The Transmission of Electricity, Part I

Eric P. Dollard, “Wireless Engineer” © 1987

Originally Published: Sept-Oct 1987 JBR, pgs 4-7

Electro-Magnetic Energy

A) When electro-magnetic energy is conveyed from one point in space to another point in space a closed loop is required to connect the point of generation with the point of utilization. This closed loop is called the electric circuit and consists of a boundary formed by what have become known as electric conductors. This boundary encloses a definite quantity of space.

When electro-magnetic energy flows through the space enclosed by the electric circuit phenomena take place inside the circuit material as well as the space outside this material.

Within the circuit conductor material, during the passage of electro-magnetic energy, this energy is continuously being consumed within the molecular space and converted into thermo-dynamic energy (heat). This may be represented by the passing electro-magnetic wave dragging into the electric circuit material. This drag is analogous to frictional losses and is called the resistance of the electric circuit, r.

In the space outside the circuit conductor material, during the passage of electro-magnetic energy, a condition of aetheric stress exists, which is called the electric field of the electric circuit. The energy contained by the electric field is continuously being transferred through this space from the point of generation which supplies energy to the electric field to the point of utilization which abstracts energy from the electric field.

The electric field of the circuit exerts physical magnetic and dielectric actions. The magnetic action is orientated parallel to the surface of the conductor material (in its immediate vicinity). That is, a needle shaped magnetic body tends to set itself in a direction parallel to the surface of the conductor material.

The dielectric action is orientated perpendicular to the surface of the conductor material (in its immediate vicinity). That is, a needle shaped dielectric body tends to set itself in a direction perpendicular to the surface of the conductor material. Thus, the electric field of the circuit, over which passes the flow of electro-magnetic energy, has three fundamental axes which are at right angles with each other:

The <u>dielectric</u> axis, perpendicular to the conductor surface,

The <u>magnetic</u> axis, parallel to the conductor surface,

The <u>electro-magnetic</u> axis, co-axial with the direction of the electric circuit.

The space outside of the conductor material, bounded by the electric circuit, has the property of propagating a wave-front of light at a definite velocity, c. This velocity is a characteristic property of the aether in which the electric circuit exists. The inverse square of this velocity is called the capacitance of the electric circuit.

$$C = \frac{1}{c^2} \qquad \frac{1}{4\pi 10^{-9}} \text{ Farads}$$

The capacitance is a measure of the ability to store energy in the dielectric field of induction, of the electric circuit.

The quantity of space enclosed by the bounding electric circuit is proportional to the total length of the electric circuit, l_1, multiplied by the distance between the bounding conductors, l_2,

$$l_1 l_2 = {l_0}^2 \qquad cm^2 \text{ Square Centimeters}$$

and has the dimensions of an area. This area in square centimeters defines what is called the inductance of the electric circuit.

$${l_0}^2 = L \qquad \frac{4\pi}{10^9} \text{ Henrys}$$

The inductance is a measure of the ability to store energy in the magnetic field of induction of the electric circuit.

Together, the capacitance and the inductance representing the dielectric and magnetic fields of induction of the electric circuit, serve as a measure of the propagation characteristics of the electric circuit for the transmission of electro-magnetic energy.

$$LC = {t_0}^2 \qquad \text{natural period}$$

$$\frac{L}{C} = {Z_0}^2 \qquad \text{natural impedance}$$

B) The popular conception of electro-magnetic energy transmission as it exists today is; energy is transmitted through the interior of the conductor material, that is, electricity flows through wires like water flows through pipes. This transmission is said to involve the flow of charged sub-atomic particles called electrons.

According to this theory the materials possessing the most “free electrons” serve as the best conductors of electro-magnetic energy. Conversely, the materials possessing the least “free electrons” serve as the poorest conductors of electro-magnetic energy. These materials are called insulators. Insulators are said to block the passage of electricity.

The conclusion drawn is that electricity is the flow of electrons and that the space outside of the conductor material is empty and dead. It follows that a superconductor is that material which offers no opposition to the flow of electrons and hence no opposition to the flow of electricity. Conversely, free space devoid of matter offers total opposition to the flow of electricity. Nothing could be further from the truth, yet this is the concept of electricity propounded by the scientist of today.

The real action of the conducting material presents itself when it is in the so-called superconducting state. If a section of a superconducting material is suspended in space, free to move, and a magnetic field of induction is made to approach this material, it is found that the material is repelled by the approach of the field. If the material is indeed superconducting it will maintain a definite distance, l, for an indefinite period of time $t \rightarrow \infty$, from the source of magnetic induction. Any tendency for the material to sink into the magnetic field, $l \rightarrow 0$, indicates the material is not perfectly superconducting but has a finite resistance, r.

