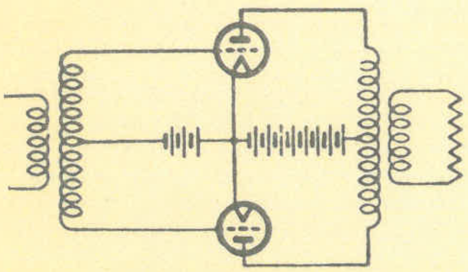


Fig. 4A - Push Pull connection of two vacuum tubes arranged to duplicate the circuit of Fig. 1A but deliver twice the power to the load and reduce harmonics.

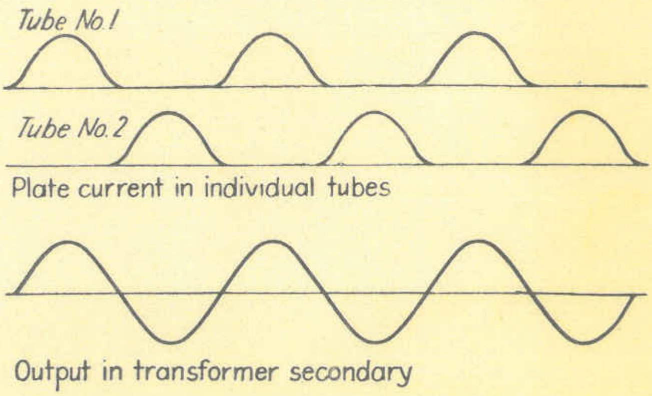


Fig. 4B - Plate current flicks similar to that shown in Fig. 3D. Tubes 1 and 2 operate alternately and produce the resultant A.C. wave in the secondary or load circuit.

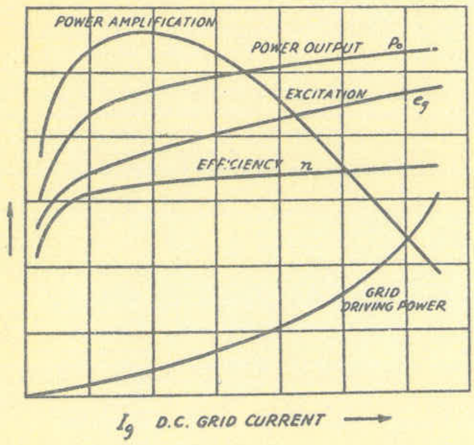


Fig. 5 - Since I_g the grid current is a convenient measure of the excitation, the graphs show for any given power amplifier the changes which occur in the various sections.
NOTE carefully the shapes of the curves and the manner in which they rise or fall.

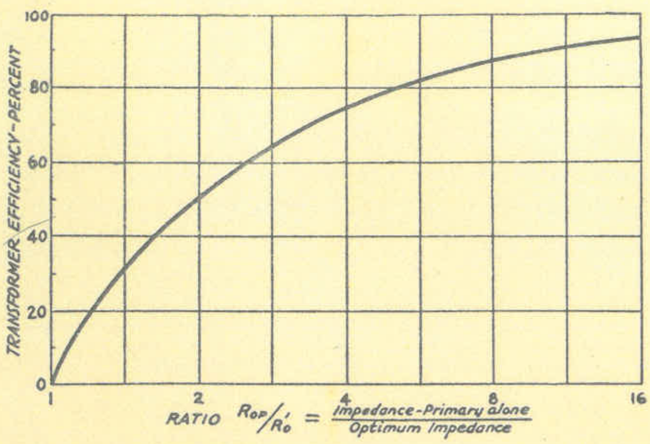


Fig. 6 - Curve showing the variation of efficiency of power transfer with ratio of self impedance of the unloaded tank circuit divided by impedance reflected by the load. The optimum value is usually taken as four times the anode resistance

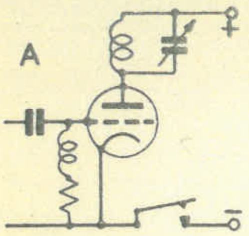


Fig. 1A - Negative H.T. Keying.

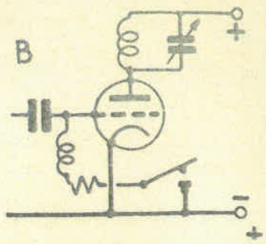


Fig. 1B - Grid Blocking Keying.

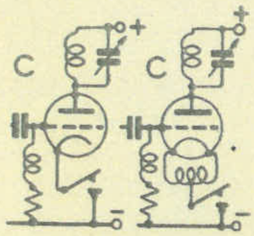


Fig. 1C - Cathode Keying.

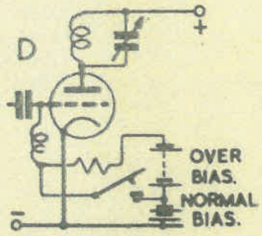


Fig. 1D - Grid Blocking Keying with over Bias.

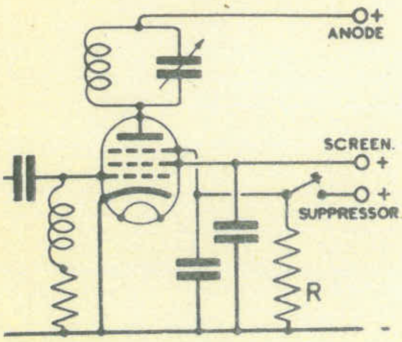


Fig. 2.

← Suppressor grid keying for pentodes The resistance R should be high enough to give cut-off with the key raised. From 10,000 to 50,000 ohms is a suitable value.

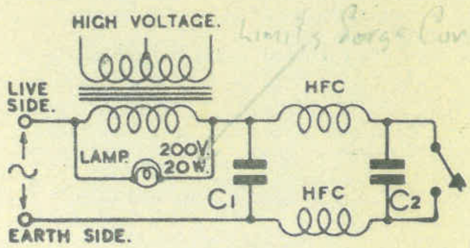


Fig. 3 - Primary Keying.

Limits Surge Current

Necessitates Separate Filament Windings

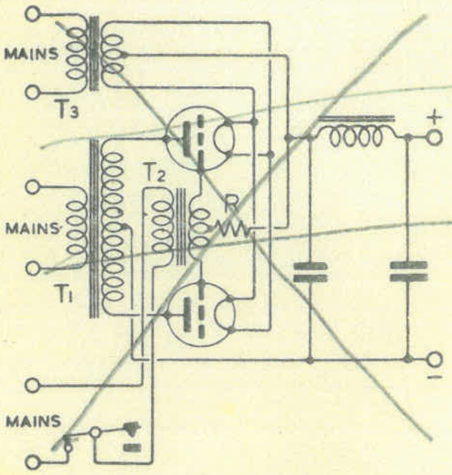


Fig. 4 - Grid controlled rectifier circuit.

← The transformer T_2 supplies a negative grid bias cutting off the rectifier valves when the key is up. A back contact key is required.

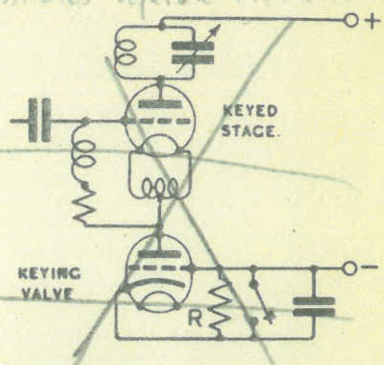


Fig. 7 - Use of a keying valve.

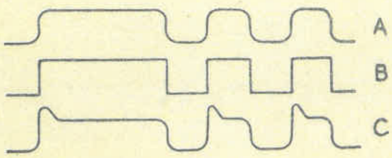
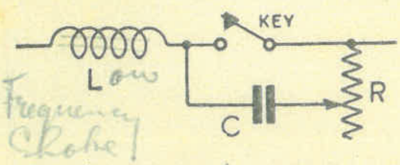


Fig. 5.

A - Keying waveshape which will not cause local interference

B - Keying waveshape using no keying filter.

C - Peaky waveshape resulting from poor regulation in the H.T. supply



L 5 to 20 Henrys depending upon the load.
C 0.5 to 2 F.
R Approximately 1,000 ohms.

Fig. 6 - A common type of keying filter.

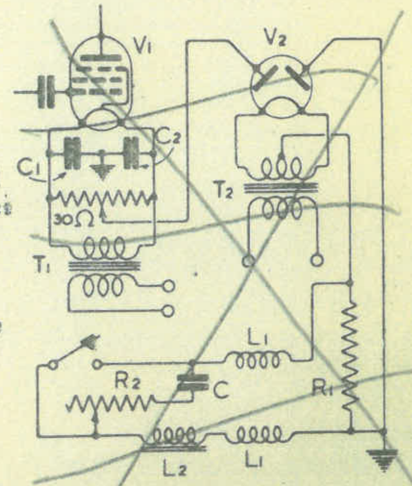


Fig. 8 - A valve keying circuit using mercury vapour rectifier as keying re

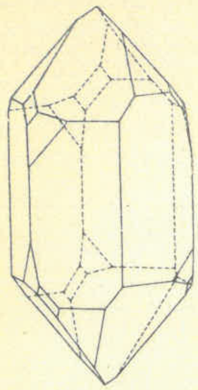


Fig. 1 - Natural Quartz Crystal showing hexagonal faces.

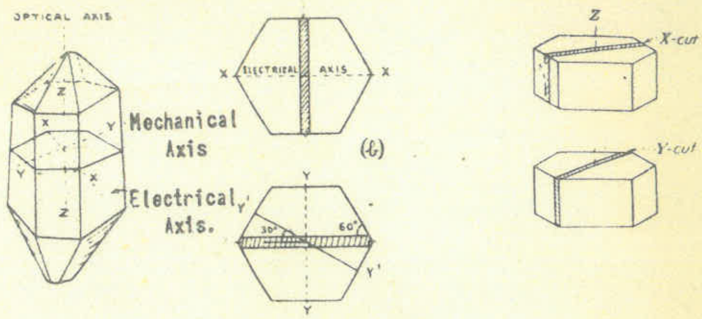


Fig. 2 - Sections of a crystal showing how X and Y cut blanks are obtained.

