Hints and Kinks for the Radio Amateur

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Foreword

Are you looking for fun in Amateur Radio? Many *QST* readers say they need look no further than the monthly Hints and Kinks column. Each month, Hints and Kinks brings *QST* readers the most creative ideas of other resourceful hams. Every few years, the best of the recent submissions are gathered up and reorganized into a convenient reference volume.

This edition of *Hints and Kinks* is the thirteenth in a line that stretches back almost 60 years! A ham stepping out of a time machine from 1933 would scarcely recognize any of our modern equipment. We have whole transceivers that are smaller than some vacuum tubes of that time! He or she might recognize little in a '90s ham shack. One anchor is *QST*, but even that has changed: Inside are articles about digital techniques and microwave projects. Many columns have come and gone, but one the time traveler would recognize immediately is Hints and Kinks.

There is a reason for such long-lived popularity. Coming up with a better idea—to meet a challenge, either making your station more competitive or just a bit more comfortable—is fun. We all love it, because it brings Amateur Radio to life for us. Even better is seeing your idea published in Hints and Kinks.

This book holds ideas from many hams—good ideas for any shack. Enjoy them, but don't stop there; come up with something better. Let's see *your* idea in the next edition.

David Sumner, K1ZZ
Executive Vice President

Newington, CT
May 1992

Preface

This book is a compilation of material that originally appeared in the *QST* Hints and Kinks column from January 1987 through December 1991. Authors' addresses have been left as published in *QST*. Some of the addresses may have changed since publication. If you wish to write to an author, check the latest *Radio Amateur Callbook* for a current address.

All suppliers mentioned in this book appear in a Suppliers List at the back. The addresses in the Suppliers List were verified at the time of publication.

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Units of Measure and Equivalents

Multiply ⟶

Metric Unit = Conversion Factor × U.S. Customary Unit

⟵ **Divide**

Metric Unit ÷ Conversion Factor = U.S. Customary Unit

Metric Unit =	Conversion Factor ×	U.S. Unit
(Length)		
mm	25.4	inch
cm	2.54	inch
cm	30.48	foot
m	0.3048	foot
m	0.9144	yard
km	1.609	mile
km	1.852	nautical mile
(Area)		
mm^2	645.16	$inch^2$
cm^2	6.4516	in^2
cm^2	929.03	ft^2
m^2	0.0929	ft^2
cm^2	8361.3	yd^2
m^2	0.83613	yd^2
m^2	4047	acre
km^2	2.59	mi^2
(Mass)	(Avoirdupois Weight)	
grams	0.0648	grains
g	28.349	oz
g	453.59	lb
kg	0.45359	lb
tonne	0.907	short ton
tonne	1.016	long ton

Metric Unit =	Conversion Factor ×	U.S. Unit
(Volume)		
mm^3	16387.064	in^3
cm^3	16.387	in^3
m^3	0.028316	ft^3
m^3	0.764555	yd^3
ml	16.387	in^3
ml	29.57	fl oz
ml	473	pint
ml	946.333	quart
l	28.32	ft^3
l	0.9463	quart
l	3.785	gallon
l	1.101	dry quart
l	8.809	peck
l	35.238	bushel
(Mass)	(Troy Weight)	
g	31.103	oz t
g	373.248	lb t
(Mass)	(Apothecaries' Weight)	
g	3.387	dr ap
g	31.103	oz ap
g	373.248	lb ap

U.S. Customary — Metric Conversion Factors

International System of Units (SI) — Metric Units

Prefix	Symbol			Multiplication Factor
exa	E	10^{18}	=	1,000,000,000,000,000,000
peta	P	10^{15}	=	1,000,000,000,000,000
tera	T	10^{12}	=	1,000,000,000,000
giga	G	10^{9}	=	1,000,000,000
mega	M	10^{6}	=	1,000,000
kilo	k	10^{3}	=	1,000
hecto	h	10^{2}	=	100
deca	da	10^{1}	=	10
(unit)		10^{0}	=	1
deci	d	10^{-1}	=	0.1
centi	c	10^{-2}	=	0.01
milli	m	10^{-3}	=	0.001
micro	μ	10^{-6}	=	0.000001
nano	n	10^{-9}	=	0.000000001
pico	p	10^{-12}	=	0.000000000001
femto	f	10^{-15}	=	0.000000000000001
atto	a	10^{-18}	=	0.000000000000000001

Linear

1 meter (m) = 100 centimeters (cm) = 1000 millimeters (mm)

Area

1 m^2 = 1 × 10^4 cm^2 = 1 × 10^6 mm^2

Volume

1 m^3 = 1 × 10^6 cm^3 = 1 × 10^9 mm^3
1 liter (l) = 1000 cm^3 = 1 × 10^6 mm^3

Mass

1 kilogram (kg) = 1000 grams (g)
(Approximately the mass of 1 liter of water)
1 metric ton (or tonne) = 1000 kg

