CONSTRUCTION OF AN AUDIO FREQUENCY OSCILLATOR

by

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Table of Contents.

	page
Introduction	2
Statement of Purpose	3
General Theory	4
Description of the Method and Apparatus Used	6
Conclusions	10
Bibliography	11
Approval	12

Introduction

This thesis prepared under the direction of Dr. C.A. Perkins is practical in nature. No theoretical work was done and no theory was used in arriving at the results of this thesis. Although no theory was used, a knowledge of the general theory was necessary for the completion of the project in view. The method of obtaining the results might be termed the trial and error method, different conditions being tried until a satisfactory result was obtained.

Statement of Purpose

The purpose in undertaking the work on this thesis was to make an oscillator that can be used for sound resonance method of testing apparatus that has an audible vibration or pitch. For this work an audible frequency of about 1000 cycles per second is desirable.

In the following pages it is intended to be shown the general theory of the work undertaken and the difficulties encountered and the things to be avoided in work of this nature. A complete description of the completed work will be given with all necessary diagrams for a thorough understanding of the detailed construction.

General Theory.

If a capacitance C and an inductance L (Fig. 1) are connected in series in a closed circuit and an e.m.f. is applied across the condenser or capacitance it will become charged. If now the e.m.f. is removed the condenser will discharge through the inductance. The self induction of the inductance will not allow the current to stop when the potential across the condenser has become zero but causes the condenser to become charged in the opposite direction. The current dies out and the condenser discharges again in the reverse direction. This charging and discharging takes place at a definite rate but quickly dies out due to the resistance of the circuit. The frequency with which this current oscillates depends on the capacity and the inductance in the circuit. If the e.m.f. applied to the condenser could be reversed at each time the potential of the condenser became zero, then the oscillations would not die out. An alternating generator with a frequency exactly that of the oscillating circuit would be necessary to sustain the oscillations.

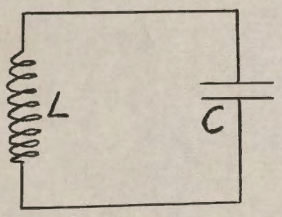

Fig. 1

The three element vacuum tube as a generator of alternating current is well recognized in the radio industry, and it will oscillate with the frequency of the oscillating circuit.

In Fig. 3 the three elements of the vacuum tube are

represented by the letters G, P, and F. As shown the current flows from P to F; never from F to P. When the circuit is first closed the current in the circuit PFDC is on the increase. Flowing from D to C while increasing causes an e.m.f. to be set up in the inductance L in the direction DE. This e.m.f. charges the condenser AB making B positive and also makes the grid G positive. G being positive will allow more current to flow from P to F. This current reaches a limit and the e.m.f. in the coil L dies out allowing the condenser to discharge through the coil L. The grid G becomes less and less positive causing the current to decrease. This decrease of the current in the circuit PFDC sets up an e.m.f. in L in the direction ED. This e.m.f. charges AB again making A positive. B is then negative and also G. G being negative causes still further decrease in the current from P to F because of the electrons emitted from F being repulsed. When G acquires a high enough negative charge the current from P to F becomes zero. The condenser then discharges and the process is repeated. The frequency of this charge and discharge depends on the capacity of AB and the inductance of L. The pulsating current in PC caused by the current starting and stopping is heard in the phones if the frequency is in the audio range of frequencies.

Description of the Method and Apparatus Used

A radio audio-frequency transformer was first connected as shown in Fig. 2 but the saturation of the iron core made the frequency vary widely for small variation in the voltage impressed on the plate. This change of frequency makes such an inductance impractical for a test oscillator of this kind. Since having iron in the core of the inductance coil was a serious drawback to the use of the circuit, the logical thing to do was to use an air core coil in the oscillating circuit. An oscillator used for testing radio sets was investigated as a probable circuit for an audio frequency oscillator. What at first was thought to be an audible oscillation was later attributed to the charging and discharging of the grid condenser from the radio frequency oscillations. Such a note was misleading until a change of grid leak caused a change in pitch of the sound.

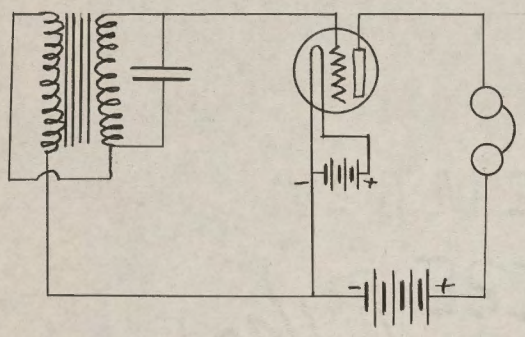

Fig. 2

Several coils were tried in connection with condensers of capacities from .1 to 2 micro-farads but with no success. After trying various hook-ups and combinations of coils and condensers, a coil was found which would give a clear aud-

ible note when used with a similar coil as a feedback from the plate and a .2 micro-farad condenser in the oscillating circuit. More turns of wire were wound on the oscillating coil and the single coil used as feedback and oscillating circuit. The vacuum tube used was of the 201A detector-amplifier type radio tube using five volts to heat the filament and a plate voltage of 90 volts or less. The connection of apparatus is shown diagrammatically in Fig. 3.

The completed oscillator gave a pleasing melodious note having a frequency of approximately 1000 cycles per second with the .2 micro-farad condenser. A tuning fork with a pitch of 1024 was compared with the note of the oscillator and found to be close to resonance. The coil first used successfully was connected in a bridge and the inductance found to be about 0.165 henries. Using the equation $f = 1000/2\ \sqrt{LC}$, where f is the frequency in cycles per second, L is the inductance in henries, and C is the capacity in micro-farads, the frequency was calculated to be about 900 cycles per second. This was just a rough check and time was not available to attempt to check it closely as to the calculated and actual frequency.

