Battery and resistor.

We will insert two switches, one in the top conductor and one in the bottom conductor (Fig. 3).

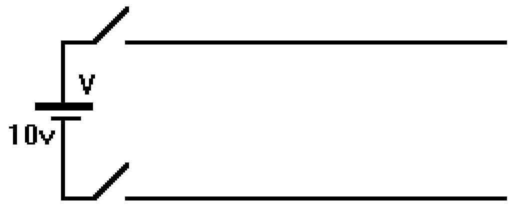


Figure 3

When we close the two switches, the distant resistor cannot define the energy which rushes along between the wires (or also, according to conventional theory travels along the wires http://www.ivorcatt.co.uk/x2c8.pdf ,) because the wave front has not yet reached the resistor (Fig.4.)

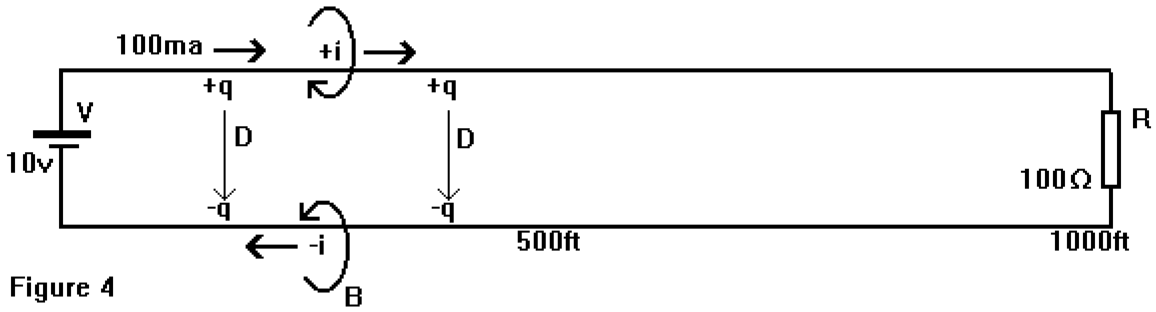


Figure 4

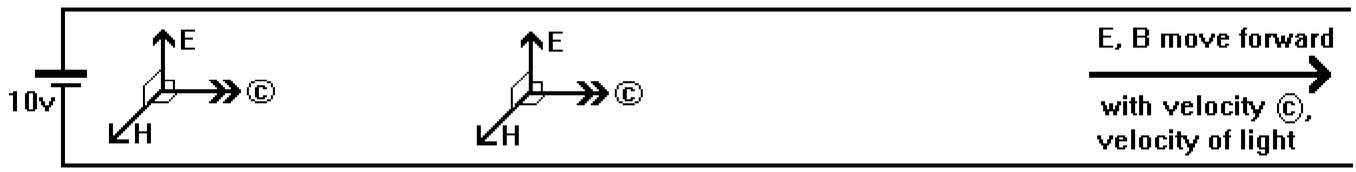
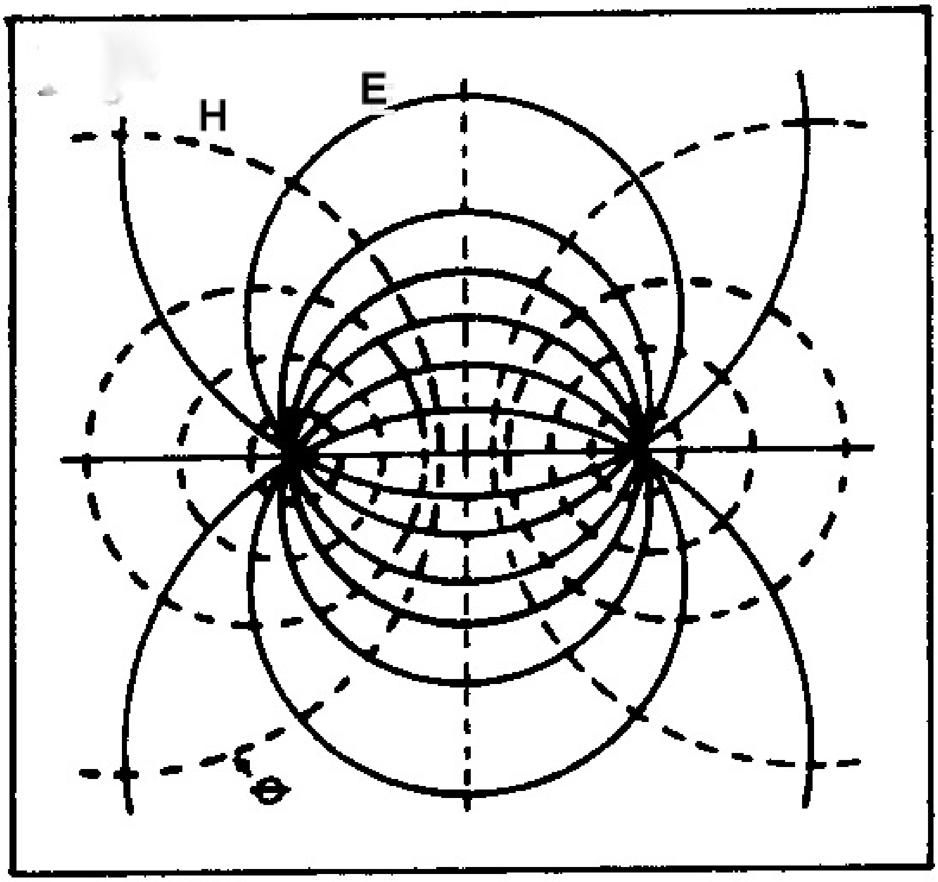