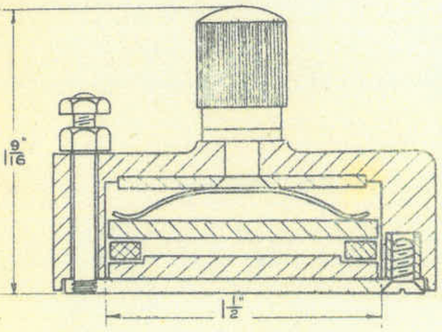


Fig. 4 - Typical Crystal Holder of the direct contact type.

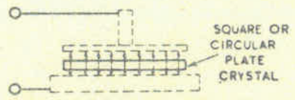


Fig. 3 - Action of a crystal under the influence of A.C. potentials.

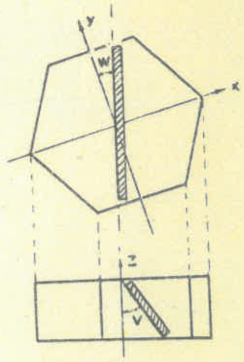


Fig. 5 - Method of obtaining an AT cut crystal.

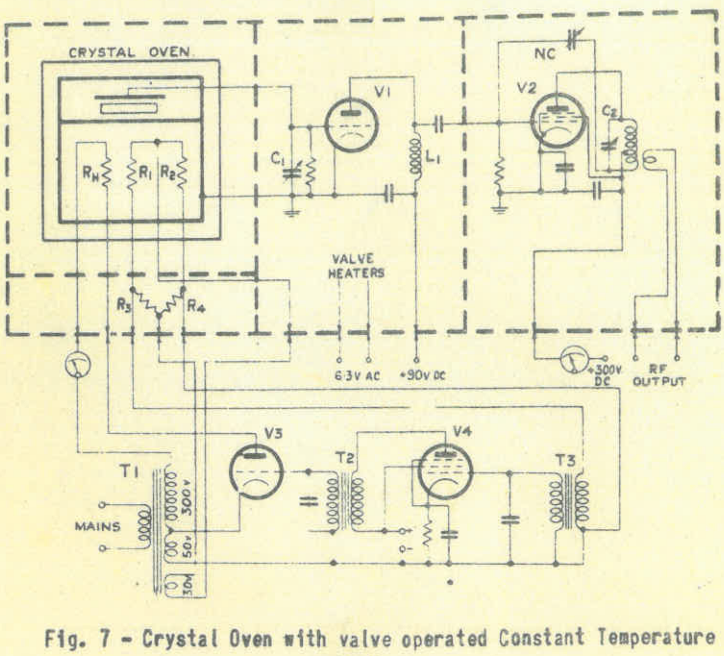


Fig. 7 - Crystal Oven with valve operated Constant Temperature control.

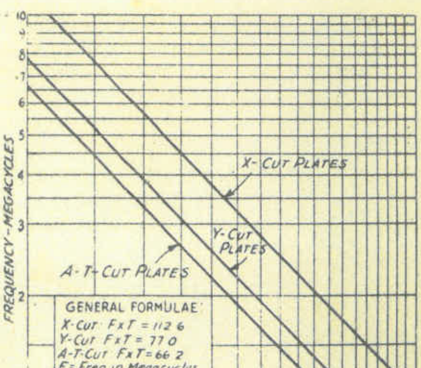


Fig. 6 - Graph showing thicknesses of the three types of crystal cuts for different values of operating frequency.

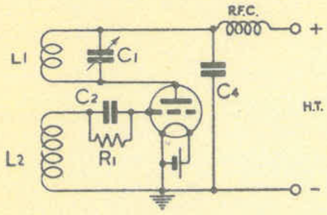


Fig. 20 - Oscillator with the tuning removed from the grid circuit to the plate circuit to reduce harmonics in the output.

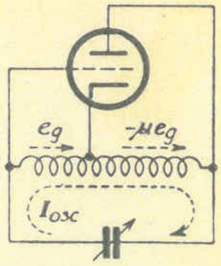


Fig. 21 - Hartley circuit showing how grid excitation is obtained by tapping the coil.

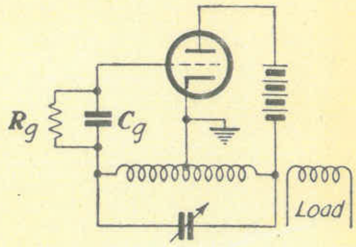


Fig. 22 - Practical Hartley circuit using series feed.

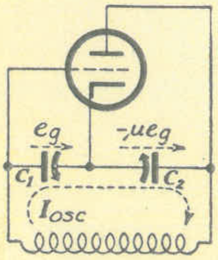


Fig. 23 - Colpitts circuit showing how grid excitation is obtained by tapping capacities.

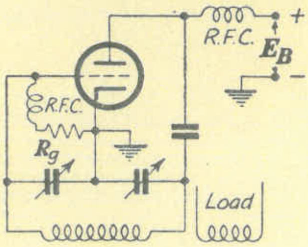


Fig. 24 - Practical Colpitts circuit using shunt feed.

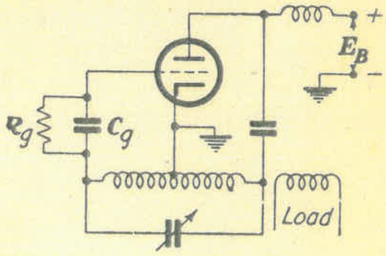


Fig. 25 - Practical Hartley circuit using shunt feed.

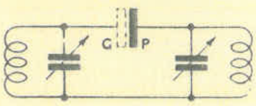


Fig. 26 - Theory of operation of the T.P.T.G. oscillator. R.F. voltages built up in the right tuned circuit set the left tuned circuit into oscillation through the coupling condenser G.P.

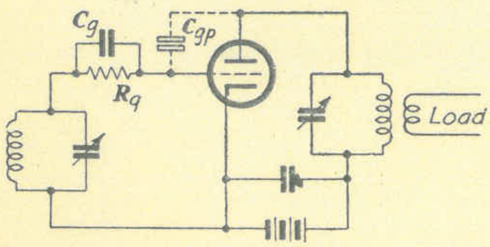


Fig. 27 - Practical series feed tuned plate tuned grid oscillator showing how the feed back of energy occurs through the grid plate electrode capacity shown by the dotted lines.

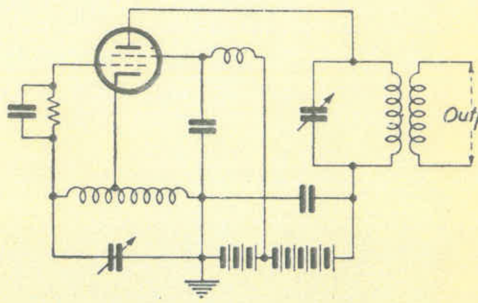


Fig. 28 - Series electron coupled tetrode oscillator. Compare the circuit with the Hartley shown in Fig. 25. Note that the output section is separate from Hartley driving circuit.

Voltages 90° out of phase

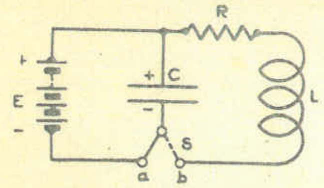


Fig. 1 - Circuit containing R, L & C connected by a 2 way switch to a battery so that the top plate of the condenser C is positively charged.

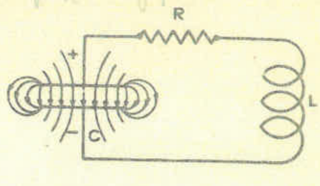


Fig. 2 - Conditions existing at the moment of throwing the switch S to b. The energy is in the electric field.

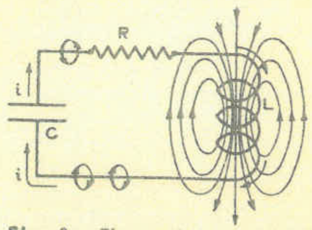


Fig. 3 - The condenser has discharged the energy and it now exists in the form of a magnetic field about the coil L.

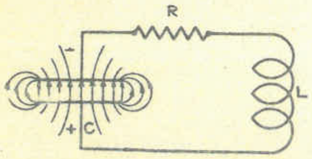


Fig. 4 - As the lines of magnetic force about L in Fig. 3 collapse, they generate a voltage which is in the direction of the original current.

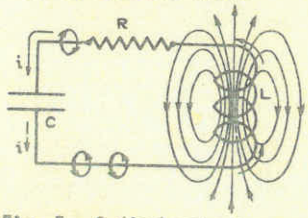


Fig. 5 - C discharges in a manner similar to Fig. 3, but the reversed current causes a reversed field.

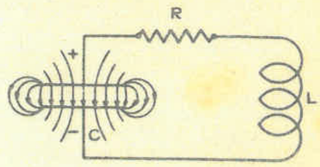


Fig. 6 - The collapsing magnetic lines about L in Fig. 5 generate a voltage which recharges the condenser C of opposite polarity to that in Fig. 4.

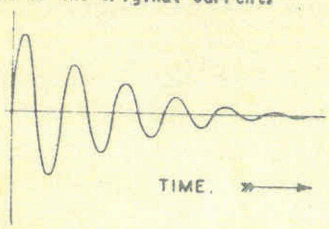


Fig. 7 - Amplitude of the oscillatory current or voltage with time. Note that the resistance R in Fig. 1 to 6 causes losses and the wave soon dies away.

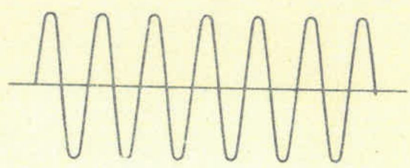


Fig. 8 - Oscillations to be expected in a circuit containing no resistance. The frequency of the oscillations always be

$$f = \frac{1}{2\pi\sqrt{LC}}$$

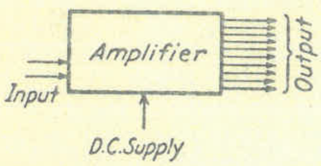


Fig. 10 - Schematic diagram of an amplifier, having an amplifying factor of 5. With 2 units input the output is 10 units.

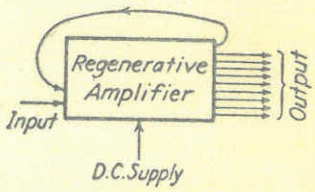


Fig. 11 - An amplifier with feed back. One unit of input still produces the output of 10.

