

# FUNDAMENTALS OF ENERGY TRANSFER

I agree with Chris Parton's attack on the definition of electric current, *Wireless World*, December, 1984, page 65.

Parton discusses "Forces on conductors guiding a TEM wave." I have a chapter with that title in vol. 2 of my book, *Electromagnetic Theory*. I feel that these strange forces may guide us to a unified field theory.

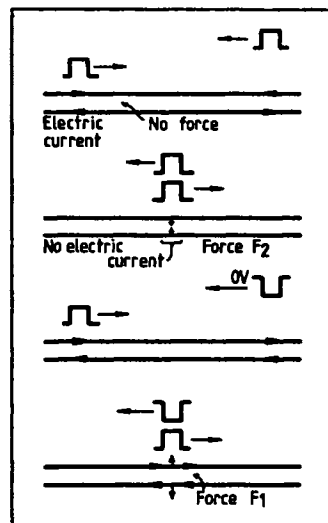
## Force on conductors guiding a TEM wave

After a TEM wave step has passed by, guided by two parallel conductors, there remain two steady state "fields":

(1) Electric current flows down the wires, and a B field exists in the dielectric right next to the surface of the conductor.

(2) Electric charge remains on the surface of the conductors, and an E field exists in the dielectric right next to the conductor.

The magnetic field exerts a force into the conductor; that is, a force which tends to drive the conductors apart. The electric field exerts a force out of the conductor; that is, a force which tends to pull the two conductors together.



The forces are  $F_1 = -iB$ ,  $F_2 = qE$ . Now the electric current in the surface of the conductor  $i$  and the electric charge in the surface of the conductor  $q$  are related by the equation  $i = q \odot$ . That is, the current is equal to the speed with which the charge density travels along the surface of the conductor. Dividing, we find that numerically:

$$\frac{F_1}{F_2} = \frac{-iB}{qE} = \frac{\odot B}{E} = \frac{1(\mu H)}{\sqrt{\mu} \cdot E} = \sqrt{\frac{\mu}{E}} \frac{H}{E}$$

But we know that in a TEM wave,

at every point  $E/H = \sqrt{\mu/E} \mu$ . Therefore  $F_1 = F_2$  numerically.

We conclude that when a TEM wave (which we call a Heaviside signal) glides along between two conductors at the speed of light, there is no force on the conductors guiding the signal. This very interesting feature of a Heaviside signal was first pointed out by David Walton, and is here proved.

(For the equations giving  $F_1$  and  $F_2$ , see for instance P. Hammond, "Electromagnetism for Engineers", Pergamon, 1978, pages 107 and 55.)

It is generally thought that if an electromagnetic wave travels down a coax cable from left to right and passes through another such wave travelling from right to left, then superposition applies. However, this is not true in the very important matter of the forces on the conductors. Where each wave on its own exerts no force, (the electric force and magnetic force cancelling,) when two waves are passing through each other one of the "fields" E or B — cancels, and we are left with a net force resulting from the non-cancelling "field". So superposition does not strictly apply, because when we superpose two TEM waves, something new suddenly appears, a physical force. If the two pulses passing in opposite directions are of the same polarity, another strange thing happens for the short time during which they overlap. That is, there is no electric current in the surface of the conductors. So if the conductors are imperfect, there is no resistive loss during that short period of time. (Similarly, if the pulses have opposite polarity, then if the dielectric is imperfect, there will be no losses due to leakage during the short period of pulse overlap.)

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I am not very surprised to notice that many readers of *Wireless World* (e.g. N.C. Hawkes, December, 1984) have been finding difficulty in appreciating the contradiction implicit in classical electromagnetic theory pointed out by Ivor Catt (September, 1984).

A slow drift of electrons along a wire may well account for a "steady state" movement of charge, and until recently it seems that this was all that was required.

However, with the growing importance of high-speed logical signals, new problems have been brought into the limelight which are inexplicable purely in terms of classical "electron drift".

I will attempt to explain the "Catt anomaly" from a slightly different angle in the hope that this may serve to shed more light on the contradiction.

(i) Experiment shows that a voltage "step" travels at the speed of light (of the dielectric between the wires).

(ii) Classical theory tells us that electrons cannot travel at the speed of light because they have a finite rest mass. (At normal temperatures the average speed of the free electrons is of the order of 1/1000 of the speed of light). In fact the "drift velocity" of the free electrons turns out to be much smaller, (of the order of 1cm/second).

(iii) Electrons in a given section of wire will not start to "drift" until they have received the message to do so.

