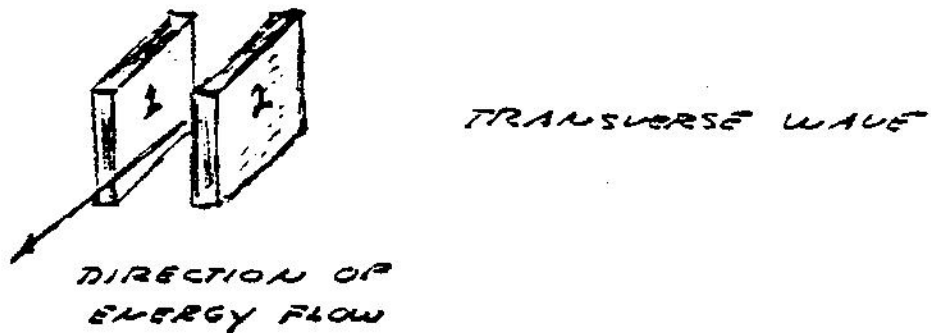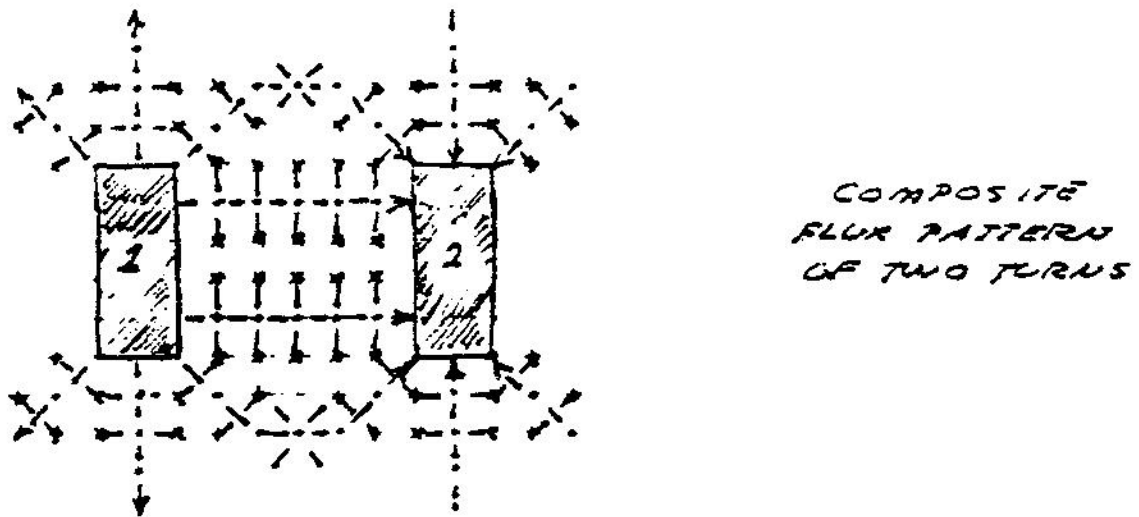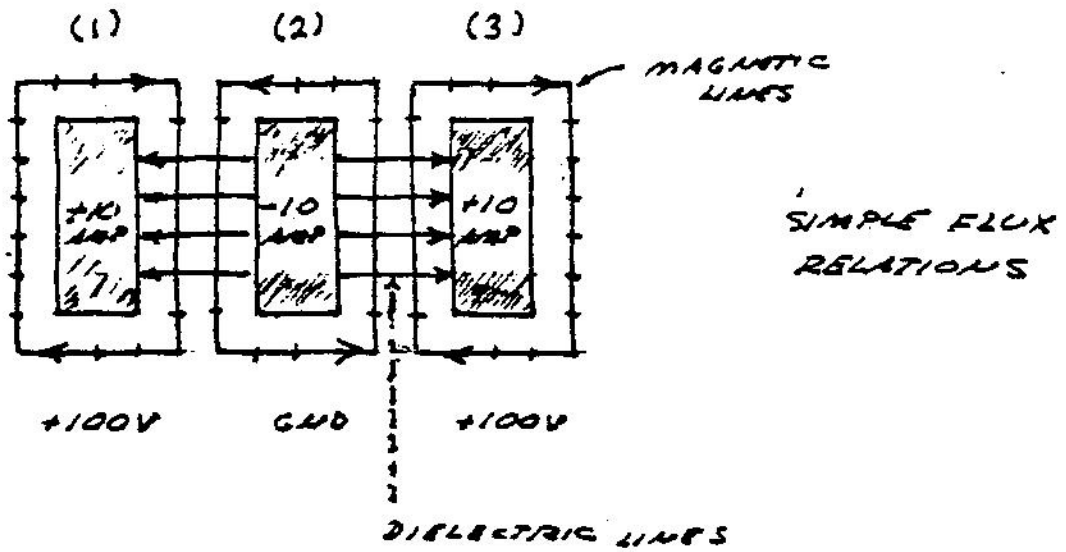## The Oscillating Current Transformer

