OPERATION CRYSTAL

it can happen here . . .

Disaster . . . no radio, no newspaper, no telephone . . . Hurricane? Explosion? A-bomb? H-bomb? How many bombs? What should you do to save yourself and your family?

Your car radio soon goes dead after you run out of gas . . . but the disaster goes on, gets worse . . . two days, three days . . . no trains, no trucks, no food . . . you recall how easy it was to get information with radio, newspaper and telephone. . .

The third day your neighbor's portable radio goes dead . . . the storekeeper laughs when you mention batteries . . . you remember how fresh milk used to taste . . . and you say you'll never eat cold canned food again, if you get out of this . . .

IF you get out . . . but you can't get out without information! Is help on the way? Or are worse disaster areas taking up all the relief? Should you start hiking? Which way? North? South? East? West? Will there be more bombs? More hurricanes? Where will they hit? And when?

Still no radio, no newspapers, no telephone . . . just rumors—wild, contradictory rumors that may lead you the wrong way . . . one neighbor says flee . . . another says stay.

Superhuman effort has kept one broadcasting station on the air, perhaps on the Conelrad frequency. But you can't hear the official reports and advice without power or batteries.

What is the answer? You, the radio amateur have the answer—right in your junk box. You guessed it. A crystal diode detector.

There are probably as many ways to hook up a powerless diode detector in an emergency as there are amateurs. What works best on the broadcast band in your locality?

G-E HAM NEWS will award $10 tube certificates for the three most outstanding emergency crystal diode designs submitted for publication for each issue during 1955. In addition, we will award copies of our first Bound Volume (plus a complete set of subsequent issues) and one-year subscriptions to G-E HAM NEWS for other designs accepted for publication. Be sure to include in your contribution some notes on local receiving conditions. DO NOT SEND IN YOUR MODEL. All material submitted becomes the property of G-E HAM NEWS.

During a recent hurricane, our editor was visiting in New Jersey. Although the storm merely jostled the community, 25,000 homes were without power for the entire week-end.

Fretting because he couldn't turn on the BC set to learn about progress of the storm, it occurred to W2ZBY that every home ought to be equipped with a crystal detector for emergency purposes—and, furthermore, that the neighborhood ham is the logical person to show folks how to provide themselves with such an affair.

Impressed with the endless variety of crystal set designs possible with modern components, we decided to ask you fellows to help. Receiving conditions vary almost from house to house—depending on signal strength of local broadcasting stations, available space for antennas, the character of grounds, and so on ad infinitum.

Here is a discussion of some of the basic principles and how they have been turned into practical circuits by a few of the G-E hams. Old timers' experience should enable them to make significant contributions to this emergency and civil defense need. But that's not to say novices can't do just as well or better. And, incidentally, what better way is there for a novice to get some basic practical experience with tuned circuits?

Let's have your contributions, fellows.

—*Lighthouse Larry*

The basic component in a simple radio detector is a rectifier to peel the audio envelope from the incoming RF signal. In the early days of crystal sets a small chunk of the mineral galena was found to be a pretty "hot" rectifier. The rectified signal was taken off the piece of galena with a very fine wire called the "cat whisker."

The big trick was to find a good "sensitive" spot on the galena. This inconvenience is eliminated today by germanium diodes which now are turned out like buttons. Thus the germanium diode—often called a crystal diode—looks like a good bet for simple diode detector design.

However, it might be worth mentioning at the outset that a poor connection caused by rust or corrosion of some other kind can serve the same rectifying purpose. The rust or corrosion creates a "semi-conductor"—passing RF current in one direction.

Every once in a while one finds an audio-resonant system attached to the corroded metal—like, for instance, a bathtub of proper dimensions with rusty pipes—and lo and behold, we actually have a "singing bathtub." This phenomenon is, of course, the basis for the oft-told tales in ham circles about the old lady next door complaining she can hear your voice CQ'ing in the gold in her teeth or booming out of the drain pipe in her sink.

A fellow located close enough to a high power broadcast station often can pick up the local program by putting on a pair of headphones and touching the pin tips to his water pipes, a window screen or his bed springs.

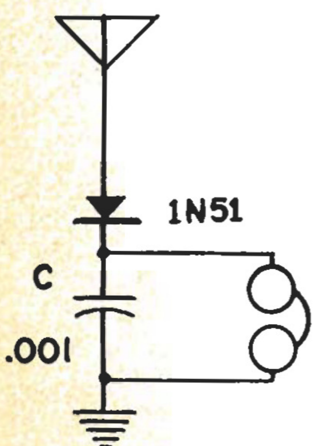


Fig. 1

A slightly more complicated—but very un-electronic—type of rectifier can be made with a pair of razor blades, a bar of soap and a needle. Another version—reported from Alaska—is a "blue blade" and a safety-pin used as a "cat whisker."

However, for more reliable performance, we suggest the crystal diode. And this can be hooked up in a variety of ways. Perhaps the simplest—again usable only in strong signal areas—is illustrated in Figure 1.

Here a piece of wire for an antenna is connected to one side of the diode, the other side of the diode to the earphones—which are by-passed by C—and the other side of the earphones to ground. The efficiency of antenna and ground required will vary with local conditions—depending principally on the strength of the incoming signal.

However, when you get farther away from the broadcast transmitter, you find the need for more over-all efficiency than the best ground and antenna alone can give. Thus the next step is to employ a tuned circuit, as in Figure 2. In this circuit, L and C are tuned to

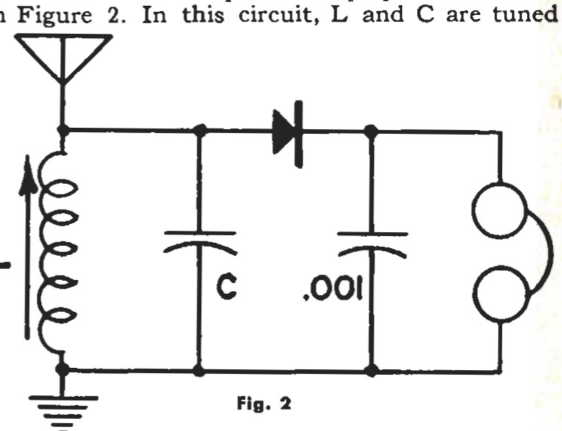


Fig. 2

the frequency of the station desired—and it still must be a pretty strong station with this simple setup.

