventual suppression of the technology by the medical establishment. Electrotherapy, however, is making a big comeback. In chiropractic and sports medicine, low-frequency AC and DC pulses are being used to kill pain and exercise muscles. High-frequency electrotherapy is coming back in alternative healing practices. There is an increasing appreciation of the electrical nature of biological functioning and that some electric vibrations in the environment are harmful while others are healing. Reprints of Lakhovsky's works are widely read. There is a growing conviction that cancer can be effectively treated with high-frequency therapies.

In his experimenting over an eight-year period, Tesla made no fewer than 50 types of oscillating coils. He

experimented with lighting and other vacuum effects, including x-rays. He also experimented with novel shapes for the normally cylindrical coils, getting satisfying results from cone shapes and flat spirals. At Colorado Springs Tesla achieved phenomenally increased outputs by using a third coil resonantly tuned to the secondary. Observing the tremendous magnification this achieved, he gave much of his attention to integrating this extra coil, as he called it, into an evolved outsize tesla coil called the magnifying transmitter.

4. Magnifying Transmitters; Wireless Power

In 1893 Tesla told a meeting of the National Electric Light Association that he believed it practical to disturb, by means of powerful machines, the electrostatic conditions of the earth, and thus transmit intelligible signals, and, perhaps, power. He said, It could not require a great amount of energy to produce a disturbance perceptible at a great distance, or even all over the surface of the earth. The ultimate powerful machine for these tasks is Tesla's magnifying transmitter.

How it works

An extra coil gives the resonant boost of a Tesla coil secondary but has the advantage of being more independent in its movement. A secondary, being closely slaved to the primary, is inhibited somewhat by it, its oscillations slightly damped. The extra coil is able to swing more freely. Extra coils, writes Tesla, enable the obtainment of practically any EMF, the limits being so far remote that I would not hesitate to produce sparks of thousands of feet in this manner.

The engineering challenge of the magnifying transmitter, then, becomes one of containing and properly radiating its immense electrical activities, measured in the tens and even hundreds of thousands of horsepower, as Tesla put it. Containment and effective radiation of this power is the whole point of the design shown, for which Tesla applied for patent in 1902. The heavy primary is wound on top of the secondary at the base of the tower. The extra coil extends upward through a hooded connection to a conductive cylinder.

The antenna is a toroid, a donut-shaped geometry that allows for a maximum of surface area with a comparative minimum of electrical capacity. Since this is a high-frequency device, a relatively low capacity is desirable. To increase the area of the radiating surface, the outside of the toroid is covered with half-spherical metal plates. A subtlety of the design is that the conductive cylinder is of larger radius than the radius of curvature of these plates, since a tighter curve would allow escape of energy. The cylinder is polished to minimize losses through irregularities in the surface. At the center of the top surface sits a pointy plate that serves as a safety valve for overloads so the powerful discharge may dart out there and lose itself harmlessly in the air.

Tesla advises bringing the power up slowly and carefully so pressure does not build at some point below the antenna, in which case a ball of fire might break out and destroy the support or anything else in the way, an event that may take place with inconceivable violence. Current in the antenna could build to an incredible 4000 amperes.

A.C. / D.C.

Wireless power transmission via the magnifying transmitter was the ultimate development of the inventor who had earlier brought alternating-current power to the world with his poly phase system. The predecessor of A.C. was a direct-current system developed, manufactured, and marketed chiefly by Thomas Edison. Direct current was adequate for serving small areas but was unworkable for long distance transmission. By contrast, A.C. could be transmitted for long distances over lighter wires and its voltage could be stepped up for transmission and down for consumption by means of transformers. Tesla invented from scratch a new kind of motor (poly phase) that could utilize A.C., and he greatly evolved earlier concepts of dynamos to generate A.C. as well as transformers to step voltage up and down. Whereas Edison's D.C. would have been suitable for a society of

small, autonomous communities, the evolving system of industrial rule wanted centralized power and needed A.C.'s long distance capability to serve huge sprawling populations.

George Westinghouse, an inventor (the air brake) who, like Edison, turned industrialist (having found that to profit from an invention one must undertake manufacturing and marketing as well) saw the promise in Tesla's poly phase inventions and formed an alliance with the young prodigy. Westinghouse paid Tesla one million dollars and contracted to pay a royalty of one dollar per horsepower for the poly phase inventions. Later Westinghouse was forced to renege on the royalty.

Together, Westinghouse and Tesla triumphed over Edison's D.C. system and installed the first A.C. power facilities, the most notable being the hydra plant at Niagara Falls. Tesla believed in hydropower. His ultimate energy-magnifying, wireless power system would have been hydro-based. The centralized A.C. electric power system we have today was forced into existence on a colossal scale by utility magnates of that era, the most prominent being Samuel Insull, who became infamous in some circles for his massive bilking of the investing public and famous in others for hammering together the electric power complex now in place. This complex has developed into a federally protected monopoly with greater capital wealth than any other industry in the U. S. In the order of energy sources used, Tesla's hydropower has been left well behind the burning of fossil fuels, a process that dumps 24 million tons of pollutants into the nation's air supply each year.

Hydropower even runs way behind the nukes in kilowatt-hours produced. So went another Tesla dream. Tesla was a celebrity in his poly phase heyday, but today his celebrity is as an underground cult figure known for his radically progressive energy-magnifying, free-energy, and wireless power inventions, which, of course, have no place in the established system.

Power by wire

Prior to his wireless power inventions, Tesla patented in 1897 a high frequency system that transmitted power by wire. The system used previously unheard of levels of electric potential. He notes that at these voltages, conventional power would destroy the equipment, but that his system not only contains this energy but is harmless to handle while in use. This system is not a circuit in the usual sense but a single wire without return. It employs the familiar Tesla coil configurations at both sending and receiving ends. The primary circuit (power source, capacitor, spark gap) is represented in the drawing by the generator symbol. The secondary coil is a flat spiral. An advantage in this coil design is that the voltage adjacent to the primary, where arcing across could occur, is at zero and soars to high values as the coil spirals inward. The same patent also shows a cone-shaped secondary in which the primary is at the base of the cone, which is at zero potential.

Wireless power

The drawing for Tesla's wireless power patent looks like the earlier power-by-wire patent except now spherical antennas replace the transmission lines, which are dropped out of the picture almost as if they were redundant. The ball antenna is peculiarly Tesla, as is the toroid, and you wonder why nothing like them have appeared since. In this 1900 patent, wireless power is not represented as an earth-resonant system. Here Tesla talks about transmission through elevated strata. The patent contains much discussion of how rarefied gases in the upper atmosphere became quite conductive when there is applied many hundred thousand or millions of volts. Balloons are suggested to send the antennas aloft. Appreciate that Tesla in this patent has invented nothing less than the principles of radio.

Tesla recognizes only a quantitative difference between sending radio signals and broadcasting electric power. Both involve sending and receiving stations tuned to one another by means of tesla coil circuits. Tesla's wireless power would be the ultimate centralized electric system, a capitalist dream, but for the fact that the technology is too simple. Just raising an antenna, planting a ground, and connecting simple Tesla coil circuitry in between could achieve reception of power.

Although Tesla himself patented a couple of electric meters for high frequencies, it would be all too easy for consumers to tune in for free, just as many today bootleg pay TV signals using illicit equipment far more sophisticated. It is no wonder, then, that the electric power establishment didn't welcome this invention. This was one problem. Another was that the established electric power system would have to be relegated to another great pile of scrap, and maybe the established system of political power as well.

Tesla's announced dream was to use hydra sources where available and through wireless power broadcast that energy around the planet, thus liberating the world from poverty. Such a scheme would not be readily embraced by powers that sustain their rule by keeping populations poor and weak. Centralized control of energy, as well as other resources, is, of course, believed to be essential to civilized rule, at least as far as thinking on that subject has progressed in this era. Moreover, no multinational political system was in existence, or is now for that matter, that could implement a technology of such global implications. Tesla was blind to such considerations.

His commitment, his overriding priority as a technological purist, was to take machine possibilities to their logical conclusions. Today, if wireless power were seriously proposed, there would no doubt be at least one political problem that would not have arisen in Tesla's time: resistance from environmentalists. What would an environmental impact report have to say about biologic hazards? A Navy submarine communication system that uses extremely low frequency (ELF) waves, down to below 10 cycles, has been challenged by environmentalists, as have microwave and 60 cycle high-voltage transmission lines.

Engineering details

Patents normally don't give many quantitative specifics, but Tesla's wireless power patent does give some about the big prototype power-transmission Tesla coil (which was, incidentally, used to conduct a demonstration before skeptical patent examiners). A 50,000-volt transformer charged a capacitor of .004 mfd., which discharged through a rotary gap that gave 5,000 breaks per second. The eight-foot diameter primary had just one turn of stout stranded cable. The secondary was 50 turns of heavily insulated No. 8 wire wound as a flat spiral. It vibrated at 230-250,000 cycles and produced 2 to 4 million volts. This coil evolved into the huge experimental magnifying transmitter

Tesla describes in his Colorado Springs notes. Housed in a specially built lab 110 feet square, the device used a 50,000 volt Westinghouse transformer to charge a capacitor that consisted of a galvanized tub full of salt water as an electrolyte, into which he placed large glass bottles, themselves containing salt water. The salt water in the tub was one plate of this capacitor, the salt water inside the bottles the other plate, and the bottle glass the dielectric. Various capacities were tried, incremental changes being made by connecting more or fewer bottles. A variable tuning coil of 20 turns was connected to the primary, which consisted of two turns of heavy insulated cable that ran around the base of the huge fence like wooden secondary framework. The secondary had 24 turns of No. 8 wire on a diameter of 51 feet Various extra coils were tried, the final version being 12 feet high, 8 feet in diameter, and having 100 turns of No. 8 wire.