The oscillating current transformer functions quite differently than a conventional transformer in that the law of dielectric induction is utilized as well as the familiar law of magnetic induction. The propagation of waves along the coil axis does not resemble the propagation of waves along a conventional transmission line, but is complicated by inter-turn capacitance & mutual magnetic inductance. In this respect the O.C. transformer does not behave like a resonant transmission line, nor a R.C.L. circuit, but more like a special type of wave guide. Perhaps the most important feature of the O.C. transformer is that in the course of propagation along the coil axis the electric energy is dematerialized, that is, rendered mass free energy resembling Dr. Wilhelm Reich's Orgone Energy in its behavior. It is this feature that renders the O.C. transformer usefull for wireless power transmission and reception, and gives the O.C. transformer singular importance in the study of Dr. Tesla's research.

FUNDAMENTALS OF COIL INDUCTION

Consider the elemental slice of a coil shown in fig. 1. Between the turns 1,2 & 3 of the coiled conductor exists a complex electric wave consisting of two basic components. In one component (fig. 2), the lines of magnetic and dielectric flux cross at right angles, producing a photon flux perpendicular to these crossings, hereby propagating energy along the gap, parallel to the conductors and around the coil. This is the transverse electro-magnetic wave. In the other component, shown in fig. 3, the lines of magnetic flux do not cross but unite along the same axis, perpendicular to the coil conductors, hereby energy is conveyed along the coil axis. This is the Longitudinal Magneto-Dielectric Wave.

FIGURE (2)

(1)   (2)   (3)

