PHILCO SERVICE

PHILCO Factory-Supervised Service

Shop Practices and Service Techniques

RADIO

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Following last month's discussion of basic oscillator theory, an attempt will be made in this article to cover as many problems as possible that arise involving these circuits.

Fig. 1 shows two typical oscillator circuits used in recent models. The first, Fig. 1-A, is a parallel fed Hartley using one half of a 7F8 dual triode as the oscillator tube. The second, Fig. 1-B, is a tuned grid using two grids of a multi-grid converter tube, a 1R5, as the oscillator tube elements. Not only are these two oscillators dissimilar in circuit but they also differ in regards to method of injecting the oscillator voltage to the mixer. It is, of course, known that where two signals, differing in frequency, are fed into an amplifier, the output will contain the two original signals, the sum frequency, and the difference frequency. Thus, to obtain the IF of a superhetrodyne receiver, it is only necessary to mix with the incoming signal a frequency that is either the IF above or below it, selecting the IF or difference frequency from the mixer output by a tuned circuit. In circuit 1-A the mixing action is accomplished by tying the cathodes of the oscillator and mixer sections together, thus modulating the mixer cathode with the oscillator signal while feeding the incoming signal to the control grid. In circuit 1-B the oscillator uses two grids of a common tube. The control grid, which carries the incoming signal, lies between the two sections of the grid which acts as the oscillator plate. In this manner the tube current is then controlled by both signals as before.

Therefore, from the operation of the oscillator mixer, several quick and easy checks can be made to determine if the oscillator is working. If the static and noise level seems normal in tuning across the band, although there are no stations heard, and if an IF signal is passed by the mixer section with proper gain, the oscillator is immediately suspected. Also when the oscillator is operating properly, there will be a negative voltage developed at the grid across the grid leak resistor, Rg. This is the check for oscillator operation; using a suitable range, such as 0-10 volts dc, and connecting the positive lead to the cathode and the negative lead through a 100,000 ohm resistor to the oscillator grid, a negative voltage should be indicated for all positions of the tuning gang.

The causes of oscillator failure are as numerous as the components of the circuit. The tube may be at fault