The antenna was a 30-inch conductive ball adjustable for height on a 142-foot mast. The huge transmitter could vibrate from 45 to 150 kilocycles. Even with the big transformer, this bill of materials does not seem inaccessible to enterprising people, and the technology does not seem so abstruse, so it is no wonder that people have gotten together to build magnifying transmitters and experiment with wireless power without support from corporations or government.

One such group was the People's Power Project in central Minnesota in the late 70's. This group, largely farmers, objected to high voltage power lines trespassing on their land and set out to build an alternative. Limited by the sketchy information then available, the project was not successful. Another attempt, called Project Tesla, is being set up in Colorado. Endowed with more precise calculations and more experienced personnel, Project Tesla will try to repeat Tesla's wireless-power experiment and verify his theory by taking measurements at various remote locations.

Earth resonance

Among the appealing features of Colorado Springs for Tesla was the region's frequent and sensational electrical storms. For Tesla, lightning was a joyous phenomenon. Biographers report that, during storms back East, Tesla would throw open the windows of his New York lab and recline on a couch for the duration, muttering to himself ecstatically. In Colorado Springs he tuned in and tracked lightning storms using rudimentary radio receiving equipment. He thereby determined that lightning was a vibratory phenomenon, which set up standing waves bouncing within the earth at a frequency resonantly compatible with the earth's electrical capacity. This earth-resonant frequency, he reasoned, was the ideal frequency for wireless power transmission, and he tuned his ultimate magnifying transmitter accordingly.

The literature contains various reports on exactly what this frequency is. Some say 150 kilocycles, which would be at the upper range of the Colorado Springs transmitter. Others give frequencies considerably lower, 11.78 cycles, 6.8 cycles, frequencies Tesla's transmitter may have achieved harmonically. With reinforcement from the earth resonance, the power would actually increase in the process of transmission.

In one memorable experiment with the Colorado Springs transmitter, Tesla shot from the antenna ball veritable lightning bolts of 135 feet, producing thunder heard 15 miles distant, and, in the process, pulled so many amperes that he burned out the municipal generator. In another experiment he lit up wirelessly, at a distance of 26 miles from the lab, a bank of 10,000 watts worth of incandescent bulbs. Two years after Colorado Springs, Tesla applied for patent for the far more refined magnifying transmitter shown at the opening of this chapter, a patent that was not granted until a dozen years later.

In this patent he no longer speaks of energy broadcast through the upper strata of the atmosphere but of a grounded resonant circuit. Tesla predicted that his magnifying transmitter would prove most important and valuable to future generations, that it would bring about an industrial revolution and make possible great humanitarian achievements. Instead, as we shall see, the magnifying transmitter became Tesla's Waterloo.

5. Magnifying Transmitter II ; Grounded Radio:

With the backing of J. P. Morgan, Tesla began, soon after returning from Colorado Springs, the construction of a magnifying transmitter tower at Wardenclyffe, near Shoreham, Long Island. Though closely related to a wireless power propagator and intended for further experimentation in that area, the tower was built specifically as the first station in Tesla's proposed World System of broadcasting. The system was to carry programming for the general public as well as private communications.

Tesla was the first to suggest the broadcasting of news and entertainment to the public; only point-to-point signaling had been experimented with up to then. The fully realized World System was to serve as a multi-frequency wireless interconnects for all existing telephone, telegraph, and stock ticker services around the planet. Exclusivity and noninterference of priority private communications was to be assured by multiplex techniques. The giant transmitter was also to carry a universal time register, navigation beacons, and facsimile transmissions. This was in 1902. As we shall see, Tesla's massive contribution to radio is still largely unrecognized.

The Wardenclyffe tower's rugged wooden structure, designed by Stanford White, stood at 187 feet. It was topped by a mushroom-like terminal 68 feet in diameter. A separate brick building at the foot housed generating and other equipment. The entire project was to cover 200 acres and include housing for 2,000 employees of the facility. Tesla estimated that the tower would emit a wave complex of a total maximum activity of 10 million horsepower. The top of the tower was outfitted with a platform that may have been intended to accommodate powerful ultraviolet lamps, which Tesla could have used for an experimental beam system of electric power transmission that was on his mind. The tower structure and building beneath were

built and partially equipped, but they never saw operation.

From: **A MUSEUM AT WARDENCLYFFE - THE CREATION OF A MONUMENT TO NIKOLA TESLA**

The year was 1900 and following 9 productive months of wireless propagation research in Colorado, Nikola Tesla was anxious to put a mass of new found knowledge to work. His vision focused on the development of a prototype wireless communications station and research facility and he needed a site on which to build. In 1901 he cast his eyes some 60 miles eastward to the north shore village of Woodville Landing. Only six years before the north branch of the Long Island Railroad had opened, reducing travel time to the locality from a horse drawn five hours to less than two. Seeing an opportunity in land development a western lawyer and banker by the name of James S. Warden had purchased 1400 acres in the area and started building an exclusive summer resort community known as Wardenclyffe-On-Sound. With an opportunity for further development in mind, Warden offered Tesla a 200 acre section of this parcel lying directly to the south of the newly laid track. It was anticipated that implementation of Tesla's system would eventually lead to the establishment of a "Radio City" to house the thousands of employees needed for operation of the facility. The proximity to Manhattan and the fairly short travel time between the two, along with the site's closeness to a railway line must surely have been attractive features and Tesla accepted the offer.

The Wardenclyffe World Wireless facility as envisioned by Tesla was to have been quite different from present day radio broadcasting stations. While there was to be a great similarity in the apparatus employed, the method in which it was to be utilized would have been radically different. Conventional transmitters are designed so as to maximize the amount of power radiated from the antenna structure. Such equipment must process tremendous amounts of power in order to counteract the loss in field strength encountered as the signal radiates out from its point of origin. The transmitter at Wardenclyffe was being configured so as to minimize the radiated power. The energy of Tesla's steam driven Westinghouse 200 kW alternator was to be channeled instead into an extensive underground radial structure of iron pipe installed 120 feet beneath the tower's base. This was to be accomplished by superposing a low frequency baseband signal on the higher frequency signal coursing through the transmitter's helical resonator. The low frequency current in the presence of an enveloping corona-induced plasma of free charge carriers would have pumped the earth's charge. It is believed the resulting ground current and its associated wave complex would have allowed the propagation of wireless transmissions to any distance on the earth's surface with as little as 5% loss due to radiation. The terrestrial transmission line modes so excited would have supported a system with the following technical capabilities:

1. Establishment of a multi-channel global broadcasting system with programming including news, music, etc;
2. Interconnection of the world's telephone and telegraph exchanges, and stock tickers;
3. Transmission of written and printed matter, and data;
4. World wide reproduction of photographic images;
5. Establishment of a universal marine navigation and location system, including a means for the synchronization of precision timepieces;
6. Establishment of secure wireless communications services.

The plan was to build the first of many installations to be located near major population centers around the world. If the program had moved forward without interruption, the Long Island prototype would have been followed by additional units the first of which being built somewhere along the coast of England. By the Summer of 1902 Tesla had shifted his laboratory operations from the Houston Street Laboratory to the rural Long Island setting and work began in earnest on development of the station and furthering of the propagation research. Construction had been made possible largely through the backing of financier J. Pierpont Morgan who had offered Tesla $150,000 towards the end of 1900. By July 1904, however, this support had run out and with a subsequent major down turn in the financial markets Tesla was compelled to pursue alternative methods of financing. With funds raised through an unrecorded mortgage against the property, additional

venture capital, and the sale of X-ray tube power supplies to the medical profession he was able to make ends meet for another couple of years. In spite of valiant efforts to maintain the operation, income dwindled and his employees were eventually dropped from the payroll. Still, Tesla was certain that his wireless system would yield handsome rewards if it could only be set into operation and so the work continued as he was able. A second mortgage in 1908 acquired again from the Waldorf-Astoria proprietor George C. Boldt allowed some additional bills to be paid, but debt continued to mount and between 1912 and 1915 Tesla's financial condition disintegrated. The loss of ability to make additional payments was accompanied by the collapse of his plan for high capacity trans-Atlantic wireless communications. The property was foreclosed, Nikola Tesla honored the agreement with his debtor and title on the property was signed over to Mr. Boldt. The plant's abandonment sometime around 1911-1912 followed by demolition and salvaging of the tower in 1917 essentially brought an end to this era. Tesla's April 20, 1922 loss on appeal of the judgment completely closed the door to any further chance of his developing the site.

Tesla; the Father of Radio?

