# Practical RADIO COURSE

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***Part 38. Covering the special oscillator pre-selector tracking problems that exist in multi-band, manually-tuned receivers, and methods employed in solving them.***

QUITE a variety of oscillator tuning and band-switching circuit arrangements have been developed and used in multi-band manually-tuned receivers. Unfortunately, space restrictions make it impossible to present all of them here. However, descriptions of two general arrangements that have been widely used (with only slight modifications) in the receivers of various manufacturers—one mostly in 2-band receivers and one in 3-band receivers—will serve to outline the general way in which the oscillator tracking and band-switching problems have been solved for each tuning band.

Fig. 1 illustrates a popular oscillator tuning coil, band-switching, and oscillator-preselector tracking arrangement that has been used in many 2-band receivers employing a tapped-coil system for multi-waveband coverage. For reception on the 540 to 1720 kc. broadcast-band tuning range provided in this particular receiver, the four band switches shown are thrown over to the *"B"* contact. This places the full tickler winding (*1* + *3*) in the plate circuit (the second grid acts here as the plate of a triode oscillator), and the full secondary winding (*2* + *4*) in the tuning circuit. The full secondary is tuned by a combination made up of fixed low-frequency padder *19* shunted by adjustable broadcast-band padder *18,* all in series with main oscillator tuning capacitor *7* shunted by its broadcast-band, high-frequency trimmer *7B.* (Notice the similarity between this circuit arrangement and that of the fundamental "padder" circuit illustrated in Fig. 3 in the installment of this series that appeared in the September 1945 issue of RADIO NEWS.)

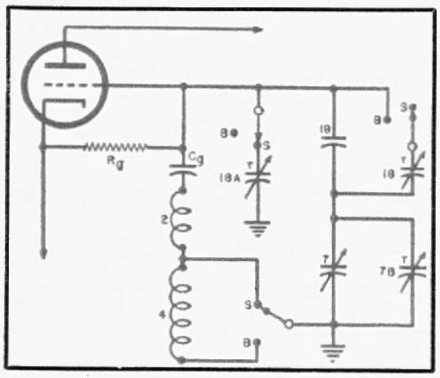


**Fig. 2. Leaving portion 4 of the tuning coil open, as shown, when the short-wave band is being used has disadvantages over that of shorting the coil, illustrated in Fig. 1, as discussed in the text.**

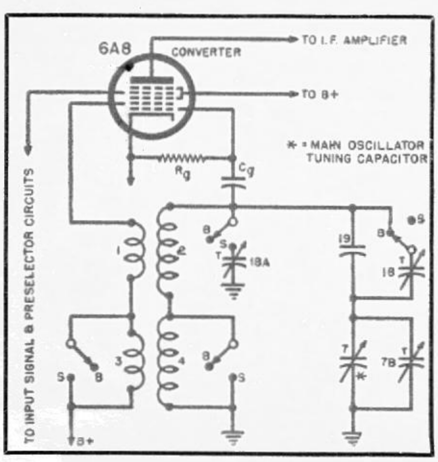


**Fig. 1. Band-switching, tuning, high-frequency trimmers, and low-frequency padder arrangements employed in oscillator of a two-band receiver using tapped coil system (Philco model 42-322).**

The manufacturer's aligning and tracking instructions specify that broadcast-band, high-frequency trimmer *7B* and the similar one on the preselector tuning capacitor section (not shown) are to be adjusted at a preselector frequency of 1500 kc. to obtain correct oscillator-preselector tracking at the high-frequency end of the broadcast-band. The broadcast-band, low-frequency adjustable padder *18* must be adjusted at a preselector frequency of 580 kc. in order to correctly tie down the oscillator tracking at the low-frequency end. Tracking will then be close and satisfactory all over the broadcast band.

For reception on the 8.7 to 15.5 mc. short-wave band provided in this receiver, the four band-switches shown are thrown over to the *"S"* contact. This shorts out portion *3* of the tickler coil and portion *4* of the secondary, leaving only portion *1* of the tickler and portion *2* of the secondary in the circuit. Padder *18* is now out of the circuit and adjustable short-wave high-frequency trimmer capacitor *18A* is shunted across the tuning coil *2.* Fixed series padder *19* still remains in series with the main tuning capacitor *7* that is shunted by its broadcast-band trimmer *7B.* Short-wave high-frequency trimmer *18A,* and a similar one across the short-wave preselector tuning coil (not shown), are to be adjusted for correct tracking at a preselector frequency of 15 mc. No means for adjustment of the padder capacitance is provided or necessary for the short-wave band.

