

14/17 Paignton Devon

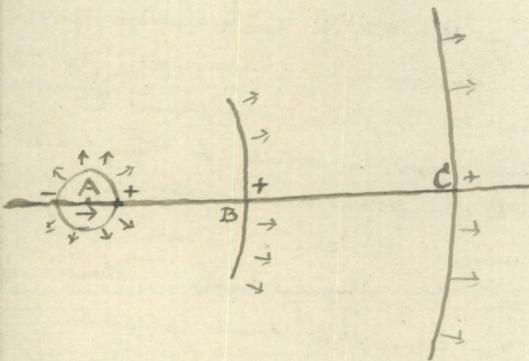
5 Aug. 94.

My dear Fitzgerald,

By a corrugated conductor I presume is meant one with periodic swellings, with periodic variations in the resistance, inductance and permittance. The exact theory would be very difficult, but the approximate theory on the lines of the eqns $-\frac{dC}{dx} = SV$, $-\frac{dV}{dx} = RB + LC$ would not present any substantial difficulty, provided you kept to simple periodic train of waves. That the ^{electrical} wave length & the wave length of "Corrugations" would be mutually influential is one of the things to be expected; the precise influence to be dug out of the formulae, which is usually troublesome work.

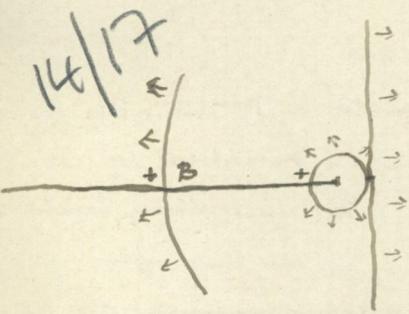
I don't quite see the meaning of internal waves bending round and coming to a sort of cusp at the free end of a needle. My idea of reflection at the free end of a straight wire is this:—

Let a voltaic impulse act at A. It generates a spherical shell wave, the + electric at right, and - at left, on the wire, if the impulse acts \rightarrow . The shell expands and makes approximately a pair of plane shells. Disregard the one going to the left; the other will be seen at B. The arrow heads show motion of wave front. Later at C. The wire itself is supposed to be



infinitely fine & of no resistance, in order to make the theory an exact simple one, coming under the head of the Simplest Spherical Wave Considered by me in "El. Waves", Part 3, near the beginning.

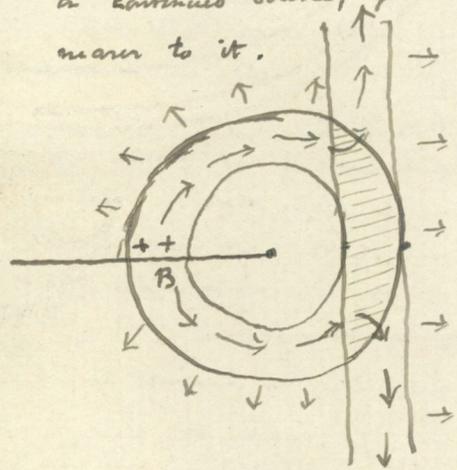
When the free end is reached, what happens may be concluded after the manner of the spherical waves considered in Chap II of "El. Theory".



The plane wave moves on, but is joined on to a spherical wave centered on the end of the wire. The core of the plane wave is taken away; so the only electrification is on the left side of the expanding spher. shell, which soon becomes practically a plane wave going from right to left.

Whilst the plane & sph. shells partly cancel on the right side.

The electrification keeps on the wire, of course - But there is a loss of energy in reflection. Superficially it might look as if the plane wave going on caused a loss of nearly all the energy. But there are infinities in these simple solutions. There is ∞ energy at the core, before the reflection occurs, but not after, that is not in the plane wave going straight on, but only in the reflected wave, so the loss may be very little. We can't tell its amount from solutions of this kind, I think, on account of the infinities. But if you have a continued source, generating a shell of finite depth, you come nearer to it.



