Likenesses and Differences of Resonance Curves Produced by Damped Wave and Continuous Wave Transmitters

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The resonance curve of a circuit is one which shows the relative value of the current in the circuit as the frequency of the impressed electromotive force is changed. Often the frequency of the e.m.f. is kept constant and the current is read while the capacity of the circuit is changed. These curves, in many cases, for all practical purposes, are the same as the true resonance curve. These curves, which are admittance curves, are often called resonance curves. Especially when the frequency n, as calculated from the formula $n = \frac{1}{2\pi\sqrt{LC}}$, is used instead of capacity as the abscissas.

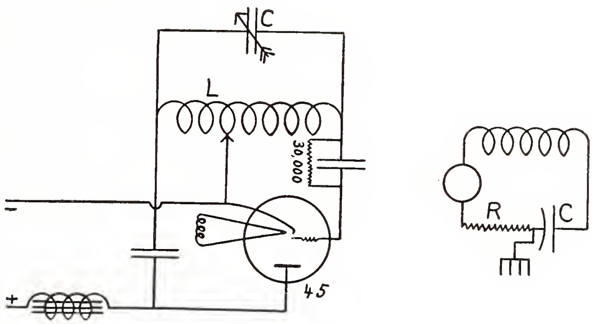

Fig. 1.

In Figure 1 the resonance curve is obtained by reading the meter in the wavemeter, while the frequency of the tube oscillator is changed by means of the variable condensers in the oscillator circuit. An admittance curve is obtained by reading the meter in the wavemeter circuit while the condenser in the same circuit is varied.

If the coupling is loose, i. e., the mutual inductance is small, both of these curves have one more or less sharp peak. If the coupling is close, or $M\omega > \sqrt{R_1R_2}$ then the resonance curves have two peaks or humps. In the above formula M is the mutual inductance; ω is the angular velocity, or $\omega = 2\omega n$ where n is the frequency. R_1 and R_2 are the resistances of the primary and the secondary circuit, respectively.

If one uses the modern tube oscillator with pure d.c. potential on the plate of the tube, one has trouble in procuring the double humped curve. If one couples the secondary, or wave-meter, circuit, to the oscillator closely and varies the impedance of the wave-meter so as to make the current increase, the current in the wave-meter increases and suddenly changes to a low value and decreases to zero as the capacity is changed in the same direction—capacity being increased, say. If, after the current has suddenly decreased to a low value, the dial is turned in the opposite direction so as to decrease the capacity, the current increases to some high value and then suddenly decreases, as in the first case. This is much as in Figure 2. If the generator is heterodyned

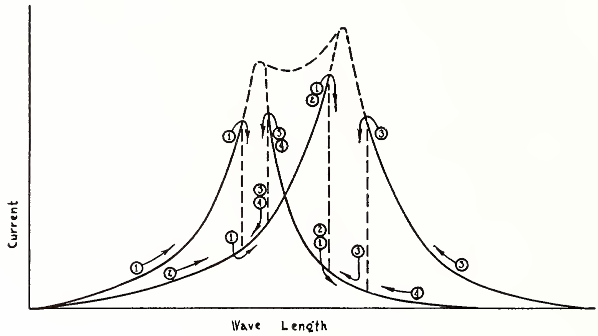

Fig. 2.

with some constant frequency, such as a broadcasting station, and the heterodyne tone is noted, there will be a sudden change of pitch when the circuit "flops." This shows that the frequency of the generator suddenly changes from one value to another. It seems that there are two possible frequencies at which the coupled oscillator system may oscillate, but it oscillates at any one time at one frequency only. It may suddenly change from one frequency to the other without any apparent cause.

If one uses a spark transmitter or damped wave and proceeds as above, a single hump is obtained with loose coupling, and a double humped curve is obtained with close coupling. This is illustrated in Figure 3. If a tuned link circuit is introduced between oscillator and

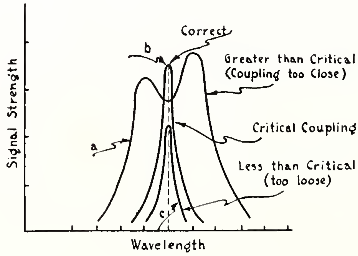

Fig. 3.

wave-meter and the coupling made loose, the position of the peak may be changed by detuning the link circuit a certain amount.

From this and other experiments with damped waves it seems that in an admittance curve or resonance curve the value of the ordinate at any frequency shows the value of the current at the particular frequency in question. Thus, in Figure 3 it seems that we have maximum response at a frequency whose wave length is 300 meters, perhaps 1000 kilocycles, and also current at 297-303 meters, or at a frequency extending from 1010 to 990 kilocycles. In the case of the closely coupled circuit, there seems to be maximum current at about 298.5 and 301.5 meters.

This seems to justify the not unusual assumption that a coupled circuit produces two frequencies, neither of which is the frequency of the oscillator taken by itself. If, instead of the damped wave generator, one uses a C. W. oscillator and introduces a tuned link as in Figure 4, all admittance curves give peak response at the same frequency, namely, at the frequency of the oscillator. This shows that link circuits do not change the frequency of the oscillator, and the oscillator vibrates at one frequency only. This is true if the wave-meter is coupled loosely or closely to the link circuit. If the link is closely coupled to the oscillator, the frequency may change suddenly from one value to another, but there is only one frequency at any one time. If the link circuit (circuit 1 in Fig. 4) is loosely coupled to the oscillator, the wave-meter (circuit 2,

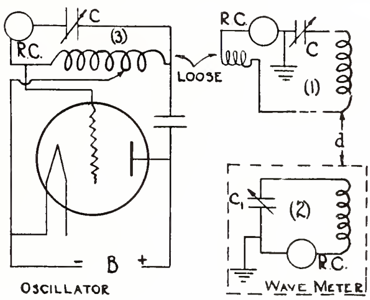

Fig. 4.

Fig. 4) being closely coupled to the link circuit and the link and wave-meter both tuned to the frequency of the oscillator, and a resonance curve is taken by changing the frequency of the oscillator, reading the ammeter in the wave-meter circuit, a douple humped curve is obtained. This shows that the closely coupled circuit is tuned for maximum response at two frequencies.

The apparent discrepancy between the continuous wave circuits and the damped wave is apparent if one remembers that a wave of varying amplitude is one whose frequencies are changing. Or a damped wave generator produces a band of frequencies, while a tube generator whose amplitude is constant generates current of one frequency.

In the early days of radio it was assumed that a spark station gave a single frequency, and apparently a closely coupled circuit produces two new frequencies. Too many physicists are still living in the spark station age.

In theoretical physics it is not an uncommon assumption that coupled circuits produce two frequencies. This, with the erroneous assumption that the sum of two sine waves produce combinational tones or side bands, has lead to many erroneous conclusions.