Figure 5

The analogy is light (which is electromagnetic) coming from your face (the battery) and hitting a mirror or a sheet of paper (equivalent to our 100 ohms). Light from your face travels at the speed of light towards the mirror (or piece of black or white paper) and in the case of a mirror reflects towards your eyes at the speed of light. How much is reflected depends on the reflectivity of the mirror or piece of paper, or on the value of the resistor.

The beaming of light between your face and the mirror is not understood, partly because of confusion created by the concept of the photon. However, in the case of the transmission line it is fully understood. The energy is guided by the two parallel conductors in a manner similar to the guidance of a train by two rails. The field pattern of the travelling energy is determined by the shape of the conductors. In the case of circular conductors, the field pattern is as follows;

Fig.4. Curvilinear squares.



The electric, or E field lines must enter the conductor at right angles, and the magnetic, or H dotted field lines are at right angles to the E lines. An equal amount of energy travels through each curvilinear square, so most of the travelling energy is concentrated in the space between the guiding conductors.

I have proved that the energy can only travel at a single velocity, the velocity of light. See http://www.ivorcatt.co.uk/4_1.htm , http://www.ivorcatt.org/x0329.jpg . After all, it ***is*** light. v=ir is the result of a complex sequence of reflections which settles down to v=ir. Power transferred is vi watts. However, the magnitude of the energy which initially departs from the battery and begins its journey is only defined by the battery and the characteristic impedance between the conductors Zo, not by the resistor at the end. The resistor value only determines how much of the incident energy will be reflected. If the resistor value matches the characteristic impedance Zo between the conductors, none of the incident energy is reflected. It behaves like a black sheet of paper.

To determine the characteristic impedance Zo between the two conductors in the last figure, take the number of curvilinear squares along an E line, 10, divided by the number of squares along an H line, 16, giving 0.62 . Multiply this by 377, the impedance of a square of space, to give Zo=377x0.62 = 236 ohms. Thus, the power emitted by the battery is always v^2/Zo = 100/236 = 0.42 watts. However, at the same time, some reflected energy may be returning into the battery if, unlike black paper, the terminating resistor has the wrong value rather than the correct 236 ohms.

Figures 33 and 34 in http://www.ivorcatt.co.uk/2_4.htm show what a battery is really like – an extension of the transmission line, not like its symbol in Figure 3.

To gain a grasp of the situation when the terminating resistor does not equal the characteristic impedance between the two conductors, Zo, 236 ohms, consider the case when you place two mirrors facing each other with you in between. The light, the image of your face, continually reflects between the two mirrors. In the case or our transmission line, the incorrect value resistor acts as one mirror, and the farther, left hand end of the battery as the other mirror. There is a continual dance of energy between them. In the end it settles down to the total rate of forward flow of energy correlating with v=ir, but actually energy is travelling in both directions at the speed of light, both the forward and the backward travelling energy being given by $v=iZ_o$, power = vi watts. An indication of this situation is given in the case of a charging capacitor at Figure 3 of http://www.ivorcatt.org/icrwiworld78dec2.htm .

Further discussion at http://www.ivorcatt.co.uk/1_3.htm could be helpful. Also Figure 6 at http://www.ivorcatt.co.uk/1_2.htm

Ivor Catt 8.12.12