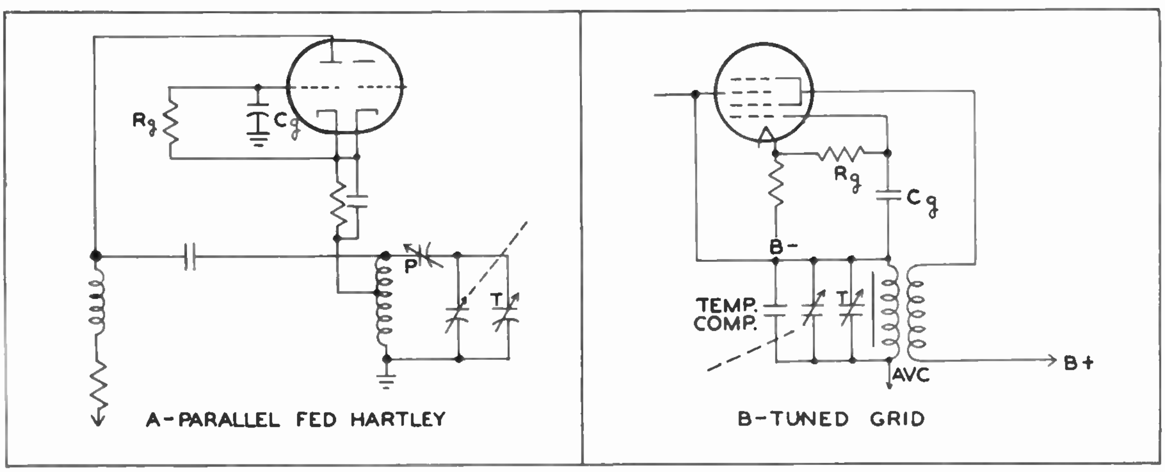

FIGURE 1

even though the mixer section works (in such tubes as the dual triode 7F8) and the tube tests good in a tube tester. The best test for a tube used in an oscillator circuit is whether or not it works in the circuit. Oscillator tubes are best checked by substituting one known to be good. The other circuit components can be checked by the usual voltage, resistance, and substitution methods. Having determined that the oscillator is not functioning, the following test can be made. Measure the B+ supply voltage and the oscillator plate voltage to see if there is a voltage drop across the decoupling network, thus showing that the tube is drawing current. The cathode voltage (or absence of it) will also indicate whether or not the tube is conducting. An absence of plate voltage indicates an open in the plate B+ circuit. No cathode voltage would be caused by either an open in the cathode circuit, such as open coil or resistor, or a faulty tube. A continuity check (in case of Fig. 1-A) from cathode to ground will establish if the trouble is in the tube or the circuit. The rest of the circuit may be checked in a similar way.

The following chart outlines some of the possible types of faulty oscillator operation with the common causes of each.

TROUBLE		REMARKS	CAUSE
Drift	Initial	All sets drift to some degree after initial turn on.	Change of tube spacing and component values coming up to operating temperature.
	Operational	An excessive amount of drift which lasts for longer than is necessary for the set to heat up. This can be caused by blocking the ventilation holes, by a tube overheating, or by components of the tank being subjected to too much heat.	Heat causes continuing change of value in coil and condenser components of tank. Replace, or if none—add, temperature compensating condenser.
	Long Term	Usually sufficient to realign. If tube shows a reduction in emission—replace. Clean plates of variable condenser.	Tube aging and change in value of tuning condensers due to dirt or of coil due to aging of form or insulation.
Partial Operation		This condition may be coupled with either a reduced or high oscillator voltage in the portion of the band that works. If the injection voltage is too high the tube will block—this is accompanied by low mixer gain in the operative portion of the band. Moisture or leakage in the coil is often accompanied by shift in frequency.	Tube may fail to operate at particular frequencies. Leakage in coil, condensers, or leads. Over or under coupling between grid and plate coils. Low emission of tube caused by either poor tube or low filament voltage.
Motor Boating		Oscillator starts and stops. The on-off cycle is quite rapid and normally regular.	Open grid return or increased grid capacitator. The time constant of Rg Cg is too large to allow the complete discharge of Cg during a cycle thus building up a charge which cuts the tube off.
Shift of Frequency		This is usually accompanied by a drop in sensitivity and poor tracking.	Shorted turns. Leakage in coil or condenser. Open condenser in tank.

Oscillator drift (a changing of oscillator frequency which results in a shifting of dial calibration) can be caused by either purely mechanical changes or expansion due to thermal changes. Any oscillator of the type normally used in receivers will exhibit drift to some extent immediately following the initial turn-on. This is thermal drift and is caused by the mechanical changes through which all the associated parts pass before reaching their stable state of operating temperature. Following the turn-on the various supply voltages will, from an initial high value, decrease, due to the tubes increasing conduction as the filaments' temperature rises to normal thus raising the cathode's temperature and emission. The rising tube temperature also affects the spacing of the tube elements thus changing the various interelectrode capacitances. As the tube itself is reaching its final temperature, the electrical components are then being heated both by current flow through them (as in the case of resistors and coils) and by radiation from the tubes. For good operation this drift should not last for more than a few minutes and should not affect the oscillator frequency by more than approximately 5KC at the high end. An example of mechanical drift is relaxation of the trimmer's plates. This can be caused by a gradual loss of the spring tension or by the plates having attained a "set" from a previous position and then tending to return to the original setting.

Thermal drift can be minimized by various methods such as reducing the heat within the cabinet and chassis by improving ventilation, relocating the effected parts to a cooler and more thermally stable position in the chassis, and by adding a negative coefficient condenser across that portion of the oscillator tank (whether coil or gang) that suffers the value change due to heat. These ceramic, temperature compensating condensers are the easiest and most common means of combating thermal drift. Their value of capacitance must be large enough to provide adequate compensation, and yet not so large as to shift the trimmer's setting outside of its usable range.