MAGNETIC LINES

+10 AMP   -10 AMP   +10 AMP

+100V   GND   +100V

DIELECTRIC LINES

SIMPLE FLUX RELATIONS

1   2

COMPOSITE FLUX PATTERN OF TWO TURNS

1   2

TRANSVERSE WAVE

DIRECTION OF ENERGY FLOW

INSULATING RODS

SOLENOIDAL COIL OF N TURNS AND WIRE LENGTH OF l_o.
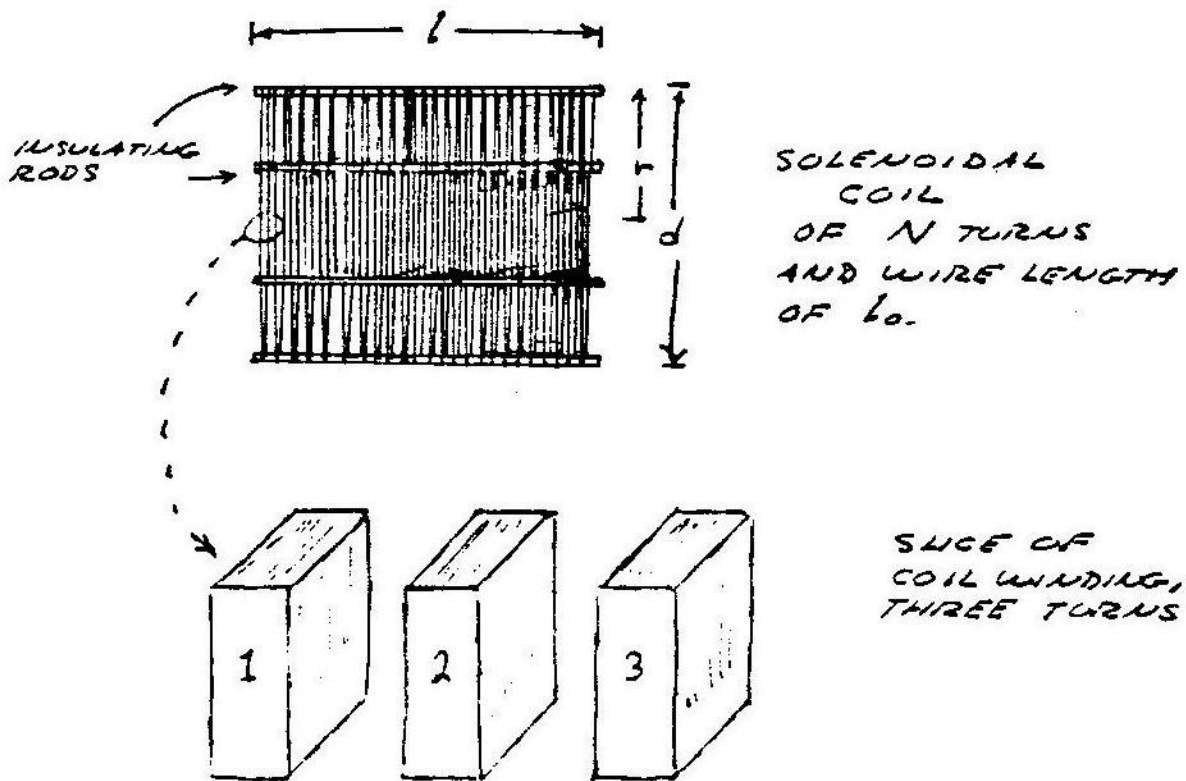
SLICE OF COIL WINDING, THREE TURNS

FIGURE (1)

Hence, two distinct forms of energy flow are present in the coiled conductor, propagating at right angles with respect to each other, as shown in fig. 4. Hereby a resultant wave is produced which propagates around the coil in a helical fashion, leading the transverse wave between the conductors. Thus the oscillating coil posses a complex wavelength which is shorter than the wavelength of the coiled conductor.

COIL CALCULATION

If the assumptions are made that an alternating current is applied to one end of the coil, the other end of the coil is open circuited. Additionaly external inductance and capacitance must be taken into account, then simple formulae may be derived for a single layer solenoid.

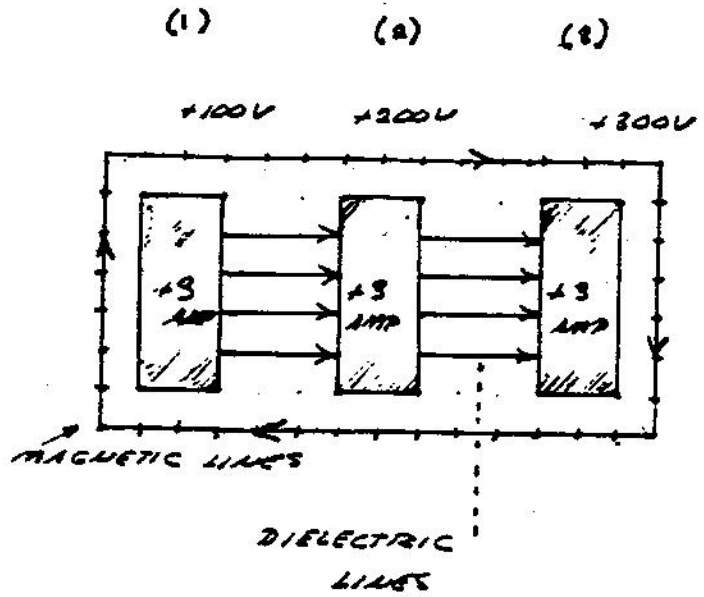The well known formula for the total inductance of a single layer solenoid is

$$L = \frac{r^2 \, N^2}{(9r+10l)} \quad \times 10^{-6} \; \text{Henry} \atop \text{(inches)} \quad (1)$$