From this point on the experimenter can branch out into countless forms of antennas, grounds, and tuned circuits.

For instance, Don Norgaard, W2KUJ—designer of the Signal Slicer, the SSB Jr. and other pieces of somewhat more complicated gear that have been described in past issues of G-E HAM NEWS—recalls considerable success many years ago with an arrangement like that shown in Figure 3.

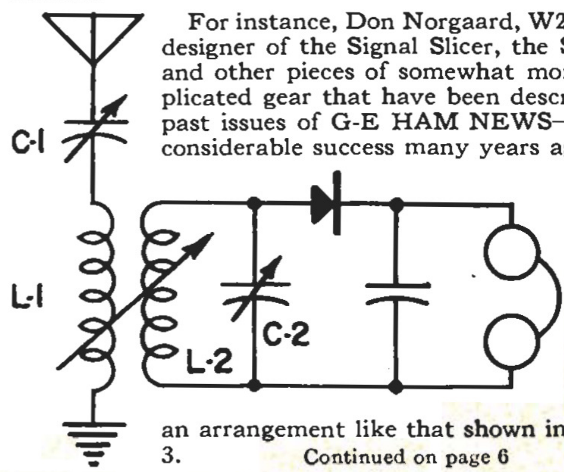


Fig. 3

Continued on page 6

This simple crystal set was built and used in Texas—and it brought in KDKA from Pittsburgh, KFI from Los Angeles, and many stations in between. Let's take a closer look at it.

In the first place, the antenna was about 180 feet long. It was No. 30 wire—to conceal from the rooming-house landlord the fact that a radio was in the house.

Note, also, that two tuned circuits plus the coupling between them afforded a total of three tuning controls. Not quite as simple an affair to tune as today's BC set with its one tuning knob—but much more effective. Both the series-tuned circuit of L_1 and C_1 and the parallel-tuned circuit of L_2 and C_2 must be tuned to the desired frequency, and the coupling between the coils must be correct. Varying this coupling can change the tuning of the resonant circuits, of course, and this is what complicates matters a bit in tuning such an arrangement.

To return, for a moment, to the subjects of grounds and antennas. The average home contains quite a few possibilities. Another G-E ham—Bill Coffey, W2ZHI—found a few loops of wire strung around a window frame pretty effective. Another OM here—who in this instance prefers to remain unnamed—suggested that as long as the telephones weren't working and it was a real tough emergency the telephone line would make a nice antenna. He also commented that your body—floating with RF of indeterminate phase—often does quite well as a sky-hook.

Another G-E ham found the best ground at his house is the kitchen sink drain pipe. The sink empties into a dry-well through a forty-foot 2-inch pipe buried about two feet underground. For some reason this pipe surpasses the well, the water pipes and the drain to the septic tank.

HOW ABOUT COMPONENTS?

Figure 4 shows a fairly efficient little BC receiver made by W2ZBY with the relatively new "loopstick"

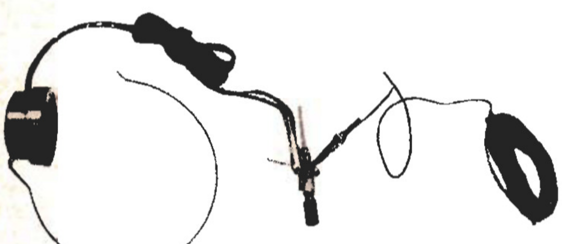


Fig. 4

type antenna. (The circuit is the same as Figure 2.) The broadcast band can be tuned by sliding the ferrite slug in and out. Although the slug in this particular loopstick is designed to be cemented permanently in place, a simple method of arranging for tuning is to cement a matchstick into the hollow core of the slug, then cement a soft rubber washer into the top end of the loopstick coil form to act as friction-type holder for the matchstick. The coil is tuned with a 330 micro-microfarad ceramic capacitor. A mica trimmer could be used to band-set the receiver with a variety of antennas.

The phone tips are held by clips pulled from an old tube socket. One clip is soldered to one of the loopstick terminals; the other is forced in between the loopstick coil form and a paper-insulation ring that comes on the loopstick. The single earphone illustrated is an inexpensive (96¢) 1000-ohm affair purchased from Allied Radio in Chicago. The entire receiver can be housed in the cardboard box the loopstick comes in, a plastic pill box or any other convenient nonmetallic container.

A deluxe arrangement—worked out by W2GYV—is shown in Figure 5. This employs the common coil and capacitor found in old broadcast receivers. Only one section of the capacitor is used to tune the broadcast band. The circuit is shown in Figure 6. The 50-micro-