As we have seen, Tesla's earliest oscillators were dynamos, but, having determined that he could not reach the higher frequencies by this means, he went on to develop the spark gap oscillator, the Tesla coil, and the magnifying transmitter. But did any of these devices become the first to be used for overseas radio transmission? No, ironically, the first commercial overseas transmitter was a 21.8 kilocycle GE Alexanderson alternator operated by RCA, a design evolved straight out of Tesla's early dynamos. Such was Tesla's luck in radio.

Official histories often credit Tesla with the poly phase system and either ignore his later inventions altogether or dismiss them as the work of. a crackpot. But among those who have published honest research on the subject, there is one hundred percent consensus that Tesla was cheated out of his rightful place in history, particularly his status as the leading inventor of radio technology.

Radio simplified

Early radio devices are fascinating and worthy of study if only because they remind us that powerful radio technologies can be so simple and accessible to anyone, the present-day micro complexity notwithstanding. As we have seen, the earliest transmitters in wide use by amateurs were not alternators but spark-gap oscillators. To get on the air all you needed was a battery, a telegraph key, an induction coil, a spark gap, a length of wire as an antenna, and a ground. Of course, the addition of a capacitor juiced it up considerably.

The very earliest experiments in radio receiving used spark gaps as receivers. When you saw an arc across the gap, this was the detection of a disturbance in the medium. This evolved into a detector called a coherer. This is just a horizontal glass tube loosely filled with metal chips (iron, nickel). It is placed in series with a battery and a telegraph sounder, and one side of the coherer goes to the antenna, the other to ground.

The coherer is a switch (a semiconductor, really) that conducts when there is a disturbance of the medium. The more easily conducted radio-frequency energy triggers conduction of this almost conductive material. To get the coherer back to a non conducting state requires a tap that can be accomplished manually or by mechanical linkage to the telegraph sounder. Tesla comes into the technology about here. He improves the coherer by putting it into continual rotation (rotating coherer) so it didn't need a tap to reset.

Tuned radio

The spark gap transmitter was indiscriminate as to the frequency of the disturbance. It put out a dirty complex of frequencies consisting of a rough fundamental determined by width of gap, together with parasitic

oscillations, harmonics splatter what-have-you. The coherer was set off by any disturbance. In Colorado Springs, Tesla used a rotating coherer to track electrical storms. The celebrated Marconi units employed nothing more evolved than this crash method of signaling.

So why is Marconi so famous? It is because, like Edison and Westinghouse, he built up an industry around the invention and made himself famous in the course of promoting his enterprise. Marconi's company was ultimately incorporated into RCA (now incorporated into General Electric). It owed much of its technological development to ideas lifted from the likes of Tesla. Tesla's contribution was nothing less than selective tuning. He set forth the principle of resonantly tuned circuits in his Tesla coil patent of 1896, and the principles of transmitter-receiver tuned circuits a year later in his wireless power patent.

The Tesla coil is a powerful and simple radio transmitter. If the primary circuit is smoothly vibrating well above the audio range, its signal can even be modulated for voice transmission by varying some circuit element.

Tesla's few published notes on modulation describe crude ways of varying spark gaps, but, conceivably, an inductance core mechanically linked to a loudspeaker transducer might modulate the signal with some fidelity. Tesla and his supporters waged a fight for recognition of Tesla as the founder of radio. The struggle was finally won in the Supreme Court, but this did not happen until shortly after Tesla's death.

Tesla vs. Hertz

Tesla was not a theoretician by calling, but he made plenty of observations on the electrical nature of the universe that put him at odds with of official theory. In fashion then (and even now) was the theory of Heinrich Hertz, an interpreter of the physics of James Maxwell. Hertz explained radio propagation as transverse waves akin to light. Tesla was convinced that radio disturbances were standing waves in the ether akin to sound. When you drop a pebble into water, the disturbances you see in the form of concentric circles are standing waves.

Both Tesla and Hertz assumed the existence of an aetheric medium, but differed as to its energy transmitting properties. Tesla believed that the ether was a gas like medium, that electric propagation was very much like that of sounds in air, alternate compression's and rarefaction's of the medium, and that Hertzian waves could only take place in a solid medium. Tesla once said that Hertz waves are radiation and that no energy could be economically transmitted to a distance by any such agency. He said, In my system, the process is one of true conduction which can be effected at the greatest distance without appreciable loss.

When quantum physics and particle theory came into vogue, the aetheric medium was dropped out of electric theory altogether, but Hertz's theory was more compatible with the new concepts of propagation and therefore survived. By way of rubbing this in, the unit of frequency, formerly cycles per second (cps), was renamed in honor of Hertz (Hz), while only an obscure unit of magnetic flux density remembers Tesla. It is in respect to Tesla that I have reverted to the old unit in this book. Hertzian radio is straight-line, light-like radiation's that bounce off hills and mountains. Long distance Hertzian transmissions are explained in terms of radiation's bouncing off a radio reflective upper layer called the ionosphere. Tesla thought this was all nonsense and declared in 1919 that Hertzian thinking has stifled creative effort in the wireless art and retarded it for 25 years. Hertzian radio is aerial.

Most of us are conditioned to thinking in terms of aerial radio; the air waves, on the air. Tesla's radio is grounded; the lower end of the energized coil is rooted in the earth. Pure Hertzian radio has no such natural load. Tesla doesn't speak of antennas as such; the element he places aloft is an elevated capacity. Tesla said radio devices should be designed with due regard to the physical properties of this planet and the electrical conditions obtaining in same. Grounded radio is indeed more powerful than the Hertzian aerial. But this is true particularly for the frequencies Tesla was using. The higher frequencies do behave in a Hertzian manner. Yet grounding is all but a lost concept in consumer electronics. Up through the 1940's, AM radio receivers customarily had a terminal one was encouraged to connect to a cold water pipe or other deep earth

connection. Ground the chassis of any of today's receivers, and, unless there is some kind of interference coming up through the ground (from fluorescent circuits, light dimmers, which are oscillators, or from the local Tesla coil), you will usually improve signal strength and range.

Among Tesla's contributions to radio was remote control. Tesla demonstrated a radio-controlled boat before crowds at Madison Square Gardens and sent another robot craft 25 miles up the Hudson River. Grounded radio works particularly well through water. Tesla's basic radio tuning tank circuit for receiving (coil plus capacitor between antenna and ground) was, and is, all by itself, a powerful signal amplifier, and a beautifully simple one, at that. But as radio developed over the years, the tank circuit shrank in size and the result was a loss in gain. This was compensated for by the addition of stage upon stage of complex amplification circuitry.

Tesla watched this development with bewilderment. Tesla knew that the most efficient long-distance radio took place in the lower frequencies, especially those close to the earth-resonant frequency. Frequencies well below the AM broadcast band were the favored ham frequencies in the early days prior to World War I. In fact, waves of 600 meters (500 kc) were considered short while considered fairly long were the waves of 1200 meters (25 kc). Like a lot of good real estate, many of these more radio-effective frequencies below the AM broadcast band have been appropriated for military use, but also for navigation beacons, weather stations, and time registers.

Underground radio

The mind conditioned by Hertzian aerial radio concepts has trouble grasping the idea that signaling can take place without any above-surface antenna, totally through the ground. James Harris Rogers, taking a cue from Tesla, circa World War I, built a radio system in which both sending and receiving antennas were sunk completely into the ground or submerged in bodies of water. He found this system far more effective and far less vulnerable to interference than any aerial radio Signal strength has been said to be 5,000 times stronger

The military is on to this, as evidenced in the Navy's ELF and by a U. S. Air Force project underway called Ground Wave Emergency Network. GWEN is a low-frequency communications system designed for used during a nuclear war. The network will have a cross-continent series of 600-foot diameter underground copper screens connected to 300-foot towers reminiscent of Tesla's Wardenclyffe.

Among the advantages of the system is its invulnerability to the effects of the electric pulse sent out by nuclear blasts. Such a pulse fries at one stroke any and all solid-state electronics within its extensive range. (Strong electric vibrations from a Tesla coil or magnifying transmitter have a similar effect on solid state and will scramble or disable such circuitry temporarily or even dud it permanently.) It's revealing that for last-ditch doomsday communications, the government reverts to Tesla's grounded radio.

J. P. Morgan sinks Tesla

Tesla's ambitious World System came to an end when its principal financier, J. P. Morgan pulled the plug on funding. Morgan, the financial giant behind the formation of many monopolies in railroads, shipping, steel, banking, etc., was a major conduit of European capital into U. S. industrial development in the Robber Baron era. He looms large in Tesla's life. Morgan money was in the Niagara Falls project. He backed Edison, too. It was Morgan's pressure on Westinghouse, whom he also financed, that caused the cancellation of Tesla's dollar-a-horsepower contract and the loss of millions in royalties to Tesla for his poly phase.

When Tesla's lab burned down (arson was suspected), one of Morgan's men promptly arrived with aid, as well as with the offer of a partnership with Morgan interests. Acceptance would have put Tesla firmly under Morgan's control. Tesla refused. And Tesla succeeded in preserving his autonomy until he became possessed with overwhelming ardor to fulfill the dream of his World system. Tesla was ready to sell his soul to finance Wardenclyffe, and J. P. Morgan was right there to buy it.