It may be concluded that the so-called conducting material does not so much conduct as it does repel or reflect magnetism, or electro-magnetic energy in general.

If an electric circuit is conveying electro-magnetic energy as previously discussed it is found that a force or pressure is exerted upon the circuit material. This pressure tends to repel opposing parts of the circuit material and cause the circuit to expand. The quantity of this pressure in the space bounded by the circuit is called the magneto-motive force of the circuit.

It can therefore be seen that the conducting materials serve as the walls of a container holding magnetic pressure. If the conducting material is in the so-called superconducting state and the ends of the circuit are shorted the electric circuit will hold this magneto-motive pressure indefinitely, in analogy with compressed air stored in a tank. In order for this to be the result of electron flow requires that this flow be in perpetual motion, an unlikely proposition.

It may be concluded that materials called electric conductors might best be called electric obstructors and serve not to conduct electro-magnetism but serve to reflect it back on itself. The flow of electro-magnetism is conducted by the aethereous space bound by the obstructing material.

The character of this aethereous space is represented by its inductance, L and its capacitance, C. Since pure space is considered a perfect insulator by atomic theory, is it not ironic that it offers the least resistance to the flow of electro-magnetism? It is then the insulators that are the true conductors of electricity.

The Transmission of Electricity, Part II

Eric P. Dollard, “Wireless Engineer” © 1988

Originally Published: May-June 1988 JBR, pgs 10-12

Part I of "The Transmission of Electricity" (Sept-Oct 1987 JBR) dealt with the nature of electric transmission along space bounded by a set of guiding wires. These wires were found not to be the conductors of electricity, but space itself is the electric conductor. In reality the so-called conductor material of which the wires are made are reflectors of electricity, analogous to the reflective metal coating on the back of glass (dielectric) mirrors.

Because the dimensions of the co-efficient of dielectric induction, or farads, is given by the inverse of the square of the velocity of light,

$$\frac{1}{c^2} = \frac{t^2}{l^2} \qquad seconds^2 \ per \ cm^2 \qquad \frac{1}{4\pi 10^{-9}}$$

Farads

the notion has occurred that these dimensions establish the propagation velocity of electric transmission, and thereby electricity and light are the same thing. This concept may have become the most significant obstacle to the understanding of electric transmission.

In this part of the study of the transmission of electricity the conduction of electricity of space will be further examined through observation of the characteristics of radio transmission and reception in the medium frequency range, 300-3000 kilocycles per second.

When the distance between the guiding wires of an electric system is significantly increased the electric field that is associated with these wires occupies a large volume of space which extends far beyond the vicinity of the guiding wires. The expanded electric field of induction associated with the spaced apart guiding wires now can combine with the electric fields of induction associated with more distant sets of guiding wires. This sharing of electric fields by two or more remote systems of wires is known as the mutual inductance of the systems. Through the process of mutual inductance electricity may be transmitted through space without the employment of a set of guiding wires to connect the transmitter to the distant receiver. Hence, the "wireless" system of electric transmission through space.

One example of such a system is the AM broadcasting service in commercial use today (535-1650 Kc/sec). In this form of transmission the guiding wires spread out into a very tall tower (75-300 ft) far into space on one side and a large copper screen buried in the ground on the other side of the system.

The spacing that exists between the uppermost part of the tower and the outermost part of the screen is very large, therefore that electric field of this system extends to great distances as a result of the spacing. As with any system involving an electric field of induction, energy is taken up by the field during one portion of the AC cycle and returned during the next portion of the AC cycle. If measurements are taken on the flow of energy at the terminals of the tower-screen arrangement it is observed that only a small fraction of the energy taken by the electric field is returned during the discharge portion of the AC cycle.

This loss of energy is unlike that which occurs in the oscillating energy exchange that takes place with closely spaced guiding wires. For close spacing the loss of energy is very small and that energy which is lost is fully accountable by the equivalent quantity of heat gain in and around the wires. However, for wide spacing the loss of energy is very large but the gain of heat is disproportionately small.

This direct observation of the disappearance of electric energy without its reappearance in an equivalent quantity of a differing form such as heat or mechanical activity raises a most important question, that is, where does all this energy go?

Many believe that this lost energy is radiated away from the tower in the same manner as light and heat radiation from a light bulb. While this theory seems plausible, there exists evidence that it may not be the correct interpretation of how the energy is lost. Nikola Tesla, the discoverer of radio, claimed repeatedly that the electromagnetic radiation theory (then know as the Hertzian wave theory) was inimical to the proper understanding of the wireless process as he conceived it.