U.S. Customary Units

Linear Units

12 inches (in) = 1 foot (ft)
36 inches = 3 feet = 1 yard (yd)
1 rod = 5½ yards = 16½ feet
1 statute mile = 1760 yards = 5280 feet
1 nautical mile = 6076.11549 feet

Area

1 ft^2 = 144 in^2
1 yd^2 = 9 ft^2 = 1296 in^2
1 rod^2 = 30¼ yd^2
1 acre = 4840 yd^2 = 43,560 ft^2
1 acre = 160 rod^2
1 $mile^2$ = 640 acres

Volume

1 ft^3 = 1728 in^3
1 yd^3 = 27 ft^3

Liquid Volume Measure

1 fluid ounce (fl oz) = 8 fluidrams = 1.804 in^3
1 pint (pt) = 16 fl oz
1 quart (qt) = 2 pt = 32 fl oz = 57¾ in^3
1 gallon (gal) = 4 qt = 231 in^3
1 barrel = 31½ gal

Dry Volume Measure

1 quart (qt) = 2 pints (pt) = 67.2 in^3
1 peck = 8 qt

1 bushel = 4 pecks = 2150.42 in^3

Avoirdupois Weight

1 dram (dr) = 27.343 grains (gr) or (gr a)
1 ounce (oz) = 437.5 gr
1 pound (lb) = 16 oz = 7000 gr
1 short ton = 2000 lb, 1 long ton = 2240 lb