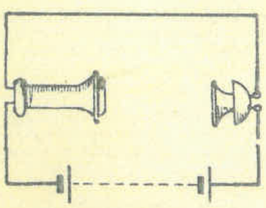
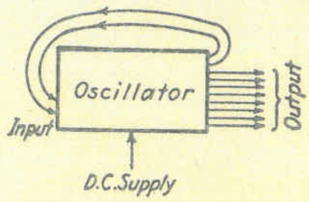


Fig. 9 - Circuit of a telephone howler. If a microphone and receiver are arranged as shown, a continuous howl will be produced. The energy will be supplied from the battery.



The amplifier with 2 units of feed back forms a self oscillator and continues to supply the output of 10 units, even when the original input of 2 disappears.

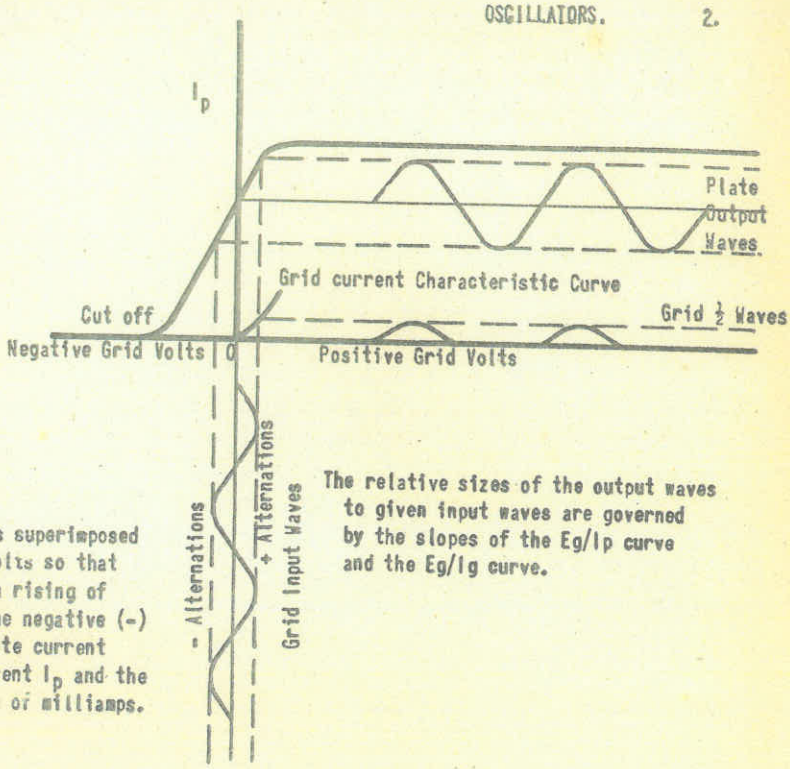


Fig. 13 - Actions occurring in a triode fed by a sine wave input signal of E_g volts. There being no bias every positive alternation of grid input voltage produces a half cycle of rectified grid current.

Simultaneously the plate current will change according to the grid volts plate current characteristic curve and the plate voltage will vary because of the drop in the output load resistor R_o.

The input A.C. signal to the grid is superimposed on the existing value of zero grid volts so that the positive (+) alternations cause a rising of plate current and grid current and the negative (-) alternations produce a decreasing plate current and no grid current. The plate current I_p and the grid current I_g are to the same scale of milliamps.

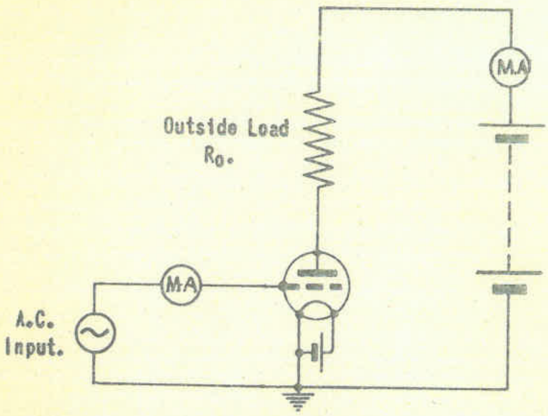


Fig. 14 - Circuit diagram for the curves produced in Figs. 13 and 15.

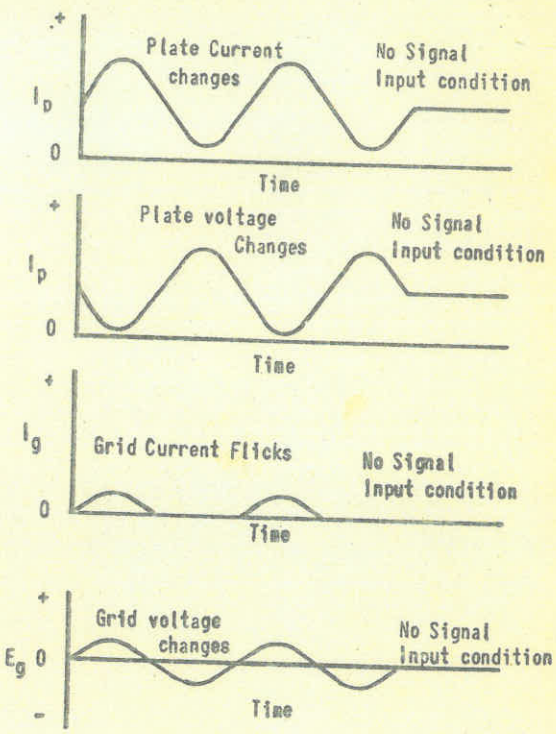


Fig. 15 - (at the right) shows the individual curves of Fig. 13 arranged above each other for phase comparison. This should be studied carefully because it determines the principle of correct feed back polarity to produce self oscillation in a valve.

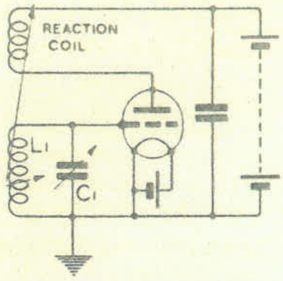


Fig. 16 - A tuned grid circuit amplifier arranged with magnetic feed back from the coil which carries the pulsations of the plate or anode circuit. If these are phased correctly so that they assist the prevailing tendancy to amplify as in Fig. 11 and the feed back is sufficient then the valve maintains itself in a state of self oscillation Fig. 12 at a frequency determined by the L.C. values in the grid circuit.

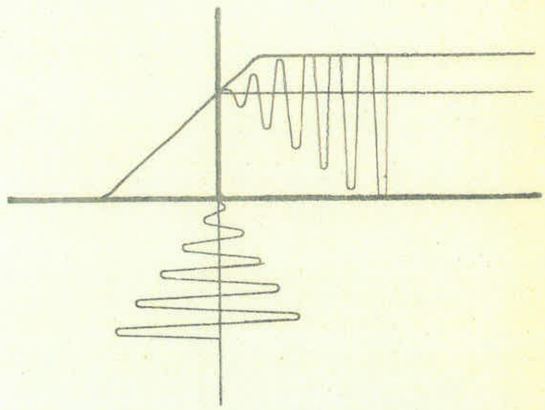


Fig. 17 - There being in bias the initial static conditions are the same as for Fig. 13. The sudden closing of the plate circuit starts the building up of a wave train which grows till saturation and cut off are reached in the output circuit and the distorted wave results. Grid current flicks are not shown.

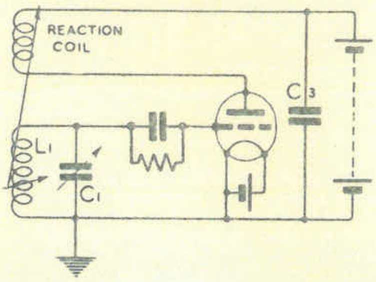


Fig. 18 - Circuit similar to Fig. 16 except that the circuit is a practical one in that it uses the voltage drops down the grid leak as grid bias and so reduces the plate current to a very much lower value than that shown by the average line in Fig. 17.

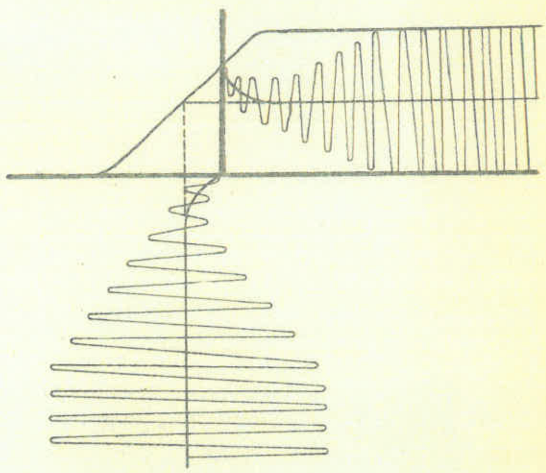


Fig. 19 - Building up of self oscillations in the circuit of Fig. 18. Note the reduction in average plate current and consequent cooler operation of the valve plate or anode.

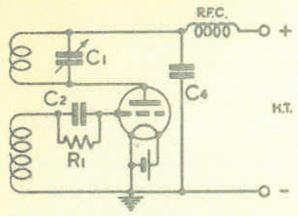


Fig. 20 - Oscillator with the tuning removed from the grid circuit to the plate circuit to reduce harmonics in the output.

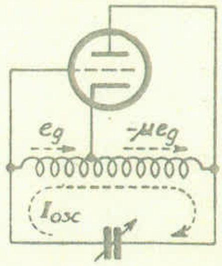


Fig. 21 - Hartley circuit showing how grid excitation is obtained by tapping the coil.

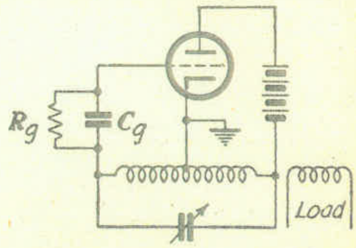


Fig. 22 - Practical Hartley circuit using series feed.

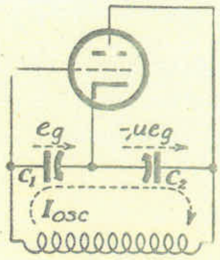


Fig. 23 - Colpitts circuit showing how grid excitation is obtained by tapping capacities.

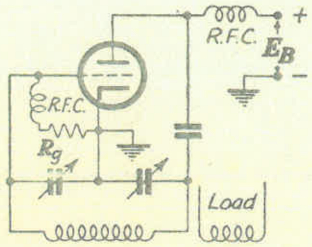


Fig. 24 - Practical Colpitts circuit using shunt feed.

