Build A Tuna-Tin 2

Ham radio lost its kick? Go QRP with this weekend-project transmitter! WAS with a 40-meter half-watter? You betcha!

By Doug DeMaw,* W1CER

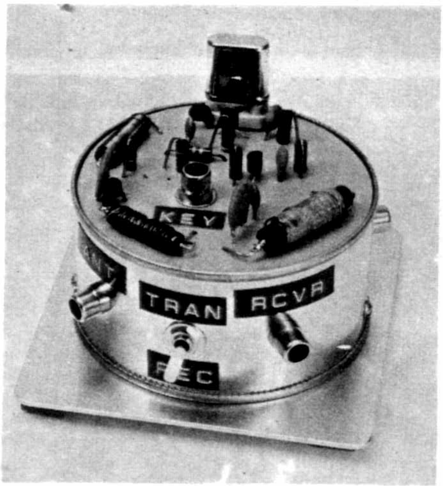
Workshop weekenders, take heart. Not all building projects are complex, time consuming and costly. The Tuna-Tin 2 is meant as a short-term, go-together-easy assembly for the ham with a yen to tinker. Inspiration for this item came during a food shopping assignment. While staring at all of the metal food containers, recollections of those days when amateurs prided themselves for utilizing cake and bread tins as chassis came to the fore. Lots of good equipment was built on make-do foundations, and it didn't look ugly. But during recent years a trend has developed toward commercial gear with its status appeal, and the workshop activities of many have become the lesser part of amateur radio. While the 1-kW rigs keep the watt-hour meters recording at high speed, the soldering irons grow colder and more corroded.

A tunafish can for a chassis? Why not? This inspiration led the writer to a nearby Radio Shack store, where most of the parts for a two-transistor 40-meter cw transmitter were gleaned. A few hours later 350 milliwatt [illegible] were being directed toward the antenna, and QSOs were taking place.

Maybe you've developed a jaded appetite for operating (but not for tuna). The workshop offers a trail to adventure and achievement, and perhaps that's the elixir you've been needing. Well, Merlin the Magician and Charlie the Tuna would probably commend you if they could, for they'd know you were back to the part of amateur radio that once this whole game was about – creativity and learning!

Parts Rundown

Of course, a tunafish can is not essential as a foundation unit for this



View of the assembled Tuna-Tin 2. Dymo tape labels are used to identify the connectors and switch. The chassis is affixed to a base plate by means of No. 6 spade bolts.

QRP rig. Any 6-1/2-ounce food container will be o.k. For that matter, a sardine can may be used by those who prefer a rectangular format. Anyone for a Sardine-2? Or, how about a "Pineapple Pair?" Most 6-1/2-ounce cans measure 3-1/4 inches in OD, so that's the mark to shoot for. Be sure to eat, or at least *remove* the contents before starting your project!

One object of this venture was to obtain as many of the parts as possible from Radio Shack. A bargain pack of disk ceramic capacitors was acquired for this and other jobs in the future. All of the capacitors needed were found in the pile of mixed-value types. Coils, L1 and L2 of Fig. 1, were fashioned from ferrite-core rf chokes found in the store. A scan of the transistor types available led to the purchase of [illegible] of eight substitutes for the popular 2N2222A device. That left six spares for the rig or for use in other projects. The important characteristics for the transistors are (should you want to try substitutes) a maximum collector voltage of 30 or more, a gain (Hfe) of at least 100, and a maximum frequency (f_T) of 100 MHz or higher. Also, the transistors should have a dissipation rating of 500 mW or more.

Resistors for the circuit were already on hand, but new ones could have been purchased singly or in an assortment. Circuit-board material is also in supply at Radio Shack, so a sheet was added to the shopping bag. The tiny send-receive toggle switch is a mite expensive. The builder may want to substitute a low-cost miniature slide switch in its place. A small bag of phono jacks was purchased also, as those connectors are entirely adequate for low-power rf work.

Finding a crystal socket may be a problem of minor proportion. The type used will depend on the style of crystals the operator has on hand. International Crystal Co. has a variety of sockets for sale at low prices (see *QST* ads for their address). A Millen steatite crystal socket was used in the model shown. It is designed to handle HC-6/U crystals with the small-diameter pins. Fundamental crystals are used in the transmitter – the general-purpose (GP) type sold by International Crystal, 30-pF load capacitance. Surplus FT-243 crystals will work fine, too, provided the appropriate socket is used. If only one operating frequency will be used, the crystal can be soldered to the circuit board permanently. Estimated maximum cost for this project, exclusive of the crystal, power supply and tunafish, is $10. The cost estimate is based on brand new components throughout, inclusive of the