Where r is coil radius
       l is coil length
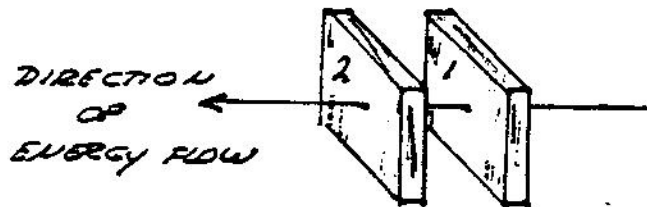   N is number of turns

FIGURE (3)

(1)   (a)   (2)

+100V   +200V   +300V

SIMPLE FLUX
RELATIONS

MAGNETIC LINES

DIELECTRIC
LINES

COMPOSITE
FLUX PATTERN OF
TWO TURNS

LONGITUDINAL
WAVE

DIRECTION
OF
ENERGY FLOW
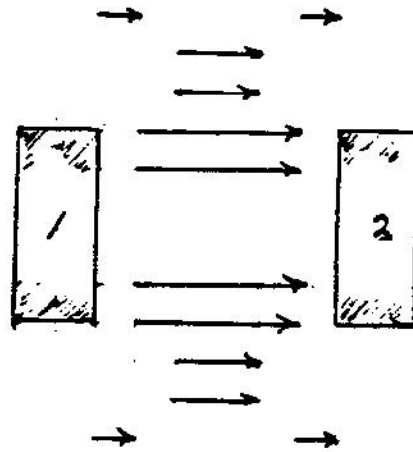
The capacitance of a single layer solenoid is given by the formula

$$C = pr \qquad 2.54 \times 10^{-12} \text{ Farads} \qquad \text{(inches)} \qquad (2)$$

where the factor p is a function of the length to diameter ratio, tabulated in table (1). The dimensions of the coil are shown in figure (1). The capacitance is minimum when length to diameter ratio is equal to one.

Because the coil is assumed to be in oscillation with a standing wave, the current distribution along the coil is not uniform, but varies sinusoidially with respect to distance along the coil. This alters the results obtained by equation (1), thus for resonance