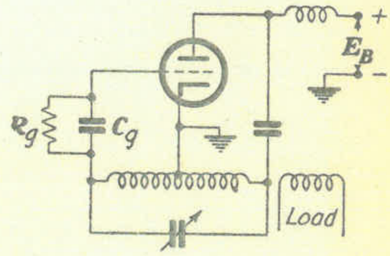


Fig. 25 - Practical Hartley circuit using shunt feed.

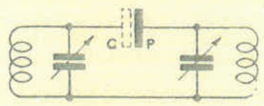


Fig. 26 - Theory of operation of the T.P.T.G. oscillator. R.F. voltages built up in the right tuned circuit set the left tuned circuit into oscillation through the coupling condenser G.P.

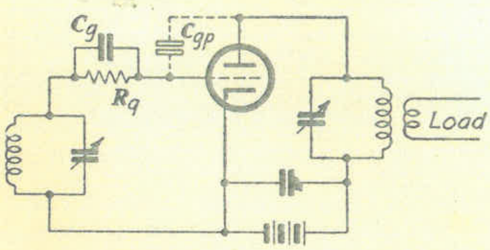


Fig. 27 - Practical series feed tuned plate tuned grid oscillator showing how the feed back of energy occurs through the grid plate electrode capacity shown by the dotted lines.

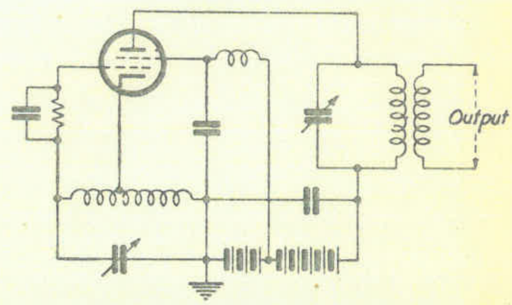


Fig. 28 - Series electron coupled tetrode oscillator. Compare the circuit with the Hartley shown in Fig. 25. Note that the output section is separate from Hartley driving circuit.

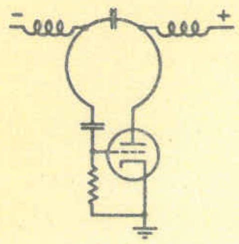


Fig. 1. Gutton-Touly or Ultraudion Type of Oscillator showing how L and C is reduced to a minimum.

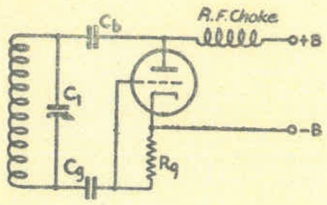


Fig. 2. Theoretical Circuit of the Ultraudion Oscillator.

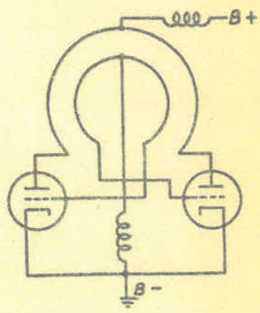


Fig. 3. Push-pull Ultraudion or Mesny Oscillator.

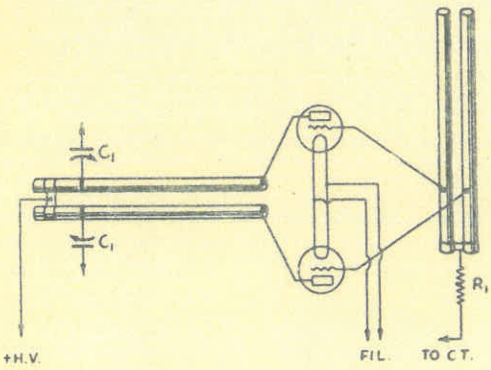


Fig. 4. Parallel Rod Type of push-pull Oscillator using Transmission lines in place of the usual L and C and resulting in great frequency stability.

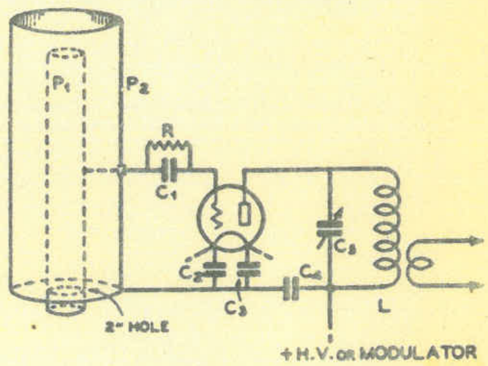


Fig. 5. Concentric Transmission line used in the grid circuit to stabilize ultra high frequencies.

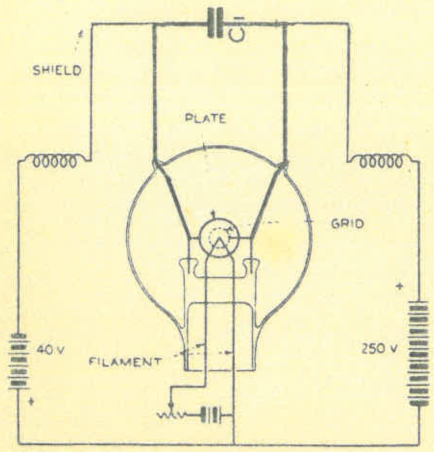


Fig. 6. Barkhausen Kurz U.H.F. Oscillator. The circuit is similar to Fig. 1, but the plate anode is run at a lower voltage than the grid.

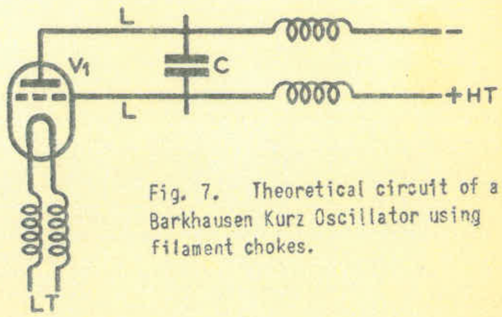


Fig. 7. Theoretical circuit of a Barkhausen Kurz Oscillator using filament chokes.

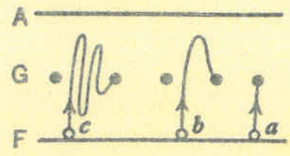


Fig. 8. Action of the electron flow in the Barkhausen Kurz Oscillator. The electron movement time determines the frequency.

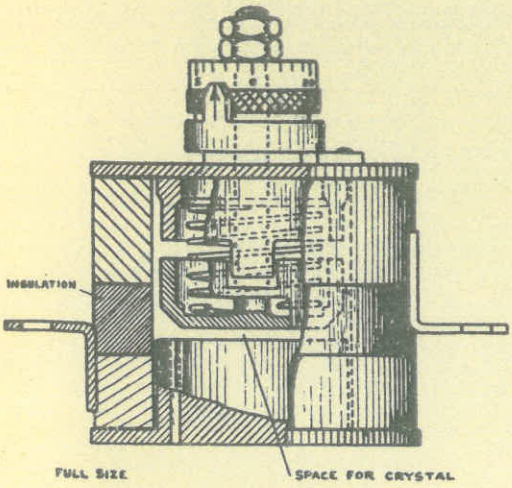


Fig. 8 - Construction of a variable air gap Crystal holder.

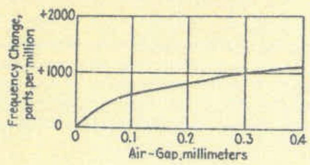


Fig. 9 - Variation in operating frequency in terms of air gap used.

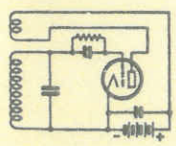


Fig. 10 - Simple plate re-action coil oscillator with tuned grid

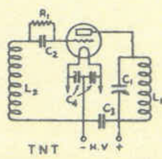


Fig. 11 - Untuned grid Tuned plate oscillator.

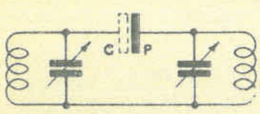


Fig. 12 - Path of feed back of energy from a plate tuned circuit.

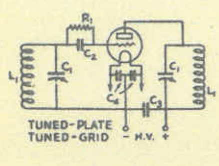


Fig. 13 - Tuned plate Tuned grid Oscillator making use of the principle shown in Fig. 12.

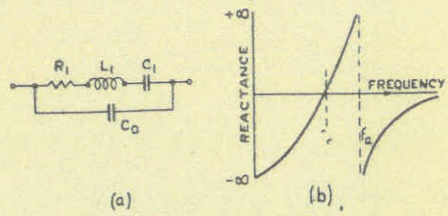


Fig. 14 - Equivalent Electrical circuit of a crystal showing change of reactance values with frequency.

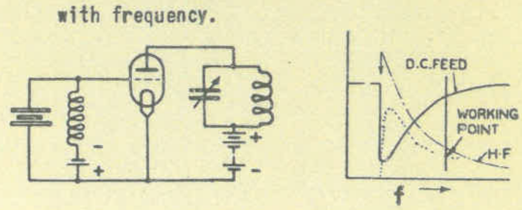


Fig. 15 - Crystal operated in the grid/cathode circuit.

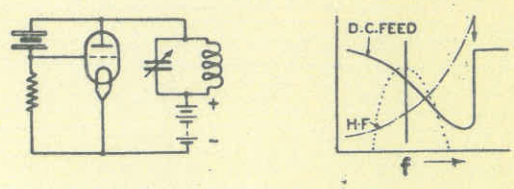


Fig. 16 - Crystal operated in the anode grid circuit.

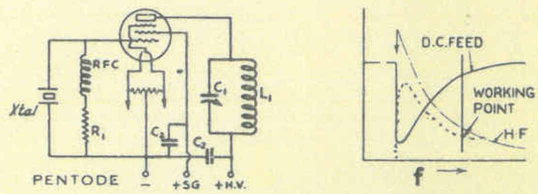


Fig. 17 - Crystal operated in the grid/cathode circuit of a pentode.

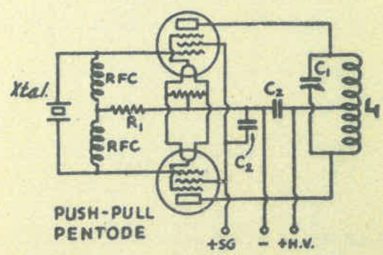


Fig. 18 - Push pull variation of Fig. 17.