The coefficient of change versus temperature rise must be of such value as to stabilize the circuit without overcompensating and thus causing the circuit to drift in the opposite direction. These condensers should be wired directly across the terminals of the part being compensated so as to receive as nearly as possible an equal temperature variation.

Loss of calibration over a long period of time can be caused by tube aging, by accumulated dirt on the trimmer or gang, by gain or loss of moisture in the insulation of the condensers or coils, or by changes in position of the trimmer or gang plates caused by lessening of spring tension. These changes are usually small and can be corrected by realignment.

Motorboating is a condition where the oscillator alternately starts and stops in rapid and usually regular fashion. The cause of this trouble is either an open or greatly increased grid resistor or a grid condenser that has increased in value. As explained in last month's article, the grid condenser charges negatively on the positive portion of the grid swing thus limiting the positive swing and the grid current. During the rest of the cycle, this negative charge leaks off across the grid resistor. If, for any reason, this charge does not completely disappear before the next positive swing of the grid, the residual charge will add to the charge normally acquired during the cycle. This is continually additive until the charge across Cg equals cutoff. The tube is then blocked and oscillations cease until the charge leaks off. The oscillator then starts, only to cut off again. It can be seen that the action at the oscillator grid is dependent upon the time constant of the combination of Cg and Rg.

Ocasionally, an oscillator will work for a period of time and then quit. There are several possible causes of this action; some part in the oscillator circuit may open, short, or change value sufficiently to prevent oscillation after warming up through operation, or the filament voltage may drop to such an extent as to lower emission below the value necessary to sustain oscillation.

These two possible causes are easily separated by applying the following tests. If the trouble is caused by component breakdown it will show up by supplying full rated supply voltage (or slightly more — such as 120 V. A.C. from a rheostat to supply an A.C. set which normally operates on 115 V.) and possibly adding heat to the suspected parts with a lamp or soldering iron. If the set is suspected to fail due to low filament voltage, the supply voltage can be reduced; the set should then quit. Measure the A.C. supply voltage at which the set just fails to operate to be sure that it is within the expected range of the service in the locality. The filament voltage should then be measured to ascertain if the voltage is below the level at which the tube should work or if the tube is at fault by requiring at least full filament voltage due to low emission. If the voltage across the oscillator tube is low, the voltage drop should be measured across the other tubes in series (in an AC-DC set) and any other components such as filament dropping resistors. This is a point to remember when portable radios require a new battery at very frequent intervals. Often the high voltage tubes will drop more than their share of the filament voltage. This may be caused by the tube itself or by a filament bypass that is leaking causing a higher current flow through one or more of the tubes.

Partial operation of the oscillator is characterized by reception of signals in only a portion of the tuning range. When a condition of this type exists, the oscillator voltage should be measured while tuning across the band. This voltage should be reasonably constant. Occasionally, a tube which checks good will refuse to oscillate on all or a portion of the band. If the oscillator voltage falls to zero or to a very low value in the portion of the tuning range that is inoperative, the trouble may be an open grid condenser, leakage in the coil, lowered oscillator plate current, or insufficient coupling between the grid and plate coils.

Overcoupling between the grid and plate sections of the oscillator transformer can also cause the circuit to be inoperative or partially so. This is due to the oscillator supplying sufficient injection voltage so that the mixer blocks. This can be checked by measuring the oscillator voltage and also by measuring the mixer stage gain. The oscillator and mixer work together to such an extent that a rise of oscillator injection voltage raises the bias on the mixer which lowers the mixer gain. A final check can be made when this condition is suspected by checking the mixer stage gain, lowering the oscillator voltage by some means such as reducing the B+ voltage applied to the plate section of the coil, and then rechecking for improved mixer gain and continuous operation across the band.