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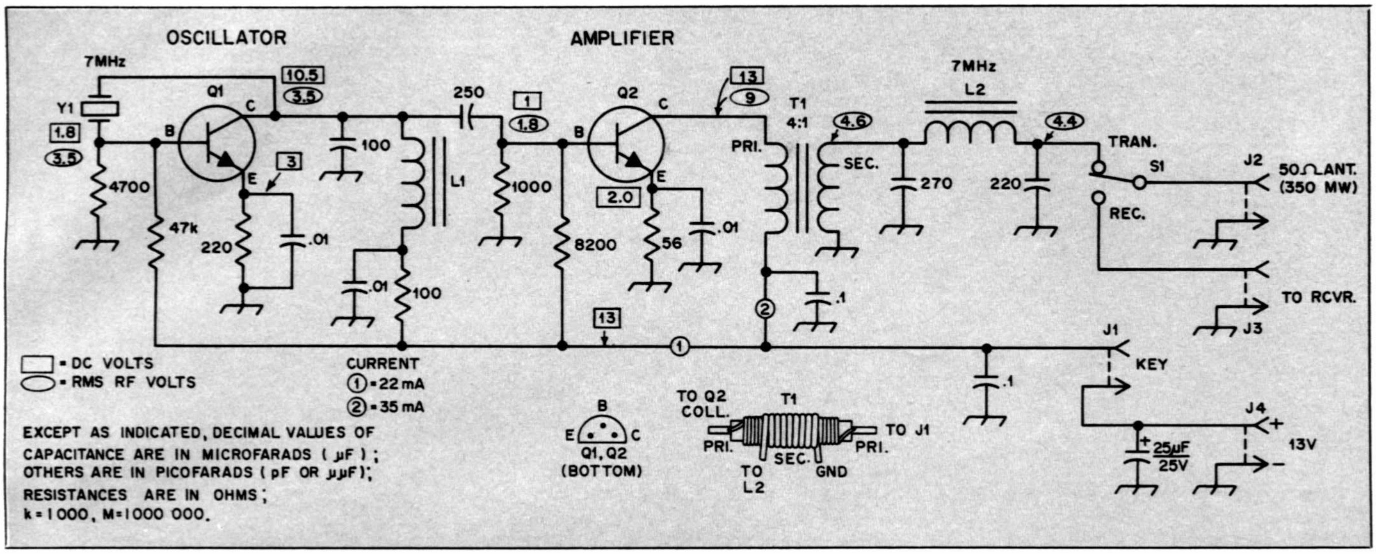

Fig. 1 — Schematic diagram of the two-transistor QRP rig. Capacitors are disk ceramic. Resistors are 1/2-watt composition. The polarized capacitor is electrolytic. See parts list for data on other components.

J1 — Single-hole-mount phone jack. Must be insulated from ground. Mount on tuna tin (Archer 274-346).
J2, J3, J4 — Single-hole-mount phono jack (mount on tuna tin).
L1 — Modified Archer 273-101 rf choke (see text).
L2 — Modified Archer 273-101 rf choke (see text).
Q1, Q2 — Archer 276-1617 npn silicon transistor. Equivalent to 2N2222A type.
S1 — Antenna changeover switch. Miniature spdt toggle (see text).
T1 — 4:1 broadband transformer. Modified Archer 273-102 100-µH rf choke. Primary has 50 turns, secondary has 25 turns (see text).
Y1 — Fundamental crystal, 7 MHz (International Crystal Co. type GP or equiv.).

left-over parts from the assortments. Depending on how shrewd he is at the bargaining game, a flea-market denizen can probably put this unit together for two or three bucks.

Circuit Details

A look at Fig. 1 will indicate that there's nobody at home, so to speak, in the two-stage circuit. A pierce type of crystal oscillator is used at Q1. Its output tickles the base of Q2 (lightly) with a few milliwatts of drive power, causing Q2 to develop approximately 450 milliwatts of dc input power as it is driven into the Class C mode. Power output was measured as 350 milliwatts (1/3 W), indicating an amplifier efficiency of 70 percent.

The collector circuit of Q1 is not tuned to resonance at 40 meters. L1 acts as a rf choke, and the 100-pF capacitor from the collector to ground is for feedback purposes only. Resonance is actually just below the 80-meter band. The choke value is not critical and could be as high in inductance as 1 mH, although the lower values will aid stability.

The collector impedance of Q2 is approximately 250 ohms at the power level specified. Therefore, T1 is used to step the value down to around 60 ohms (4:1 transformation) so that the pi network will contain practical values of *L* and *C*. The pi network is designed for low *Q* (loaded *Q* of 1) to assure ample bandwidth on 40 meters. This will eliminate the need for tuning controls. Since a pi network is a low-pass filter, harmonic energy is low at the transmitter output. The pi network is designed to transform 60 to 50 ohms.

