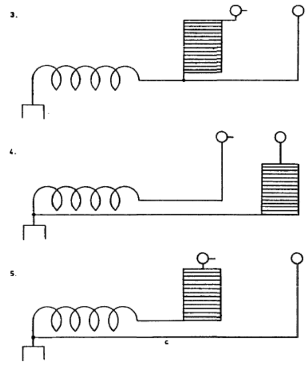
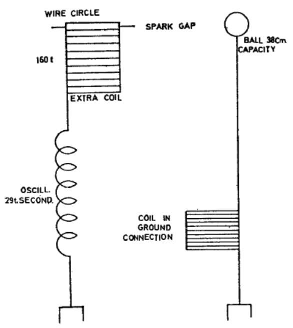
On Tesla's Magnifying Transmitter Diagrams

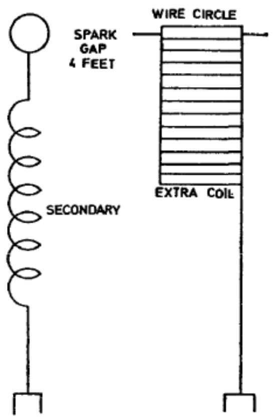
Apart from the diagrams shown thus far there is another source that we have barely touched upon; the Colorado Springs Notes and of course the Long Island Notes.
In the CSN of 30 July 1899 Tesla compares the following three set-ups:



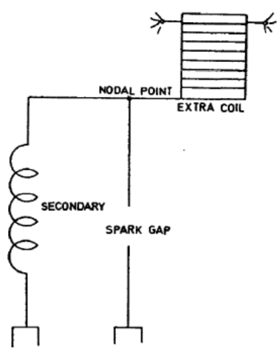
and concludes that the last one is by far the best to excite the Earth's electric charge.
The Colorado Spring Notes are most important because here the final circuit was decided upon. In these notes we find numerous diagrams to verify the working principles and find the exact parameters.
Such as these:



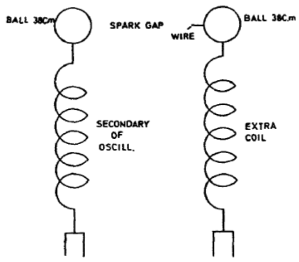
August 26th



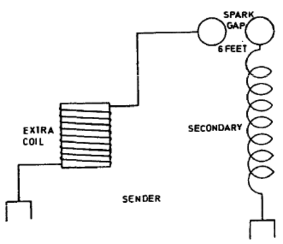
August 26th



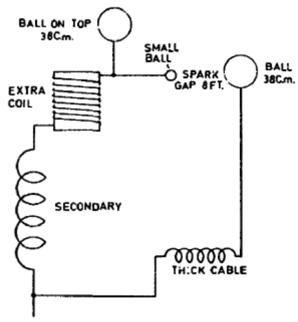
August 26th



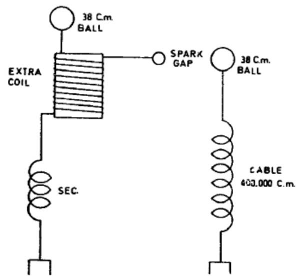
September 3rd



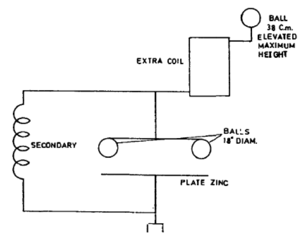
September 5th



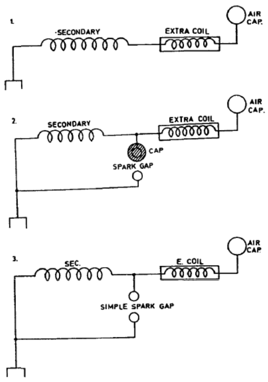
September 6th



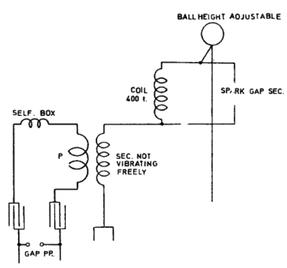
September 11th



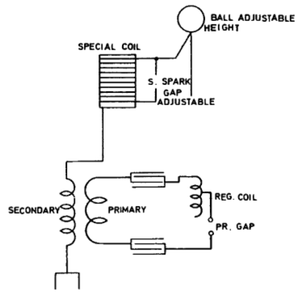
September 18th



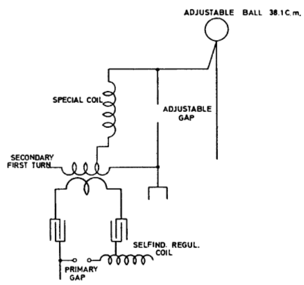
September 19th



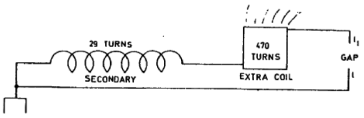
October 4th



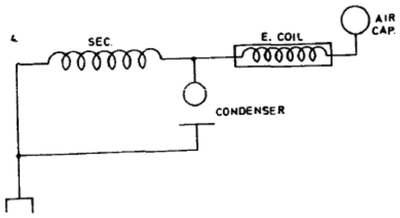
October 5th



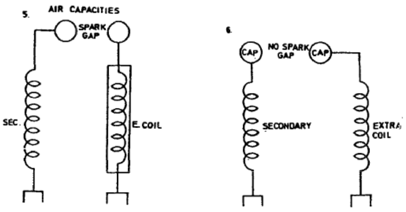
October 9th



August 19th

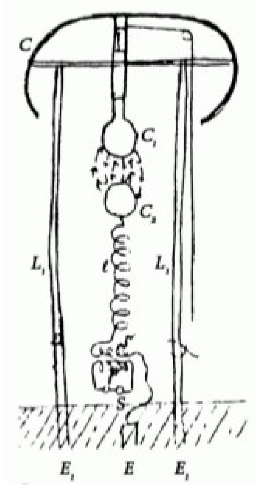


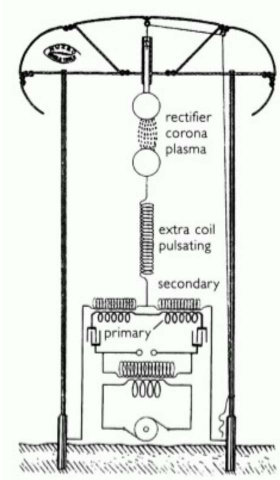
September 19th

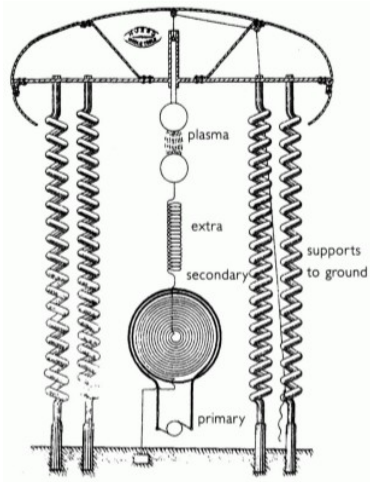


September 19th

It is easy to recognize the main theme from these diagrams, and this also matches with the “Rare Notes”. The most clear examples are from August 19th and September 6th.

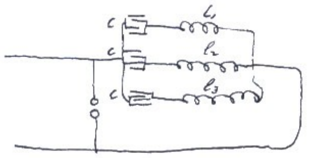






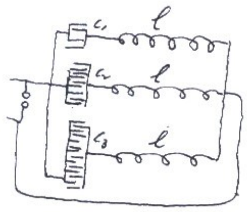
June 13. 1901.

Some of the arrangements experimented with before to be reconsidered with view of getting at best transmitter of complex vibrations.

a) 

In this case equal capacities c c c and different inductances l_1 l_2 l_3 are employed which give a complex wave chiefly of three distinct vibrations.

