Wide Range BANDPASS CRYSTAL TUNER

Construction details on a novel 540 to 1750 kc. crystal tuner. It has 12 to 18 kc. selectivity without using any vacuum tubes or power supply.

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Over-all view of laboratory "breadboard" test set along with its audio amplifier and speaker. The volume control was eliminated in this broadcast band tuner. The one in the audio amplifier is being used in its place. Circuit diagram is shown on Page 112.

THE old-fashioned crystal set is dead—let it go to a well-earned rest. This article will not be another description of the same weary circuit with a modern germanium crystal detector subbing for the "cat whisker" and galena. The broadcast band tuner to be described is capable of 12 to 18 kilocycle selectivity, without benefit of vacuum tubes or power supply. It contributes no additional hum to the amplifier following it and is free of the heterodyne whistles present in superheterodyne tuners.

Simple in construction, the unit can be built for a total cost of seven dollars and a time investment of one or two hours; or the tuner may be "dolled up" with the addition of a slide rule dial and 10 kc. anti-ring filter for a total of twelve dollars. Connected to a modern high-gain amplifier in a typical American metropolitan area, its performance is indistinguishable from that of many high priced t.r.f. and superheterodyne high-fidelity tuners.

The original model was specifically designed for a large advertising agency, to serve as a fixed frequency, high-quality monitor for spot radio show checks. Later laboratory tests showed it capable of excellent performance over the entire broadcast band. There is nothing tricky or unusual about the circuit used. It is one of the many well-known bandpass networks with which radio engineers have been familiar for years. The characteristics of such a network are a relatively "flat top" for uniform response over the desired channel and very steep sides or "skirts" to provide good selectivity between adjacent signals. Reference to Fig. 1 will show that special so-called bandpass coils have not been used. Instead high "*Q*" litz wire r.f. coils, possessing a primary and secondary winding, have been incorporated into the circuit. The primary reason for this is that coils designed for t.r.f. bandpass tuners consist of a single winding usually intended to work into an infinite impedance detector to avoid loading down the network.

In the circuit shown in Fig. 1, severe loading of the output terminals of the bandpass network was avoided by utilizing the *J. W. Miller* 242 r.f. coil, T_2, backwards; that is, the primary is used as the output winding and carries the crystal current of the 1N34. This provides a stepdown from the high impedance of the network to the relatively low impedance of the crystal circuit. While the turns ratio and coupling coefficient are not ideal for the purpose, they are sufficient to give good results. A negative mutual coil T_3 and condenser C_1 complete the bandpass circuit.

Only one caution with regard to circuit values need be stressed, and that is to make sure condenser C_1 is .015 μfd. even if two condensers of standard values have to be paralleled to get this value. While not shown in the illustrations, two precautions in construction were found necessary to avoid hum pickup from random fields. A well bonded bottom plate must be used on the chassis and a double shielded cable, such as war surplus RG5/U, provided to couple the tuner to the amplifier input. With the measured hum level of many good amplifiers down 65 db. and a gain sensitivity of 125 db., such measures are necessary to secure the performance of which the tuner is capable.

It should be pointed out that, unlike the familiar crystal set, the tuner described herein is not intended to drive a pair of earphones. Networks of the bandpass type have a given insertion loss, and hence require quite high gain amplifiers to be used in conjunction with them. Another fact which came to light during measurements of the bandpass characteristics of the tuner is that the particular coils used, when placed in the circuit shown in Fig. 1, only give satisfactory 18 to 20 kc. "flat top" response when from 30 to 50 feet of wire is used for an antenna. This is not due to the "pickup" efficiency of such length of wire, but is due rather to the reactance that this antenna places across the input terminals of the network.

Many readers may think this is getting a little fancy with a *crystal set*, but judgment in this respect should be withheld until the experience of tuning the broadcast band with this unit has been enjoyed. Also note that 18 to 20 kc. selectivity has been mentioned repeatedly. Neither this tuner

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Crystal Tuner

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nor any other really high-fidelity receiver can separate stations operating closer than this, for such bandwidth is needed for high program quality transmission.

In aligning the tuner, the really ideal instruments for the job are a bandsweeping signal generator used in conjunction with an oscilloscope. In lieu of such aids, however, a 250 μμfd. condenser should be connected to the antenna post of the tuner, and the lead from a regular signal generator connected to it. The signal generator should share a common ground with the tuner. A 20-watt resistor of a value equal to one of the higher (250- or 500-ohm) output impedances provided by the amplifier is placed across the voice coil terminals in place of the speaker. The output meter, in our case a model 260 *Simpson* set to the 2.5 volt a.c. scale, is placed across this resistor. With the tuner connected to the amplifier input (at least 50 to 80 decibels gain should be available) the gain control is advanced to about one eighth its full scale setting. Any noise or hum within the amplifier will cause the meter to read. The voltage indicated should be noted as being the "base line" or reference level for subsequent readings.

