

Paignton Devon

31.12.93. 14/9

My dear Fitzgerald.

If poor 4π could speak he would say "What have I done to be abused at? It's not my fault!"

If Mr. Trenton can find my microphone paper any use, I shall be glad. For measurements of pressures, a paper by S. Bidwell (Roy. Soc. 1883) same time as my paper, may be consulted. Also, a little later on, a discussion at the S.T.E. and E.; but without substantial advance. Previously there was only Prof. H's theory; I think he made the molecules vary from oblate to prolate spheroids under the variable pressure when vibrating, & therefore vary the resistance.

But I don't know that my views were more than a groping after a theory. My paper is mostly an account of facts observed, which I found to be more simply manageable in terms of the back E.m.f. than an <sup>some</sup> resistance at the contact, though it comes to the same thing either way in a simple circuit as regards quantitation results. I think you

interchange series and parallel in your letter. I found here the limit of increased action when in series, no gain with one or two more, and then a falling off with still more. Now this is in harmony with the behaviour of one contact with very different currents, at the same pressure. If the current were maintained constant, I believe the sound would go on increasing with more contacts, whether equal or not, similarly vibrated. But the current falls by insertion of a new contact, and this increases the resistance of all the contacts, so it falls much more. The initial gain depends on the external resistance battery, telephone and galv. If this be large, compared with res. of contacts, then you can add them in series to a greater extent.

When in parallel, the external resistance should be very small compared with the contact resistance, in order to give increased sound by putting equal contacts in parallel. If not very small, then there may be increased action with one or two or three and later on the falling off. The figuring is troublesome on account of the large variability of the res. of the

The pressure may however be quite well in a sensitive contact.

contacts with the current through them. It has of course to be remembered that the sound depends on the extent of variation of the main current through the telephone, all of which goes through contacts in series, whilst it divides when in parallel.

I never detected <sup>with</sup> certainty any increase of sound when two very good <sup>sensitive equal</sup> contacts were in parallel, compared with those same singly. It seemed just the same in both cases, and tho' it might really involve 10 p.c. difference (?  $\pm$  too much) & with several in parallel there was a falling off. I think the absence of gain with 2 as compared with 1 arose from my external res. being considerable. The total current was not very greatly increased, or not enough to overcome the effect of halving the current, <sup>and so</sup> increasing the resistance of the separate contacts.

To avoid a possible misunderstanding I say that  $e_1 + e_2$  on p. 188 does not mean the sum of  $e_1$  and  $e_2$  measured separately, but the measured value of  $e$  when the two were in series. I ought

to have had a separate letter for the  $e$  of the two together.

It seems to me that it might be useful to make observations by galv.<sup>in a single circuit</sup> and Christie as well, together or simultaneously, with good trustworthy contacts. Say  $a = b$ . Suppose the balancing is done by adding resistance to  $c$ . The results should exactly agree with those got without the Christie, for the same

current through  $x$ , if  $x$  can be really regarded as a mere resistance. On the other hand, if it were a mere back E.M.F. (obvi., reversible with the current)  $\neq$  the values of  $c$  would not be the same. And if both  $e$  and  $r$  in  $x$ , they would still not be the same, and the full formula of the Christie with impressed force would have to be used. Perhaps my trouble was to separate  $e$  and  $r$ . It would be comforting to know that  $r$  alone was satisfactory.

Electric arc investigators make out there is a back  $e$  in the arc, as well as resistance, I believe.

14/9

Yours sincerely  
Oliver Heaviside