EVERYMAN'S GUIDE TO RADIO

A PRACTICAL COURSE OF
COMMON-SENSE INSTRUCTION IN
THE WORLD'S MOST FASCINATING SCIENCE

VOLUME II

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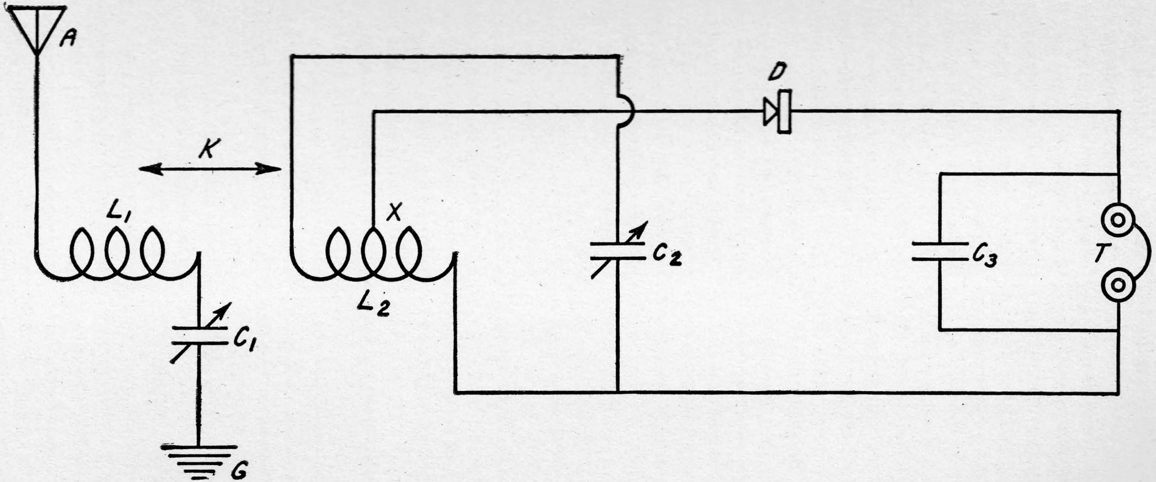


A CIRCUIT THAT WILL IMPROVE THE CRYSTAL RECEIVER

Figure T: This hook-up with a crystal detector will give high selectivity because of the coupled circuits and the method of tapping the secondary coil.

advantage of the beat-note for locating weak signals, and yet be secure in the knowledge that he is not interfering with his neighbors.

We have considered spark or code interference most specifically, and we saw that, although some improvement may be expected as a result of the reduction of the number of radio code messages being sent on waves that lie within the broadcasting range, we must go farther than this to get the desired relief. The situation will be greatly aided by the installation and operation of higher-powered broadcasting transmitters. But, it will take time to get these stations into operation. Meantime, we should improve our receivers so that they will better discriminate between the music and the speech and the undesirable code interference. This improvement must naturally be sought through increasing the selective power of our receiving sets.

It is well to remember that even the most nearly ideal radio receiver, from the point of view of selectiveness, will not entirely exclude interfering signals sent out by powerful and nearby spark transmitters. Nevertheless, most of the radio receivers in use are of types that can be substantially improved in their capacity to cut out spark signals, and, what makes the improvement of added value, they will at the same time become better able to choose between the signals of different broadcasting stations that operate on adjacent waves. Thus, while we are attempting to get more satisfactory conditions for listening to broadcast programs without interruption from ship or shore spark transmitters, we will simultaneously be reducing our troubles from "cross talk" or direct program interference between broadcasting stations.

We should consider next the way in which two-tuned circuits may be used with crystal receivers.

The most satisfactory arrangement is to tune the antenna-to-ground circuit separately and to couple it transformer-fashion with a second tuned circuit to which the detector is directly connected. Such a receiver is shown in Figure T. in which the first or antenna-to-ground circuit is shown at the left extending from the antenna A through the primary coil L_1 and the primary tuning condenser C_1 to the ground connection G. The size of the coil and condenser to give best results, will depend up on the size of the antenna to be used. As a general rule, the larger the antenna is, the smaller the coil may be and the larger the tuning condenser that may be used.

For this sort of circuit it is desirable to use an antenna that is not too long and which is large or has great capacity through its umbrella-rib or parallel wire formation. If you have a single tall flag-pole or similar support, an umbrella antenna constructed on it is very effective. The individual wires should not be over 75 or 100 feet long, and all of them should be of the same length, including the down-lead to the receiver. If you have available two masts or points of support you will get good results from four parallel wires, each of which should be not more than 50 or 60 feet long, and hung at least three feet apart between spreaders.