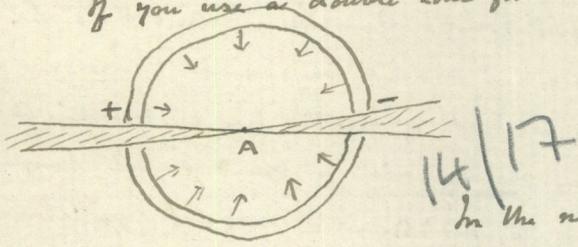
You see now that in the ^{finite} shaded region there is a cancellation of the disturbance (imperfect) so that the displacement from B goes round the shell & then leaks into the plane wave without going to the axis; as shown by the larger arrow heads. Now you can write down complete solutions, finite everywhere except at B. Infinite E and H there

owing to infinitely fine wire used. So ~~therefore~~ the loss of energy

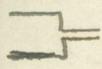
wh. we see is small, could not be expressed as a finite fraction of the incident.

To finishise completely, use a cylinder for wire. Same general results, but now not purely spherical. Of a mixed kind, with any complicated formula, of course.

If you use a double cone for wire, with a point thereon at A, you can have a purely spherical wave of finite energy. It is represented of finite depth, and contracting.



In the neighbourhood of A there is great concentration, of course. In the mathematical theory the wave expands again, the + electric being then on right, the - on left. This is with perfect conductors. Practically, there would be strongly localized resistance & dissipation of energy at and near A. If a little gap, then a spark, and fusion.



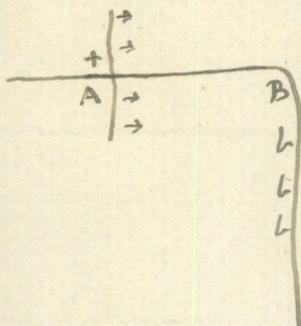
In a sudden change of gauge of wire from big to small, it is along which a wave is running, it is the suddenness that upsets things, curving the waves temporarily. But there is no necessary very great disturbance in the general intensity (except perhaps at sharp corners, wh. may be rounded off), and I should treat cases of this kind without special reference to the temporary disturbance at the sudden change of gauge; that is, do in in terms of a transmitted & a reflected wave, still of the plane type. But undoubtedly in the case you mention of a large cylinder and a small one, the conditions are such as to magnify E and H on the small wire, close thereto, by the concentration of the field, apart from the question of whether there is a

reflected wave of notable size. That is, ~~even without any reflected wave~~ on the big side, the essential transmitted wave, away from the discontinuity, would have a condensed field. The real events in the transition from the very big to the very small wire could not be done in plane waves at all. (Larmor?)

14/17 Inertia of electrified point. Question is, what does L mean by it? We can understand inertia in several senses in these cases. An electrified particle of matter has a small increase of effective inertia, when moving with a speed small compared with that of light, owing to the magnetic energy (equilibrium energy). This is, however, the magnetic inertia really, expressed in a particular way by its effect on the apparent mass. If no real mass, then it would produce apparent mass.

But it does not work out in that simple way in general. The inertia of waves, of the kind illustrated above, where a plane wave moves right off a wire, is effectively a different kind of inertia. Of course this sort of inertia occurs in all sorts of waves, but what does it mean more than that waves go on moving? You mention an electric current going round a sharp corner. Now it seems to me to be essentially dependent on the nature of the "current", in relation to waves & their moving property. If it is a case of a steady current which turns a corner, then, from the point of view of material electricity, there ought to be inertia, but from the point of view of el. mag. waves, then none. It is effectively the superposition of an infinite series of waves, with absolutely no resultant "inertia" of the kind in question. But if not a steady current; if a

pulse (electromagnetic), or a train of waves, then they would show inertia of the kind in question in the act of turning the corner, but in a complicated way. For example: - A plane



pulse A going to a corner B. When it gets there, B becomes a secondary source of disturbance and so sends out b b b; temporarily, but the parts of the original plane pulse which are not close to B b b b go right on, after the manner before described. What is to stop them. So there is a little loss of energy. But note here, that to realize

a problem of this kind, you must finitize it, as before described in one case, & you may come down to a quite insignificant loss of energy.

I do not understand the application (or experience) to electrolytic ionic rates.

As regards my paper, I think I had better drop it. I don't care to write for any medium where I am not welcome. The way the R.S. behave is extraordinary. They have lots of money to pay the cost of publication, & they deliberately refuse to use their opportunities. It is such an impractical Society.

Yours sincerely

Oleiv Heaviside

14/17