Melbourne Technical College

RESONANCE IN THE ANODE CIRCUIT AND MILLER EFFECT

The H.F. choke is universally recognised as a device which offers a high impedance to radio frequency currents without introducing appreciable D.C. resistance into the circuit in which it is connected. As to the manner in which this desirable result is achieved there is considerable divergence of opinion. The explanation generally given is that the H.F. choke is essentially an inductance, and that its impedance is therefore proportional to the frequency or inversely proportional to the wavelength.

The conception of the H.F. choke as an inductance arose by analogy with the low frequency choke which was a commonplace in electrical engineering long before its high frequency equivalent was though of. The reactance of such a choke at the frequencies used in power engineering is inductive, and the effect of any capacity it might have is not important at low frequencies but at radio frequencies the association of capacity and inductance can mean only one thing - resonance. When it is realised that the capacity across a choke is raised by 10 or 20 micromicro farads immediately it is inserted in a receiver anode circuit by the output capacity of the valve, there can be no longer any doubt that every H.F. choke resonates at some frequency.

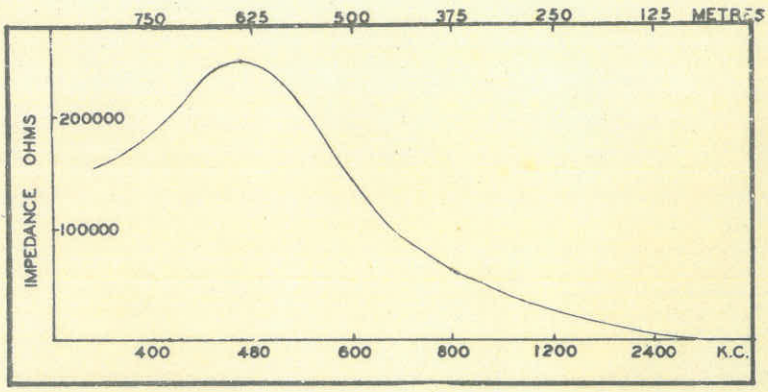


Figure 1 - Curve showing variation of impedance with frequency of a typical single-slot-wound H.F. choke; external capacity 8$\mu\mu$f.

Having satisfied ourselves that a choke is a resonant circuit, from figure 2 it is obvious that it is a parallel resonant circuit. In other words any H.F. current which flows is divided between the capacity branch and the inductive branch with its resistance. In a series resonant circuit the current is the same in all parts of the circuits but in parallel resonance the currents in the two branches may be widely different off resonance. Actually the current is greatest in the inductive branch at frequencies below resonance and it is not until the frequency exceeds resonance that the greater current transfers to the capacitive branch. Figure 3 illustrates this point diagrammatically. On the left hand side of resonance the impedance of the choke may be represented by inductance and resistance in series, and on the right hand side by a capacity and resistance in series. Most chokes are worked at frequencies above resonance so that it is the self capacity which does the choking and not the inductance.

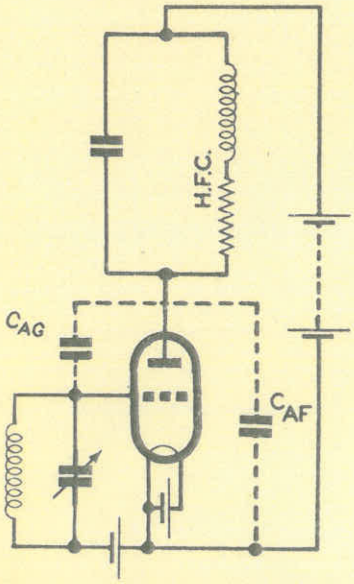


Fig. 2 - Circuit showing valve capacities which influence the performance of an H.F. choke.

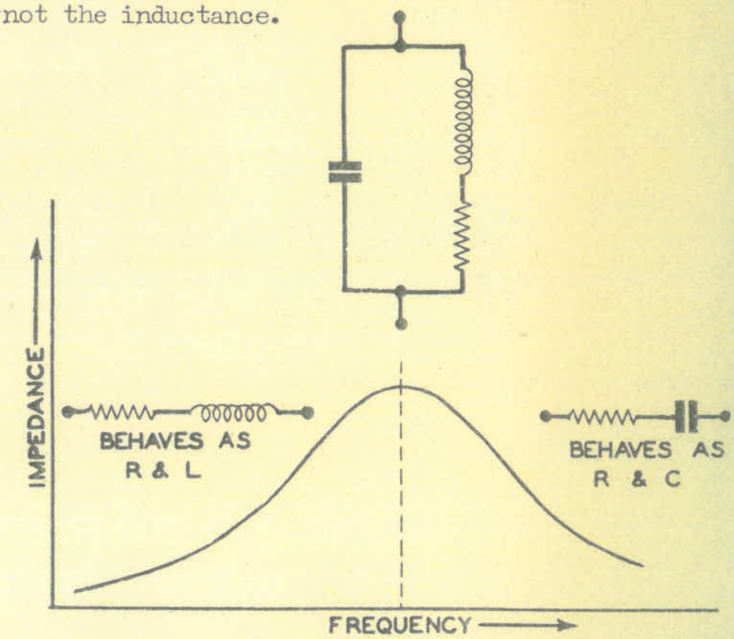


Fig. 3 - At frequencies above resonance an H.F. choke functions principally as a capacity and at frequencies below resonance as an inductance.

In figure 2 the anode-filament capacity Caf is in parallel with the choke and merely tends to lower its resonant frequency but the anode-grid capacity Cag serves to transfer H.F. energy back to the grid. The phase of the H.F. voltage returned to the grid in this way will depend on whether the choke is being worked on the capacitive or inductive side of resonance. This effect is known as "Miller Effect" which may be briefly outlined as follows:-

The input impedance of a valve is not dependent solely upon the grid to filament inter-electrode capacity and the actual amount of impedance connected between grid and filament but is also dependent upon the character of the anode load impedance. If the anode load impedance is resistive in character, there will be reflected to the grid circuit an impedance which is capacitive. If the anode load impedance is inductive (e.g. a tuned circuit which resonates at a higher frequency than the anode current A.C. component), there will be reflected to the grid circuit an impedance which will be resistive but of negative character. If the anode load is capacitive (e.g. a tuned circuit which resonates at a lower frequency than the anode current A.C. component), then an impedance which is resistive but of positive character will be reflected to the grid circuit. This can be represented as in Figures 4 to 8:-

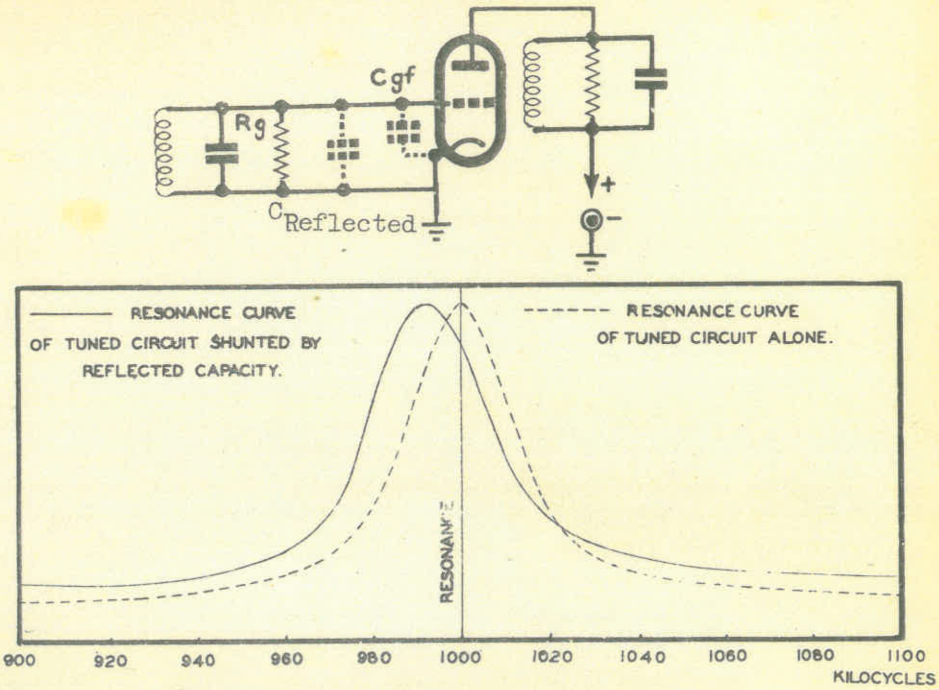


Fig. 4 & 5 - When the anode circuit is resistive, capacity is reflected to the grid and the grid is detuned.

The effect in the grid circuit of these various conditions of reflected impedance can be stated to be as follows:-

In the case of reflected capacity (Fig. 4) the resonant frequency of the grid circuit will be altered, resulting in detuning of the stage. If positive resistance is reflected, (Fig. 6), serious damping of the grid circuit may result. If negative resistance is reflected (Fig. 7) it will, if its value becomes less than that of the damping resistance of the grid circuit, cause the stage to oscillate with no coupling from anode to grid other than the anode/grid inter-electrode capacity. These conditions are clearly shown by Fig. 8. The zone of oscillation (shaded) occurs between frequencies of 975 K.C., and 998 K.C., when the parallel reflected negative resistance is less than the value of Rg, thereby neutralizing all damping resistance in the grid circuit. It is clear than oscillation could be avoided by making the value of Rg less than the reflected negative resistance. Certain famous manufacturing firms achieve stability by connecting a carbon resistance between grid and cathode.

