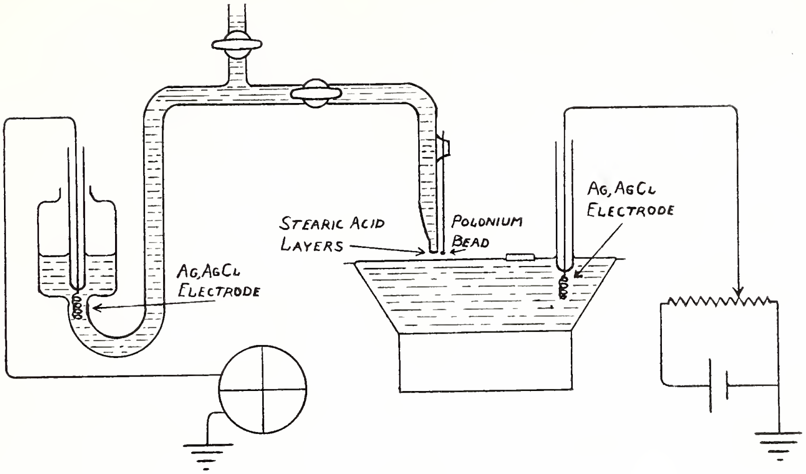

Fig. 1.

So far we have studied the relation between the concentration of the solution and the corresponding change in the potential of the circuit and found our results with the new arrangement much more reproducable, and constant with time, than with a metallic upper surface.

RADIO FIELD INTENSITY MEASUREMENTS ABOUT ATHENS, OHIO

D. B. Green and R. V. Kelch, Ohio University

A meter for measuring radio field intensities was constructed along lines similar to the instruments of Englund[1], Friis and Bruce[2], and Byrne[3].

The meter is essentially a vacuum tube voltmeter, reading the radio frequency voltage produced across the tuning condenser of the loop antenna circuit. It consists of a tuned loop antenna, feeding a superheterodyne receiver with an adjustable, calibrated attenuator in the intermediate frequency amplifier circuit. A calibrating oscillator furnishing a known voltage for comparison is coupled to the loop. Plate meters in the first and second detector circuits are used as volume level indicators.

---

[1] Proc. I. R. E. V. 5 P. 248, 1917.

[2] Bell Tel. Lab. reprint B-209, Sept., 1926.

[3] Ohio State U. Studies, V. 1, No. 4, Part 2, July, 1932.

Referring to fig. 1, the radio frequency signal, to be measured, of strength E volts per meter, induces a voltage, h E in the tuned loop circuit, where h is the effective height of the loop antenna. By the step-up action of resonance this voltage appears as Q h E across the tuning condenser C, where Q is the step up action of loop resonance. This voltage operates the first detector tube, whose output is controlled by the attenuator and amplified by the intermediate amplifier and fed into the second detector tube. The calibrating and beating oscillators are shown in the diagram. The loop can be shorted by the two switches, K_1 and K_2, without shorting the tuning condenser.

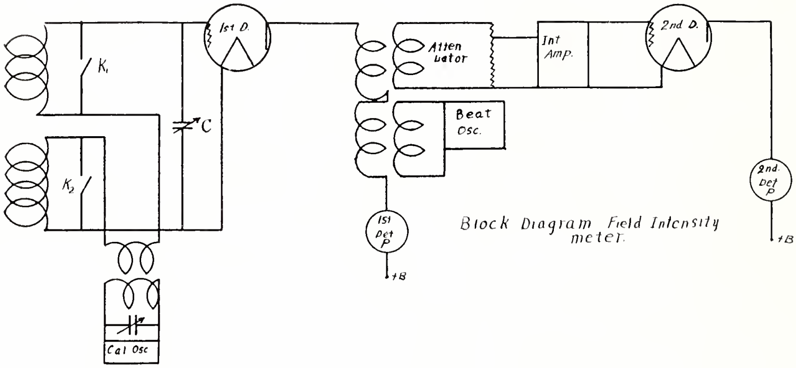

Fig. 1.

The first detector is calibrated as a vacuum tube voltmeter by impressing one volt A.C. upon the grid and noting the increase of plate current by meter No. 1. The method of measuring is, broadly, as follows: The amplified signal from the radio field is attenuated by an amount A_1 to produce a standard reading, say 100 microamperes, in the second detector plate meter. The standard voltage of one volt from the calibrating oscillator, tuned to the frequency of the radio signal is then applied to the loop and the attenuator adjusted by an attenuation of A_2 to give the same reading on the second detector plate meter. The loop is then shorted out by the switches, K_1 and K_2 and the standard calibrating voltage applied directly to the first detector without the step-up of loop resonance. The attenuator is again adjusted by an attenuation of A_3 to give standard reading on the second detector plate meter. The Q of the loop is found from the ratio of A_2 and A_3. The field strength in volts per meter can then be calculated from the three attenuator readings A_1, A_2, and A_3 and the calculated effective height of the loop antenna. The theory follows:

Since the same voltage is impressed on the second detector in all three cases, as indicated by the same reading of the plate meter, the input voltages on the first detector are proportional to the attenuator readings, required to reduce them to equality, so the voltage Q h E across the tuning condenser, caused by the distant station—

$$\frac{QhE}{1\ \text{volt}} = \frac{A_1}{A_2} \qquad \text{but } Q = A_2/A_3$$

$$\text{and} \quad hE = \frac{A_1A_3}{A^2_2}$$

The field strength in volts per meter is obtained by dividing the volts induced in the loop by the effective height of the loop. This effective height is

$$h = \frac{2\pi NA}{\lambda}$$

where N is the number of turns in the loop and λ is the wave length of the signal and A is the area of the loop.

Some typical results are given in table I. Sixteen stations were studied, varying in field at Athens from 2400 to 2 microvolts per meter. Hill-top measurements averaged about 1.5 times as strong as the same signals measured in the Hocking River valley about 300 feet below the hilltops. Measurements of the same stations taken at Logan, Ohio, 22 miles northwest of Athens, but in comparatively level country, averaged 1.4 times as strong as the average between hill and valley measurements at Athens. This is after the Logan measurements had been reduced by the distance factor affecting some of the nearer stations. This is in accord with common report that all southern Ohio has poor reception. The difference is very noticeable when operating an auto radio en route from central to southern Ohio. The hilly terrain seems to attenuate the radio waves more than level country or else to screen all but the highest points from good reception.

FIELD INTENSITY MEASUREMENTS

Station	Distance miles	Field micro volts per meter Athens		Logan		Attenuation Constant Athens
		Hill	Valley	Distance	Field	
WKRC	120	110	77	115	120	.025
WAIU	65	220	120	44	310	.041
WLW	115	425	380	100	780	.030
WHAS	232	60	45	232	18	.030
KDKA	140	75	48	140	38	.038
WTAM	135	48	34	121	30	.039
WWVA	85	100	61	97	47	.05
WSAZ	65	70	25	73	....	.057
Average[1]		138	98		193	

[1] Av. Corrected for Distance........................ 153

Table II shows the constancy of the field produced by the better stations. The early morning and night figures show the results of fading. The night signal changed intensity by a factor of 10 often during a time of only a few minutes.

The curves of fig. 2 show the variation of the attenuation constant with frequency. To be sure, these figures were taken on different stations and all were assumed to have a quarter wave, grounded antenna in order to calculate their attenuation constant from measurements made at a single location but they show a definite tendency toward higher attenuation with higher frequency. Somerfeld[4] has arrived at the above conclusion, theoretically, and Byrne has verified it experimentally by measurements on Ohio broadcasting stations.

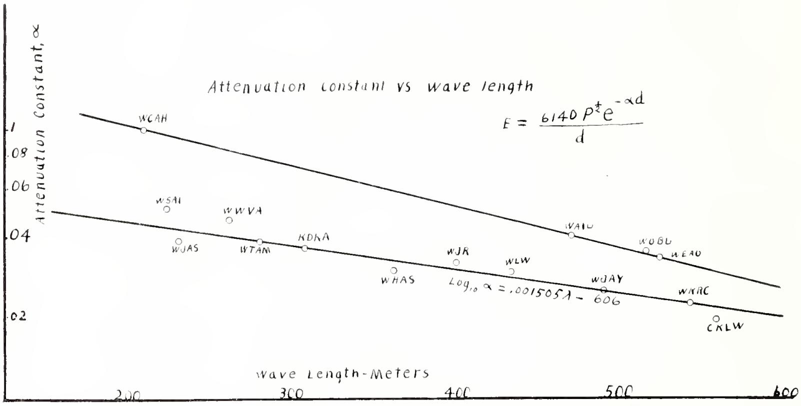

Fig. 2.

It is interesting to note that the attenuation constants for the stations whose signals followed the Hocking River valley, three Columbus stations from the northwest and a West Virginia Station from the south, were much higher than those stations whose signals came across the valley. These stations fell on a straight line which gave different constants in the equation deduced between frequency and attenuation constant, as obtained from semi-log paper.

It seems logical that ground losses might be classed as eddy current losses which always depend upon frequency.

TABLE II

VARIATION OF FIELD WITH TIME

WLW

Time 10 A. M.		May 1, 1933	
Day	Field	Hour	Field
May 4	485	6-20 A. M.	1700-550
May 7	485	9-00	680
May 9	435	11-00	680
May 16	485	12-00	680
		1-00 P. M.	680
		2-00	680
		4-00	610
		11-00	2400-240

---

[4] Ann. Physik. V. 4, No. 28, p. 665, 1909.