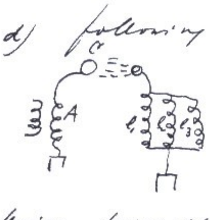
b) Similar arrangement with different capacities $c_1 c_2 c_3$ and same inductances is practicable but hardly as advantageous



as the first. Arrangement under c) below named allows more latitude in adjustment. It is important in all three cases to get same energy. Not necessarily the same actual energy but as in telegraphy the same energy qualitatively.

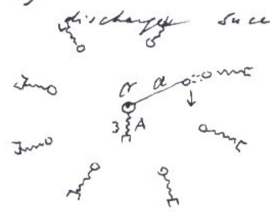
c) Arrangement with different capacities and different inductances. In all these three cases best results by far are obtainable with resonating secondaries.

d) following disposition is excellent to use with small apparatus.



A resonating secondary discharging the accumulated energy into complex transmitter. The three circuits can be together. I find it practicable to work seven in this manner. Using principle of complex receivers the number is probably as large as will be required in telegraphy across sea.

e) Better however is to separate circuits l_1 l_2 l_3 - - - etc and discharge successively and in rapid repetition as illustrated below



The circuit AC with the transmitters grounded on same or different points. It is easy when spark discharge is used to rotate the device a establishing the successive contacts at great speed. Also with mercury break great speed practicable. The energy in circuit AC should be in excess and that is easy to secure.

Long Island Notes

Note options D and E.

Sept. 8. 1901.

Transmission of energy for purposes of "Welttelegraphie"

Assume roof as now proposed with plates of 1 meter curvature. The active area may be taken as equal to $s_1 + s_2$. Now $s_1 = 2\pi r_1 h$ and $s_2 = \pi r_2 u$ u being mean circumference of toroidal surface s_2. As now planned $u = 112$ feet $r_2 = 6$ feet $r_1 = 96$ feet $h = 34$ feet from this

$s_1 = 6.28 \times 96 \times 34 = 20500$ feet square approx.

$s_2 = 3.14 \times 6 \times 112 = 2100$ " " "

Surface active $s_1 + s_2 = 22600$ square feet about.

If we make halfspherical pieces about 1 meter curvature each would take the space of about 9 square feet, hence we would have $\frac{22600}{9} = 2500$ such half spheres. The capacity of one sphere of diameter as above would be at small height 100 c.m. Of half the sphere it would be 50 c.m. but as a matter of fact we cannot count on more than 25 c.m. each. Suppose this value be nearly correct at small height we should have capacity of whole structure or roof $2500 \times 25 = 62500$ c.m. and at a height of 200 feet certainly not less than 100000 c.m.

On the basis of above estimate if I were to adopt 50000 per second I would have

$$\frac{1}{5\times10^4} = \frac{2\pi}{10^3}\sqrt{\frac{10^5}{9\times10^5}L} \text{ and } \left(\frac{3}{2\pi\times50}\right)^2 = L = \frac{9}{10^5} \text{ henry} = 90000 \text{ c.m.}$$

Long Island Notes

Cupola connected through inductor to ground

We should have higher frequency, more turns in each choking coil and greater capacity on end.

We may use as terminals horizontal roof with rounded ends (toroidal form) large radius of curvature to withstand high pressure. The capacity of such terminal if not at great altitude may be considerable. We can get very easily 10 000 cm. By using finer wire in coils we can have in each 1000 turns. Then the inductance of each will be above 12 Henry. For the same frequency as before we would then have n_1 number of coils:

$\frac{1}{130} = \frac{2\pi}{10^3}\sqrt{n_1 \cdot 12 \times \frac{10000}{9 \times 10^5}}$ n_1 = 11 **coils nearly**. This would be thoroughly practicable. The coils could be oil insulated. One terminal connected always to **core** and **oil** tank and only one terminal insulated and led to next tank core and terminal etc.

We may now consider what under above conditions might be expected from apparatus. To get 1000 turns in each coil we should have to use wire № 22 perhaps silk insulated.

1000 turns will have length approx. of: 1000 × 8 = 8000 inch = 750 feet.

Assume 6 coils in each leg, that is 12 coils total, we would then have total length of wire in choking coils: 12 × 750 = 9000 feet.