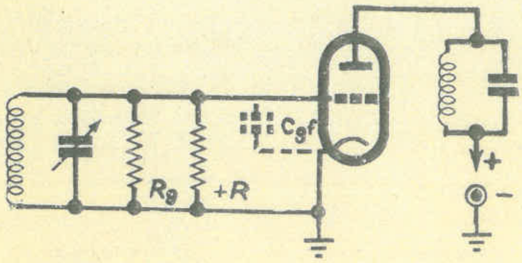
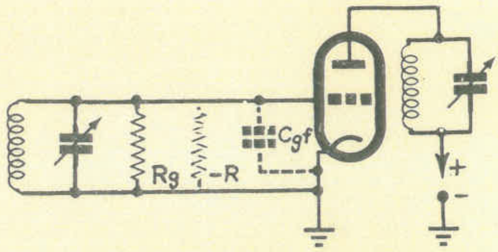
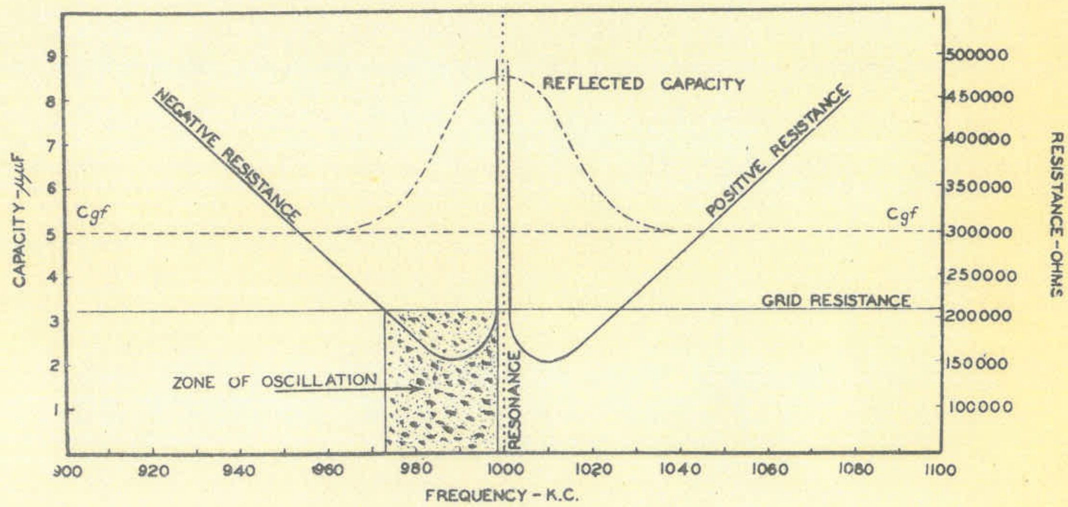


Fig. 6 - When the anode circuit is detuned with more than the capacity required for resonance, i.e., the anode circuit is capacitive, positive resistance is reflected and thus increased damping will occur in the grid circuit.





Figures 7 & 8 -

When the anode circuit is detuned with less than the capacity required for resonance, i.e., the anode circuit is inductive, negative resistance is reflected. Oscillation will occur if the negative resistance is less than the grid resistance. The shaded zone gives the range of frequencies at which oscillation will occur.

Experiment with the circuit of Figure 2 gave results as indicated in Figure 9 the shaded zone again referring to the frequencies at which oscillation occurred. The relationship of these frequencies to the curve of the choke with the output capacity in parallel demonstrates the preceding discussion.

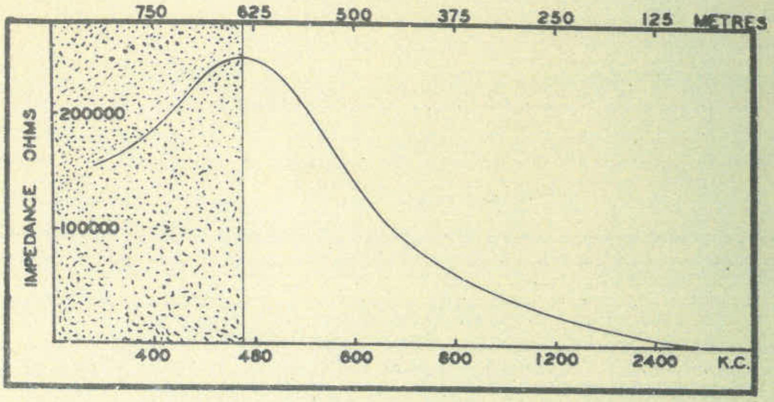


Figure 9.

It is the correct choice of operating conditions from these principles that enables a T.A.T.G., oscillator to operate as a self oscillator and prevents an R.F. amplifier from breaking into oscillation.

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and various articles in Wireless Engineer, Proc., I.R.E., and other periodicals.

See also Chapter 14 (Radio Frequency Amplifiers) under "Input Loading of Receiving Valves at Radio Frequencies."

Communication August, 1940.

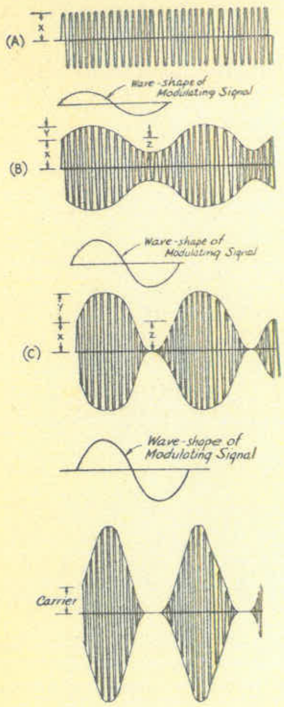


Fig. 1 -
(a) 0 % Modulation
(b) 5 %
(c) 100 %
(d) 115 %

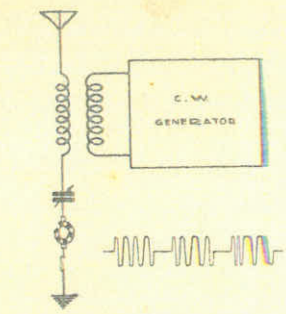


Fig.2 - Modulation by chopper wheel.

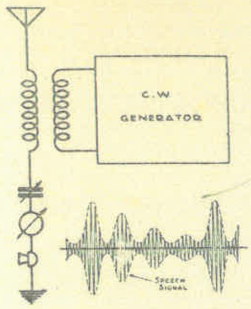
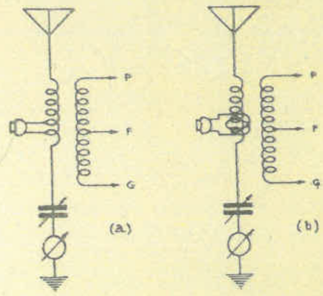


Fig.3 - Simple absorption modulation.



Figs. 4A & B. - Absorption Modulation for dealing with higher R.F. Power.

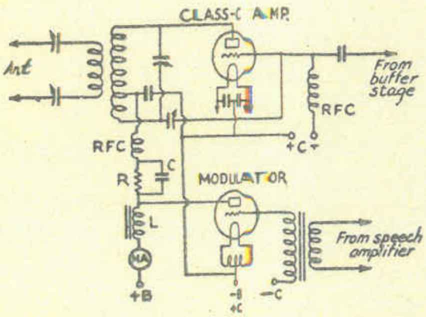


Fig.5 - Heising Modulation on an R.F. amplifier stage

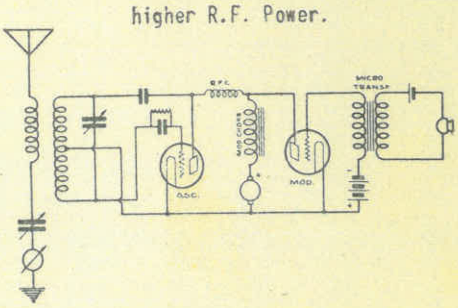


Fig. 6 - Heising Modulation on a self excited oscillator.

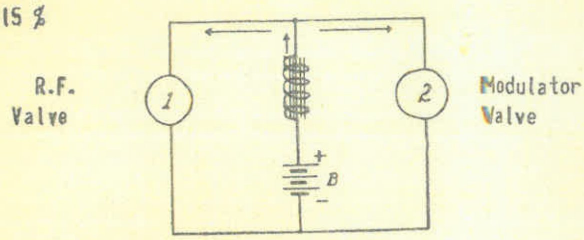


Fig. 7 - Principle of Constant Current or Heising Modulation.

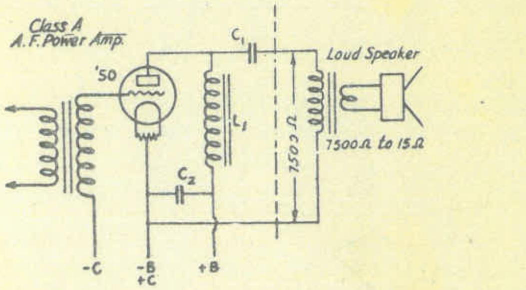


Fig. 7A - Heising Principles: Class A Amplifier working into a 7500 ohm loudspeaker load.

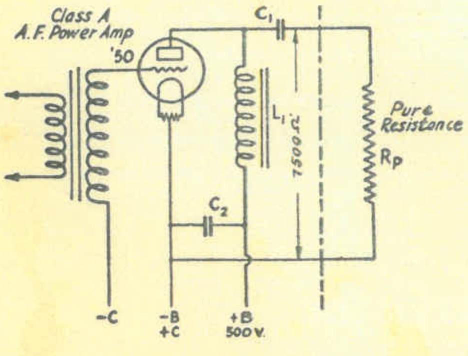


Fig. 7A - Heising Principles: Same as 7A but working into a resistive load.

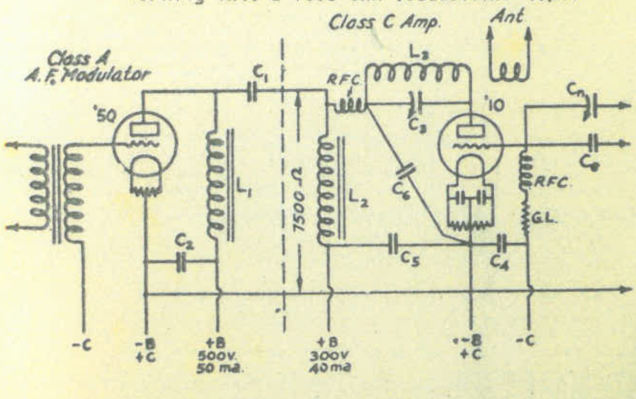


Fig. 7C - Heising Principles: Resistive Load of 7B replaced by reflected plate load of Amplifier.

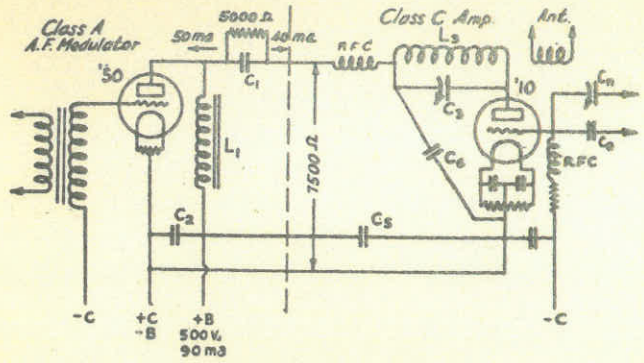


Fig. 7D - Standard choke circuit showing how the 7500 ohms load of 7c still exists in practice.