A somewhat similar band-switching and oscillator tracking arrangement is used on many 3-band receivers that employ the tapped-coil system for multi-waveband coverage.

### Why Unused Portions of Tapped Tuning Coils are Shorted by Band-Switch

We will digress from our discussion of oscillator tracking for a moment, to consider an important detail in connection with the use of tapped tuning coils in multi-band receivers. It will be noticed that the lower portion, *4*, of the full oscillator tuning coil is shorted out by the ganged waveband switch when it is set for short-wave operation, as is also the lower portion, *3,* of the plate tickler coil. The tuning coil might have been tapped, of course, and its lower end left ungrounded; then the lower terminal of main tuning capacitor, *7,* could have been arranged to be switched either to the lower end of tuning coil *4* for broadcast-band reception, or to the tap for short-wave reception, thus leaving the unused portion of the tuning coil open as shown in Fig. 2.

At first thought it would appear that leaving the unused portion of the tuning coil open would be better than shorting it, since experience has taught us that even one or two shorted turns in a tuning coil are undesirable. However, there is good reason for shorting coil *4*, as we shall see. If an appreciable part of the coil is left open, the capacitance (both distributed and due to circuit wiring, shields, etc.) across this portion of the coil is likely to resonate it to a frequency in or near the desired short-wave band. If this occurred, it would greatly reduce both the sensitivity and selectivity over part of the short-wave band. In addition, coil *3* would most likely resonate at one frequency and coil *4* at a different frequency. This would throw the oscillator so badly out of track with the preselector circuits that it is doubtful if any signal at all would be received at certain frequencies. Spoiling the oscillator tracking is much more serious than spoiling the alignment of the preselector tuned circuits with each other. Another important thing to consider is that if the resonant frequency of the unused open portion of the oscillator coil happened to fall in the desired short-wave band, it is probable that the energy absorption would be so great that the oscillations would stop entirely. Now, if one unused turn of a coil is shorted it is very serious, for a comparatively large current will flow in the shorted turn and this will absorb power from the remainder of the coil and also seriously alter its effective resistance and inductance. If two unused turns are shorted, the effect is *less* serious because while the total voltage induced in the two turns is almost twice as great, the inductance of these two turns is *four* times as great as for one turn (inductance is nearly proportional to the *square* of the number of turns). Consequently the inductive reactance and impedance will be proportionately greater, and the current flowing in the two shorted turns is only *half* what it was in one turn. Accordingly, when there are a large number of unused turns on a coil, the effect of shorting them, as was done in the circuit of Fig. 1, is usually negligible, so the band-switch circuit in multi-band receivers employing tapped coils is always designed to short *all* unused turns on the coils.

Fig. 3 illustrates the tapped-coil system employed in the preselector and oscillator of the 3-band *Stromberg-Carlson* 58 receiver. Note that the waveband switches are of the "shorting" type, designed to short out *all* unused coils when in either of the short-wave band positions, $S_1$ or $S_2$.

## Oscillator Tracking and Band-Switching in Multi-Band Receivers Employing Separate Coils for Each Band

Most multi-band capacitor-tuned receivers, especially those designed to provide reception on 3 or more frequency bands, employ an individual preselector and oscillator tuning coil for each band, as illustrated in Fig. 4. In some of these, the secondary of each individual preselector and oscillator tuning coil is shunted with its own individual adjustable high-frequency shunt trimmer capacitor, and the tuning circuit of each oscillator coil has, in addition, both a fixed and an adjustable low-frequency series padder (the adjustable padder is usually omitted from the tuning coil for the highest-frequency waveband). For each waveband, the circuits and ganged waveband switches are arranged to switch the proper preselector and oscillator tuning coils and individual trimmer