(iv) The signal which tells the electrons to move is the electric field caused by the charge on the electrons which have drifted in another section of the wire. Thus the signal resulting from the change in electric field (the voltage step) travels at the drift velocity of the electrons.

The contradiction and resulting inadequacy of the theory is clear to see.

This, the "Catt anomaly", seems to have fallen on many deaf ears. I am interested to see how the scientific community continues to react to this vitally important breakthrough, which could lead to a revolution in electromagnetic theory.  
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With reference to the correspondence concerning the physical mechanism of energy transfer along transmission lines. I believe that Catt is correct in insisting that something much faster than electrons is involved. It seems reasonable to assume that as the electrons in the wires would be continuously entering and leaving the conduction band, there would be a corresponding traffic of the associated quanta, at the velocity of light, and that it is the existence of these quanta that constitutes the basis of the energy transfer mechanism. By considering all the quanta that at any given time travel in one direction along a wire as one energy

current, and the contrary travelling quanta as an opposite current, Catt could justifiably speak of two superimposed slabs of energy and explain the experimental facts in connection with 1 metre long transmission line reported on page 80 of the December, 1980 issue.

I expect that the above suggestion, if correct, will lead to revised understanding of conduction phenomena generally, including such topics as superconductivity and the action of thermocouples.

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## RELATIVITY

Modern physics assumes Einstein's Special Relativity true. S.R. is based on three postulates, two of which are well known and the third (the unmentionable) ignored. These three postulates are:

(1) Laws observed by an observer, A, who resides solely in an inertial frame,  $A_0$ , are the same as those observed by B who resides solely in an inertial frame,  $B_0$ , both of the observers using the same units.  
(2) The speed of light produced in an inertial frame,  $A_0$ , is constant relative to  $A_0$  and is equal to  $c$ . Likewise, the speed of light produced in an inertial frame,  $B_0$ , is constant relative to  $B_0$  and is equal to  $c$ , the same units being used in both frames.

(3) Before landing on a moving object (in any inertial frame) light magically adjusts its own speed to make its reception speed relative to that object, equal to  $c$ .

Postulate (1) is called, "the principle of relativity". Postulate (2) is called, "the constancy of the speed of light". Postulate (3) is, of course, never mentioned, but it is often combined with postulate (2). The resulting, mixed-up postulate, (2/3), is called, "the invariance of the speed of light".

Most physicists today, accept postulates (1) and (2) because experiments confirm both postulates. It is the unmentionable (3) or the mixed-up, unmentionable (2/3) that produces intellectual indigestion.

Your contributor, Roy Hodges, (*Wireless World*,

December, 1984) has obviously given much thought to the unmentionable and has produced a hypothesis in which photons are pulled by matter into an invariant, reception speed. However, to even think up such an explanation assumes that postulate (3) is true! But no-one has bothered to measure the reception speed of light from a radially-moving star to discover if the unmentionable is true or not!

With today's technology, it should be possible to measure the reception speed of light from a radially-moving star to see if it is  $c$  (as invariance dictates) or  $c-v$  (as constancy dictates).

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With reference to C.F. Coleman's comments on Scott Murray's article "The Roots of Relativity", it seems to me that the situation with regard to Einstein's 1905 'thought experiment' is as follows:

Light from the two flashes A and B arrives at M, the stationary observer, simultaneously. M', on the train, arrives at M at the same time. It therefore seems inescapable to me that the two rays of light, M and M' are all together at the same place and at the same time. Hence M' must judge the two light flashes to be simultaneous, as does observer M.

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See also page 93

## DIFFERENTIAL LINE DRIVER

Since taking up an interest again in electronics, after a lapse of some 20 years, I find so much has changed and I do try to look at the new ideas and designs for positive advantages, rather than just accepting the flavour of the month, as it were. For example, I have been prototyping a balanced line system, using an NE5534, driving a Sowter line output audio transformer type 4652 into a line terminated by a 3678 screened input transformer. The design and layout are perfectly straightforward and hardly worth setting down.

What is interesting is that

switching the signal from direct input, to the alternative path via the NE5534, two transformers and about 10 metres of unscreened figure-of-eight, produces no audible difference when levels are adjusted. My original comparison, between two channels of a stereo pair, one with and one without the extra link, did give significant differences at the top end, which was a bit puzzling, because transformers are supposed to start losing performance at lower frequencies. Which does rather prove that one should compare like with like absolutely.