With a fair-sized antenna of the sort just described, the primary condenser C_1 may be of .0005 or even of .001 mfd. capacity, and the coil L_1 may be chosen by trial so that the broadcasting waves come at intervals that spread well over the scale of the condenser. A good coil to begin with would have 100 turns of No. 22 DCC copper wire wound on a tube three and a half or four inches in diameter. If the antenna is of fairly high capacity, it may be found that the long-wave broadcasters "tune in" too far down the condenser scale. If, for instance, WEAF (610 kc or 492 meters) tunes at less than 70 or 80 divisions on a 100-part scale, it is an indication that the number of turns on the coil may be reduced to advantage. The same indication may, of course, be obtained by noting the tuning point of any of the lower-frequency (longer-wave) stations such as KSD, KYW, WNYC, WCX or WIP. What is sought is to make the coil of such size that the lower frequencies tune at the maximum-capacity end of the condenser scale, because then the tuning adjustment will be most effective over a large part of broadcast wavelengths.

If the coil L_1 has too few turns for the antenna you are using, or, in other words, if the antenna is too small for the coil, you have the option of adding more wires to the antenna (it is not so good to increase its length) or of increasing the coil.

As a general rule, it is better to enlarge the antenna than to use more than 100 turns on the coil. You can, of course, tell whether the coil or the antenna is to small, because the medium-wave stations such as WJY, WGY or WFI will tune at the high-capacity end of the condenser scale instead of near the middle. Thus, if you cannot reach the longer-wave stations on your condenser dial, you will have to add turns to your coil or else increase the size of the antenna. Sometimes the use of a larger tuning condenser will do the trick. However, because the effective capacity of the whole circuit is limited by the capacity of the antenna, this does not help as directly as an increase in the coil would.

The tuned, secondary circuit consists of the secondary coil L_2 and the secondary tuning condenser C_2.

This is a simple closed circuit the tuning range of which depends almost entirely upon the size of the coil and the condenser. Forty turns of No. 22 DCC on a three-and-a-half-inch tube as the coil will ordinarily work quite well in connection with a variable condenser of .0005 mfd. maximum for C_2. In making this coil you should tap it at the tenth, twentieth (midpoint) and thirtieth turns so that the detector connection may be attached, as will be described later. It may be that your present receiver contains the parts necessary for this secondary circuit. Some sets have a coil and a variable condenser in series with it for tuning the antenna circuit; and, if yours is one of these, you need only connect the antenna and ground binding posts together by a short piece of wire. Then, if the detector is connected across the coil within the set, your outfit will be like the secondary circuit of Fig. T, except that the lead from the detector will be connected to the left-hand end of the secondary coil instead of to the tap X.

Of course, your antenna and ground are to be disconnected from the set and connected to a separately tuned primary coil and condenser as described in the preceding paragraphs.

The detector circuit of Fig. T consists simply of the crystal detector itself, at D, an accumulating condenser of .001 or .002 mfd. (the size of this condenser is not particularly important) and the headphones.

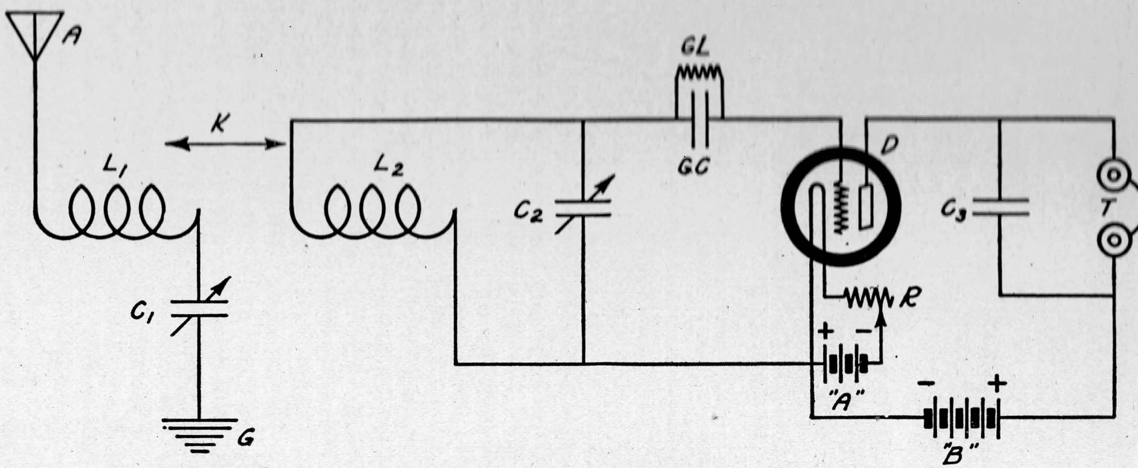
The detector is not connected across the entire secondary coil, but instead its upper lead-wire runs to a tap on that coil as indicated at X. Ordinarily about half-way down the coil there will be the best average position for this tap, but, if still greater selectivity is desired in tuning to strong signals, less than half the turns may be included between X and the right-hand end of the coil leading to C_3. The greater the number of turns you place between X and the right-hand end, the louder the signals may be, but you will obtain less selectivity. Under some conditions the use of the midpoint tap will give not only greater selective power but also louder signals than a position for X including more turns in the branch circuit containing the detector. This, however, is a matter that must be determined by trial under your particular working conditions.