The resistance would be: 62 feet per Ohm 9000 : 62 = 145 Ohm.

Suppose total resistance of circuit to be 200 Ohm. Neglecting for the moment hysteresis and other frictional losses we would have E at the terminals:

$$E = e \cdot \frac{Lp}{R}$$

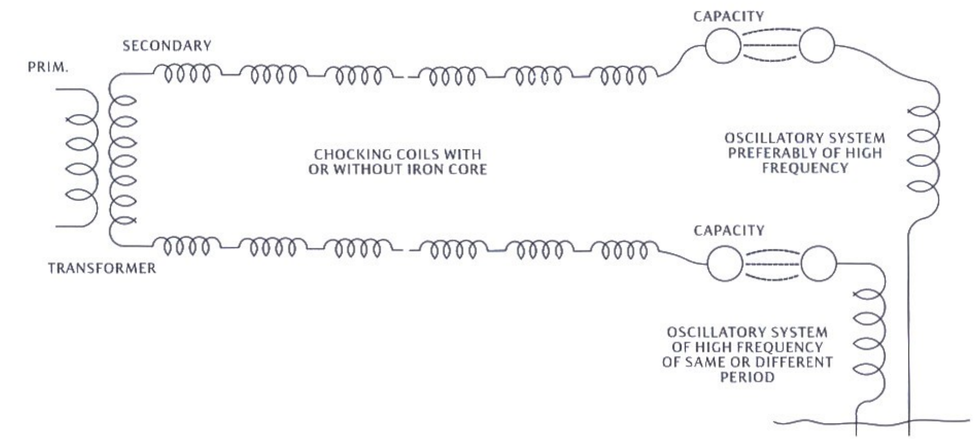
e initial e.m.f. at the terminals of exciting transformer.
$L = 12 \times 12 = 144$ Henry.
$p = 2\pi\, n = 820$ approx. $R = 200$.

$$E = e \cdot \frac{144 \times 820}{200} = 580 \cdot e$$

say approximately the e.m.f. initial will be raised to 500 times the value

Now e can be under above conditions easily 10000 Volts judging from the number of turns the secondary might have with resistance assumed. Hence $e = 500 \times 10000 = 5$ million Volts.

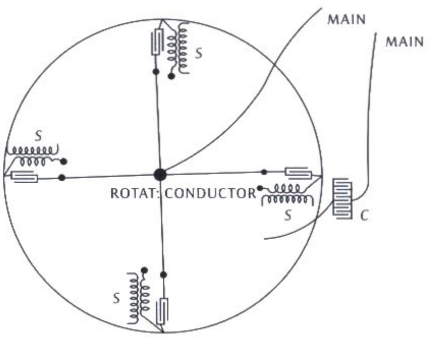
Summing up preceding results show that it is practicable to raise the e.m.f. in the manner for many purposes. For example in telegraphy without wires a high pressure may be in this way attained and by discharging the capacity or capacities at the terminal or terminals of the system into an other system strong effects may be secured without the necessity of converting to high frequency currents first. A scheme of this kind is illustrated below:



C a large condenser supplied from direct current generator of 220–500 Volts. Higher tension would have been preferable. C_1, C_2 smaller condensers. b b_1 b_2 break generation effected by mercury as in my breaks.

It was found in this arrangement break points can be close. No arcing. The condenser C prevents short-circuit effects. For many purposes this scheme is excellent. An improvement was effected by using great many small condensers, C_1, C_2, ... C_n . In one case 24 condensers were used. The condensers are discharged successively through the same primary. The apparatus worked very well but output is comparatively small.

The machine wad subsequently modified and instead of one many primaries used, one for each condenser. The secondaries were connected in series. Also in multiple they may be connected under certain conditions. The scheme of connections is obvious in diagram below:



Only four condensers and primaries are shown. The secondaries *ssss* may be used separately or any number of them connected together. The condenser C must be always large as it is charged and discharged completely only twice by one complete revolution of rotating discharging conductor.