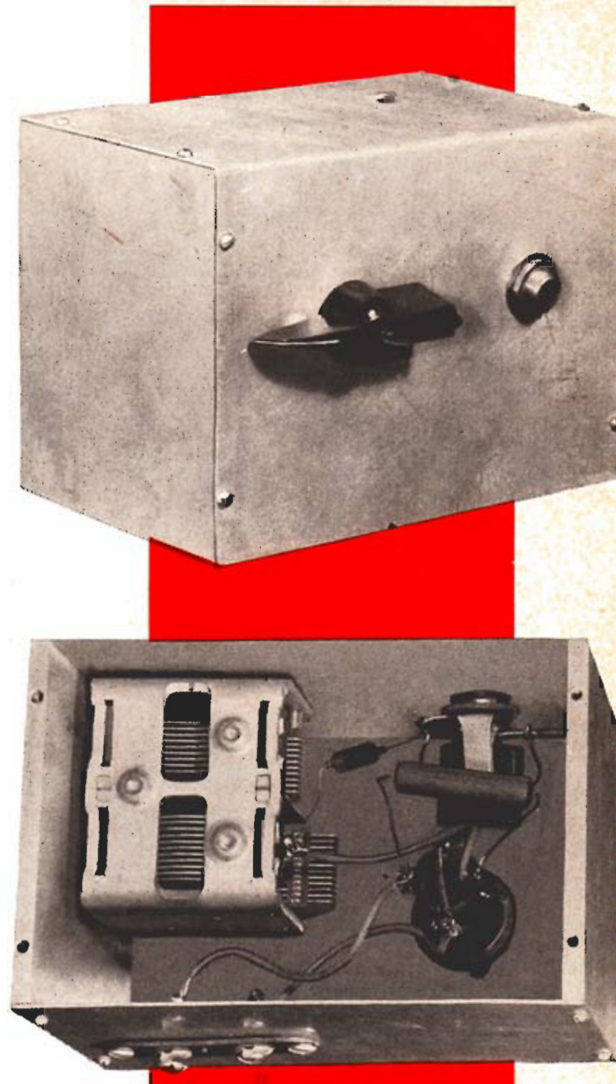


Fig. 5

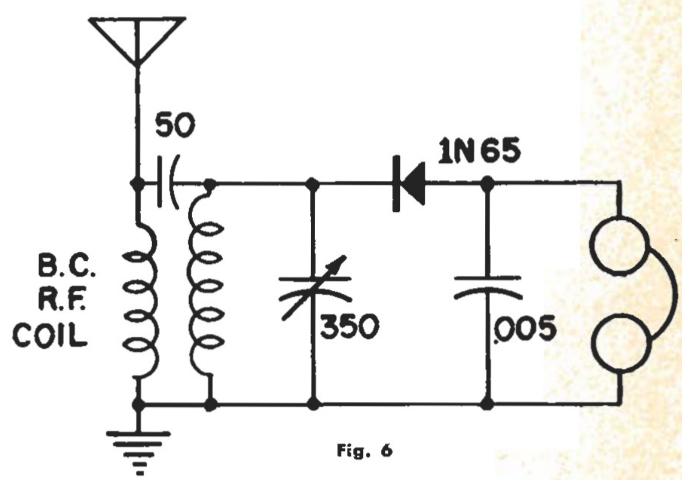


Fig. 6

microfarad capacitor provides additional coupling. Other arrangements may work better in other locations.

We've thought of installing a diode detector in an empty "can" on one side of a head set, in a hat, and in an empty wristwatch case—comic strip style.

Any more ideas?

OPERATION CRYSTAL

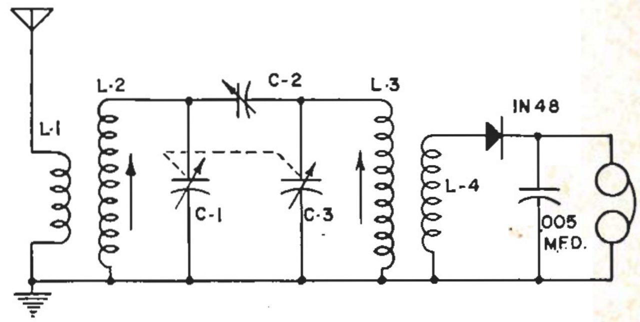
The ideas for OPERATION CRYSTAL (see G-E HAM NEWS, Volume 10, No. 1) have been rolling in so fast that Lighthouse Larry has had to add the character you see in the above heading to his staff. Gentlemen: Meet "DANNY DIODE," now in charge of this department. He has had a tough time choosing the three ideas and circuits published below which qualify for the certificates for $10 in G-E Electronic Tubes. All ideas submitted before December 1, 1955, will be considered for publication in the next five issues of G-E HAM NEWS. Send your idea in to Danny Diode today!!

—*Lighthouse Larry*

"KNOB TWISTER'S SPECIAL"

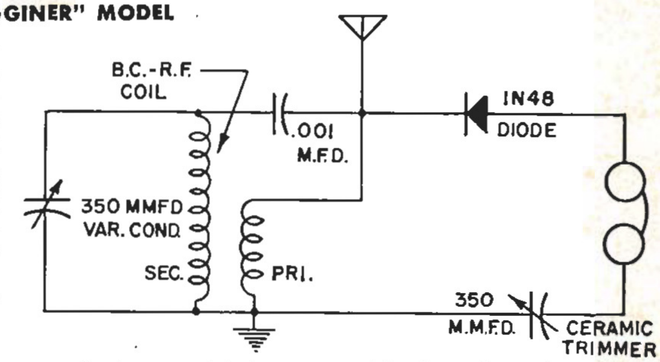
This circuit well deserves the above title for it has five tuning adjustments, two of which are ganged for convenience! William Patzer, W8RWX, Benton Harbor, Michigan, says that the 1000-watt local broadcast station was received with enough volume to drive a 4-inch speaker in a quiet room. The selectivity is adequate to separate all the Chicago stations, about 70 miles away, with good earphone volume.

The diagram shows the vari-loopstick coils L_2 and L_3, coupled to L_1 and L_4. These are 30 turns of No. 26 DSC wire wound on a close-fitting cardboard sleeve placed over the winding on the loopstick. The sleeve may be held in place with scotch tape or model-airplane cement after positioning for maximum gain. C_1 and C_3 is a dual 365-mmf variable condenser salvaged from an old broadcast receiver. C_2 is a 0.005-mfd ceramic condenser, and the diode is a 1N48 or 1N52. Some adjustment in the L/C ratio in the tuned circuits can be obtained by adjusting the tuning slugs in the loopsticks for maximum volume as well as for proper tracking of the tuned circuits when several stations are to be received. The coupling condenser, C_2, is a 3–30-mmf compression type trimmer. It is adjusted for maximum volume on local stations or maximum selectivity on distant stations. Imagine a crystal receiver with a selectivity control!!