L1 is made by unwinding a 10-µH Radio Shack choke (No. 273-101) and filling the form with No. 28 or 30 enamel covered wire. This provides an inductor of 24 µH. In a like manner, unwind another 273-101 so that only 11 turns remain (1.36 µH). The 11 turns are spaced one wire thickness apart. Final adjustment of this coil (L2) is done with the transmitter operating into a 50-ohm load. The coil turns are moved closer together or farther apart until maximum output is noted. The wire is then cemented in place by means of hobby glue or *Q* dope. Indications are that the core material is the Q1 variety (permeability of 125), which makes it suitable for use up to at least 14 MHz.

T1 is built by removing all but 50 turns from a Radio Shack No. 273-101 rf choke (100 µH). The ferrite core in this choke seems to be on the order of 950, in terms of permeability. This is good material for making broadband transformers, as very few wire turns are required for a specified amount of inductance, and the *Q* of the winding will be low (desirable). A secondary winding is added to the 50-turn inductor by placing 25 turns over it, using No. 22 or 24 enameled wire. The secondary is wound in the same rotation sense as the primary, then glued into position on the form. Tests with an *RX* meter show this to be a very good transformer at 7 MHz. There was no capacitive or inductive reactance evident. The primary winding has an inductance value of 80 µH after modification.

Increased power can be had by making the emitter resistor of Q2 smaller in value. However, the collector current will rise if the resistor is decreased in value, and the transistor just might "go out for lunch," permanently, if too much collector current is allowed to flow. The current can be increased to 50 mA without need to worry, and this will elevate the power output to roughly 400 mW.

Construction Notes

The pc board can be cut to circular form by means of a nibbling tool or coping saw. It should be made so it just clears the inner diameter of the lip which crowns the container. The can is prepared by cutting the closed end so that 1/8 inch of metal remains all the way around the rim. This will provide a shelf for the circuit board to rest on. After checkout is completed, the board can be soldered to the shelf at four points to hold it in place. The opposite end of the can is open. The container can be mounted on a metal plate if the builder wishes. A base plate will help keep the transmitter in one spot on the operating table, especially if adhesive-backed plastic feet are used on the bottom of the plate.

Those with art in their souls may choose to paint the tuna can some

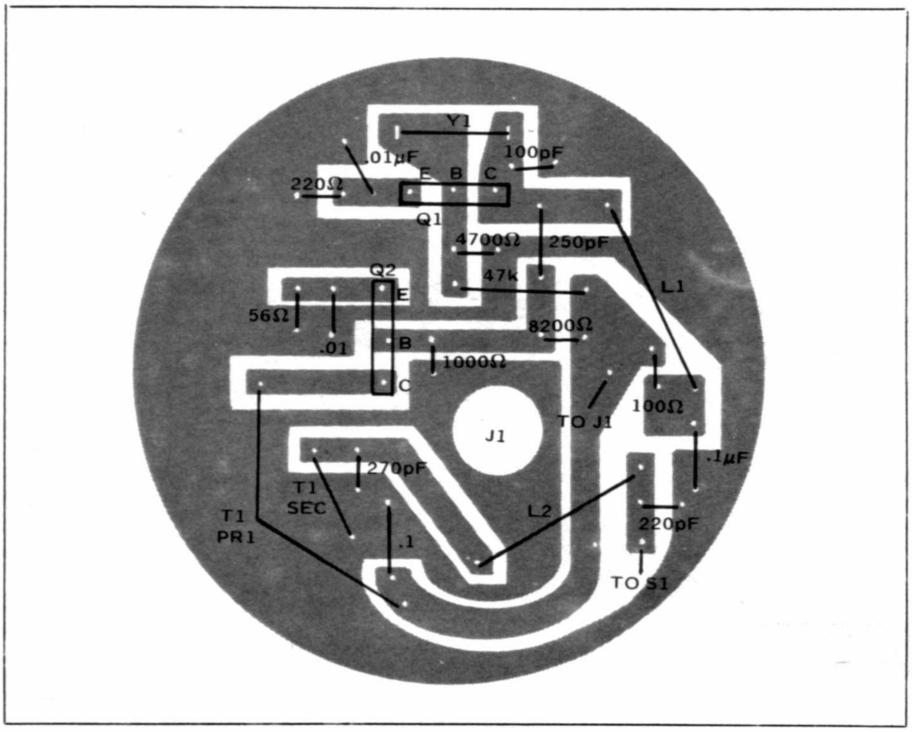

Fig. 2 — Scale layout of the pc board. Copper is etched away where J1 is mounted to prevent shorting the terminals to ground and other parts of the board. Size is for 6-1/2-ounce food can. Square format may be used if different chassis is desired. The 25-µF capacitor mounts between J4 and the pc-board ground foil.

favorite color. Alternatively, decorative contact paper may be used to hide the ugliness of the bare metal.