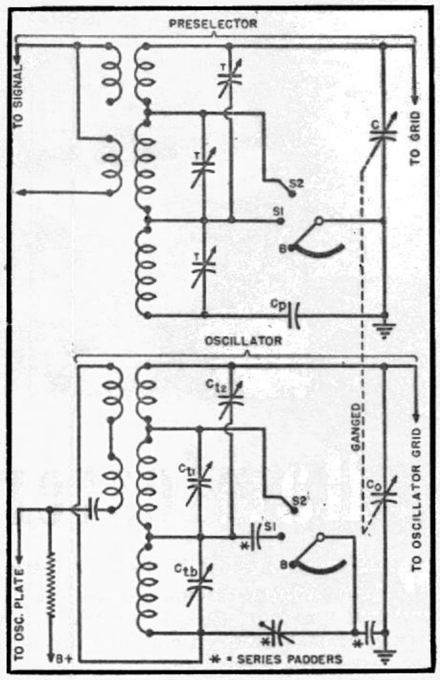


**Fig. 3. Preselector and oscillator circuit arrangement employed in 3-band receiver, using tapped-coil system with coil-shorting type band switches (Stromberg-Carlson 58).**

and padder capacitors into the circuits as units.

Fig. 4 illustrates a typical preselector and oscillator tuning and switching arrangement of this type, as used in the *Fada* model 290 series receivers which provide reception on the regular broadcast band and on two short-wave bands. Capacitors $C_p$ and $C_o$ are the main preselector and oscillator tuning capacitors, respectively, and are ganged together for single tuning control.

*B* is the broadcast-band position of

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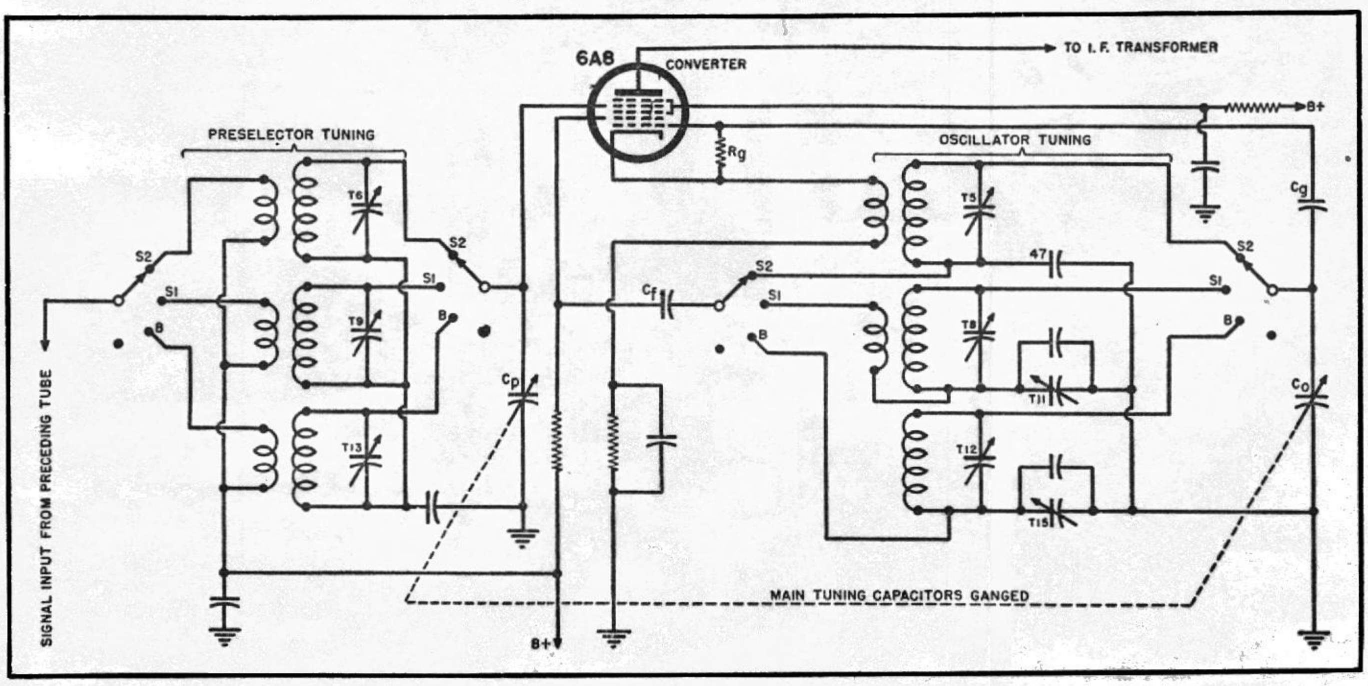
**Fig. 4. Tracking arrangement provided in typical 3-band receiver (Fada model 290 series), employing individual tuning coils, high-frequency trimmers, and low-frequency padders for each of the three bands.**



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each band switch. Capacitors $T_{13}$ and $T_{12}$ are the broadcast-band preselector and oscillator high-frequency trimmers respectively, which are to be adjusted for proper high-frequency tracking at a preselector frequency of 1500 kc. Capacitor $T_{15}$ is the adjustable unit of the broadcast-band low-frequency padder, and is to be adjusted for proper low-frequency tracking at 600 kc.