The electromagnetic theory, or what was known as the Hertzian wave theory in Tesla's era, fails to explain certain observations made in practical radio engineering. According to EM theory, the propagating velocity of electric induction must be the velocity of light. In the practical world of engineering however, the factor $\frac{\pi}{2}$, or 1.57 times the velocity of light will appear in wave calculations. Is it not coincidental that Tesla claimed that the effective propagation velocity of his wireless system was $\frac{\pi}{2}$ faster than the so-called speed of light?

Also, according to EM theory, the propagation of electric induction must be the cross combination of the dielectric induction and the magnetic induction, these two inductions never propagating independently. The work of J.J. Thomson and M. Faraday indicate that these two distinct forms of induction do propagate independently. Wheatstone claimed that the dielectric induction propagated at $\frac{\pi}{2}$ times faster than light.

In the practical world of radio engineering, in the AM broadcast band, it is not feasible to employ electromagnetic antennae at the point of reception. This is because an electromagnetic antenna must support a large fraction of the electromagnetic wavelength, this wavelength being several hundreds of feet. That is, such an antenna must be a tall tower. Since the employment of a tower for every radio receiver is an absurdity other forms of antennae are used. One such antenna is the magnetic permeability antenna found in transistor radios. This antenna responds only to the magnetic field of induction and works on the principle that a ferrite core multiplies the effective value of space a thousand fold and thereby simulates a large structure. This type of antenna is found to be very directional and must be oriented perpendicular to the direction of the transmitting station. Another form of antenna is the electro-static capacity antenna found on automobile radios. This antenna responds only to the dielectric field of induction and works on the principle that a resonant transformer connected to an elevated capacitance counteracts the effects of distance and thereby appears close to the transmitter. This type of antenna is found to be completely non-directional and can be oriented in any fashion.

Neither of the aforementioned antennae operate on the principle of electro-magnetic induction as propounded by Hertzian wave theory, but on distinctly magnetic inductive propagation or dielectric inductive propagation. This is contrary to the notion that the magnetic and dielectric fields of induction are inseparable, that is, they must propagate co-jointly. This distinct separate propagation, of these two fields of induction, is how electric propagation was conceived by nearly all of the important electrical pioneers.

The question has remained unanswered as to where does all the energy go that the broadcast transmitter must supply to the tower if it is not radiated in a fashion similar to light or heat energy. The answer may be found in the statement of C.P. Steinmetz that it is consumed by the hysteresis of the aether in which the tower is immersed. To quote, "Mr. Kennelly says that air has apparently no hysteresis, and this is the general assumption, too. But nevertheless, in the light of modern science we must say that even air has a certain hysteresis, a time-hysteresis. For we know now, that the magnetic stress in air does not appear instantaneously with its source; but we know that magnetic disturbances are propagated through air with a finite velocity, the velocity of light. Now, if you examine the phenomenon more particularly, you will see, that then, and only then, no energy would be dissipated in space, if the magnetic disturbance set up at any place, were propagated through the whole space instantaneously. But as soon as the propagation of energy through space consumes a finite time, no matter how small this time may be, a certain loss of energy must necessarily be connected therewith, and, calling the retardation of the magnetic disturbance behind the magneto-motive force, hysteresis, we must say: even air has hysteresis." [1]

The notion of aethereous hysteresis will be explored in part III of "The Transmission of Electricity"

[1] Transactions of the AIEE, Kennelly on Magnetic Reluctance, Oct. 27, 1891

Hysteresis of the Aether, Abstract

Eric P. Dollard, “Wireless Engineer” ©

Originally Published:

In the theoretical investigation of electric induction the propagating velocity of the transverse electro-magnetic (T.E.M.) component of induction is the only propagation constant considered. The propagation throughout space of the independent magnetic field of induction and the independent dielectric field of induction is not considered. In reality, however, these fields of induction start at the conductor and propagate from there throughout space at a definite velocity; that is, at any point in space the field of induction of magnetism or dielectricity at any moment in time corresponds not to the condition of induction at the conductor at that moment but that at a moment earlier by the time of propagation from the conductor to the point in space under consideration. Hence the given field of induction lags in time the more, the greater the distance from the conductor.

This lag in phase with respect to distance results in the cycle of energy return of the field of induction falling behind its point of phase opposition with the cycle of energy storage. This lag in phase gives rise to an energy component, that is an effective magnetic resistance or an effective dielectric conductance to the reactance or susceptance of the magnetic & dielectric fields respectively.

The phase angle of this lag in the cycle of energy return has been called the angle of hysteresis of the inductive medium and has become well known for ferrous materials. However, the application of this concept to the inductive medium known as the aether has received no attention except by Steinmetz. The purpose of this paper is the adaptation of Steinmetz' inductive propagation to the study of the hysteresis of the aether and a determination of the propagation velocity therefrom.