

LETTERS TO THE EDITOR

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OSCILLATION CHARACTERISTICS OF A HARTLEY OSCILLATOR

APPLETON¹ and Appleton, Watt and Herd² determined the oscillation characteristics by direct experiment for valve circuit. They did not try the Hartley circuits. Neither did they draw the oscillation characteristics by calculation from the static characteristic curves of the valve. In the present communication comparative study of the oscillation characteristics for the Hartley oscillator by the two methods is put forth.

2. Let M be the mutual inductance between the grid and the plate coils whose inductances are L and L_a having negligible resistances. The relation between the induced anode potential v_a and the induced grid potential v_g is given by

$$v_a = -\frac{L_a}{M} v_g \quad (1)$$

It is well known that M must be negative to produce self-excitation so that v_a and v_g are in opposite phase. The anode current I_a at any instant is a function of both the anode and grid potentials for a given filament current; and the action of a triode is usually interpreted in terms of the relation,

$$I_a = \phi(V_0 + v_a, v_g) \quad (2)$$

where V_0 is the steady potential applied to the plate of the valve. The direct determination of the relation between I_a and v_a can be done when the values of v_g are made consistent with the relation (1). Then we have

$$I_a = \phi\left(\overline{V_0 + v_a}, -\frac{M}{L_a} v_a\right) \quad (3)$$

as oscillation characteristic.

3. A parallel fed Hartley Oscillator circuit suitable for short-wave range 50 to 150 metres, of which the oscillation characteristics were determined is shown in Fig. 1. This is fitted

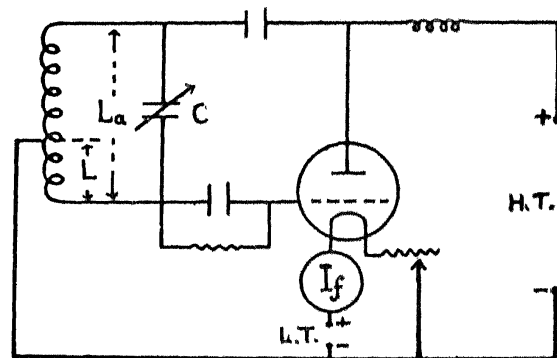


FIG. 1

with the usual pulse generating device of a fixed condenser shunted by a high resistance.

From the dimensions of the coil L_a and the position of tapping, the values of L_a and M were calculated by usual formulæ and found to be 18.6 and 10.1 μ H respectively, giving the ratio

$$\frac{L_a}{M} = 1.84. \quad (4)$$

As a check the value of L_a was experimentally determined by calibrating the oscillatory circuit for wave-length λ and plotting a graph between λ^2 and the corresponding capacity of the variable condenser C . This graph is evidently a straight line. The gradient of this line gave

TABLE I
($V_0 = 60$ volts)

v_a volts	..	+10	+8	0	-10	-14	-20	-30	-35	-40	-50	-60
I_a mA	..	..	1	5	13	16	20	25	26	24	14	0

TABLE II
 $V_0 = 100$ volts

v_a Volts.	..	+20	+16	+10	0	-10	-20	-30	-40	-50	-60	-70	-80	-90	-100
I_a mA	..	..	1	3.5	12	22	30	36	39	40	37	32	22	13	0

the value of L_a as $18.58 \mu H$, which is in close agreement with the calculated one.

The experimental arrangement for the direct determination of oscillation characteristics is shown in Fig. 2. The fixed non-inductive

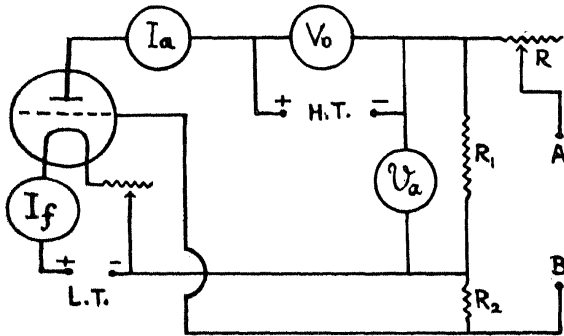


FIG. 2

resistances R_1 and R_2 are so chosen that

$$\frac{R_1}{R_2} = \frac{L_a}{M} = 1.84$$

A variable resistance R serves to adjust the potential v_a to any required value, which can also be made negative or positive by interchanging the connections of D.C. supply between A and B. The filament current was maintained constant at the rated value of 150 mA. A series of readings of I_a corresponding to v_a beginning from positive and ending with negative values were recorded, for

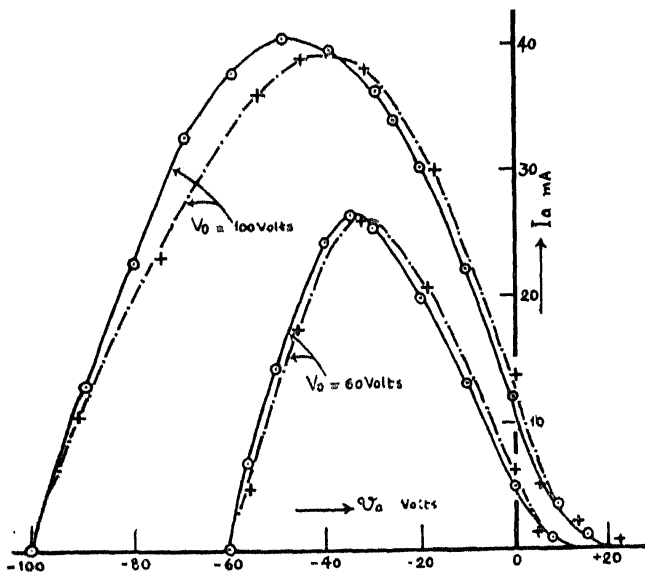


FIG. 3

two different values of V_0 . These are given in the Tables I and II.

The two oscillation characteristics are graphically shown in Fig. 3 by full lines.

4. Appleton¹ has mentioned that the oscillation characteristics of a circuit could be drawn from the I_a, v_g curves of the valve but this process involves laborious calculations. The present author has used plate-potential characteristic curves for different grid bias, to effect simplification.

With this in view, V_a, I_a static curves were determined for several values of V_g ranging between -12 volts to $+60$ volts. Then using relations (1) and (4) and remembering that $V_a = V_0 + v_a$ the values of I_a are read off from these curves corresponding to the values of V_a . Calculations are made for two oscillation characteristics corresponding to V_0 equal to 60 and 100 volts. These are given in Table III.

TABLE III

v_g Volts	v_a Volts	$V_0 = 60$ Volts		$V_0 = 100$ Volts	
		V_a Volts	I_a mA	V_a Volts	I_a mA
-12	22.1	82.1	..	122.1	0.5
-8	14.7	74.7	0.5	114.7	1.5
-3	5.5	65.5	1.0	105.5	5.0
0	0	60.0	6.0	100.0	13.5
10	-18.4	41.6	20.5	81.6	29.5
18	-33.1	26.9	25.5	66.9	37.5
25	-46.0	14.0	17.0	54.0	38.5
30	-55.2	4.8	4.5	44.8	35.5
40	-73.6	..	..	26.4	22.5
50	-92.0	..	..	8.0	10.0

The two calculated oscillation characteristics are shown by broken lines in Fig. 3.

5. Although there is a slight difference between the calculated and the observed values of I_a yet the agreement between the two may be deemed as fairly good considering the uncertain factors like over-heating of the valve in such experiments.

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1. Appleton, E. V., *Phil Mag.*, 1921, 42, 201. 2. Appleton, Watt and Herd, *Proc. Roy. Soc.*, 1926, 111, 672.