In 1901, Tesla signed over to Morgan controlling interest in the patents he still owned, as well as all future ones, in lighting and radio. Morgan then put about $150,000 startup funding into Wardenclyffe. Later he invested more, just enough to bring the project within sight of completion. Morgan then became elusive. Tesla tried desperately to communicate with the investor, but to no avail. When word was out on Wall Street that Morgan had withdrawn support, no one would touch the project. This finished Tesla as a functioning inventor. Work on the Wardenclyffe tower came to a halt. Left to dereliction, the tower remained only as a curiosity to passersby. During World War I, the tower was unceremoniously dynamited to the ground.

6. Lighting

In 1891 Tesla said that existing methods of lighting were very wasteful, that some better methods must be invented, some more perfect apparatus devised. Tesla went and did just that. Yet, here we are today, in a world lit predominantly by the same Edison bulb! Edison's bulb burns with six percent efficiency, the rest going off as heat, while the high resistance filament cooks at 4,000 degrees and eventually breaks without warning. Today's fluorescent tube, though inspired by Tesla, is no model of efficiency either.

Its inner surfaces are stimulated to phosphorescence by energy-consuming filament-like cathodes that also burn out, and the lit-up tube would present a dead short to the current if it were not for the so-called ballast transformer, an inductance placed in the circuit to oppose and thus eat up yet more current. What sent Tesla into an exploration of high frequency phenomena was his conviction that these rapid vibrations held the key to a superior mode of lighting. The explorations were not Tesla's first venture into lighting. His very first U. S. patent (1885) is for an improvement in the arc lamp. He used an electromagnet to feed carbons to the arc at a uniform rate to produce a steadier light (No. 335,785).

Early arc lamps produced a brilliant blue-white light, good for street lighting but not for the home, and they emitted noxious fumes. Home lighting was by gas. Street arc lighting used series circuits. Edison introduced the parallel circuit, and designed his lamp for such a circuit. Edison introduced the big scale production and sale of electric power itself on the model of gas lighting, a major industry at the time. He wanted to be first in the business and announced to the press that he had an operable bulb before he actually had a bulb that worked. When Tesla's a.c. system was established, it was grafted on to Edison's, greatly extending its range and efficiency. But, essentially, it was still Edison's parallel circuit, high consumption, incandescent lighting system, and this is what we have to live with today.

A better way

Tesla patented both his spark-gap oscillator and his Tesla coil specifically as power sources for a new lighting system that used currents of high frequency and high potential. Lest you get the impression that a lone genius named Tesla invented this new form of lighting out of the blue, you should know that others before him had used high frequencies to stimulate light, and others, like Sir William Crookes, had done the same with high potentials, but Tesla was the first on record to put the two together.

In Jules Verne's 1872 novel A Journey to the Center of the Earth, the narrator tells of a brilliant portable battery lamp used by the underground explorers. The device was powered by a Ruhmkorf coil; a high voltage buzzer-type induction coil (step-up transformer) popular among early electrical experimenters. The Ruhmkorf coil stimulated a lamp (type unspecified but probably a gas tube), which produced the light of an artificial day. The lamp had such a low current draw that the battery lasted throughout the subterranean adventure. Verne evidently was drawing, at least in part, on experimental knowledge of his day for what he calls this ingenious application of electricity to practical purposes.

Perhaps somebody should reinvent such a high potential lamp to replace today's flashlight, which seems to exist for the purpose of enriching the Eveready division of Union Carbide. Modern neon lighting is high potential at 2,000 to 15,000 volts. (Neon sign transformers are good for powering tesla coils, but a low-

frequency, high voltage device: caution.) Neon, as well as its cousin, 7,500-volt cold cathode (filament's) fluorescent, which is used in some industrial lighting, is as close as we get to Tesla lighting today.

Circa 1900, Tesla experimented with luminous tubes bent into alphabetic characters and other shapes. Although today's neon is simplistic Tesla, being driven by 60-cycle high-voltage transformer power alone without the benefits of high-frequency excitation, it should suggest to us the amazing efficiency of high-potential lighting, since a single 15,000-volt neon transformer drawing only 230 watts can light up a tube extending up to 120 feet. How superior is the economy of Tesla high potential, high frequency lighting over Edison incandescent? Tesla says certainly 20 times, if not more light is obtained for the same expenditure of energy.

"Pure" light

Tesla invented a variety of lamps, not all of which show up in his patents. He lit up solid bodies like carbon rods in vacuum bulbs, or in bulbs containing various inert gases at low pressure (rarefied). He noted that tubes devoid of any electrodes may be used, and there is no difficulty in producing by their means light to read by. But he noted that the effect is considerably increased by the use of phosphorescent bodies, such as yttrium, uranium glass, etc. Here Tesla lays the foundation for fluorescent lighting. Applied to such lamps were currents at potentials ranging from a lower limit of 20,000 volts up to voltages in the millions and vibrations of 15,000 cycles per second and up.

Tesla dreamed of creating what he called pure light or cold light by generating electric vibrations at frequencies that equaled those of visible light itself. Light produced by this direct and efficient means would require vibrations of 350 to 750 billion cycles, but Tesla believed such oscillations, far above those attainable by his coils, would someday be achieved. Even so, his rarefied gas-tube lamps produced a light that more closely approximated natural daylight than any other artificial source Tesla's light is like the full-spectrum light that is coming to be recognized as far more healthful than Edison incandescent and particularly more healthful than conventional fluorescent. Full-spectrum lighting is believed by some health practitioners actually to have healing properties.

No sudden burnout

Tesla's gas tube lamps burn indefinitely, as do today's neon tubes, for there is nothing within to be consumed. Tesla's lamps that contain electrodes like carbon rods, however, do undergo some deterioration. In Tesla's words, a very slow destruction and gradual diminution in size always occurs, as in incandescent filaments; but there is no possibility of sudden and premature disabling which occurs in the latter by the breaking of the filament, especially when incandescent bodies are in the shape of blocks. In vacuum lamps, the life of the bulb depends upon the degree of exhaustion, which can never be made perfect. Also, the higher the frequency applied to such a lamp the slower the deterioration. Electrodes glow at high temperatures, and this raises the problem of how to conduct energy to them since wires or other metallic elements will melt. The problem must be addressed in lamp design. For example, in the incandescent lamp shown at the opening of this chapter, the lead-in wires connect to the hot electrodes via bronze powder contained in a refractory cup. Tesla may have designed his capacitor-base bulbs to help address this same problem.

High heat

Tesla's search for the ideal electrode is reminiscent of Edison's search for the long lasting filament: The production of a small electrode capable of withstanding enormous temperatures, said Tesla, ìI regard as the greatest importance in the manufacture of light. One of the electrodes he tried was a small button of carbon, which he placed in a near vacuum. Tesla regarded the high incandescence of the button to be a necessary evil. For lighting purposes, it was the incandescence of the gas remaining in the mostly evacuated chamber that was important. But the carbon-button lamp proved to have some remarkable properties beyond its use for illumination. When the voltage was turned up, the lamp produced such tremendous heat that the carbon button

rapidly vaporized. Tesla experimented extensively with this fascinating phenomenon. For the button of carbon he substituted zirconium, the most refractory substance available at the time. It fused instantly. Even rubies vaporized. Diamonds, and, to a greater degree, carborundum, endured the best, but these could also be vaporized at high potentials.

Tesla worked on the problem of heating. I have read that he contributed to the development of a high-frequency induction heating. Did Tesla work on the problem of space heating? Certainly the huge current draw of conventional electric heaters, which use resistive elements, argues for some inventiveness in this area. Tesla did observe that the discharges from a tesla coil resembled flames escaping under pressure and were indeed hot. He reflected that a similar process must take place in the ordinary flame, that this might be an electric phenomenon. He said that electric discharges might be a possible way of producing by other than chemical means a veritable flame which would give light and heat without material consumed. The behavior of the carbon-button lamp suggests that a new heating mode might be found in the effects of high-frequency currents in a vacuum.

Lighting up the sky

Hold a fluorescent tube near a Tesla coil and it will light up in your hand. This is true of any tube or bulb with vacuum or rarefied gas. A more efficient way is to ground one end of the tube and put a length of wire as a sort of antenna on the other. Better yet, put a coil of wire that resonates with the secondary in series with the tube and ground and you have the optimal wireless power arrangement.

Tesla conducted many experiments with different arrangements like this, using on some occasions the widely available Edison filament incandescent, which lighted up more brilliantly than usual because of the effects of high frequencies on the bulbs rarefied interior. Inside his New York lab Tesla strung a wire connected to a tesla coil around the perimeter of the room. Wherever he needed light he hung a gas tube in the vicinity of this high frequency conductor.

Tesla had a bold fantasy whereby he would use the principle of rarefied gas luminescence to light up the sky at night. High frequency electric energy would be transmitted, perhaps by an ionizing beam of ultraviolet radiation, into the upper atmosphere, where gases are at relatively low pressure, so that this layer would behave like a luminous tube. Sky lighting, he said, would reduce the need for street lighting, and facilitate the movement of ocean going vessels. The aurora borealis is an electrical phenomenon that works on this principle, the effects of cosmic eruptions such as those from the sun being the source of electric stimulation. I, for one, am grateful that this particular Tesla fantasy never materialized since it is difficult enough to see the stars with existing light pollution, and there might be undesirable biological impacts as well.