The only factor that remains to be considered is the coupling between the primary and secondary coils, which is indicated by the double-ended arrow marked K. This shows that the coils are intended to be relatively movable along the line of their common axis; you may fix L_2 in position and arrange L_1 so that you may slide it back and forth. It should be possible to move the coils together into the abutting or end-to-end position, or to separate them so that two or three inches of free space will separate their nearer ends. It is not necessary to make one coil slide within the other, as has been done in many old designs of couplers. Ordinarily the circuit will show very poor selective qualities with the coils in this position.

Having set up the circuit in accordance with the above suggestions, you will find it rather different in behavior from (and far superior to) the usual crystal receiver. To learn to use this improved receiver, it is well to begin with the two coils abutting and at a time when you are certain that several broadcasting stations in your neighborhood are transmitting. Also, you will need a test buzzer to make sure that your crystal is adjusted to a sensitive point. With the ordinary crystal set you will hear something as soon as you start to adjust your detector, and, thereafter, turned adjustments will merely improve or hinder matters a little. With this outfit you should hear nothing unless your crystal is a sensitive condition and both your tuning condensers are properly set.

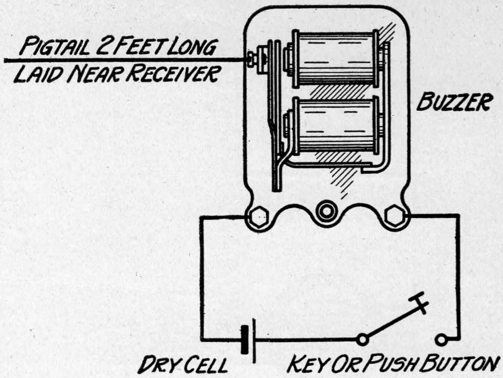
Therefore, begin by making your crystal respond strongly to the test buzzer, and slide the two coils close together. Listen in the headphones carefully, set the antenna or primary tuning condenser at 100 and then swing the secondary condenser slowly back and forth between, say, 60 and 100. If you hear nothing, set the primary condenser at 95 and search again with the secondary condenser. Continue to reduce the primary condenser in five scale-reading steps and swing the secondary condenser more widely through its scale as the primary setting becomes smaller. If your set is working and if there is any station that is transmitting within your range, you should "pick it up" without difficulty. Once you hear a station, find the best positions for both condensers and *write them down*. Try to get similar records for a number of stations throughout the wavelength range that your set covers. It may help you the first time you attempt to pick up these stations if you connect the detector across the entire secondary coil. If you have to do so, you should then tune for the same stations again and record the tuning settings when the midpoint tap X is used. You will be surprised by the improvement in tuning sharpness that the use of this X tap produces.

Having prepared a list of stations and their best tuning settings as above, mark it "K maximum" (indicating that it applies when the coils are as close together as possible—i.e., with the maximum coupling) and then go through the pro-



A SIMPLE VACUUM-TUBE HOOK-UP

Figure W: This is a type of selective circuit that employs tuned antenna and secondary circuits. If a WD-11 or WD-12 tube is used, the "A" battery need be only a single dry-cell and the "B" battery a small 22½-volt block.