"FURSCHLUGGINER" MODEL

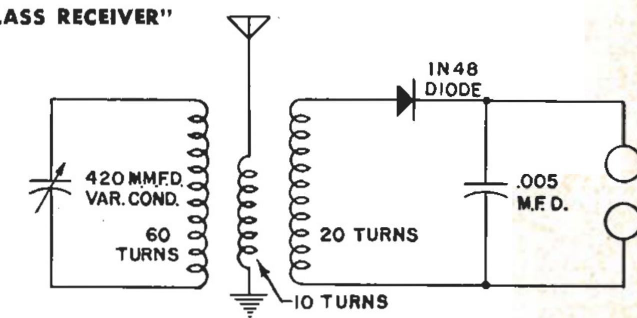
This tricky little circuit was submitted by Curt Olofsson, W6GTY, who claims it was designed by a Dr. Smerdschlossenzwiehammerschtenkel. A measure of impedance matching is provided by the 350-mmf ceramic trimmer condenser in series with the 1N48 crystal diode. Curt says this really brings up the signal strength when the set is used with a short antenna (25 to 30 feet). The salvaged broadcast receiver antenna coil shown in the diagram is connected "backwards," with the primary winding in the crystal detector circuit. Modern slug-tuned coils are also suitable, such as the Meissner 14-1026 or 14-1056; or a Miller 6300 or 70-A. W6GTY also recommends that medium impedance earphones (about 2000 ohms) be used in preference to high-impedance types (20,000 ohms). He built this particular model into an old cigar box, but hasn't pulled in Havana yet!!!



"DRINKING GLASS RECEIVER"

A clever arrangement built around a 2-inch-diameter plastic drinking glass was master-minded by Jack Lambuth, an eighth-grade school student who unfortunately did not include his street address with his entry. (Please send it to Lighthouse Larry when you read this so I can send you the award certificate for your $10.00 in G-E Electronic Tubes.) He states that WBAA, Purdue, and WASK, Lafayette, Indiana, are received very well using a 25-foot antenna and his bedspring for a ground! This set is another cigar-box construction job.

The 60-turn close-wound coil of No. 26 DSC wire on the 2-inch form figures out to approximately 140 uh and tunes with a standard single-gang 420-mmf variable condenser. The 10-turn antenna and 20-turn detector coils are wound over the 60-turn coil with a layer of plastic electrician's or scotch tape for insulation. The selectivity of this circuit is also fairly good because the 1N48 crystal diode does not load the tuned circuit heavily.

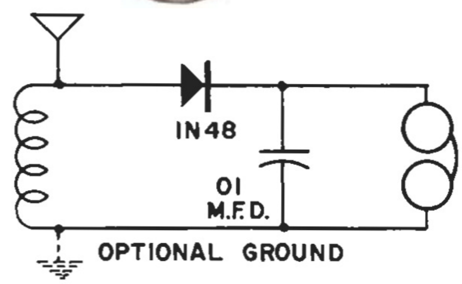


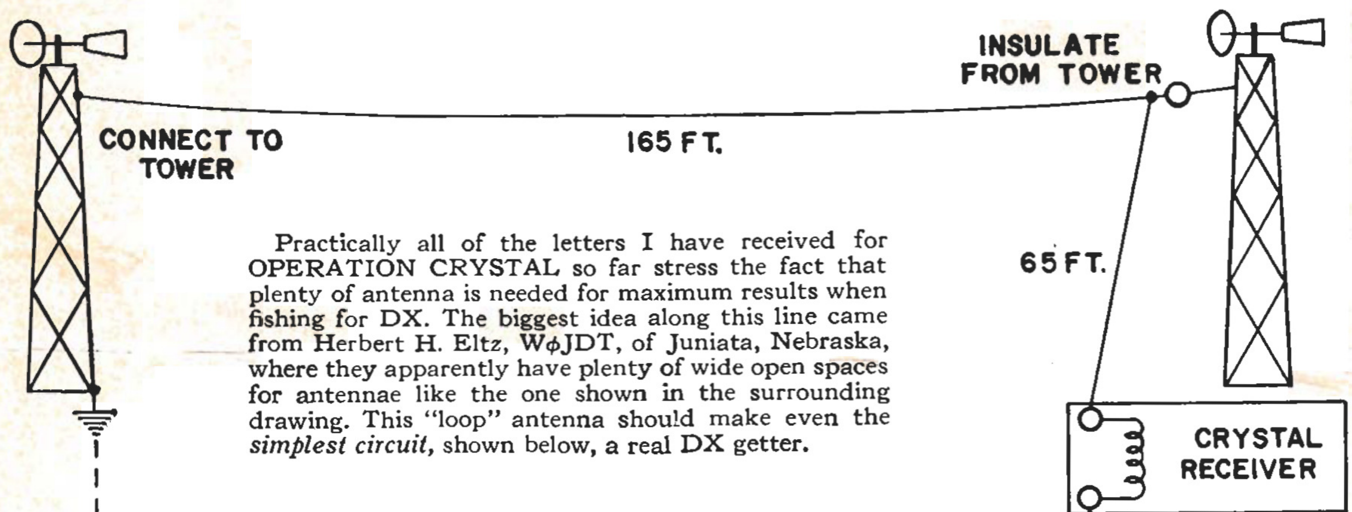
OPERATION CRYSTAL

Checking the operation of this "earphone chassis" model sent me digging into my old junk box to find the necessary material. Out came a plastic-cased earphone instead of the metal one shown in the original model built by Edgar M. Weed, K2BO, of Morris Plains 22, N. J.