Rotating brush

Tesla took an evacuated incandescent type lamp globe, suspended within it at dead center a conductive element, stimulated that element with high voltage currents from an induction coil, and thus created a beam-like emanation, a brush discharge that was so eerily sensitive to disturbances in its environs that it seemed to be endowed with an intelligent life of its own. The device works best if there is no lead-in wire. In the bulb shown, every measure has been taken to construct it so it is free from its own electrical influence. The bulb could be stimulated inductively by applying energy to metal foil wrapped around its neck. Thus excited, an intense phosphorescence then spreads at first over the globe, but soon gives place to a white misty light, observes Tesla. The glow then resolves into a directional brush or beam that will spin around the central element. So responsive is it to any electrostatic or magnetic changes in its vicinity that the approach of an observer at a few paces from the bulb will cause the brush to fly to the opposite side. A small, inch-wide permanent magnet will affect it visibly at a distance of two meters, slowing down or accelerating the rotation according to how it is held relatively to the brush.

Tesla never patented the rotating brush or used it in any practical application, but he believed it could have

practical applications. He saw one use in radio where the device could conceivably be adapted to being a most sensitive detector of disturbances in the medium. The rotating brush appears to be a precursor of the plasma globe toys now in fashion; these are sometimes called Tesla globes. Tesla's new lighting was famous in its time. Tesla, the promoter, saw to it. He conducted demonstrations at lectures before the electric industry associations, before large audiences in rented halls, and before select groups of influential New Yorkers in his Manhattan lab.

His articles about the new lighting were published in the popular scientific press and it was reported in the newspapers. Still, it did not catch on with the powers-that-be who no doubt saw in it Tesla's perennial pile-of scrap problem. But, I wonder, would the whole electric distribution system have to be scrapped to implement the efficiencies of Tesla lighting? Conceivably, the new lighting could be run off of local oscillators at the consumer end, the old power distribution system remaining intact. This is still a possibility, as it has been for about one hundred years.

7. Transportation

Tesla speculated, that, perhaps the most valuable application of wireless energy, will be the propulsion of the flying machine, which will carry no fuel and be free from any limitations of the present airplanes and dirigibles. The possibility of electric flight intrigued Tesla, though he never did patent an electric aircraft. But he did patent an electric railway using his high frequency, high-potential electricity in a by-wire mode, and also patented a radical aircraft that, while not electric, did have an advanced power plant: his disk turbine. Tesla's railway and aircraft can be numbered among the lost inventions. The closest transport technology has come to putting any of Tesla into actual practice is with diesel-electric power using Tesla poly phase motors, an early and notable example of which was the ocean liner Normandy. In the field of transport, Tesla is more commonly identified with antigravity flight and UFOs. Although this identification is based upon nothing more than a few public utterances, his suggestions charge the imagination with possibilities.

High-frequency railway

Tesla's high-frequency, high-potential railway picks up its power inductively without the use of the rolling or sliding contacts used in conventional trolley or third-rail systems. A pickup bar travels near a cable carrying the oscillating energy. This cable, which Tesla specifically invented to carry such currents, is the precursor of the grounded shielded cable used today to carry TV and other high-frequency signals. But unlike today's cables, which carry energy only of signal strength and shield by means of a continuous grounded static screen of fine braided copper wire, Tesla's high voltage cable uses metal pipe or screen that is broken up into short lengths, very much shorter, says Tesla in his patent, than the wave lengths of the current used. This feature reduces loss. Since the shielding must not be interrupted, the short sections are made to overlap but are insulated from one another. To further reduce loss to ground, an inductance of high ohmic resistance or a small capacity is placed in the ground line.

Motor mystery

A conundrum raised by Tesla's railway patent is that the vehicle is powered by an electric motor, but nowhere among Tesla's inventions is to be found an electric motor that runs off of high-frequency currents. Was Tesla planning to use a lower frequency here, something under 1,000 cycles? Did he have a converter in mind that could bring the frequency down? Or did Tesla invent a high-frequency motor that never made it into patent, an invention that may be among his unpublished notes? Anyway, Tesla proceeds in many of his discussions of high-frequency power as if this problem were solved. I've seen references post-Tesla to the existence of such a motor. Free-energy inventor, Hermann Plauson, (next chapter) refers to high-frequency motors. These motors have magnetic cores made of very thin laminations insulated from each other, a design that would limit damping effects.

Turbine aircraft

Tesla's only patented aircraft is a vertical takeoff and landing (VTOL) plane that he intended as an improvement upon the helicopter, already invented at this time (1921): The helicopter type of flying machine, especially with large inclination angle of the propeller axis to the horizontal, at which it is generally expected to operate, is quite unsuitable for speedy aerial transport; it is incapable of proceeding horizontally along a straight line under prevailing air conditions; it is subject to dangerous plunges and oscillations ... and it is almost certainly doomed to destruction in case the motive power gives out. Advances in helicopter design may have mitigated some of these problems, but at least the last one still holds true: Tesla's craft, which has a large wing area, is powered by two disk turbines, rotating in opposite directions. The engineering problem of swinging the pilot and passengers around 90 degrees after takeoff, is solved at least to Tesla's satisfaction. There have been some experimental VTOL's but nothing in production.

Electric flight

Tesla's dream electric aircraft would be powered by means of magnifying transmitters: Aerial machines will be propelled around the earth without a stop. Also, in 1900, he predicted a cold coal battery with such output that a practical flying machine would be possible. Such a battery also would enormously enhance the introduction of the automobile. Tesla fantasized a personal aerial taxi which could be folded into a six-foot cube, and would weigh under 250 lb.: It can be run through the streets and put in a garage, if desired, just like an automobile.

Explaining how his earth-resonant wireless-power system could energize vehicles aloft, he said, power can be readily supplied without ground connection, for, although the flow is confined to earth, an electromagnetic field is created in the atmosphere surrounding it. Tesla believed such a system to be the ultimate method of man-made flight: With an industrial plant of great capacity, sufficient power can be derived in this manner to propel any kind of aerial machine. This I have always considered the best and permanent solution to the problems of flight. No fuel of any kind will be required as the propulsion will be accomplished by light electric motors operated at great speed.

Antigravity

Tesla wrote in 1900 of an antigravity motor: Imagine a disk of some homogeneous material turned perfectly true and arranged to turn in friction less bearings on a horizontal shaft above the ground. Now, it is possible that we may learn how to make such a disk rotate continuously and perform work by the force of gravity. To do so, he said, we have only to invent a screen against this force. By such a screen we could prevent this force from acting on one-half of the disk, and rotation of the latter would follow.

Does it not follow then, that such a gravity screen could also be used to levitate a vehicle? Tesla held no patent on such a device or on any other antigravity device, and there are no published notes on experimentation in the area. Nevertheless, Tesla inevitably pops up in the literature of antigravity and UFOs. This may be because Tesla was a prominent exponent of a physics in which antigravity seems more feasible because gravity is better explained.

A researcher-theorist of today, Thomas Bearden, allows for gravity control in the physics he calls the new Tesla electromagnetic. Scalar (standing) waves in time itself can be produced electrically and this becomes a magic tool capable of directly affecting and altering anything that exists in time, including gravitational fields, says Bearden. In 1931 the editor of Science And Mechanics, Hugo Gernsback reported, It is believed by many scientists today that the force of gravitation is merely another manifestation of electromagnetic waves. Edward Farrow, a New York inventor, reported in 1911 an antigravity effect produced by a ring of spark gaps. When the gaps were fired, the device, called a condensing dynamo, lost one-sixth of its weight. T. Henry Moray wrote, Frequencies may be developed which will balance the force of gravity to a point of neutralization. Antigravity researcher Richard Lefors Clark places the frequency of gravity's vibrations right at Nature's neutral center in the radiant energy spectrum, above radar and below infrared, at $l0^{12}$ cycles per second.

8. Free-Energy Receiver

For starters, think of this as a solar-electric panel. Tesla's invention is very different, but the closest thing to it in conventional technology is in photovoltaic. One radical difference is that conventional solar-electric panels consist of a substrate coated with crystalline silicon; the latest use amorphous silicon. Conventional solar panels are expensive, and, whatever the coating, they are manufactured by esoteric processes. But Tesla's solar panel is just a shiny metal plate with a transparent coating of some insulating material, which today could be a spray plastic. Stick one of these antenna-like panels up in the air, the higher the better, and wire it to one side of a capacitor, the other going to a good earth ground. Now the energy from the sun is charging that capacitor. Connect across the capacitor some sort of switching device so that it can be discharged arrhythmic intervals, and you have an electric output. Tesla's patent is telling us that it is that simple to get electric energy. The bigger the area of the insulated plate, the more energy you get. But this is more than a solar panel because it does not necessarily need sunshine to operate. It also produces power at night Of course; this is impossible according to official science.

