THE HIGH FREQUENCY RESISTANCE OF CONDENSERS IN SERIES.

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The results of Callis[1] and of C. N. Weyl and S. Harris[2] are so different from the values usually assumed, values deduced from low frequency measurements, it seems desirable to get a check on the results. Many of the attempts made to check the results seemed to be reasoning in a circle. As an illustration I give the attempt to check by measuring the resistance of two condensers in series.

Since the resistence of each condenser is known at any dial setting it was thought that the resistance of the circuit could be measured with one condenser in the circuit and then two could be placed in series in the circuit and the resistance could be measured again and the law of variation could be checked.

The condensers were placed in the circuit as shown in figure 1. The single condenser was placed in the circuit and tuned to the frequency of

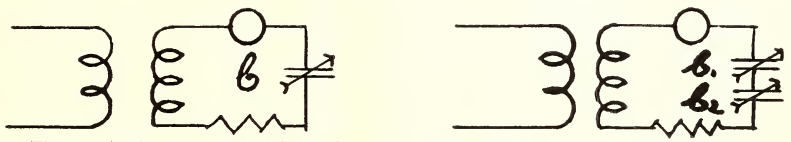

Fig. 1—At left, circuit with condenser whose capacity is C; at right, circuit with two condensers in series whose combined capacity is equal to C.

the oscillator and the resistance measured. Then the single condenser was replaced by the two in series and the circuit tuned to the same frequency and the resistance was measured again. To our surprise it was found that the resistances of the two circuits were the same, which amounts to saying that the resistance of two condensers in series is the same as that of a single condenser.

If we assume that the resistance of condenser varies inversely with the capacity, we have

$$r_1 = K/C_1 \text{ and } r_2 = K/C_2$$

for the resistances of the two condensers. Then since

$$R = r_1 + r_2$$

for series connection. Then

$$R = K/C_1 + K/C_2 = K(1/C_1 + 1/C_2) = K(C_1 + C_2/C_1C_2) = K/C$$

where C, is the capacity of the two in series and since the circuits were tuned to the same frequency it is also the capacity of the single condenser in the first circuit.

[1] Phil. Mag. 1926.

[2] Inst. Radio Eng. Proc. 13, 109. Feb., 1925.

"Proc. Ind. Acad. Sci., vol. 34, 1925 (1926)."

Thus if the capacity of a condenser varies inversely as the capacity the resistance of any number of condensers in series is a constant provided the effective capacity is constant.

I might add that this will be true also if the resistance of a condenser is small enough to be neglected.

ON THE RESISTANCE OF RADIO CIRCUITS.

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In a radio circuit we have resistance, inductance and capacity. The current, I, is given by the well known formula for alternating current

$$I = \frac{E}{\sqrt{R_2 + \left(\frac{1}{Cw} - Lw\right)}}$$

where E is the electro-motive force, R, L, and C are the resistance, inductance, and capacity, respectively. When $\frac{1}{Cw} = Lw$, the impedance will be a minimum and the current rent will be a maximum, or I=E/R.

In alternating current of low frequency we have voltmeters by means of which the E. M. F. and difference of potential between various points can be measured. In high frequency work we have no voltmeters. The only measuring instrument we have is a thermal ammeter which depends upon the heat developed in the circuit.

In measuring the resistance of a radio frequency circuit there are two general methods—the impedance variation method and the resistance variation method. In the first the resistance is calculated from the change of the square of the current produced by a certain change of the capacity of the circuit. The second depends upon the change of the current produced by inserting known resistance in the circuit. In the resistance variation method the circuit is tuned until the current is a maximum, or I=E/R. Then resistance is inserted and the value of I is noted. As a particular case resistance is inserted until the current is one-half of the original current, then $I_2 = \frac{E}{2R}$ and the resistance inserted is equal to the resistance of the circuit. The resistance thus formed is that of the coil, condenser and of other devices which may absorb energy from the circuit. It is comparatively easy to measure the total resistance of the circuit but is very hard to measure the resistance of any part of the circuit. Thus, to measure the resistance of a coil it is necessary to know the resistance of the condenser and other parts of the circuit. It will be necessary to define the term resistance. Resistance as used here means anything which