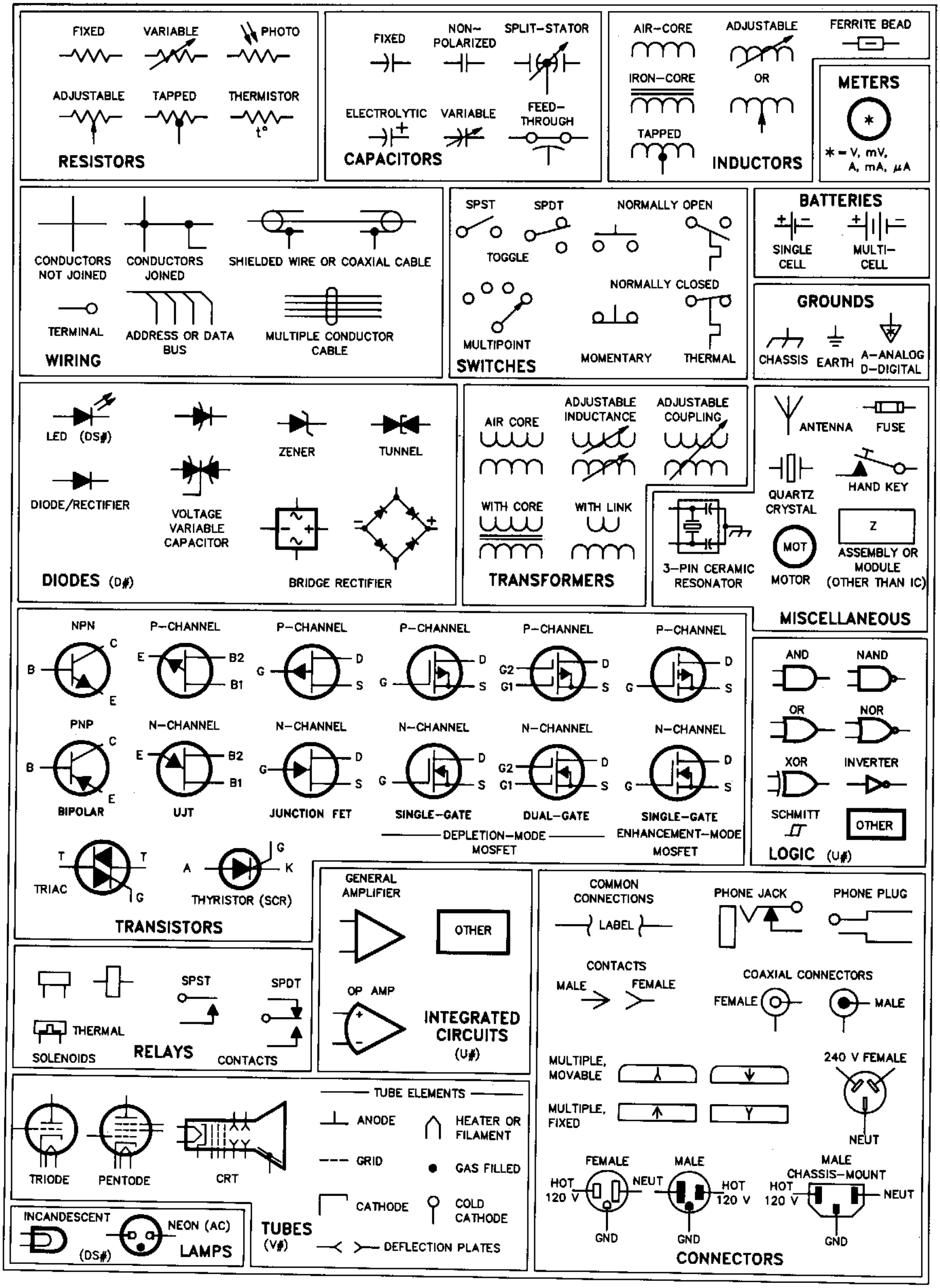
Troy Weight

1 grain troy (gr t) = 1 grain avoirdupois
1 pennyweight (dwt) or (pwt) = 24 gr t
1 ounce troy (oz t) = 480 grains
1 lb t = 12 oz t = 5760 grains

Apothecaries' Weight

1 grain apothecaries' (gr ap) = 1 gr t = 1 gr a
1 dram ap (dr ap) = 60 gr
1 oz ap = 1 oz t = 8 dr ap = 480 gr
1 lb ap = 1 lb t = 12 oz ap = 5760 gr

Schematic Symbols



CHAPTER 1

Equipment Tips and Modifications

SIMPLER CW/RTTY MODE CHANGES WITH THE AEA PK-232

□ After I'd sorted out various options for equipment control and interconnection, CW and RTTY operation with my Advanced Electronics Applications PK-232 multimode communications processor and IC-751A transceiver went well—except for one snag. I prefer to copy code aurally and use the PK-232 only to transmit during CW operation. To do this, as the PK-232 manual says, you must "disconnect your microphone cable from the PK-232 to the radio so that the radio does not hang in transmit."[1] The culprit is the PK-232-to-transceiver PTT-line connection, which, in my setup, must be present for RTTY operation but absent during CW operation. Without this connection, the PK-232 cannot switch the IC-751A into RTTY transmit; *with* this connection, the IC-751A transmits a continuous carrier when the PK-232 is commanded to transmit CW! The need to plug and unplug this connection—or install a switch in the PTT line—seemed to be an unnecessary complication of an otherwise elegant PK-232/IC-751A/PC system. There *had* to be a better way!

There is. Lacking the program documentation necessary to figure out a suitable software PTT switch, I looked for an automatic hardware solution. The PK-232 schematic shows signal lines labeled CW and CWN. I suspected that the state of these lines would indicate whether or not the PK-232 is in the CW mode. Tests confirmed my hunch.

Armed with this information, I disabled the PK-232's CW-mode PTT output by adding just *one* component—a silicon switching diode—to the '232. I installed the diode between U37 pin 12 and U38 pin 10, with its cathode at U37 pin 12 on the PK-232 circuit board (see Fig 1). U37 and U38 are close together, allowing the diode leads to be soldered right to the IC pins.

This modification works as follows: The fifth section of U38 (U38 pins 10 and 11) is in series with the '232's PTTN line. PTTN is low when the '232's PTT output goes low to switch the associated transceiver into transmit. The signal at U38 pin 10 is high in this situation. With the diode installed, however, the '232's CWN line—low when the PK-232 is in CW mode—pulls U38 pin 10 low through the diode, keeping the PK-232's PTT output high regardless of whether the PK-232 is in CW transmit or CW receive. This allows the IC-751A's semi-break-in function to handle CW TR switching functions. When the PK-232 is in the RTTY mode, the CWN line is high and the '232 works as if the diode isn't there. Note: I haven't yet tried my PK-232 on AMTOR or packet; I assume that the diode will not affect operation of the PK-232 in those modes.—*Guy Olbrechts, NY7O, 4809 116th Ave SE, Bellevue, WA 98006*

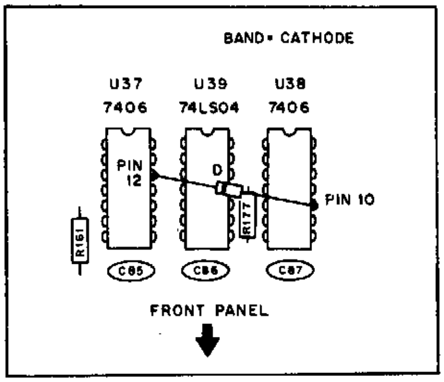


Fig 1—Guy Olbrechts solved his PK-232/IC-751A compatibility problem with this modification. Addition of a diode, D, disables the PK-232's PTT output during CW operation, allowing the transceiver's keyed VOX circuitry to handle TR switching. D is a silicon switching diode (1N914, 1N4148 and others suitable). See text.