A pi from a mangled 2.5 mh RF choke was connected as a self-resonant coil in the illustrated circuit to receive the local broadcast station operating on the 1240 KC *Conelrad* frequency. Another pi may be connected in series with the first for improved results if your local station operates below 1000 KC. For the "last ounce" in volume, a Miller type 70A slug-tuned antenna coil could be used in a large headphone case with the slug adjusted by a screwdriver through a hole in the case.

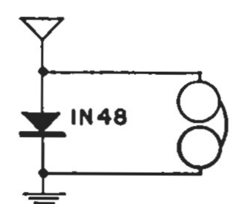
A "field" test was made by running around the neighborhood clipping the antenna lead onto fences, fire hydrants, unoccupied automobiles, and the like. A weighted length of antenna wire was even tossed over some tree branches with good results. (These tests are best made at night unless you want to convince your already skeptical neighbors that their favorite radio amateur has gone completely crazy!)





Practically all of the letters I have received for OPERATION CRYSTAL so far stress the fact that plenty of antenna is needed for maximum results when fishing for DX. The biggest idea along this line came from Herbert H. Eltz, WϕJDT, of Juniata, Nebraska, where they apparently have plenty of wide open spaces for antennae like the one shown in the surrounding drawing. This "loop" antenna should make even the *simplest circuit,* shown below, a real DX getter.

This set makes up in volume and simplicity what it lacks in selectivity, according to tests run at my shack. The strongest local station will be the one that wins at the earphones. In some locations a mixture of stations will result, but that should be no problem when receiving *Conelrad.* Polarity of the crystal seems to be unimportant. Although several persons submitted this idea, Jerry Lucha, of Wilmington, Delaware, sent the first such entry to be received at my office.



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—*Danny Diode*

OPERATION CRYSTAL

Have you ever wondered how more than one germanium diode would work in a crystal receiver. Well, I found out when tests were made on these entries I received recently. Fig. 1 is a full-wave detector using a split coil and a 2-section tuning capacitor, which can be any old broadcast type ranging from about 10 to 400 mmf. L_1 is 45 turns of No. 32 insulated wire wound in the middle of a 6-inch long, 1¼-inch diameter form. L_2 and L_3 each have 140 turns wound either side and spaced ⅛ inch from L_1. All coils are wound in the same direction. The series antenna capacitors, C_1, a 15–400-mmf variable, and C_3, a 500-mmf fixed, help resonate most any antenna and ground system. Les Trude, W2GXV, of Clyde, N. Y., submitted the first of several full-wave circuits received.

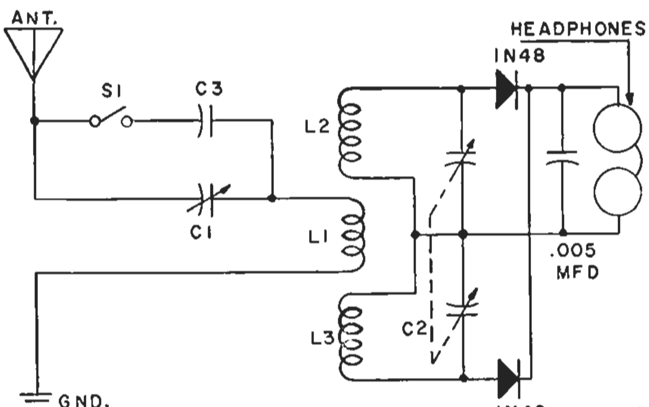

FIG. 1

The circuit shown below makes use of a bridge-type detector circuit which, when tested, showed greater selectivity than a single crystal connected across the same tuned circuit. The audio output voltage was about the same for either detector. The selectivity becomes greater and sensitivity decreases as the spacing between the coils is increased. The two vari-loop sticks may be placed either end to end or parallel with about ½-inch spacing center to center. J. L. Knaus of Glassport, Pa., submitted this circuit.

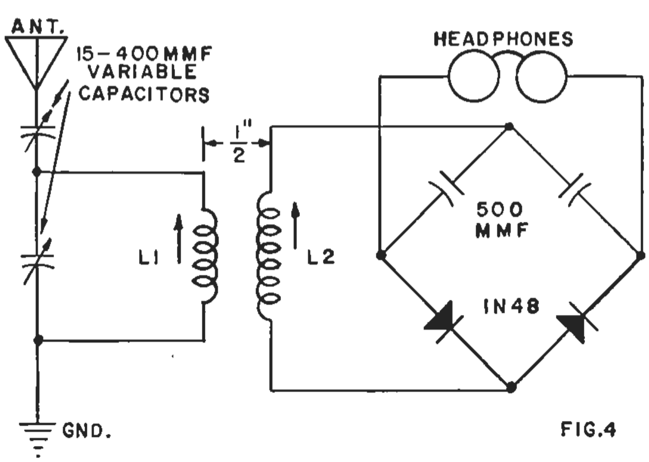

FIG. 4

The simplest two-crystal circuit I have received came from R. J. Baker, W8JIA, North Industry, Ohio. Several of the local hams glanced at the circuit and told me, "Impossible!! There's no ground return path." So, try it yourself. It only takes a couple minutes. If you have more than one local broadcast station, the optional tuned circuit will help separate them. Even in the form shown in the solid lines in Fig. 2, high output was obtained with only a few feet of wire for an antenna.

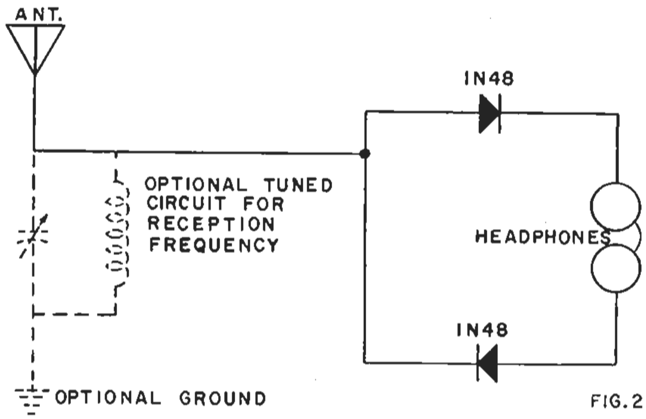

FIG. 2

W8JIA also submitted a design with one crystal and high selectivity, shown in Fig. 3. The coils are wound on a G-E tube carton $1\frac{9}{16}$-inches square. L_1 is 50 turns of No. 26 wire, L_2 is 25 turns spaced ⅛ inch from L_1 and L_3 is 60 turns spaced ⅛ inch from L_2. All the variable capacitors are separate—and for simplicity the two in the antenna circuit could be the mica-padding type.