Summary Comments

Skeptics may chortle with scorn and amusement at the pioneer outlook of QRP enthusiasts. Their lack of familiarity with low-power operating may be the basis for their disdain. Those who have worked at micropower levels know that WAS *is* possible on 40 meters with less than a watt of rf energy. Of course, the odds are a bit greater against a speedy WAS achievement when crystal-controlled QRP rigs are used, but it can be done. From the writer's location in Connecticut, all call areas of the USA have been worked at the 1/4-W power plateau. It was done with only a 40-meter coax-fed dipole, sloping to ground at approximately 45 degrees from a steel tower. Signal reports ranged from RST 449 to RST 589, depending on conditions. Of course, there were many RST 599 reports too, but they were the exception rather than the rule. The first QSO with this rig came when Al, K4DAS, of Miami answered the writer's "CQ" at 2320 UTC on 7014 kHz. An RST 569 was received, and a 20-minute ragchew ensued. The copy at K4DAS was "solid."

Keying quality with this rig was good with several kinds of crystals tried. There was no sign of chirp. Without shaping, the keying is fairly hard (good for weak-signal work), but there were no objectionable clicks heard in the station receiver.

There is a temptation among some QRP experimenters to settle for a one-transistor oscillator type of rig. For academic purposes, that kind of circuit is great. But, for on-the-air use, it's better to have at least two transistors. This isolates the oscillator from the antenna, thereby reducing harmonic radiation. Furthermore, the efficiency of oscillators is considerably lower than that of an amplifier. Many of the "yoopy" QRP cw signals on our bands are products of one-transistor crystal oscillators. Signal quality should be good, regardless of the power level used.

The voltages shown in Fig. 1 will be helpful in troubleshooting this rig. All dc measurements were made with a VTVM. The rf voltages were measured with an rf probe and a VTVM. The values may vary somewhat, depending on the exact characteristics of the transistors chosen. The points marked 1 and 2 (in circles) can be opened to permit insertion of a dc milliammeter. This will be useful in determining the dc input-power level for each stage. Power output can be checked by means of an rf probe from J2 to ground. Measurements should be made with a 51- or 56-ohm resistor as a dummy load. For 350 mW of output, there should be 4.4 rms volts across the 56-ohm resistor.

Operating voltage for the transmitter can be obtained from nine Penlite cells connected in series (13.5 volts). For greater power reserve one can use size C or D cells wired in series. A small ac-operated 12- or 13-volt regulated dc supply is suitable also, especially for home-station work.

A fellow staff member, WA1LNQ, was inspired by the size of this transmitter. He vowed to build a mating receiver for it. I think I heard him refer to his upcoming project as the "Clam-Can 5." QST

Feedback

□ Silent Key Charles D. Miller's call is WB4GZP not WA4GZP as listed in *QST* for March, 1976.

□ The name of Russell Groth, W9CW, of Park Ridge, IL, inadvertently appeared among Silent Keys for July, 1975, *QST.*

□ The Key West Amateur Radio Club Conchfest will be held on May 8-9 instead of March 27-28 as listed in Hamfest Calendar in *QST* for March.

□ W1KLK, author of "A VOX for a Very Small Box." *QST* for March, 1976, states that the input resistor should be 100,000 ohms rather than 100 ohms. Also, older models of the NE-555 IC may cause latch-up of the relay. If that happens, insert a 1N914A or equivalent diode in series with the lead to the relay coil.

□ Re the September FMT (reported on p. 89 of the November issue): W4AWS should have been shown with 8.2 ppm (not 40.0!). Although we got K6MZN's correct for the November FMT placement in the Honor Roll (p. 74, February *QST*), the feedback listed his call incorrectly as K6MLN. Our apologies, Art. In the November FMT W1JH was shown with .6 ppm and in actuality he scored .5 ppm.

Strays

1975 10-Meter Contest High-Claimed Scores (W/VE only)

K3OIO 116,556, W4WSF 104,340, K9HMB 97,600, WA8ZDF 95,160, K3IGA/4 87,408, K9BGL 71,280, WA3WIK 71,036, K2GBC 70,980, W3RRX 62,976, K9EGA/2 57,780, W9LT (K9UWA, opr.) 55,696, K1RQE 53,550 W1CWU 51,282, K1IKN 51.520. *Multi-Operator*: K3EST 152,352, W2SKE 104,580.