For this reason, you could not get a patent on such an invention today. Many an inventor has learned this the hard way. Tesla had his problems with the patent examiners, but today's free-energy inventor has it much tougher. Tesla's free-energy receiver was patented in 1901 as An Apparatus for the Utilization of Radiant Energy. The patent refers to the sun, as well as other sources of radiant energy, like cosmic rays. That the device works at night is explained in terms of the nighttime availability of cosmic rays.

Tesla also refers to the ground as a vast reservoir of negative electricity. Tesla was fascinated by radiant energy and its free-energy possibilities. He called the Crooke's radiometer (a device which has vanes that spin in a vacuum when exposed to radiant energy) a beautiful invention. He believed that it would become possible to harness energy directly by connecting to the very wheelwork of nature. His free-energy receiver is as close as he ever came to such a device in his patented work. But on his 76th birthday at the ritual press conference, Tesla (who was without the financial wherewithal to patent but went on inventing in his head) announced a cosmic-ray motor. When asked if it was more powerful than the Crooke's radiometer, he answered, thousands of times more powerful.

how it works

From the electric potential that exists between the elevated plate (plus) and the ground (minus), energy builds in the capacitor, and, after a suitable time interval, the accumulated energy will manifest itself in a powerful discharge which can do work. The capacitor, says Tesla should be of considerable electrostatic capacity and its dielectric made of the best quality mica, for it has to with stand potentials that could rupture a weaker dielectric.

Tesla gives various options for the switching device. One is a rotary switch that resembles a Tesla circuit controller. Another is an electrostatic device consisting of two very light, membranous conductors suspended in a vacuum. These sense the energy buildup in the capacitor, one going positive, the other negative, and, at a certain charge level, are attracted, touch, and thus fire the capacitor. Tesla also mentions another switching device consisting of a minute air gap or weak dielectric film, which breaks down suddenly when a certain potential is reached. The above is about all the technical detail you get in the patent.

Plauson's converter

Tesla's invention may have helped to inspire the many other inventors who have worked in the field of free energy. At least a dozen are on record. Let's look at one in particular. In 1921 Hermann Plauson, a German experimenter, succeeded in obtaining patents, including one in the U. S., for Conversion of Atmospheric Electric Energy. In school, every introduction to electricity touches on the phenomenon of so-called static (or electrostatic) electricity, and this is what Plauson means by atmospheric. Static electricity is built-up charge,

electricity in a raw state, and it comes easy in Nature, as evidenced by lightning and the aurora borealis.

If you have ever seen a frictional static machine in operation, it's not difficult to imagine the tremendous potential in artificially produced static. A rotating disk type of static machine or the silk belt type, as in the Van de Graff generator, produces discharges like those from a tesla coil. Unfortunately, in school, the subject of static electricity is briefly touched upon and then abruptly dropped, never to be mentioned again. Electrical power sources thereafter are limited to the battery or the wall socket.

How it works

In the Plauson drawing the free energy converter on the left interfaces with a disk type static machine via special pick up combs. When the static collecting disk is rotated, the combs pick up the charge, one comb going positive, and the other negative. The combs, in turn, charge up their respective capacitors until sufficiently high potential builds to jump the spark gap. The oscillatory discharge is induced into the transformer primary. This is high-voltage, high frequency electric energy. The familiar spark-gap oscillator has turned charge into dynamic energy.

The transformer steps down the vibrating high voltage to practical levels to power lighting, heating, and special high-frequency motors. The Plauson patent drawing shows a device that works on the same principle but collects energy by means of an antenna, as does Tesla's receiver. Since the higher the antenna the better, and the more area the better, Plauson favors big metallic helium balloons. Plauson says the safety gap, which has three times the resistance of the working gap, is absolutely necessary for collecting large quantities of charge. The capacitors across the gaps in the series safety gap allow for uniform sparking. Plauson's device suggests that Tesla's might be explained in terms of electrostatics.

Tesla, at the press conference honoring his 77th birthday in 1933 declared that electric power was everywhere present in unlimited quantities and could drive the worlds machinery without the need of coal, oil, gas, or any other fuels. A reporter asked if the sudden introduction of his principle wouldn't upset the present economic system...

Tesla replied, "It is badly upset already."

END

tesla technology, today

International Turbine & Power, LLC

Bladeless Disk, Vortex & Implosion Technologies

Welcome to the most exciting part of this website. **International Turbine And Power**, a company that was founded by a young and energetic engineer and scientist in 1999 - Frank Germano, had a dream...To paraphrase Nikola Tesla - ***"Suppose someone should discover a new mechanical principle...something as fundamental as James Watt's discovery of the expansive power of steam, by the use of which it became possible to build a motor that would give ten horse power for every pound of the engine's weight? A motor so simple that a novice in mechanics could construct it and so elemental that it could not possibly get out of repair. Then suppose that this motor could be run forward or backward at will, that it could be used as either an engine or a pump, that it cost almost nothing to build as compared with any other known form of engine, that it utilized a larger percentage of the available power than any existing machine, and, finally, that it would operate with gas, steam, compressed air or water, any one of them, as its driving power..."***

It does not take a mechanical expert to imagine the limitless possibilities of such an engine. It takes very little effort to conjure up a picture of a new world of industry and transportation made possible by the invention of such a device. "Revolutionary" seems a mild term to apply to it. That was quite the dream, Taking this as a starting point, we went on to design, build, and test this amazing engine. We are now ready to offer the Bladeless Boundary Disk Turbine and Pump to the world...(**BDT prototype engine, in CAD rendering, pictured to right - click to view larger image of picture.**)

"International Turbine And Power, LLC" is currently designing the next generation of powerful, efficient engines and pumping systems. We call this revolutionary engine, a "thermodynamic transformer," as this is a more proper name for the device. Our engine is based on the pioneering work of Nikola Tesla. His engine - the Tesla, Bladeless Boundary Disk Turbine - was originally developed in the early 1900's. These engines, powered by steam, or any combustible fuel, such as methane, natural gas, propane, gasoline, diesel, or hydrogen, or even flowing water from rivers or from an ocean's tides, offer an incredible advantage over "conventional" engines. They are fairly inexpensive, extremely efficient, require virtually no maintenance, and will run in environments where other engines, would, quite simply - fail.

This engine offers an incredible advancement over "conventional" units (Turbines, Diesel, Internal Combustion, etc.), in both efficiency, simplicity *and* economy. The Tesla Turbine and Tesla Pump function on the principles of adhesion and viscosity, or "boundary layer" drag. The Tesla Turbine itself, is a very simple device, consisting

of basically, a number of very thin disks, mounted on a shaft, with their centers cut out in sections...this assembly is then enclosed in an air tight case. Pure simplicity.

The turbine is powered by steam or combustion gas; virtually any combustible fuel will work. Tesla's steam turbine (an 18" diameter unit) was documented at achieving a 68% efficiency level, with an output of 330 HP. With a "multi - stage" turbine, Tesla hoped to achieve a 97% efficiency level, with an output of well over 1,000 HP. Tesla's only limiting factor was a shaft and case incapable of withstanding the forces. ***With our current modern technology, this is no longer an issue.***

Such a machine is a "thermodynamic transformer" of an activity surpassing, by far, that of any other prime mover, it being demonstrated in practice that each single disk of the rotor is capable of performing as much work as a whole bucket-wheel of a conventional turbine. Besides, a number of other advantages, equally important, make it especially adapted for operation as an internal combustion motor. With our patent pending **Thermodynamic Transformer (BDT TT)** engine design, as well as our patented Tesla/Schauberger type Pump system - our **"Centrifugal Molecular Pump"® (CMP)**, our newest line - the patent pending **"Centrifugal Molecular Turbine ®" (CMT)**, and our **"Fresh-Cool®" Air conditioning and Heat-Pump Systems**, and our revolutionary **"InVAID®" (Vortex Accelerated Implosion Drive), and "Mighty-tiny TT" Water Powered Systems**, we are in a position to offer ***GLOBAL*** energy solutions. All of our systems use environmentally sensible and sustainable technology. Our mission statement -

"Bringing fresh air and fresh ideas to a dying planet."

ITP is actively seeking investors and interested partners to join with us thus allowing the introduction of this amazing technology to the world. ITP will gladly provide business plans and detailed technology reports to all interested and *qualified* individuals or companies. Contact information is listed, below. Follow the link, below, for a listing of GI²'s full capabilities.

To view pictures and see engineering reports of our Tesla-type turbine - the BDT & CMP - use this link

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Click below for applications and systems offered by ITP

- **International Turbine And Power:**

Global Energy Solutions

"What Can ITP Do For You?"

Applications and Systems

- **The CMP and CMT systems explained**

"Just what is your new invention?" **I asked. *"I have accomplished what mechanical engineers have been dreaming about ever since the invention of steam power,"* replied Dr. Tesla. *"That is the perfect rotary engine..."* Nikola Tesla, 1911**

SUMMATION

As anyone who reads today's headlines, or watches a Television newscast , one does not need to look far to realize that our Nation is in an immediate energy crisis. This is not only happening in the United States, but appears World-Wide. We have relied on outdated forms of "prime movers" and inefficient forms of power generation and supply for nearly a century. The technology, in the form of the original Tesla Bladeless Boundary Disk Turbine, was applicable in Tesla's time...it is not only beneficial, but may be critical to implement this technology in OUR time!