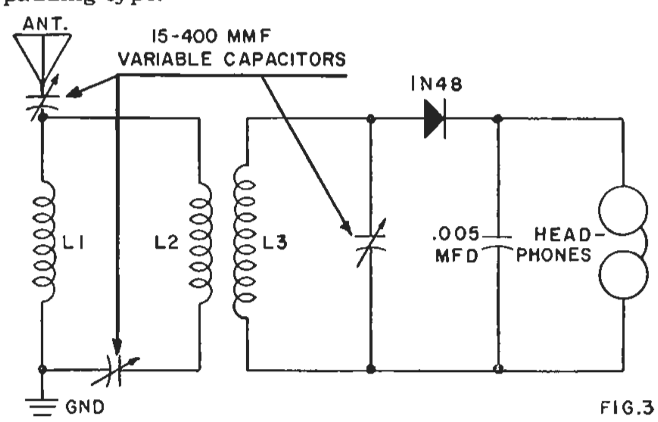

FIG. 3

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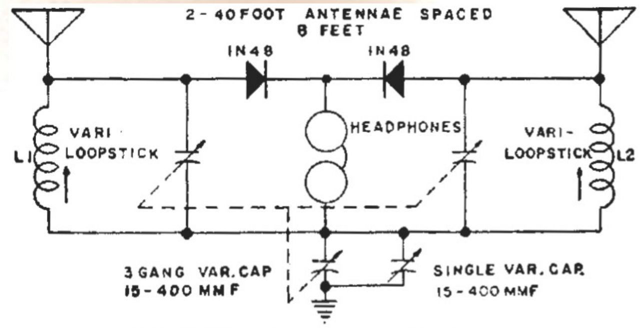
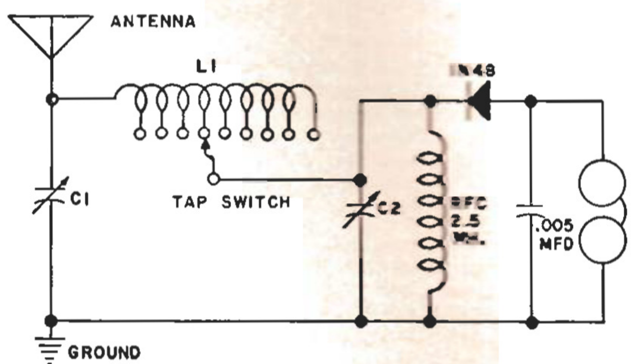
—*Danny Diode*

OPERATION CRYSTAL

The idea for this twin crystal receiver, which uses two of everything except grounds and pairs of earphones, came from Edmon L. Anderson, Moorpark, California. The three-gang 15–400-mmf broadcast band type variable capacitor, shown at right, tunes both detector circuits and the series-tuned ground circuit. A single variable air or mica-padding capacitor helps make the ground circuit tuning track. After a station is tuned in, some interesting variations in carrier and audio signal strength can be obtained by tuning the slugs in Vari-loopstick coils L_1 and L_2. A definite reduction in signal strength was noted when one crystal diode was disconnected after first peaking all the adjustments for maximum signal with both parts of the circuit working. If you try this test, do not expect to detect any startling differences by ear. In making these tests, I find that an oscilloscope used as a peak-to-peak audio voltmeter and the low voltage ranges on a vacuum tube voltmeter are necessary to evaluate the merit of most circuits. Erecting the extra antenna 8 feet from my original test antenna was a simple task because Mother Nature correctly placed the necessary trees at the test location.

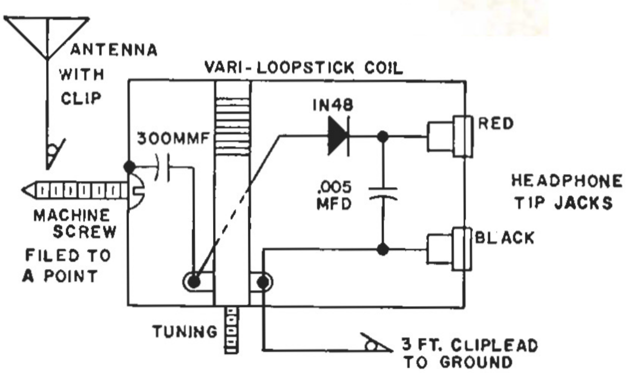


Pi-networks are getting into the act in every corner of amateur radio these days! If you haven't thrown away those old 3- or 4-gang broadcast set variable capacitors that probably have been kicking around in your junk-box for several years, stick them into this Canadian pi-network crystal receiver dreamed up by E. J. Epp, VE3AJY, of Armstrong, Ontario. A single-gang capacitor with a few 500-mmf fixed capacitors that can be switched across it with a tap switch also will work for both C_1 and C_2, pictured at the right. If you have plenty of No. 30 wire, tap switches and ambition, you can build your own coil by winding 180 turns, tapped every 10th turn, on a 1¼-inch diameter form. Or, substituting a Vari-loopstick coil will give you just about the same results, but look at all the fun you will miss by not winding and tapping those 180 turns. Both audio voltage and direct current through the headphones were somewhat higher than with a conventional tuned circuit because of an improved impedance match at both ends of the pi-network when properly adjusted.



