THREE ELECTRODES VACUUM TUBE OSCILLATOR, A SPECIAL CASE OF PARALLEL RESONANCE.

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Resonance in Parallel Circuits. Two or more parallel circuits are said to be in resonance when the inductive susceptance is equal to the condensive susceptance.

Figure 1 is an electrical generator circuit in which there is a condenser and coil in parallel, and figure 2 is the vector diagram in case of parallel

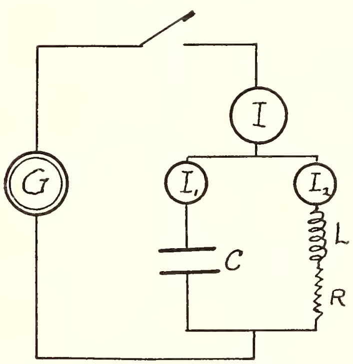

Fig. 1—An electrical generator circuit in which there is a condenser and coil in parallel.

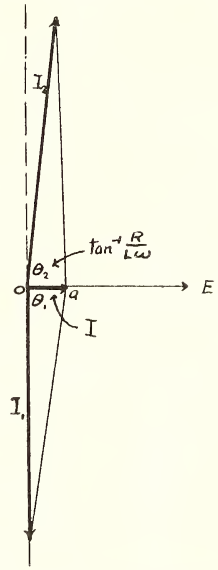

Fig. 2—Vector diagram in case of parallel resonance.

resonance, assuming that we have pure capacity and inductance a small resistance series with the inductance, L. For the figure 2 to be in resonance, I_1 must be equal to I_2. Since ($E/Lw = ECw$) and $I = E\sqrt{R^2+(Lw-1/Cw)^2} = E/R$, where R is the resistance in series with the generator. Therefore in a circuit in which resonance exists the total current, I, is equal to the current in the conductive part of the circuit, it is in phase with the total impressed E.

Assumption of Three Electrodes Vacuum Tube as Driver of High Frequency Circuit. Referring to figure 3 an assumption is made that the vacuum tube is equivalent to a generator and the regenerative or tickler circuit is equivalent to a reversing switch or commutator which does not take much energy.

Figure 4, the vector diagram is drawn from circuit 3 which is similar to figure 2.

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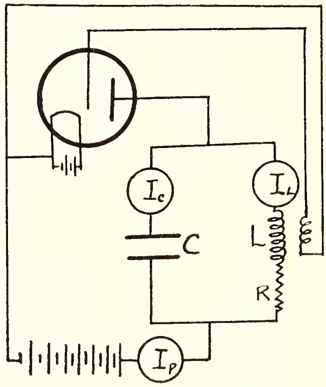

Fig. 3—A vacuum tube generator circuit.

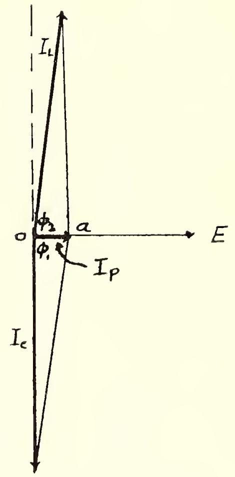

Fig. 4—Vector diagram of figure 3 which is similar to figure 2.

In figure 3, I_c is the radio frequency current through the condenser. This is numerically equal to I_L. The vector difference I_p is the radio frequency current in the plate circuit of the tube.

The current in the plate circuit consists of two currents I_p the alternating current superimposed on a direct current. The D.C. milliammeter in the circuit measures the direct current. Referring to figure 5 which gives the characteristic curve of the tube, the current when the tube is oscillating is represented by the curve which is very much like a sine curve. If this is an alternating current superimposed on a direct current, the direct current is represented by the horizontal line ab, and the maximum value of the alternating current is equal to the direct current. Then $I_p(A.C.) = I_p(D.C.)/\sqrt{2}$. Thus the D.C. milliammeter can be used to give an indication of the alternating current in the plate circuit. The vector (oa) in figure 4 should be equal to the direct current divided by $\sqrt{2}$. Thus $I_p(A.C.) = I_p(D.C.)/\sqrt{2}$.

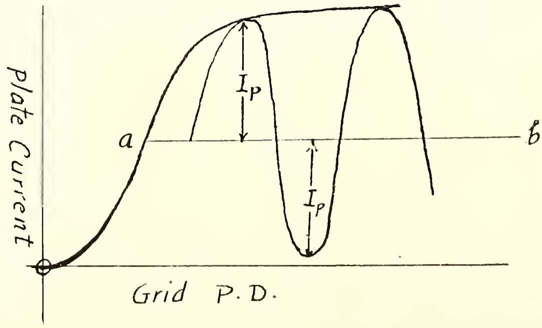

Fig. 5—Characteristic curve of the vacuum tube.

In this experiment a 201A vacuum tube is used.

From figure 4 the relationship is $I_c \tan \phi_1 = I_c RCw = I_p/\sqrt{2}$. . . . . (A)

Notes:

R is the total resistance of the resonance circuit as measured by the resistance variation method.

C is pure capacity in micro farads.

w is the angular velocity $= 2\pi n$, n being the frequency.

I_c is the oscillating current indication of the thermocouple type ammeter.

I_p is plate current indicated by D. C. ammeter.

The following data and calculation shows the relationship of equation (A).

Wave length in meters	Capacity (M. F.)	Resistance (R)	Tan ϕ_1 (RCw)	I_c	I_p(A.C.) = $I_p \text{Tan}\phi_1$	$I_p/\sqrt{2}$
1000	0.00183	7.5	0.0258	116	2.99	2.00
1140	0.00206	6.0	0.0204	111	2.26	1.89
1220	0.00236	6.0	0.0220	113	2.48	1.99
1350	0.00288	6.0	0.0242	115	2.78	2.06
1490	0.00384	5.3	0.0259	115	3.00	2.37
1510	0.00358	8.6	0.0385	116	4.47	2.27
1650	0.00428	6.0	0.0293	114	3.36	2.38
1700	0.00488	6.0	0.0322	109	3.52	2.54
1780	0.00500	6.0	0.0318	107	3.41	2.60
1920	0.00582	6.0	0.0345	104	3.58	2.66
2060	0.00663	5.0	0.0305	99	3.02	1.66

The data in the last two columns should check. However the method of estimating the alternating current in the plate circuit is very crude. The check is close enough to show that the oscillating tube generator can be explained very simply by considering it to be a special case of parallel resonance.

Note: If the tube is oscillating vigorously the alternating current will be greater than $I_p(DC)/\sqrt{2}$. The curve for A.C. current instead of being a sine curve will be more rectangular.