Everyone hears the buzzwords - "decentralized power stations"...I do not have the space here to amplify on the exact definition, however, it is quite probably the most cost effective solution to our current electrical energy situation. Small, efficient "powerhouses-in-a-hat" (the term coined by the media of Tesla's day for the Tesla Turbine) will be employed in towns, communities, groups of houses, and around large cities, augmenting the current Utilities. We (ITP) are in the enviable position of being quite able to assist end consumers in this energy crisis.

ITP's BDT TT engine has a weight to output horse power ratio of up to an unbelievable 10 HP per pound. It has the ability to run on almost any fuel. It is incredibly compact and lightweight. Pollution output from the exhaust of even the propane version is FAR below that of even today's best standard engines. The system also lends itself in use as an "air to air" refrigeration system without the need for harmful Freon gasses. The engine, by its very nature of operation is perfectly suited to "Turbo/Electric" applications. The BDT-TT engine is unequaled in it's simplicity and output, far exceeding any other conventional engine to date.

Almost a quarter of the air pollution today comes from the coal being burned to generate electricity. Fuel consumption, resulting in air pollution and acid rain, could be significantly reduced simply by replacing the conventional blade steam turbines currently used by utilities with the Bladeless Tesla Steam Turbine (ITP BDT). This also would have the added bonus of drastically reducing maintenance. But the *real solution* lies in using low temperature wet steam occurring naturally from the ground in the form of **geothermal energy**. This energy would destroy a conventional bladed steam turbine, unless expensive steam drying is employed. **However, the Bladeless Tesla Steam Turbine (ITP BDT) requires no drying and can be connected directly to the geothermal source**.

It has been estimated that the geothermal potential in just Southern California *alone*, could power the entire North American Continent with NO POLLUTION! Add to this the large geothermal potential of Wyoming (think of the geysers in "Yellowstone National Park" - that's geothermal energy), Oregon, Washington, Idaho and Montana, and you will begin to get the picture of the enormous geothermal potential available in the Northwestern states alone. Large oil companies have comprehended the potential of geothermal energy and have purchased many of these large tracks of prime geothermal land. Due to the revolutionary concepts embodied in this engine, we can easily end the so called energy crisis and dramatically reduce pollution. Even the vested energy interests are beginning to understand that now is the time for change, realizing their future health and wealth is directly linked to that of the environment. Environmentally sensible usage of available resources - "some fresh air for a dying planet"; ITP's credo.

There are a number of individuals and young companies now interested in building and designing Tesla-type engines. Many have their own approaches to design. One thing to keep in mind is this: follow Tesla's designs first, and after achieving a working, efficient engine design, then begin modifying. Far too many builders have claimed that the Tesla Turbine is somehow "faulty," or flawed... however, upon examination, it is clear that it was the builders mistakes and/or changes that caused the failure of being unable to attain Tesla's amazing results. I began this venture with the premise that the Tesla design was absolutely correct, and that by following the patent information faithfully, we would end up with a working turbine. That has proved more than true. Industry will almost definitely be forced to look further at our engine, as it will soon present itself to be a "best available technology." When that day comes, as it certainly will, ***International Turbine And Power*** will be capable of implementing the engine into commercial use. Read an article appearing in the "Bulletin of the Atomic Scientists" featuring an interview with Frank Germano in late 2002.

PRODUCT AVAILABILITY

The BDT TT engine, pump, "InVaid", "Fresh-Cool", and CMP/CMT systems are in prototype stage, and are in "patent-pending" status. We have fully functional units which we will gladly demonstrate at our facilities in Austin, Texas. For a confidential demonstration of our technology, contact us at the address below.

Information On Prototypes and Special Requests: For a response, either on the dates of availability, the engines themselves, investment opportunities, or for companies and individuals interested in purchasing our engine, pump, or system packages in a PROTOTYPE stage immediately, please contact us by email, directly. We will respond to each email, based on priority, as quickly as possible. We can also evaluate any and all requests for installation of our technology in your present structures.

Standard Engineering Fee for consultation: **Mr. Frank Germano**, **Mr. Martin Dorantes**, and **Guy Letourneau, P.E.**, **& International Turbine And Power, LLC** ***charges a standard engineering fee*** **of $195.00 per hour** for answering requests and provides detailed reports on our technology to ***qualified*** individuals and investors. This fee is refundable if purchase of one of our products is made within 90 days of the request and the delivery of the requested unit. Contact one of us through email links below for a full description of the services offered. ITP can easily look at all commercial applications and review your presently installed systems and offer suggestions and/or improvements to the existing system. By incorporating our technology, a quite substantial improvement in efficiency as well as energy savings will almost definitely result.

Investor Information: **ITP** is a privately held company, as its corporate name - **International Turbine And Power, LLC** implies. Our main focus is in the Research and Development field. We welcome the opportunity to design and build fully operational Tesla-type turbines and pumps for other individual corporations and businesses. Investors are encouraged to contact us, directly.

We also can work in a joint-venture capacity, with certain contracts. Fully detailed business plans are available to qualified investors. When the turbine, pump, "Fresh-Cool", "Centrifugal Molecular Pump", "Centrifugal Molecular Turbine" and "InVAID" systems become commercially available, it is our firm belief that we can attain a massive market share and offer an extremely high return on invested dollars, in a very short timeframe. Note: the **BDT TT**, **CMP**, **CMT** and **InVaid** systems are patent pending. ***There is no other company that we are aware of that can offer this amazing technology.*** Contact us directly for a full disclosure.

***As stated in many different locations on this site and webpage, all of our units are in the prototype stage! Until qualified interested investors are located, and investment monies applied, commercial availability of these units is still some time distant. The cost for each of these units and systems is, therefore, based on applying our standard engineering fee ($195.00 per hour for design services) plus the individual cost of manufacture, shipping and installation. ** For qualified individuals and investors interested in making a commercial release feasible and profitable, please see below for further information.**

Components of the ITP CMT bladeless engine. 1.) Internal Components 2.) Internal Components 3.) Operational Engine 4.) Thumbnail view internal components (click for larger view) 5.) CMP - Centrifugal Molecular Pump (click for larger view). All images courtesy of "International Turbine And Power, LLC. Used by permission. Copyright© and Patent Protection apply. What you are looking at below is one of our BDT (bladeless disk turbines) both operational, and with its internal component structure. Pretty simple. The conical shaped unit is our (Patent pending) CMP - Centrifugal Molecular Pump, showing its internal components as well. ITP has done what most have felt was impossible - we have proved the validity of Tesla's claims about the bladeless disk, boundary layer turbine and pump. They are the most efficient, perfect rotary engines and pumps available today. Note:**You may not copy nor distribute images without permission from International Turbine And Power, LLC.** For the history of our bladeless disk turbine's development, use this

link - **Operational BDT units.**

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The "power" of ITP - documents our full capabilities.

International Turbine And Power, LLC - the ***official*** corporate website.

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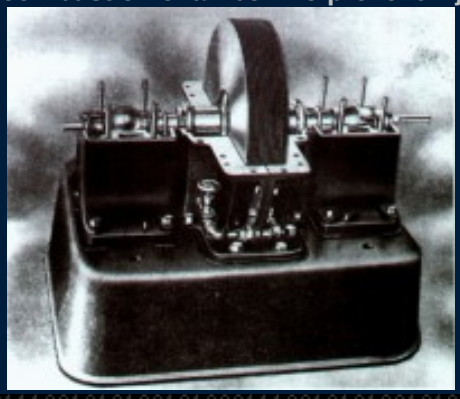
the TESLA TURBINE: Historical Perspective

"The Electrical Experimenter- The Tesla Gas Turbine"...July, 1920

"Dr. Nikola Tesla, whom the readers of this publication know very well and whose amazing work in the various scientific fields is also universally recognized, again comes in the limelight with a remarkable explosive gasoline turbine perfected by him recently which he describes in detail in a patent just granted. This remarkable turbine does away with all the troubles and complexity to the former attempted types. Stated briefly, the invention consists in the production of a peculiar shape conduit, thru which the gases are admitted into the turbine, and which has the singular property of permitting their passage in that direction only; in other words, uni-directionally. This device when used in conjunction with the bladeless turbine produces an engine which may be explosively operated by gasoline, alcohol, or other fuels and is absolutely devoid of all valves. It is the simplest internal combustion motor conceivable. Owing to the tremendous output of the turbine, one single disk being practically equivalent in performance to a whole bucket wheel, a very small machine of this kind is capable of developing an astonishing amount of power...

The upper part of the turbine casing has bolted to it a separate casting, the central cavity of which forms the combustion chamber. To prevent injury thru excessive heating, a water jacket may be used, of else water injection, or air cooling, this all the more readily as very high temperatures are practicable. The top of the casting is closed by a plate with a spark-plug inserted and in it's sides are screwed two of the valvular conduits communicating with the central chamber. One of these is , normally, open to the atmosphere while the other connects to the fuel source. The bottom of the chamber terminates in a suitable nozzle which consists of separate member of heat-resisting material. To regulate the influx of the explosive constituents and secure the proper mixture the air and gas conduits are equipped with regulating valves. The exhaust openings are in communication with a ventilator..."