Your contributor makes the point that transformers are expensive and suffer from limited bandwidth and stray magnetic fields; true up to a point, but the extra cost of an NE5532 dual op-amp, associated components and p.c. board must be getting on towards that of a 4652, and whether a pair of 5534s driving a 600Ω line in push-pull are a good enough match is debatable. At 0dBm, normal care with layout will eliminate hum pick-up even in an unscreened line-output transformer; dramatic overload capability is not normally needed in a complete balanced line system because somewhere or other in the system there are going to be greater constraints, as for bandwidth, the 4652 is only 0.8dB down at 100kHz, and at +20dBm low frequency distortion at, say, 30Hz is only 0.25%.

So all in all I am not convinced that the basic simplicity of a transformer is worth sacrificing — and I do hear tell that you can achieve perfectly satisfactory results driving the output transformer with something a lot less expensive than an NE5534.  
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## VELOCITY OF LIGHT

Roy Hodges (December, 1984) made some good arguments in favour of the proposition that the velocity of light  $c$  must be always referred to the rest frame of nearby matter, and to this frame only. Mr Hodges and those readers who thought that this hypothesis is sound,

promising, and more reasonable than the incredible relativistic postulate, namely that  $c$  can be referred to any frame, might be interested to read further arguments supporting various refinements of the former hypothesis, as well as proposals for experimental tests, in the following works:

H. Aspden, *Physics Unified* (Sabberton Publications, Southampton) 1980; Chapter 3, pp.47-69.

Z.L. Bourdikis, "Ritz's Electrodynamics as a Microscopic Basis for Maxwell-Lorentz Electromagnetism", *Proc. IREE Australia* 29, pp.343-358, 1968.

"Might Electrical Earthing Affect Convention of Light?", *Spec. Sci. Techn.* 5, pp.171-187, 1982.

T. Theocharis, "On Maxwell's Ether", *Lett. Nuovo Cimento* 36, pp.325-332, 1983.

C.A. Zapffe, A Reminder on  $E = mc^2$ ,  $m = m_0(1 - v^2/c^2)^{-1/2}$ , &  $N = N_0 \exp(-t'/\gamma\tau_0)$ , (Lakeland Color Press, Brainerd, Minnesota) 1982.

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## BAIRD TELEVISION

Referring to the response by Doug Pitt in the November issue to Pat Hawker's comments in the June 'Communications' column, the closest analogy that I can find to the everlasting Baird controversy is a Wimbledon tennis match that has overrun by 50 years. Every so often some pro- or anti-Baird person makes some badly-worded or ill-informed comments about Baird and suddenly we have a rather pathetic slanging match.

With due respect to both factions, I would like to make some comments from the relatively unbiased position of having studied one of Baird's achievements from a purely engineering standpoint.

J.L. Baird is considered to be the first of many independent inventors to demonstrate electrical transmission and reception/display of moving pictures with grey tones. At the time this was considered to constitute a demonstration of

'television' (which literally means 'seeing at a distance'). He also explored the engineering possibilities of television which resulted in demonstrations of colour and stereoscopic moving pictures. His electrical recordings of the vision signal in the late 1920's — the first in the world — have been the subject of my researches in the past few years (the results of which can be studied in the references).

The main problem for the would-be researcher in assessing Baird's achievements is sifting through the over-enthusiastic claims which resulted both from the media's excitement at Baird's tv demonstrations and from an efficient p.r. department. Today it is clear that these claims exceeded the capabilities of Baird's 30-line tv system.

To put the situation into context, this over-enthusiasm is reminiscent of the claims (such as control of power stations . . .) surrounding the appearance of the first Sinclair home computer — the ZX80 — in the late 1970's. In comparison with home computers today, the best use for the ZX80 (with apologies to Sinclair) is for propping up the leg of a wonky table.

Although we can study the operation and performance of Sinclair's first home computers in detail, Baird's 30-line system cannot be so appraised since actual performance measurements of the broadcast chain are not available and probably were never made. From this lack of hard evidence, the distinction between myth and truth becomes difficult and therefore is subject to the individual bias of the person intending to 'put the record straight'.

Out of this analogy between Baird and Sinclair comes an interesting point: if Baird had not suffered the business failure in the mid-thirties and had been as successful as Sinclair is now, would he still be the subject of this everlasting tennis match?

**References**  
*Wireless World*, October, 1983 — Using a Micro to process Baird tv recordings.  
*Royal Television Society Journal*. Article to be published in 1st quarter 1985.  
Donald F. McLean  
Edgware  
Middlesex