Here's an idea, also pictured at the right, for making a combination signal tracer and crystal radio receiver, submitted by J. L. Walty, of Walla Walla, Washington. The circuit is built into a small plastic box about 3 x 2 x 1 inches, with a probe on one end made from a 1½-inch long brass machine screw.

If your pet crystal receiver circuit can be squeezed into a small box, use it instead of Mr. Walty's simple one using just a slug-tuned Vari-loopstick coil. The 300-mmf coupling capacitor from the probe to the coil is necessary to keep DC voltages out of the circuit when tracing a plate circuit signal. The ground clip lead should be connected to the chassis when signal tracing, or an earth ground for crystal receiver operation. An outside antenna should be hooked on the probe when using this gadget as a radio.



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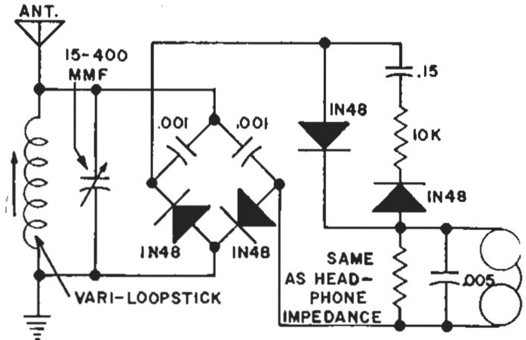
—Danny Diode

OPERATION CRYSTAL

Several interesting construction hints about the preparation of small to medium sized plastic boxes to house crystal radios have been passed along by L. B. Cebik, W1APS, of Stratford, Connecticut. Their transparency, shock resistance and low cost make them almost ideal if the following precautions are observed.

When drilling holes in the plastic, small cracks may appear in that area. To avoid this, a wire or rod of the proper diameter is heated with a soldering iron or flame and pressed through the plastic. This method can also be used for wire leads that must pass through the case. Larger holes for control shafts can be cut with a razor blade. Instead of using bolts (and holes) to mount coil forms or small parts, cement them in place with household cement. Larger diameter coils can be wound directly on the outside or inside of the plastic box, with the turns cemented in place. Control knobs and terminals can be located on an unused side of the case.

"Where will your crystal set be when an emergency comes? On some forgotten shelf or buried in the junk box? Not mine!" —says H. G. Weist, Jr., K2AWA, of Schenectady, N. Y. "My crystal radio is patch-corded to the phono-input jack of the family television receiver. It is used almost daily to get news and other special radio programs from the local broadcast station. Being in constant use, I will have no trouble finding it and putting it to good use if and when the time comes—. Remember—you can't use it if you can't find it!"



The bridge circuit detector plus ***diode network*** circuit shown above is your meat if your late rich Uncle Sparky bequeathed you a shoebox full of crystal diodes. Increased output was measured when the headphones were connected as shown over that obtained when the 'phones were connected across the output of the bridge detector. Drop me a line if you have a good explanation. Any old broadcast type variable capacitor can be used for tuning across the vari-loopstick coil, or you can substitute your favorite antenna input circuit for his, says Philip Benedict, ex-WN8KKR, of Columbus, Ohio.

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—*Danny Diode*

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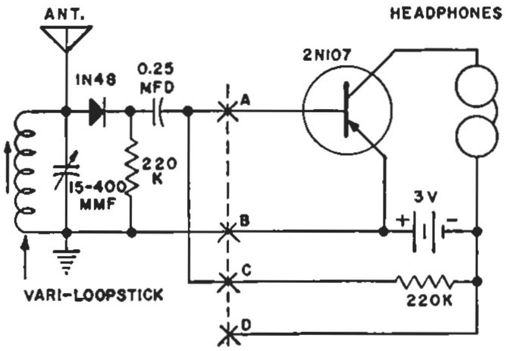
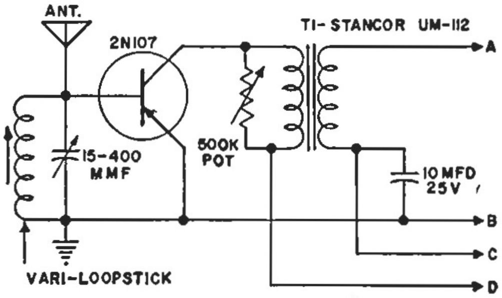
NOVEMBER—DECEMBER, 1955

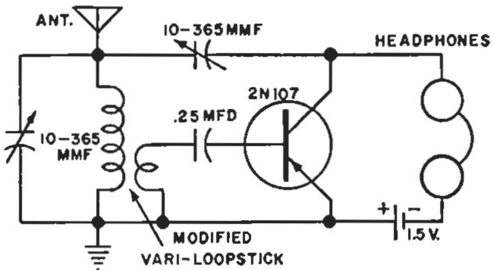
OPERATION CRYSTAL



Availability of a new low-cost transistor, the G-E 2N107, makes practical the publishing of circuits using these units. At the top right, a conventional crystal detector feeds a transistor audio amplifier. Substituting the transistor detector at the lower right, connected at points A to D, will increase the headphone volume several times. Introducing regeneration as shown below by wrapping an 8-turn feedback coil around the fiber sleeve of a vari-loopstick produces a noticeable increase in gain and selectivity. Reverse the connections or add a few more turns to the feedback coil if regeneration is non-existent at first. This detector also can be connected to the amplifier through an audio transformer in place of the headphones.

Thanks to Bob Nelson, WφKLG, Dassel, Minn.; Charles Cutter, Nashua, N. H.; and Larry Dworsky, Bronx, N. Y., for sending in ideas used in these circuits.





Even though OPERATION CRYSTAL has officially ended, the boss is keeping me on the job to check interesting crystal and transistor circuit ideas, also material submitted for the TRICKS and TOPICS, and QUESTIONS and ANSWERS columns. Certificates for $10 in G-E Tubes will be awarded for ideas published in G-E HAM NEWS.