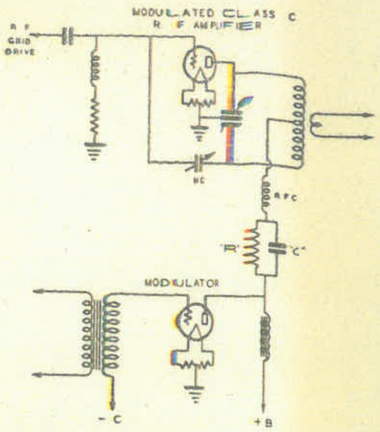


Fig. 8 - Typical Heising Modulator.

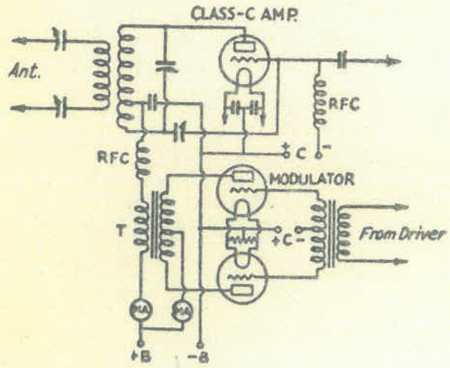


Fig. 9 - Transformer coupled plate modulation showing how speech volts are added to the plate supply of the R.F. valve.

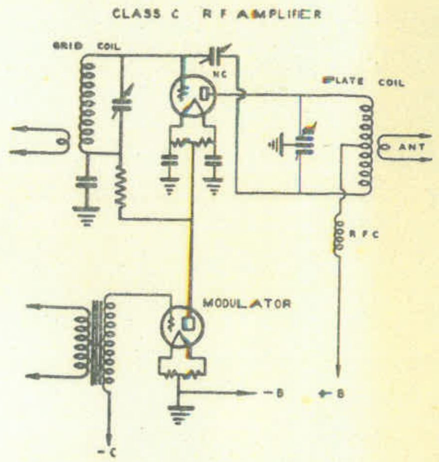


Fig. 10 - Series Modulation showing the R.F. tube and the modulator in series.

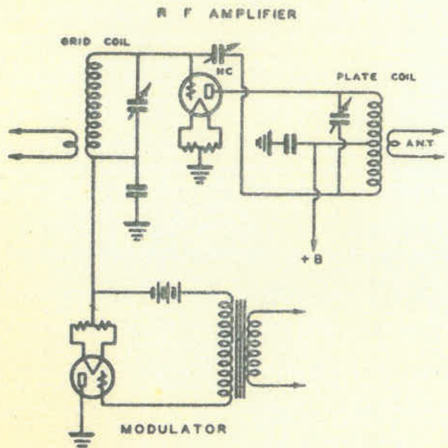


Fig. 11 - Telefunken or Grid Bias Modulation The modulator valve acts as a variable grid leak for the R.F. valve.

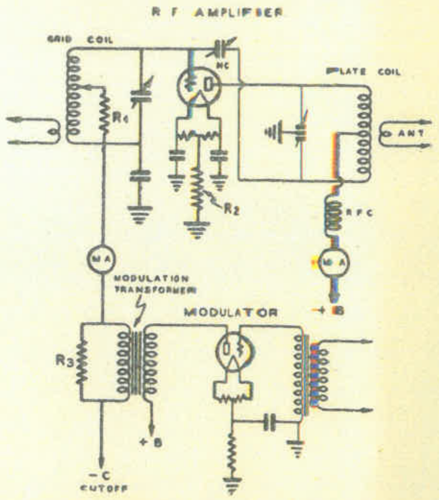
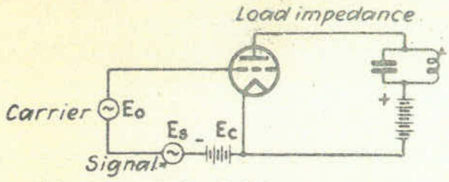


Fig. 12 - Hawking "BC" Grid Modulation compared with with ordinary Grid Modulation.



(a) Circuit for Grid Modulated Class C Amplifier

Fig. 14 - Theoretical circuit for Grid Modulation.

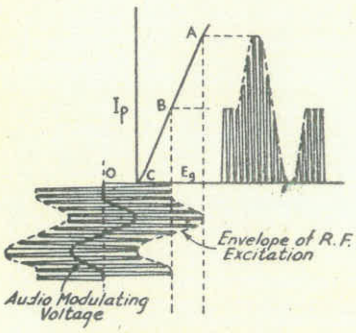


Fig. 14 - E_g/I_p Curve showing action in the R.F. Amplifier.

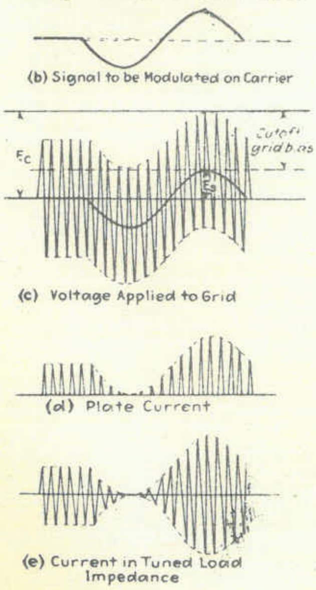


Fig. 14 - Linear Grid Modulation Showing relations existing in the various circuits including plate current flicks and oscillatory circuit currents.

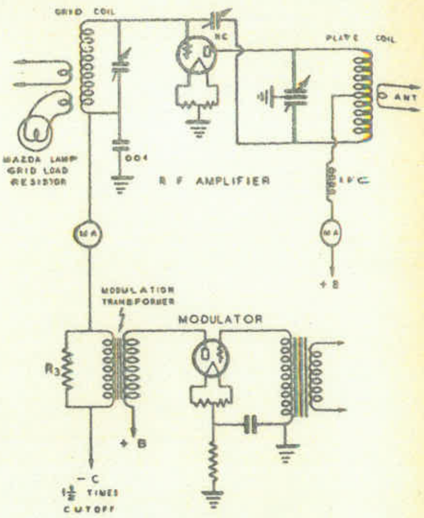


Fig. 13 - Ordinary Grid Modulation. Compare with Hawkin's "R.C." type.

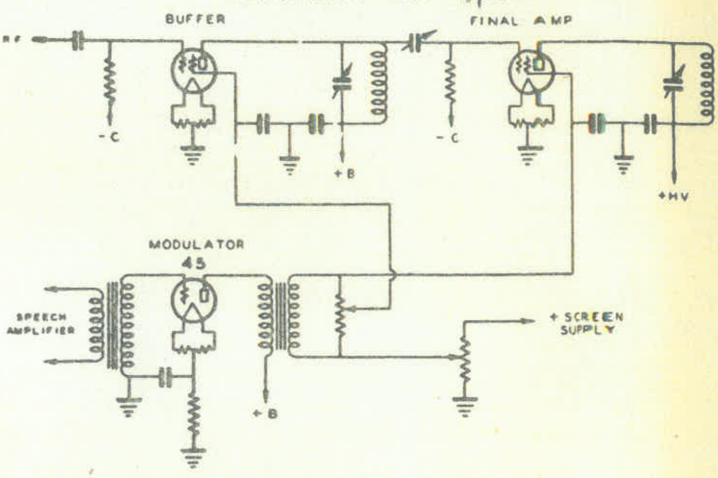


Fig. 15 - Cascade Screen Grid Modulation used when a tetrode is the R.F. Amplifier.

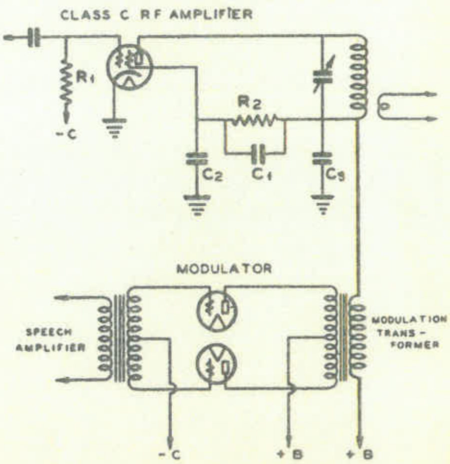


Fig. 16 - Plate & Screen Modulation on a tetrode R.F. Output stage.

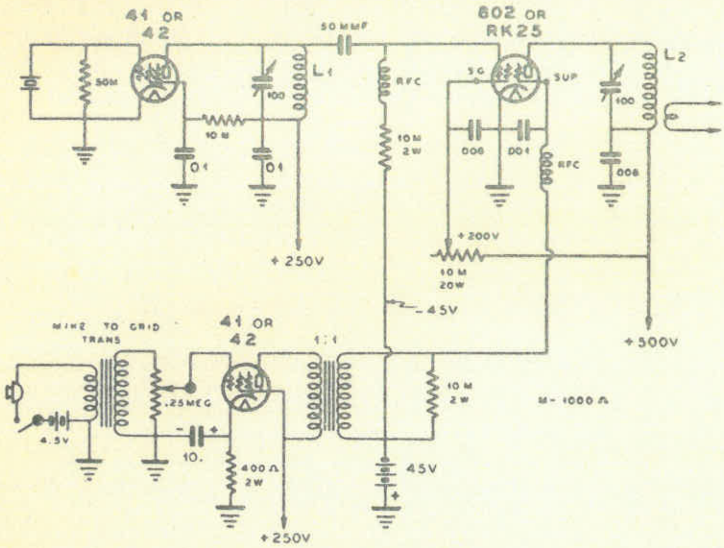


Fig. 17 - Suppressor Grid Modulation used when the R.F. Output tube is a pentode.

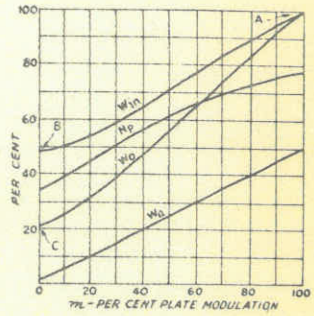


Fig. 19 - Curves showing Cathode Modulation (See text for details).