THE TEST BUZZER ARRANGEMENT

Figure X: An old electric door bell will perform the necessary work if the clapper is cut off and wired up, as shown above. When the buzzer is operated, an electromagnetic field around the pigtail will affect the receiving circuit; this effect will be heard in the headphones if the crystal detector is properly adjusted.

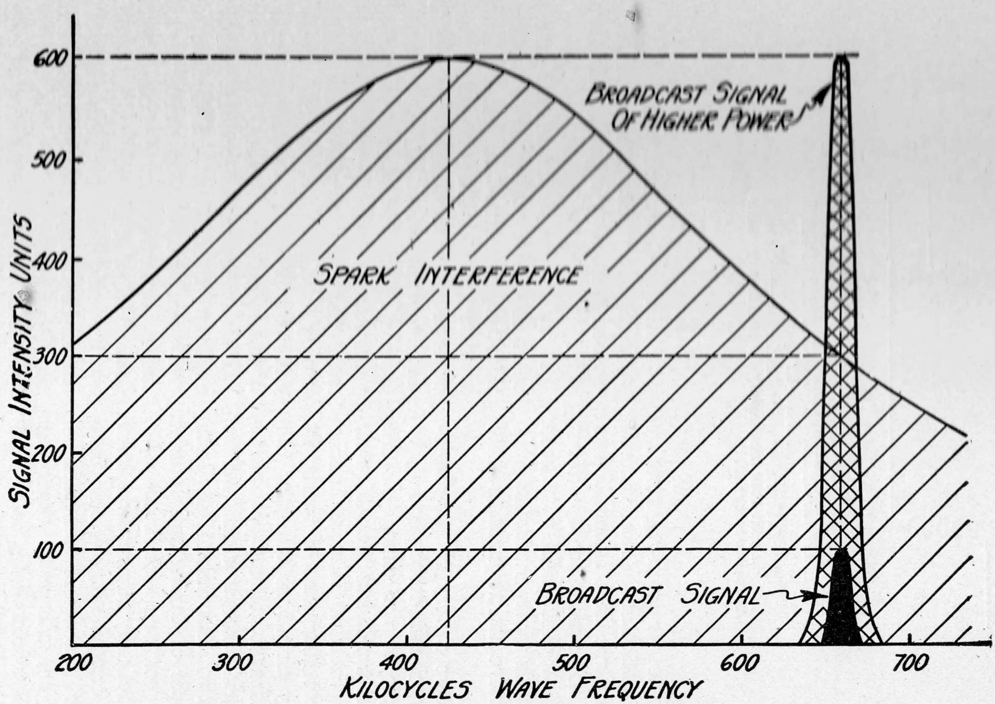
cess again with the ends of the two coils one inch apart. This will shift the tuning positions on both condensers somewhat, but the earlier records should be of considerable help to you in locating the stations under this new condition of looser coupling.

You will observe that the tuning will have sharpened up a good deal, and the signals in some cases may be a little weaker. Make a list of the settings for the several stations with "K one inch," for future reference. If this separation of the coils gives you adequate freedom from interference, you need experiment no further. You may find it worth while, nevertheless, to try a coupling distance of two inches or even more, and to reduce the number of turns in the detector portion of the secondary coil.

For your antenna and detector you will find some coupling and X tap position that give the best all around results; and that is where you should conclude your tests. If you "log" the tuning settings for a number of stations under these conditions you can draw a tuning curve such as is shown in Fig. V, which will be of great assistance to you in locating the adjustments for other stations of which you know the wave-frequencies or wavelengths.

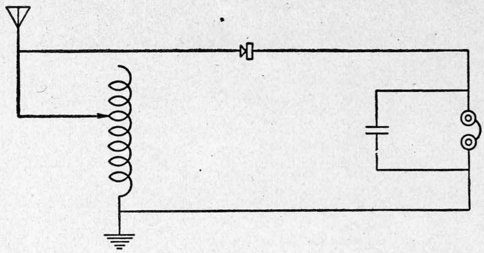
You will see at once that the foregoing instructions for operating a two-tuned-circuit receiver apply when you have built up the secondary circuit with a coil such as that described or when you are using the circuit of your old receiver as a secondary. You may have to use some ingenuity in mounting the antenna-circuit coil if you have utilized the old receiver, but this should present no real difficulty if you remember that it is to be arranged next to the secondary coil and with a common center line or axis.

