TABLE II.

Antenna Capacity = 0.002 microfarad

 $\lambda = 3000 \text{ m.}$ $\delta_1 = 0.10$

Parallel Capacity microfarad	Antenna Inductance microhenrys	Deflection mm.
0	1100	110
0.00034	980	105
.00073	874	95
.00094	830	92
.00147	720	90
.00224	620	74
.00314	515	56
.00422	415	42

DISCUSSION.

John Stone Stone: This paper discusses not only an interesting, but essentially a practical question.

In a very large number of instances the decrement δ_1 , of the wave trains to be received is less than δ_2 , that of the receiving aerial circuit when tuned by an auxiliary inductance or aerial loading coil to receive them. In such cases, there can be no doubt that the substitution of a condenser in parallel to the primary of the receiving transformer for the auxiliary aerial tuning inductance in series therewith, would diminish the rate of energy reception at the detector in the secondary circuit. In such a case the substitution of the parallel capacity for the series inductance would serve to increase the disparity between the decrement of the wave to be received and the decrement of the receiving aerial circuit. Theoretical considerations and indeed some of my own experiments lead me to the conclusion that, other things being equal, the best condition for receiving a damped train of waves is reached when the decrement of the receiving aerial circuit is equal to the decrement of the received wave trains.

There is another consideration to be kept in mind in drawing deductions from the tests outlined in this paper. When a parallel capacity is substituted for a series inductance, the coupling between the aerial circuit and the detector circuit is automatically altered. To maintain this coupling the same in the

two cases, the mutual inductance between the two circuits would have to be simultaneously reduced. Thus, if L_1 is the inductance of the primary of the transformer, L_2 the inductance of the secondary, L_{11} the auxiliary inductance in the aerial, L_{22} the auxiliary inductance in the secondary and M the mutual inductance between the circuits, it would be necessary to reduce

M in the case of the parallel capacity in the ratio $\sqrt{\frac{L_1}{L_1 + L_{11}}}$

The apparent resistance and reactance to alternating currents of a system consisting of a condenser in parallel to a coil is:—

$$R' = \frac{R}{R^2 C^2 \omega^2 + (C L \omega^2 - 1)^2}$$

and

$$X' = -L \omega \frac{R^2 \frac{C}{L} + C L \omega^2 - 1}{R^2 C^2 \omega^2 + (C L \omega^2 - 1)^2}$$

where R , C , and L are respectively the resistance capacity and inductances of the loop and ω is $2 \pi n$, where n is the frequency of the current. If ω_0 is the periodicity to which the loop is

itself resonant when isolated, so that $\omega_0 = \sqrt{\frac{1}{C L}}$ and if the periodicity of the impressed force be m times this, then:—

$$R' = \frac{R}{m^2 R^2 \frac{C}{L} + (m^2 - 1)^2}$$

and

$$X' = -L m \omega_0 \frac{R^2 \frac{C}{L} + m^2 - 1}{m^2 R^2 \frac{C}{L} + (m^2 - 1)^2}$$

These are the two quantities which have to be considered in computing the decrement in the case of a condenser in parallel with an inductance in an aerial. Of course, these expressions only apply with complete accuracy in the case of sustained oscillations. But they are approximately correct in the case of damped oscillations except where the decrement is quite large and I have found them to be of considerable utility in the case of the damped trains of waves used in commercial practice.

In the case where the coil of the loop circuit is the primary of a transformer loosely coupled to a detector circuit tuned to the

periodicity $\omega = m\omega_0$ of the received waves, the L of the above expression remains unchanged but the R must be increased by the addition of the amount $\frac{M^2 m^2 \omega_0^2}{R}$.

John L. Hogan, Jr.: Dr. Austin's paper opens a field for further investigation which should prove of value. I have no data at hand which either confirms or contradicts his results, but would suggest that in using the capacity-shunted primary I have found what appear to be two distinct cases which in general give opposite actions. When the wave length received is much greater than the natural wave length of the antenna, the distributed inductance of the aerial may be neglected and its capacity can be considered simply as a shunt to the lumped capacity in parallel to the lumped primary inductance. When the received wave is of the same order as the natural wave length of the antenna in question, it appears to be necessary to tune the antenna itself, independently of the capacity-shunted primary, to the wave length desired. This tuning is accomplished by use of a variable loading inductance in series with the aerial, above the upper point of connection to the shunting condenser.

My experiments indicate that relative efficiencies with and without shunting condenser depend not only upon the ratio of incoming wave length to receiving antenna natural wave length (and the mode of connection which this ratio indicates as the better), but also upon the decrement of the received wave as compared to that of the receiving circuit as a whole. I hope that there will be forthcoming additional data of tests in which there is varied not only the ratio of primary inductance to capacity but also the other quantities of which I have spoken.