—*Danny Diode*

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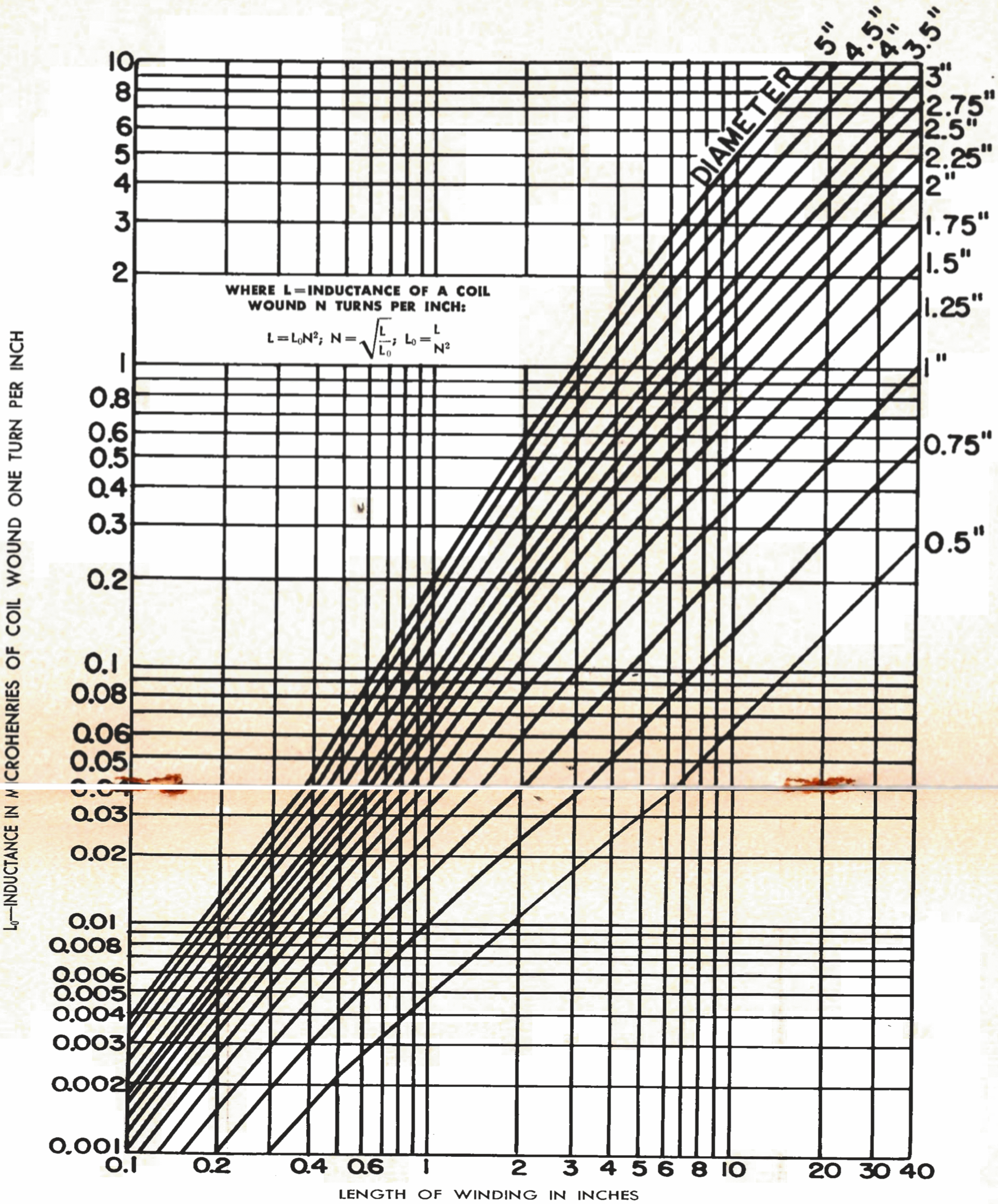
COIL INDUCTANCE CALCULATOR



The accompanying chart shows inductance of coils wound one-turn-per-inch. To find the inductance of a multiturn coil of the same dimensions, use

$$L = L_0N^2$$

where L is the unknown inductance and N is the turns-per-inch of the coil in question. (Note—N is *not* the total number of turns on the coil!)

Example: You have a 60-turn coil 3 inches long and 1.5 inches in diameter and wish to know the inductance. The turns-per-inch, N, is 20; and from the chart you determine L_0 is 0.14. Substituting in the above,

$$L = 0.14 \times 20^2 = 0.14 \times 400 = 56\ \mu h$$

Similarly, to find the number of turns necessary to arrive at a desired inductance with a coil of specified length and diameter, use

$$N = \sqrt{\frac{L}{L_0}}$$

Example: You have a 1-inch diameter coil form with space for a winding 2 inches long and want to know how many turns are required to obtain an inductance of 30 microhenries. From the chart, L_0 is 0.04. Substituting in the above formula,

$$N = \sqrt{\frac{30}{.04}} = \sqrt{750} = 27.01 \text{ turns-per-inch}$$

Total turns for a 2-inch coil, then, will be 54.

In addition, the formula

$$L_0 = \frac{L}{N^2}$$

can be used to determine either length or diameter, or both, when using a ribbed coil with a fixed number of turns-per-inch.

Example: You have a ribbed form 2.5 inches in diameter which calls for 7 turns-per-inch, and you want to wind a coil with 10 microhenries inductance. Substituting in the above formula,

$$L_0 = \frac{10}{7^2} = \frac{10}{49} = 0.2.$$

On the chart follow the 0.2 horizontal axis out to where it intersects the 2.5-inch diameter curve. From this point, drop down the vertical axis and read the length of winding required—in this case, 2 inches. (This same procedure can be used when double- or triple-spacing a winding on a ribbed form. In the case in point, double-spacing would dictate use of 3.5 for N, and triple-spacing 1.75 for N.)