It is perhaps not so obvious that the same general arrangement may be used



HOW HIGH POWER STATIONS CAN AVOID SPARK TRANSMITTERS

Figure Y: As long as the signal intensity of the broadcasting station is less than that of the spark set, interference will exist as shown graphically in the diagram. However, by increasing the intensity of transmitted signals as indicated above the broadcaster will break through spark "jamming."



THE OLD-STYLE SINGLE-SLIDE TUNER HOOK-UP

Figure Z: Crystal sets wired in the manner shown in this diagram tune too broadly for satisfactory radio-telephone reception.

with a simple or non-regenerative vacuum-tube detector. The vacuum tube is two or three times as sensitive as the crystal, and requires no adjustment of contact points; consequently its use is often well worth while, even though it is more expensive and requires two sets of batteries.

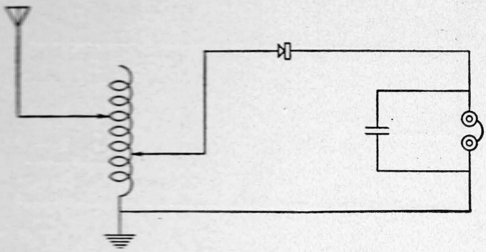
Fig. W shows a very simple single-tube receiver circuit corresponding to Fig. T except for the change in the detector. The tap X has been left out, because the vacuum tube ordinarily does not affect sharpness of tuning in the secondary circuit as much as the crystal does; thus it becomes possible to connect its grid-filament circuit across the entire coil without much if any loss.

The principle of tuning and loosely coupling the antenna circuit may be applied to practically any receiver from the simplest crystal set, such as that described, to the most complicated superheterodyne. In most cases the change is well worth while, because of the freedom from spark interference and cross-talk that it gives, even though, as ordinarily applied, it requires the tuning of an additional condenser. With the large number of broadcasting stations now in operation, and with the coming of higher powered transmitters, increased selectivity is particularly valuable.

It is feasible, moreover, to tune the antenna circuit at the same time and with the same motion that tunes the secondary or closed circuit by using equalized and simultaneously variable, double condensers. That invention (which I described some ten or twelve years ago in connection with commercial radio receivers) provides the ease of tuning that is characteristic of single circuits and besides the high selectivity of multiple-tuned circuits.

Interference with broadcast reception caused by spark transmitters was one of the topics that the Department of Commerce Conferences have studied with a good deal of care, and a number of recommendations have been made that should be directly helpful in improving the situation.

In increasing the number of wave-bands or channels to be used for broadcasting, so as to allow the broadcast stations to operate with less mutual interference, the Conferences suggested a new grouping of wave frequencies and



THE DOUBLE-SLIDE TUNER

Figure AA: The re-arrangement indicated in this diagram of a single-circuit tuner shows how selectivity may be improved whereby closer tuning for broadcasting can be accomplished.

a new classification of broadcasters, as shown in the table on this page.

Outstanding features shown by this tabulation, and features that are bound to help out our recent troubles from spark and other wave-interference, are the following:

Frequency Cycles	Wave length Meters	Service
2,000,000 to 1,764,000	150 to 170	Amateur CW and ICW Radio Telegraph
1,764,000 to 1,666,000	170 to 180	Amateur Radio Telegraph
1,666,000 to 1,500,000	180 to 200	Amateur CW and ICW Radio Telegraph
1,460,000 to 1,420,000	205 to 211	Class 3 Broadcasters (less than 100 watts power)
1,400,000 to 1,090,000	214 to 275	Class 2 Broadcasters (corresponding to old Class A)
1,070,000 to 550,000	280 to 545	Class 1 Broadcasters (corresponding to old Class B)
500,000	600	Marine calling and distress signals

1. The amateurs have agreed to eliminate spark transmission, thus freeing the high-frequency end of the broadcasting range of waves from this interruption.

2. The amateurs have agreed to restrict their radiotelephone experiments to the band between 1,666 and 1,764 kilocycles (170 to 180 meters) to aid in removing this sort of interference from the broadcast range.

3. The marine interests have agreed to stop the use of the old 1,000 kc (300 meter) and 666 kc (450 meter) waves, which caused so much trouble in broadcast reception.

4. The marine interests have agreed to use the 500 kc (600 meter) wave, adjacent the broadcast band, for calling and distress purposes only. Ship-and-shore message traffic will thus be handled upon the new lower-frequency channels more remote from the broadcasting waves.

It is only natural for all of us to hope that these various recommendations and agreements of the Conference can be put into practical operation at the earliest possible date. They are likely to