$S_1$ is the first short-wave band position of each band switch. Capacitors $T_9$ and $T_8$ are the high-frequency trimmers for this band, and are to be adjusted for correct high-frequency tracking at a preselector frequency of 4.5 mc. Capacitor $T_{11}$ is the low-frequency padder for this band, and is to be adjusted for proper low-frequency tracking at a preselector frequency of 1.8 mc.

$S_2$ is the higher-frequency short-wave band position of each band switch. Capacitors $T_6$ and $T_5$ are the high-frequency trimmers for this band, and are to be adjusted for correct high-frequency tracking at a preselector frequency of 15 mc. No low-frequency adjustable padder is provided for this band—the fixed low-frequency padder 47 sufficing for correct tracking here.

To insure perfect tracking the ganged main oscillator tuning capacitor should be "rocked" while adjusting the low-frequency padders, so that the maximum signal output will be followed.

### Interlocking Trimmers

Inspection of the separate-coil multi-band oscillator circuit in Fig. 4 reveals that a separate coil and oscillator high-frequency trimmer is used for each band. The trimmer is connected across the coil for that particular band and utilized only when that coil is in the circuit. Hence, the adjustment of a trimmer on one band is entirely independent of the trimmer adjustments on any other band so it does not matter which band is first adjusted for correct high-frequency tracking.

Many multi-band receivers that use a tapped-coil tuning system instead, employ trimmers that are in the circuit on more than one band. For example, for the broadcast band in the oscillator of the *Stromberg-Carlson* 58 receiver (see Fig. 3), all three trimmers are in series across the full tuning coil. Therefore, the oscillator tracking at the high-frequency end of the bands must be adjusted on the highest-frequency band first, when the lower two portions of the tuning *coil*, and their trimmers, are shorted out by the waveband switch. Then the adjustment is made on the medium-frequency band, and finally the broadcast-band. If the tracking adjustment were made on the broadcast-band first, the subsequent tracking adjustments made on the other two bands would





nullify the settings on the broadcast-band because the trimmer capacitors for the two short-wave bands also have a tuning effect on the full tuning coil when it is used for broadcast-band reception. Similarly, adjustment of trimmer $C_{12}$ affects the tuning of the portion of the coil used for the medium-frequency band, so, unless the highest frequency band is tracked before the medium-frequency band, it will nullify the settings on the latter.

### Fixed Tracking Padders

In the oscillators of some multi-band receivers there is only an *adjustable* type series-padding capacitor for the broadcast-band, the series padder for the medium- and short-wave bands being in the form of fixed capacitors (see Fig. 3). In others, all bands but the highest-frequency band are provided with adjustable padders, the latter requiring only a *fixed* padder of the proper capacitance value (see Figs. 1 and 4).

It is interesting to note that if the receiver is designed to have the oscillator operating at a *lower* frequency than the signal, the low-frequency pad or pads are placed in the preselector tuning circuits instead of the oscillator tuning circuits. Using a "low side" oscillator is advantageous in ultra-high frequency receivers, since the oscillator has greater output and stability when operating at a *lower* frequency. Let us see the reason for this. The difference between "low side" (or lower-frequency) oscillator operation and "high side" (or higher-frequency) oscillator operation amounts to twice the intermediate frequency. Therefore, in a standard broadcast-band receiver employing the usual 455 kc. i.f., the frequency advantage gained by low-side oscillator operation would be only $455 \times 2 = 910$ kc. The benefits of such operation would be negligible! The difference in efficiency also would be negligible. On the other hand, in a u.h.f. receiver employing a much higher i.f., say 5 megacycles, the difference of $5 \times 2 = 10$ mc. between the two methods of oscillator operation could result in a considerable improvement in oscillator performance if the "low-side" mode of operation is employed.

The special oscillator-preselector tracking problems encountered in receivers that employ push-button station selection will be explained in the next article of this series.

(*To be continued*)

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