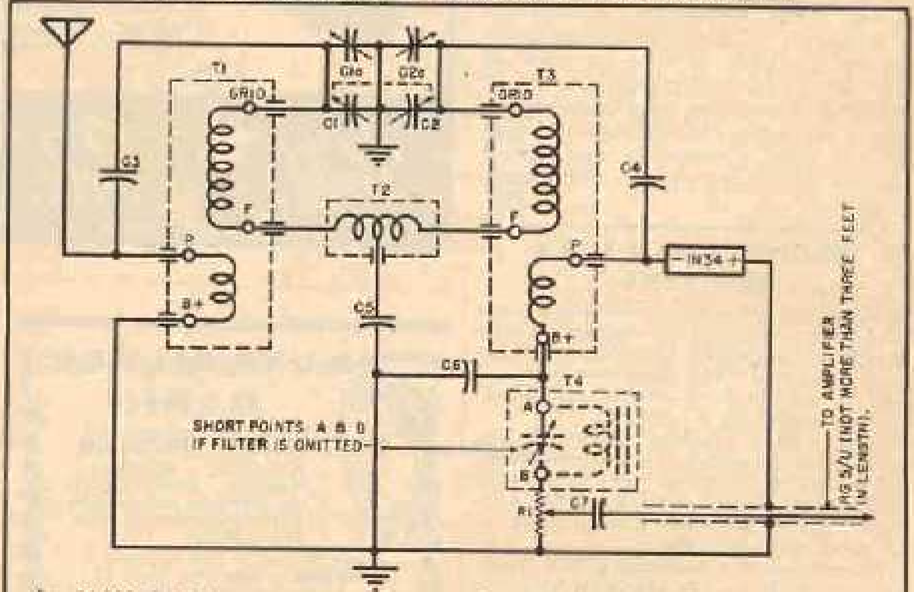
The modulated signal generator is now tuned to approximately 900 kc. and the tuning condenser of the tuner rocked back and forth to find the signal. Once such a point has been found, the output attenuator of the signal generator should be adjusted until the output meter reads just full scale on the peak response of the signal. Adjust trimmers C_{1a} and C_{2a} until, upon tuning through the signal, *two* slight peaks or rises are noticed on each side of the signal generator's frequency. These peaks should be made equal to each other by careful adjustment of the trimmers; this is the proper alignment. The antenna may now be connected and the speaker replaced for an actual air check.

If no signal generator is available, the tuner may still be aligned, at the expense of a little sleep, by waiting until the hour most broadcast stations end their regular programs. It will be found usually that several return to the air in the early morning hours, emitting a steady tone-modulated signal for transmitter adjustments. With such signals available it is then a simple matter to follow the procedure outlined above.

If it is found impossible to make the two slight peaks each side of the center frequency equal in magnitude, the bottom plate of the chassis should be removed and the wires leading from the "grid" connection of each *J. W. Miller* r.f. coil slowly moved with an insulated probe. It will usually be found that this has an appreciable effect upon the magnitude of the first or second peak. The lead found to have the major effect should be bent away or nearer to the metal chassis and the trimmers adjusted until the two peaks are matched.

So called "monkey chatter" may be noticed when listening to one or more stations in a given locality due to interchannel interference. This effect may also take the form of a very high-pitched ringing sound. If this interference is objectionable, T_4 should be added to the circuit. This filter is an iron core, parallel-tuned circuit, which should be tuned while listening to a signal until the "chatter" is eliminated. —30—

Fig. 1. Schematic diagram of the low-cost bandpass crystal tuner.



R_1—50,000 ohm pot.
C_1, C_2—365 μμfd. per section, 2 gang var. cond.
C_{1a}, C_{2a}—Trimmers on gang cond.
C_3, C_4—15 μμfd. mica cond.
C_5—.015 μfd. mica cond. (See text)
C_7—250 μμfd. mica cond.
C_6—.01 μfd., 400 v. cond.
T_1, T_3—R.f. coil (J. W. Miller #242)
T_2—J. W. Miller EL-56 negative mutual coil
T_4—J. W. Miller EL-58 filter
1—1N34 crystal rectifier