The pitch remained constant for plate voltages of 20 to 100; below 20 volts it would not oscillate. Change in the filament voltage only changed the strength of the oscillations.

The oscillator was mounted on a base as a unit with binding posts for outside connections for batteries and

phones. Three condensers of .1 micro-farads each were mounted on the base and so connected by switches that either one, two, or all three could be connected in parallel. This arrangement gives three different pitches of the oscillator so that the ear would be relieved and also provide a pitch above and one below 1000 cycle frequency.

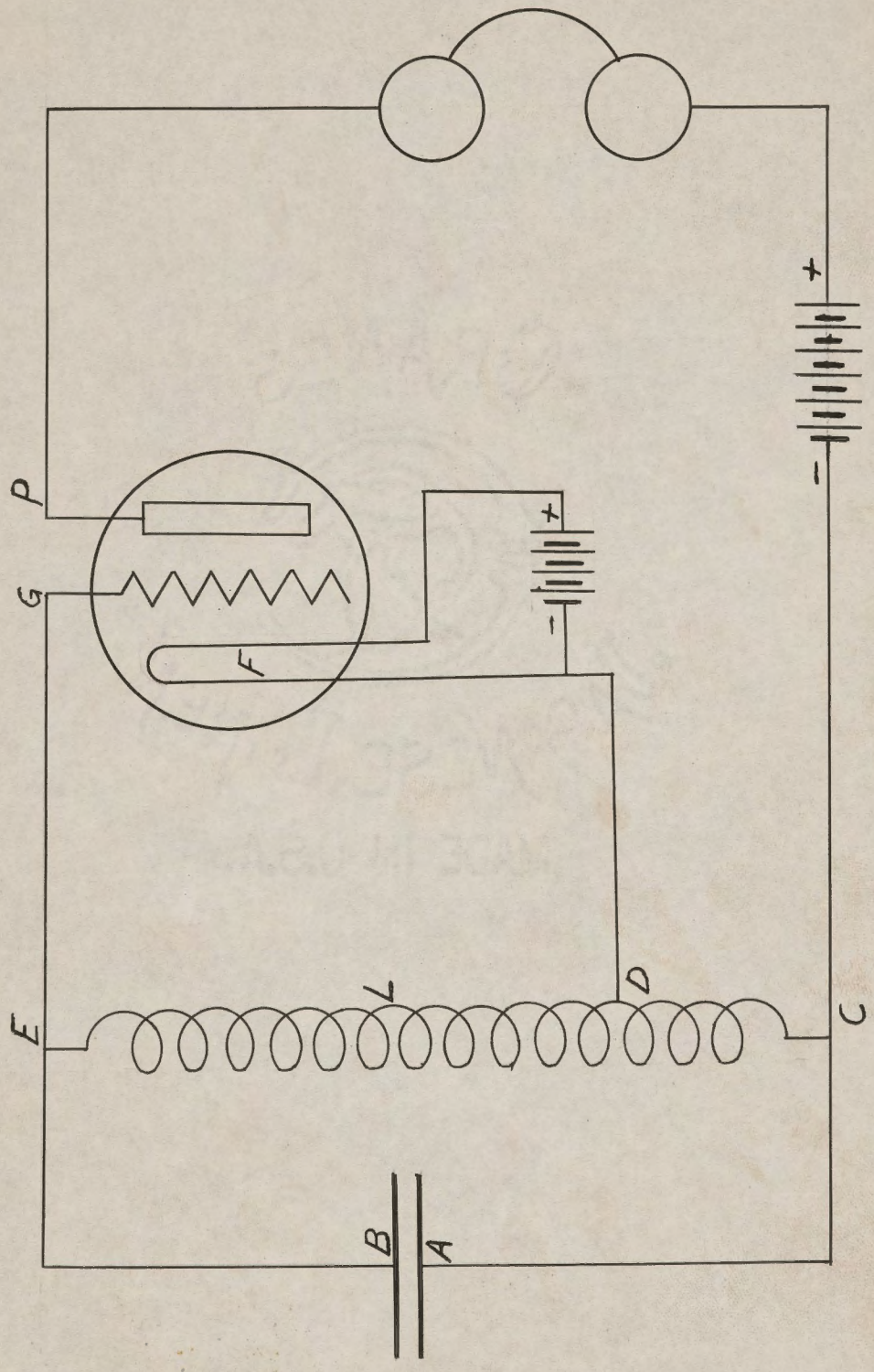

Fig. 3

Conclusions.

The preparation of this thesis showed clearly the superiority of the air core coil over the iron core coil for use in work of this nature where a constant inductance is to be maintained. It is believed that a number of so-called audio frequency oscillators are being used with the discharge of the grid circuit as the basis of experimentation instead of the actual oscillation of the oscillating circuit.

Although no test work was done with the oscillator, it is easily seen that the electric current of audio frequency will be very useful for calibrating purposes.

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APPROVAL

The foregoing thesis is hereby approved as a creditable study of an engineering subject, carried out and presented in a manner sufficiently satisfactory to warrant its acceptance as a prerequisite to the degree for which it has been submitted. It is to be understood that by this approval the undersigned does not necessarily endorse or approve any statement made, opinions expressed, or conclusions drawn therein, but approves the thesis only for the purpose for which it is submitted.

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