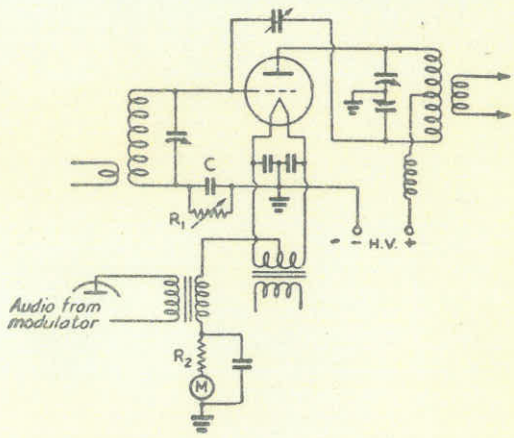


Fig. 18 - Cathode Modulation showing how modulation is applied partly as grid and partly as plate modulation.

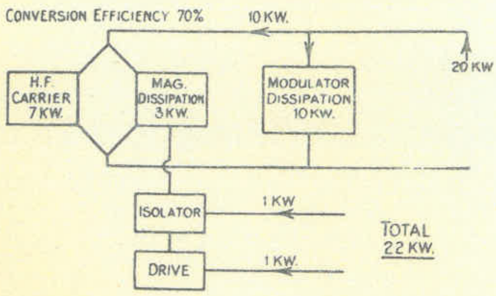


Fig. 20 - High Power Modulation.

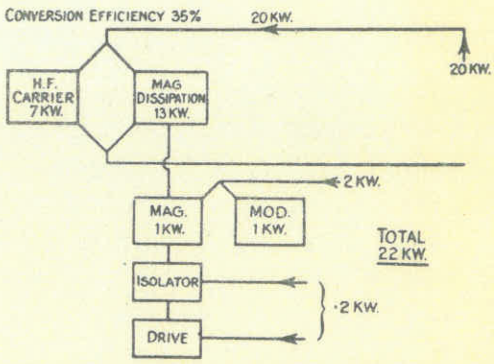


Fig. 21 - Low Power Modulation

Comparison between the two methods of applying modulation (See text for details).

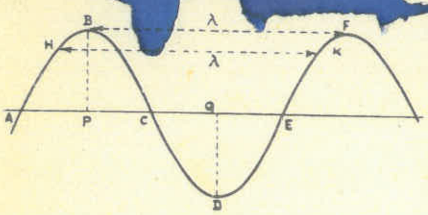


Fig. 1. Sine wave showing relationships. B to F or H to K is a cycle. P to Q is a half-cycle, B to P Amplitude.

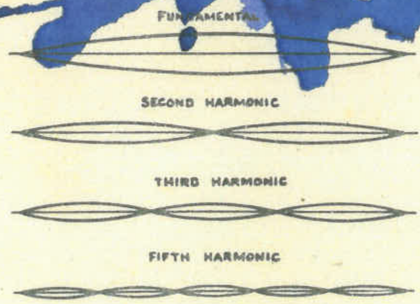


Fig. 3. Vibration of a string showing how it can vibrate and emit a fundamental tone if held at the ends and second harmonics if it is held in the centre and higher harmonics if held as shown.

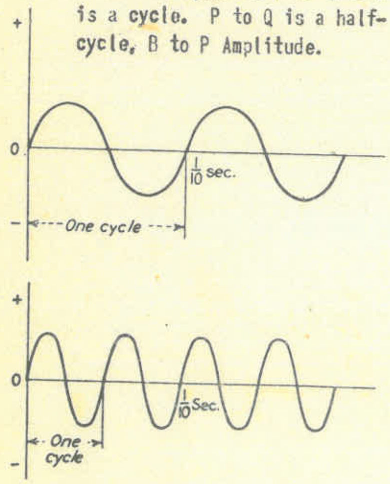


Fig. 2. Comparison between one wave and another of double the frequency or half the wavelength although of equal amplitude.

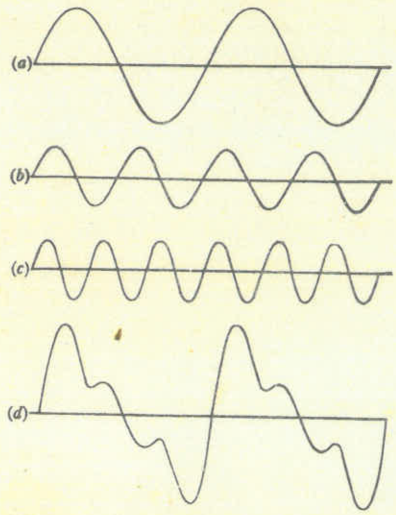


Fig. 4. Composition of an impure wave as shown at (d). (a) is the lowest and therefore the fundamental frequency. (b) is the second harmonic and (c) the third harmonic.

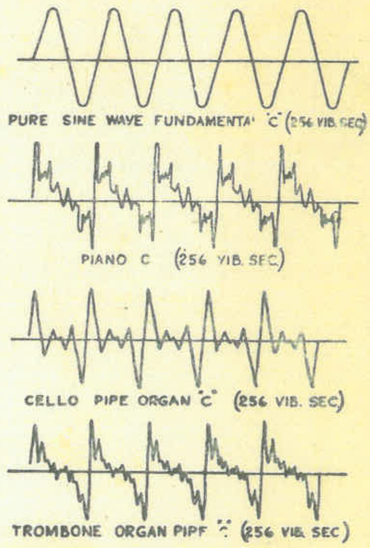


Fig. 5. Comparison between a pure sine wave and the notes emitted by various musical instruments having the same fundamental frequency.

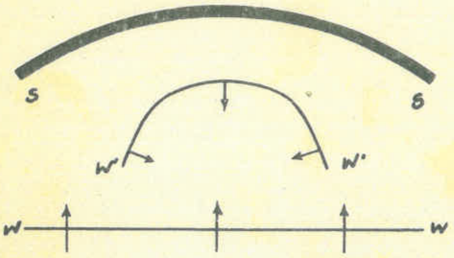


Fig. 6. Concentration of sound waves by reflection from a concave surface S-S.

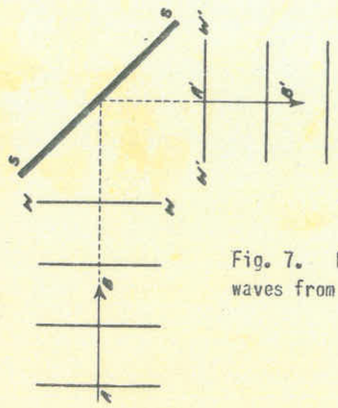


Fig. 7. Reflection of sound waves from a smooth flat surface.

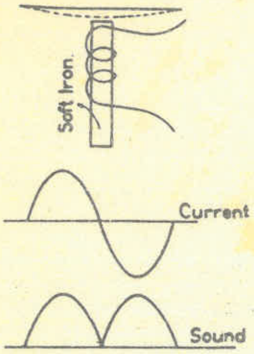


Fig. 1. Behaviour of a soft iron disc placed over a soft iron cored electro-magnet. Note that the disc is attracted and released each half cycle without regard to polarity.

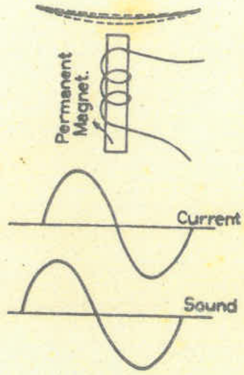


Fig. 2. Behaviour when the core possesses permanent magnetism. Note that the diaphragm movement follows the A.C. wave exactly.

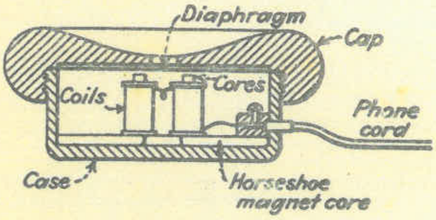


Fig. 3. Construction of a headphone showing the electromagnets, the permanent magnet and the soft iron diaphragm.

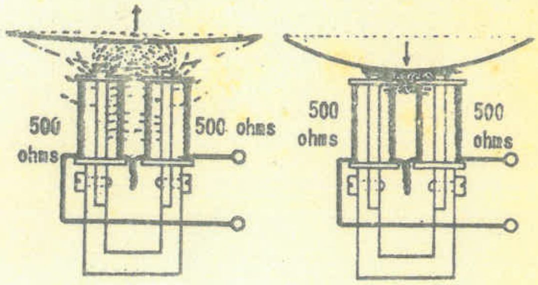


Fig. 4. Movement of the diaphragm with change in total magnetic field made up of f perm. ± f electro.

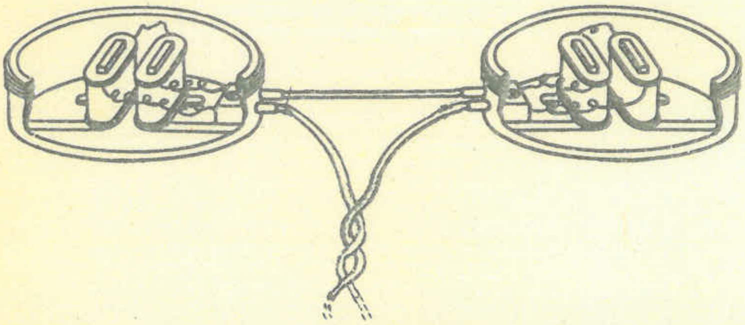


Fig. 5. Connection for a pair of headphones. Each coil is normally 500 ohms and all four are in series making a total of 2,000 ohms. The ear pieces must be phased correctly otherwise the movements are not assisting each other.

Fig. 6. Arrangement of a typical pair of headphones showing adjustable headband and tinsel cable cords.

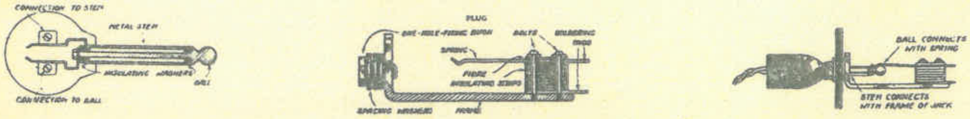


Fig. 7. Operation and sections of a telephone plug and jack.