ular to both the electric and magnetic intensities. Thus the torque, (magnetic intensity,) H is around the x axis, (axis in direction of the electric intensity.) The medium has a resistance to shear across the z axis which is $\frac{1}{\mu}$, (magnetic permeability,) The torque H acting on the medium, of shearability μ, twists it round through an angle B, so that $B = H\mu$. Of course this does not imply any elastic solid theory, and in fact I cannot see how such a theory can be made to work, as we ordinarily conceive of an elastic solid, but in this respect the result is the same as if it were an elastic solid, i.e. a torque produces a rotation through a certain angle.

You will be interested to know that we have started work on the new observatory. Wadsworth has been elected director, and (20) my plans in that direction have been successful and I believe that he will more than keep up the reputation of his predecessors in our college, i.e. Langley and Keeler. though unfortunately we will have to move both university and observatory to different places, the University across the river to Pittsburgh and the observatory out to the park. This will leave Brashear by himself, on the old site, and break up what has been for years a very happy and congenial group of neighbours.

I remain, Very sincerely yours,

7/53 Reginald A. Fessenden.

REGINALD A. FESSENDEN,
ALLEGHENY, PA.

JUN 6 1899

7/53

Dear Professor Fitzgerald,

It was with great pleasure that I read your letter and learned that, though you did not consider the work as conclusive, you ~~condidered~~ regarded it as suitable for publication. I thank you very much for what you have done for me in the matter and would like to acknowledge my indebtedness in the paper but that it might give the erroneous opinion that you had approved all the conclusions in it, so I must wait until I can do so without prejudice to yourself.

Your criticisms are very just, and while I feel that the relation between H and μ is a touchstone to the whole question and a test which is absolutely decisive I must admit that much of the other work is far from conclusive. However I hope that some day I may fill up the chinks. I thank you very much for calling my attention to various other sins of omission and commission, with regard to the fuller developement of the argument on the density and also for your very important suggestions in regard to writing B_ϵ and μ_ϵ instead of unity. This will improve the general form of the paper very much, as it was an inexcusable blunder for me, in a paper on dimensions, to make such a gross pair of errors. I will correct it throughout in accordance with your suggestions in this respect. I note also what you say about the dimensions of B. In my first work I gave it as of no dimensions, as I was not taking the directions of the L s into account. I have since found, as given in the appendix, what the directions of the L s are, and find that B has the dimensions $L_y \div L_z$; or, it is the angle whose arc is along the direction of magnetic ~~force~~ intensity H, and radius along the axis perpendic-

Western University of Pennsylvania,
Perrysville Avenue, Allegheny, Pa.
W. J. HOLLAND, D. D., LL. D., CHANCELLOR.

Nov. 10th. 1898.

G. F. FitzGerald, F. R. S.

Dublin.

7/53

Dear Sir,

At the British Association Meeting in Toronto I had the honour of being introduced to you, by Professor Roberts-Austen, and, if I am not vanished entirely from your recollection, you may remember me as your neighbour at the Association dinner. At that time I mentioned to you a method by which I was trying to ascertain the true nature of electricity and magnetism, "Qualitative Mathematics," I called it, -an extension of Fourier's Dimensions. I pointed out that all the electric phenomena of which we had full knowledge could be expressed by means of the following three equations,

$q/b = k^{1/2}/\mu^{1/2}$

$k^{1/2}\mu^{1/2} = T/L$

$qb = ML^2/T.$

q = quantity of electricity
b = " " magnetism
k = specific ind. capacity
μ = permeability

That if we let $k^{1/2}/\mu^{1/2}$ equal some other quantity, say Z, then the different quantities, on solving, became.

$q = M^{1/2} L Z^{1/2}/T^{1/2}$
$b = M^{1/2} L/Z T^{1/2}$
$k = TZ/L$
$\mu = T/Lz$

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7/53

~~Cons~~ So that we could get all the different theories which have been proposed by giving suitable values to Z, i.e. one value of Z gives Lodges theory, another value, one of Heavyside's, etc. Also that as soon as we had discovered some phenomenon which was not included the above three equations, we would know what electricity was.

I have now discoveded the desired additional datum, and have been definitely able to prove what the true nature of electricity is. It is that theory in which k is a density and $\frac{1}{\mu}$ an elasticity. No other theory is possible. A number of interesting results have been obtained. One is that the hysteresis of iron is directly proportional to its Young's modulus, which was predicted by the theory and proves true on experiment. I subjoin some figures.

	Elasticity	a.	η	S
Ferrotype Iron, hard.	950	.450	.0548	.04975
" " annealed.	697	.337	.04758	.04975
Steel, hard,	6030	2.7	.0279	.054
" " annealed.	1900	.88	.00848	.054

where E is the elasticity, a is a coefficient expressing the reluctance of the iron to very small magnetising forces, given by the equation,

$$\text{reluctivity}, (= 1/\mu) = a + sH.$$

and η is the hysteresis coefficient, defined by the equation,

$$\text{Hysteresis per cub. cm. per cycle} = \eta B^{1.6}$$

There are a number of proofs, for instance the fact that the reciprocal of μ must be a linear function of the magnetic potential drop per cm.; the specific inductive capacity of gases, etc. in fact quite a number of phenomena, some of them new.

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7/53

As the subject is an important one, I have thought that it would ~~b~~ be best to publish it in some well recognised ~~sta~~ standard scientific proceedings. I am going to ask you if you think you would care to look over my paper, with a view, (if you find that my statements are borne out,) to presenting it to some suitable body, i.e. the Royal Society or the Phil. Mag. My reason for asking this is, that, as ~~it~~ is well known, you have done a considerable amount of work in the line of ether theories, and consequently you will be able to criticise my paper in a way which possibly I could not secure otherwise ~~in any other way~~, so that I would be free from any anxiety in regard to publishing a half-baked theory. I say half-baked, for though I have now gone over the matter for nearly six months and can find no error, and have discovered a number of new phenomena, all of which confirm it, -also though I have read a number of your papers on the subject, and those of Lodge, Heavyside and Poincaré, I do not feel very confident when it comes to original work.

I enclose a couple of papers which may interest you, and remain,

Sincerely and respectfully yours,

Reginald A. Fessenden.

× Sample of method. Since ~~K~~ = μ = elasticity; ρ = elasticity = $\frac{M}{LT^2} = \frac{M}{T} \times \frac{1}{T} \times \frac{1}{L} = \frac{q}{T} \times L$ = difference of magnetic potential per cm, = H. Also α must be of nature of elasticity (which proves true on experiment) & since ~~to~~ hysteresis × vol = work, hysteresis also = $\frac{ML^2}{T^2} \div L^3$ = elasticity. For a lot of data conforming this see Proc. Amer. Inst. of Elect Engineers, vol IX page 680-681. & vol VIII. Kennelly "Magnetic Reluct" fig 7.

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