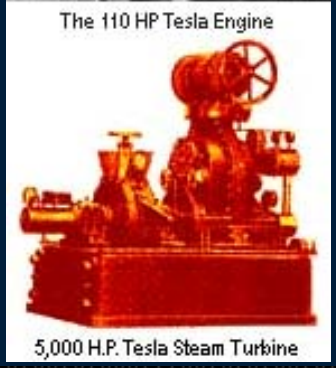
Quotes from Nikola Tesla, circa 1911...

"It is a radical departure in the sense that its success would mean the abandonment of the antiquated types of prime movers on which billions of dollars have been spent. Under such circumstances the progress must needs be slow and perhaps the greatest impediment is encountered in the prejudicial opinions created in the minds of experts by organized opposition."

"I have developed 110 horsepower with disks nine and three quarter inches in diameter and making a thickness of about two inches. Under proper conditions the performance might have been as much as 1,000 horsepower. In fact there is almost no limit to the mechanical performance of such a machine. This engine will work with gas, as in the usual type of explosion engine used in automobiles and airplanes, even better than it did with steam. Tests which I have conducted have shown that the rotary effort with gas is greater than with steam."

"It is the lightest prime mover ever produced and can be operated without trouble at red heat, thereby obtaining a very high economy in the transformation of energy."

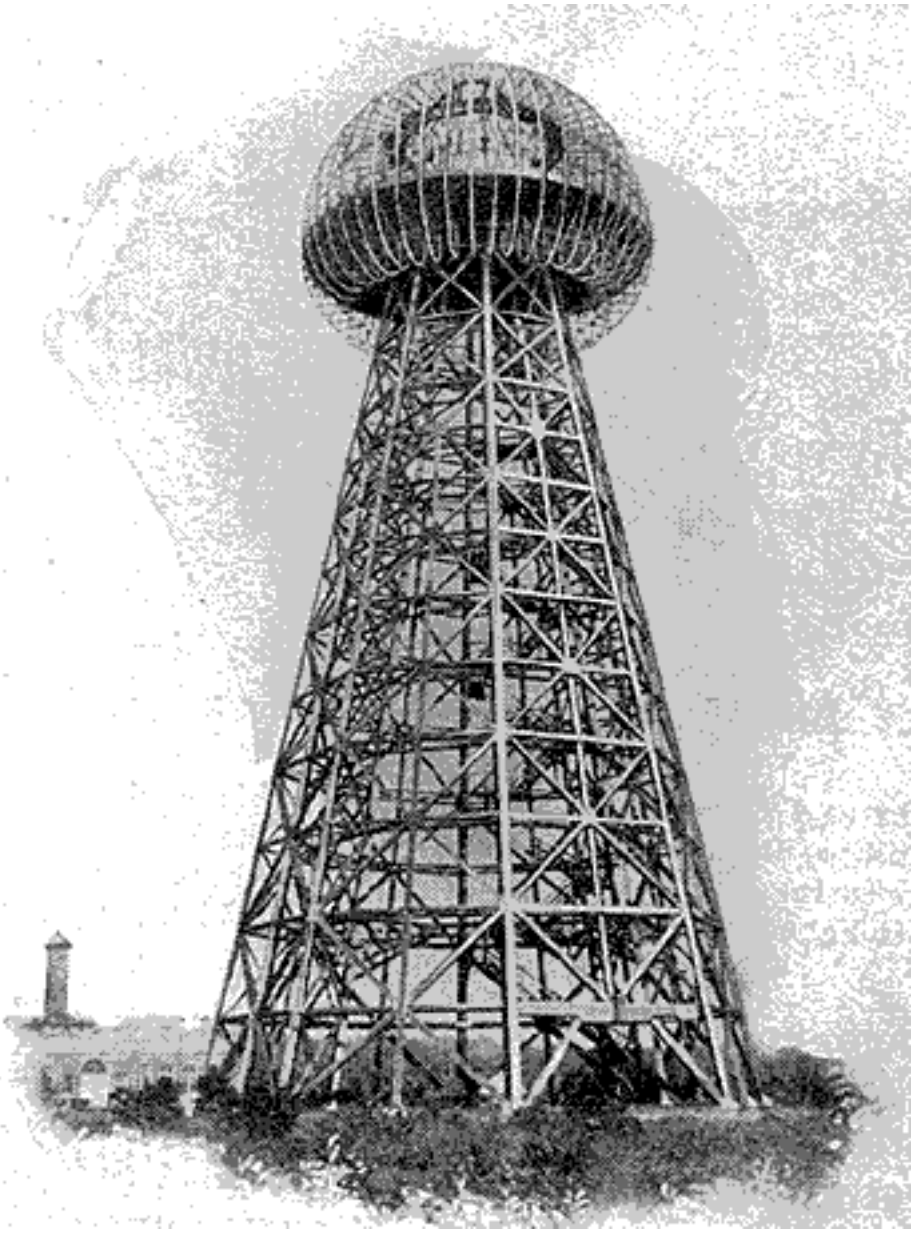
The 110 HP Tesla Engine

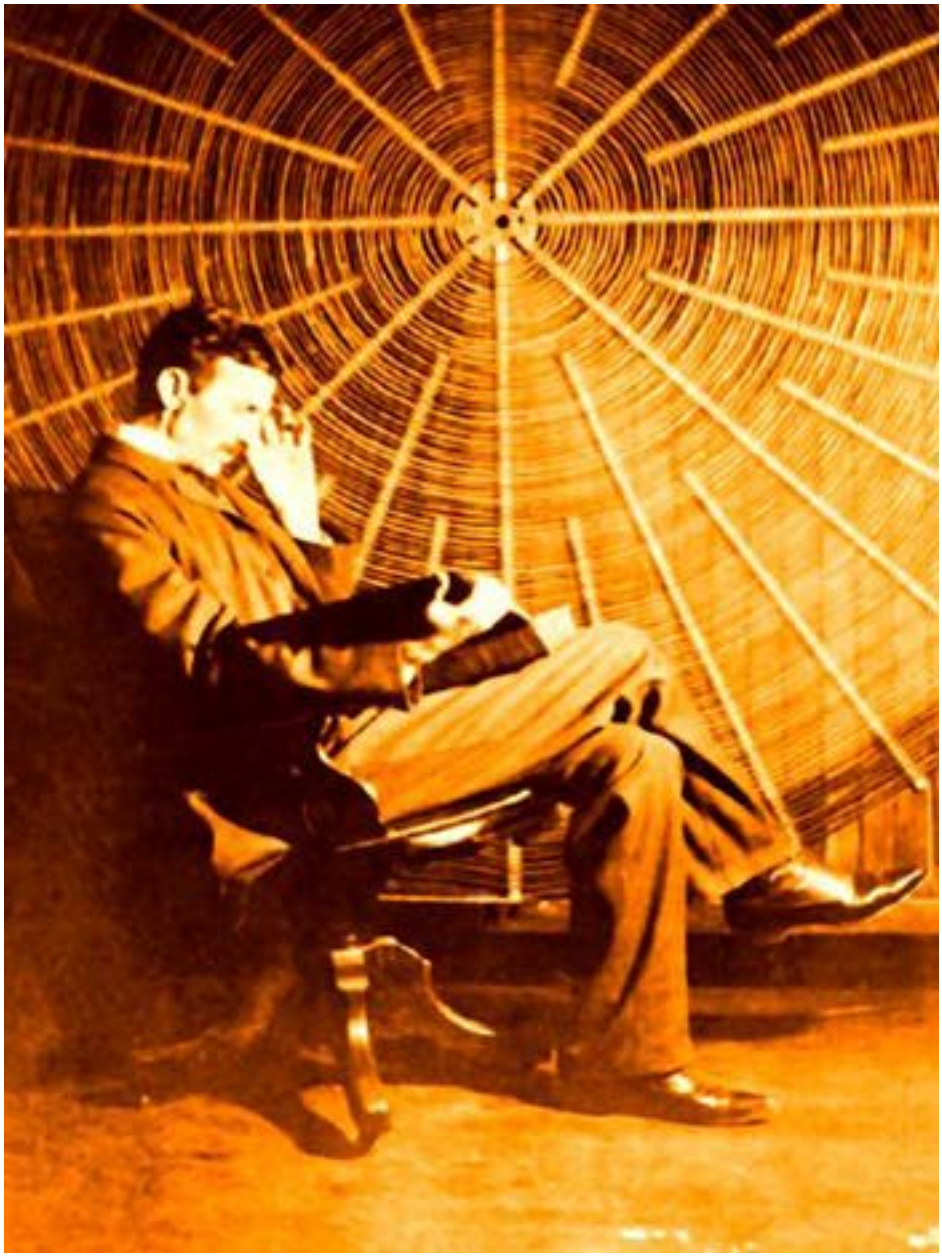


5,000 H.P. Tesla Steam Turbine

Click here for the Nikola Tesla and Viktor Schauberger Bookstore, from "AMAZON.COM"

NIKOLA TESLA:



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