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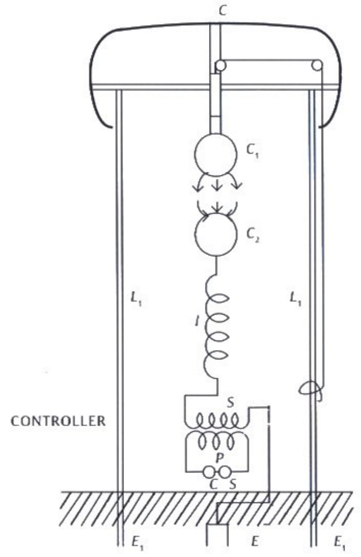
From old notes



In annexed sketch a terminal C in form of a roof is supported on **conducting** supports L_1L_1. Terminal C_1 is adjustable and in contact with structure of roof or terminal C. A resonating system C_2lsE discharges into C_1 and produces oscillations in system $CL_1L_1E_1E_1$. This arrangement obviates necessity to support roof or terminal C on **insulated** supports.

Now in a sketch the difficulty will be probably to get the oscillations of the free system $CL_1L_1E_1E_1$ slow enough to be very effective in transmission through Earth as in my system. The length of conductors in the free system should be $\frac{\lambda}{4}$, and the length of the discharging circuit should be $\frac{3}{4}\lambda$ or $\frac{n}{4}\lambda$ eventually, n being uneven number. Suppose to get an idea we take C = 10000 cm. This is realizable. Then we have $\frac{2\pi}{10^3}\sqrt{L\times\frac{10000}{9\times10^5}}$ the period of system. We should have vibration not much quicker than 100 000 and to satisfy this L would have to be : $\frac{1}{100000}=\frac{2\pi}{10^3}\sqrt{\frac{L}{90}}$; $L=\frac{9\times10^5}{4}=225000C$.

Calculated it would appear that the supports L would have to be about 600 feet. The arrangement would be o.k. with quick oscillations. The self-induction of a straight conductor is $L' = r\,l'\,(\log_e \frac{2l'}{r} - 0.75)$. Now, take L' = 300 feet = 9000 cm. If we have to use iron pipes 4" diam. r = 5 cm. Then $\frac{2l'}{r}=3600$ and from this I find L' = **134000** cm. Again taking the length 600 feet we would get inductance probably 268 000 cm. To get lower frequencies evidently in above scheme self-induction must be increased. The charging and discharge circuit may also be of different period and both vibrations used to excite receiver.

May 30, 1901

Previous calculation decidedly shows that we can expect 1) to store 1000 Watts in condenser primary per charge 2) that condenser can be charged and discharged 5000 times per second. This ignores all losses so far. Primary rate would be limited to one discharge and so also secondary rate without further provision. But if discharges fall together and are all added up, then secondary rate determined by 1) duration 2) by Ohmic etc. loss.

Suppose then 1000 Watts stored charges and discharges 5000 times.

The rate will have to be reduced first of all to **one half** because of intermissions necessary for charging. This might be overcome by a number of condensers 2 or more which are charged and discharged alternately. But with one condenser evidently primary rate can not be more than 2,500,000 Watt rate during the intervals of charges while the break is working. This too is by far too high.

The losses in the arc etc. must bring this rate down to one half. Conservatively estimated we can not transfer to the secondary more than 1,000,000 Watt rate. The mechanical system does not limit, nor the capacity of the condenser for storing and giving off. During signalling energy may be taken of for $\frac{1}{30}$ of a second if necessary. We may take ⅕ of second then the total energy accumulated in secondary swinging system will be $\frac{1}{2}CP^2=\frac{10^6}{50}=20000$ Watt. Hence with C = 1000 cm, $p^2 = 40000 \times 9 \times 10^8$, $P = 6 \times 10^6$ Volts.

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Transmission to a distance through wires or conductors of writing, print, pictures or images. Also "seeing by wire".

Method of and apparatus for same.

The broad idea underlying the invention is to enable a condition – similar in many respects to that existing in the eye and optic nerve – to be attained. There must be a definite relation as to order