$$L_o = \tfrac{1}{2}L \qquad \qquad \text{Henrys} \qquad (3)$$

likewise, for capacitance

$$C_o = \frac{8}{\pi} C \qquad \qquad \text{Farads} \qquad (4)$$

Hereby the velocity of propagation is given by

$$V_o = 1/\sqrt{L_o C_o}$$
$$\text{Units/sec} \qquad (5)$$
$$= \eta V_c$$

Where

$$V_c = 1/\sqrt{\mu \varepsilon} \qquad \qquad \text{Inch/sec} \qquad (6)$$

That is, the velocity of light, and

$$V_o = V_c \eta$$
$$= \left[\frac{1.77}{p} + \frac{3.94}{p}n \right]^{\frac{1}{2}} \quad 2\pi 10^9 \text{ Inch/sec} \qquad (7)$$
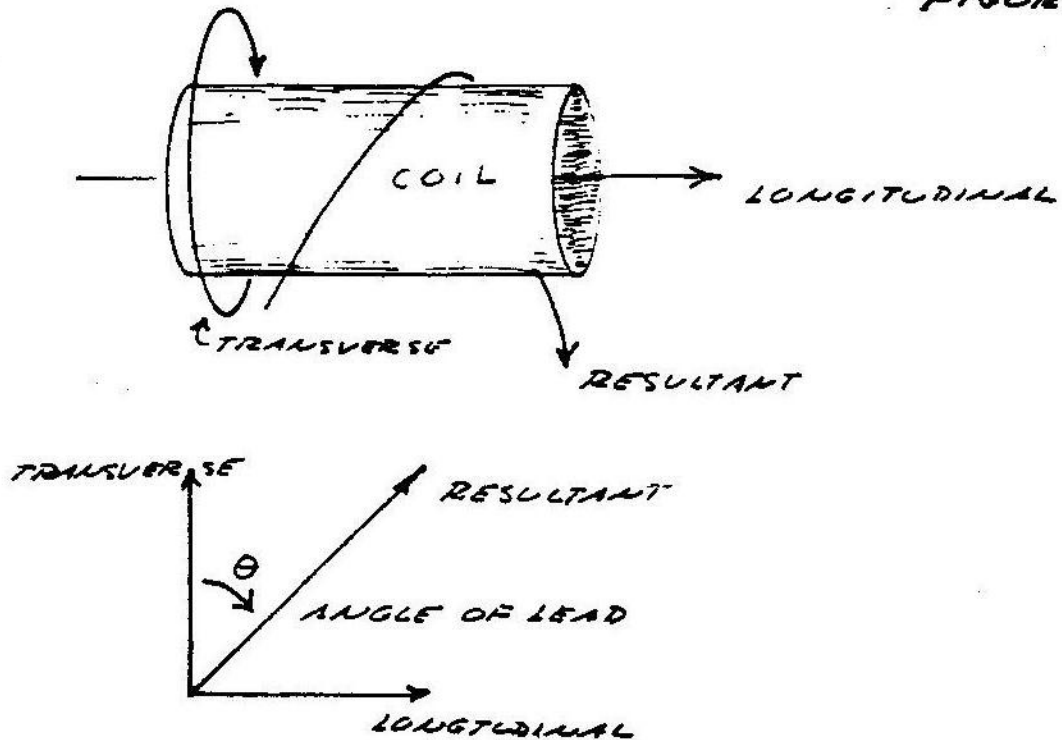
Where   n = the ratio of coil length to coil diameter. The values of propagation factor η are tabulated in table (2).

Thus, the frequency of oscillation or resonance of the coil is given by the relation

$$F_o = V_o/(1_o \cdot 4) \qquad \qquad \text{Cycles/sec} \qquad (8)$$

Where 1_o = total length of the coiled conductor in inches.

FIGURE (4)

The characteristic impedance of the resonant coil is given by

$$Z_c = \sqrt{\frac{L_o}{C_o}} \qquad \text{Ohms} \qquad (9$$

Hence,

$$Z_o = NZ_s \qquad \text{Ohms} \qquad (1$$

Where

$$Z_s = \left[(182.9 + 406.4n)p\right]^{\frac{1}{2}} \qquad \frac{\pi}{2} \, 10^3 \quad \begin{array}{l}\text{Ohms}\\ \text{(inches)}\end{array} (1$$

and N = number of turns. The values of sheet impedance, Z_s, are tabulated in table (3).

The time constant of the coil, that is, the rate of energy dissipation due to coil resistance is given by the approximate formula

$$u = R_o/2L_o = \left(\frac{2.72}{r} + \frac{2.13}{1}\right)\pi\sqrt{F_o} \qquad \begin{array}{l}\text{Nepers/sec}\\ \text{(inches)}\end{array} (1$$

Where r = coil radius

1 = coil length

In general, the dissipation of the coil's oscillating energy by conductor resistance:

1) Decreases with increase of coil diameter, d;

2) Decreases with increase of coil length, l, rapidly when the ratio, n, of length to diameter is small with little decrease beyond n equal to unity;

3) Is minimum when the ratio of wire diameter to coil pitch is 60%.

By examination of the attached tables, (1), (2) & (3), it is seen that the long coils of popular designs do not result in optimum performance. In general, coils should be short and wide, and not longer than n=1. The frequency is usually given as $F_o = V_c/\lambda_o$ which by equation (7) is incorrect. Winding on solid or continous formers rather than spaced slender rods, as shown in figure (1), greatly retards wave propagation as indicated in equation (6), thereby seriously distorting the wave. The dielectric constant of the coil, ξ , should be as close to unity as is physically possible to insure high efficiency of transformation.