Stoppage of the oscillator in a portion of the band may be due to nicks or foreign matter in the plates of the variable condenser. Moisture or leakage across the coil or the insulation of the variable condenser may cause increased power consumption in the tuned circuit to such an extent that the oscillator feedback will not make up the loss, thus causing the circuit to fail to oscillate. Cases of moisture absorption in the tank components are often accompanied by a change in frequency.

The following paragraphs deal with the checking of auto sets which intermittantly blow fuses. Much of the information may be applied to the servicing of home sets as well. The check of operation using abnormal voltages (voltages which represent the high and low limits at which the set can be expected to operate) is very useful in any form of radio servicing. Many localities experience periods of high voltage (such as late at night when the load is least) and low voltage (such as the evening hours in residential neighborhoods or during the day in industrial locations). It will be noticed that often what appears to be an intermittant trouble is merely an inability on the part of the set to operate on other than normal voltage from the lines. As an example, the customer may complain that the radio shuts off for several minutes at irregular intervals during the evening. This may be a case of low supply voltage (or low oscillator emission) which is further lowered, below the set's operating point, by the added load of an electric refrigerator.

It is well known to all service stations and car dealers that a blown fuse is the complaint in a high percentage of auto radio repairs. A large number of these cases are remedied by the location and removal of a direct short to ground caused by a bit of solder or wire in the high voltage or B+ section or the replacement of a shorted filter section. Usually, these troubles will cause fuses to blow consistently as soon as voltage is applied.

Occasionally, however, a set will come in with a blown fuse and operation on the bench will be perfectly normal. At this point a great many servicemen make the mistake of replacing the vibrator and returning the set as repaired. This is laying themselves open for a subsequent identical complaint and irritation on the part of the customer. The car dealer and customer both begin to have suspicions as to the competence of the serviceman which may soon lead to curtailment of his business.

During normal vibrator operation, the voltage to the set may vary from 5.2 volts to as high as 8 volts, depending on the condition of the car battery, the setting of the voltage regulator and the resistance in the car wiring. This is a variation of 2.8 volts and can cause the voltage at the secondary to range between 200 and 310 volts on a normal power supply designed to furnish 250 volts at 6.3 volts input.

In order to locate power supply troubles (as well as oscillator failure, regeneration and high voltage breakdown) it is of tremendous advantage to be able to simulate input voltage fluctuations between the above limits. As this cannot be done with a common storage battery, it is highly advisable to equip the test bench with a manually variable low voltage, DC power supply.

In bench testing a set which has blown a fuse, the input voltage should be set to the nominal value as given by the manufacturer (usually 6.3 volts) and the input current noted. If the current is more than 1 ampere greater than that set forth in the specifications, the set should be thoroughly checked before being returned.

a. Replace temporarily the rectifier tube and see whether the current is reduced to normal.
b. Check the secondary buffer condenser and replace if necessary, using a capacity voltage rating, and type as recommended by the manufacturer.
c. Check by-pass condensers for shorts or leakage — especially in screen grid circuits.
d. Check feed-through condenser on "A" circuit and hash condenser between B+ and ground if they are used.
e. Check electrolytic condensers.
f. Check all tubes, especially output tubes, for shorts or abnormal consumption of current.

If the current is normal at 6.3 volts, the voltage should be raised slowly meanwhile watching the input current for signs of a rapid increase indicating a breakdown. When this has been established, it is easy to check the set as previously outlined. DO NOT EXCEED 8 VOLTS INPUT!

When replacing vibrators and buffers, it is wise to remember that the capacitance of the buffer condenser and the inductance of the secondary plus the reflected inductance of the primary form a resonant circuit which must be matched to, or track with, the cycling period of the particular type of vibrator used in the circuit. Thus, it can be seen that proper buffer values are extremely important, as the life of a vibrator can be shortened by as much as 50% by incorrect buffing.