The equations for the voltampere relations of the oscillating coil are

$$\dot{E}_1 = j \ (Z_c \ Y_o + \delta) \ \dot{E}_o \qquad \text{Complex Input Voltage} \qquad (13)$$

$$\dot{I}_1 = j \ (Y_c \ Z_o + \delta) \ \dot{I}_o \qquad \text{Complex Input Current} \qquad (14)$$

$$Z_1 = \frac{Z_c \ Y_o + \delta}{Y_c \ Z_o + \delta} \ Z_o \qquad \text{Input Impedance, Ohms} \qquad (15)$$

Where

$\dot{E}_o$ = Voltage on elevated terminal

$\dot{I}_o$ = Current into elevated terminal

$Y_c = Z_c^{-1}$

Z_o = Terminal impedance

Y_o = Terminal admittance

$\delta = u/2F_o = $ Decrement

$j = $ root of $\sqrt{-1}$

For negligible losses and absolute values

$$E_1 = (Z_c 2\pi F_o C_o)E_o \qquad \text{Volts} \qquad (16)$$

$$I_1 = (Y_c/2\pi F_o C_o)I_o \qquad \text{Amperes} \qquad (17)$$

Where

$$C_o = \text{Terminal capacitance}$$

By the law of conservation of energy

$$E_1 I_1 = E_o I_o \qquad \text{Volt-Amperes} \quad (18)$$

If the terminal capacitance is small then the approximate input/output relations of the Tesla coil are given by

$$E_o = Z_c I_1 \qquad \text{Output Volts} \qquad (19)$$

$$I_1 = E_o Y_c \qquad \text{Input Amperes} \qquad (20)$$

$$I_o = Y_c E_1 \qquad \text{Output Amperes} \qquad (21)$$

$$E_1 = I_o Z_c \qquad \text{Input Volts} \qquad (22)$$

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TABLE (1)
Coil Capacitance Factor

Length/Width = n	Factor p	Length/Width = n	Factor p
0.10	0.96	0.80	0.46
0.15	0.79	0.90	0.46
0.20	0.70	1.00	0.46
0.25	0.64	1.5	0.47
0.30	0.60	2.0	0.50
0.35	0.57	2.5	0.56
0.40	0.54	3.0	0.61
0.45	0.52	3.5	0.67
0.50	0.50	4.0	0.72
0.60	0.48	4.5	0.77
0.70	0.47	5.0	0.81

TABLE (2)			TABLE (3)	
Length/Width = n	V_o Inches/Sec	Percent Luminal Velocity = η	L/W = n	z_s
0.10	9.42×10^9	79.8%	0.10	0.107×10
0.15	10.9	92.2	0.15	0.070
0.20	12.0	102	0.20	0.116
0.25	13.0	110	0.25	0.116
0.30	13.9	118	0.30	0.116
0.35	14.8	125	0.35	0.115
0.40	15.6	132	0.40	0.115
0.45	16.4	139	0.45	0.114
0.50	17.2	146	0.50	0.113
0.60	18.4	156	0.60	0.110
0.70	19.5	165	0.70	0.106
0.80	20.5	176	0.80	0.103
0.90	21.4	181	0.90	0.099
1.00	22.1	187	1.00	0.095
1.5	25.4	215	1.5	0.081
2.0	27.6	234	2.0	0.070
2.5	28.7	243	2.5	0.061
3.0	29.7	251	3.0	0.054
3.5	30.3	257	3.5	0.048
4.0	30.9	262	4.0	0.044
4.5	31.6	268	4.5	0.040
5.0	32.4	274	5.0	0.037
6.0	33.0	279	6.0	0.032
7.0	33.9	287	7.0	0.028

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Books by Eric Dollard

CONDENSED INTRO TO TESLA TRANSFORMERS. This book is an abstract of theory and construction techniques of Tesla transformers. It is the result of experimental investigations and theoretical considerations. Includes relevant Tesla patents and an article on capacity by Fritz Lowenstein, Tesla's assistant. (BSRA #TE-1).....................$5.50

INTRODUCTION TO DIELECTRIC & MAGNETIC DISCHARGES IN ELECTRICAL WINDINGS. Theory of abrupt electrical oscillations such as those used by Tesla for experimental researches. Contains ELECTRICAL OSCILLATIONS IN ANTENNAE AND INDUCTION COILS by John Miller, 1919. This is one of the few articles containing equations useful to the design of Tesla coils. (BSRA #TE-2)......................................$5.50