ELECTRONIC BIAS SWITCHING FOR THE AMERITRON AL-1200

□ Adding electronic bias switching (Fig 2) to the Ameritron AL-1200 grounded-grid-3CX1200A7 amplifier allows noiseless break-in when an electronic TR switch is used. Because this circuit biases the tube off in the absence of excitation, it can

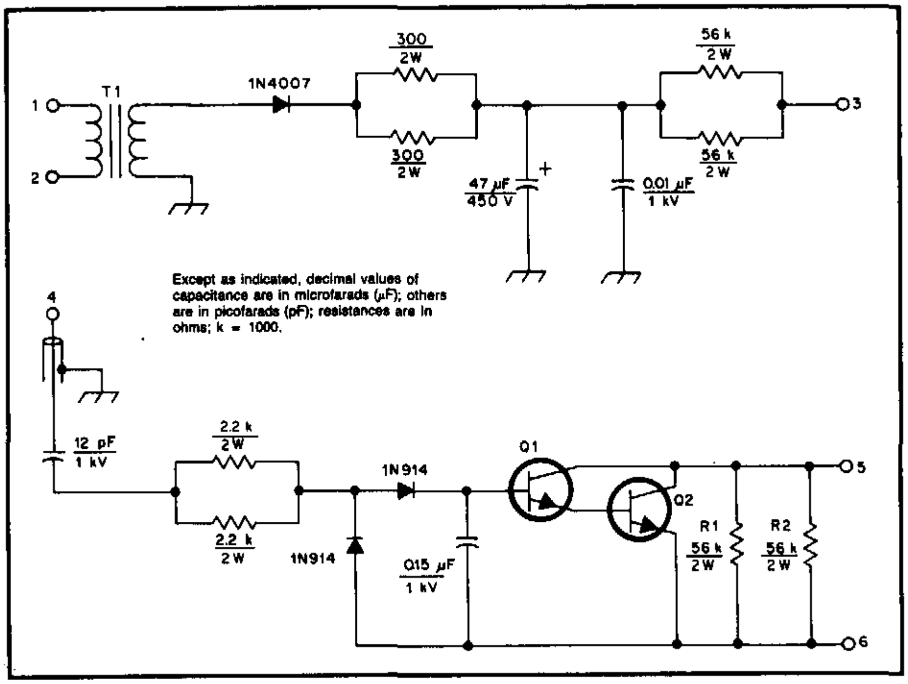


Fig 2—Hank Garretson added electronic bias switching to his AL-1200 with this circuit. The 12-pF, 0.01-µF and 0.015-µF capacitors are ceramic. Connect Terminals 1 and 2 to 120 V ac at the primary of the AL-1200's heater transformer, Terminal 3 to the center tap of the AL-1200's heater transformer, and Terminal 4 to the RF-IN terminal on the AL-1200's ALC/Power Board AR-574; do not change the AL-1200's wiring for these steps. Break the white wire between contact A of RLY1 and the RLY terminal on Meter Board AR-545 in the AL-1200. Connect Terminal 5 to contact A of RLY1 on the AL-1200, and Terminal 6 to the RLY terminal of the AL-1200's Meter Board AR-545.

Q1, Q2—2N5655. Alternatives: 2N5656, 2N5657, 2N4055, 2N4056, NTE 157, MJE3439, MJE3440, MJE9741, MJE9742.

T1—Isolation transformer, 120-V primary and secondary (two low-current filament transformers connected back-to-back will also work).

[1] PK-232 Operating Manual, p 4-4.

lengthen the life of your 3CX1200A even if you don't operate break-in.

The circuit is an adaptation of similar schemes by Clements[2] and Pittenger.[3] Two parallelled 56-kilohm resistors (R1 and R2) are placed in series with the stock AL-1200 bias circuit. With no excitation applied, Q1 and Q2 (a Darlington amplifier) are turned off, and voltage drop across R1 and R2 produces sufficient bias to cut off the AL-1200's 3CX1200A7. Excitation, rectified by D1 and D2 and filtered by C1, turns Q1 and Q2 on, bypassing R1 and R2 and applying normal operating bias to the tube.

Mount the circuit components on a piece of perf board and install this module above the AL-1200 circuit boards (immediately behind the amplifier meters). Caution: Voltages in the AL-1200 can kill you. Unplug the amplifier and ground the 3CX1200A7 plate connection before working on the amplifier.—*Hank Garretson, W6SX, 18831 Capense St, Fountain Valley, CA 92708*

[2]P. Clements, "All Solid-State QSK for the Heath SB-220," *QST*, Jan 1980, pp 25-27.
[3]J. Pittenger, "3CX1200A7 10 to 80-Meter Amplifier," *ham radio*, Aug 1985, pp 75-78, 83, 84-85, 87.

BETTER SSB FOR THE COLLINS R-390 RECEIVER

☐ The Collins R-390 is a great receiver except for its poor performance on SSB. The primary reason for this fault is an improper signal versus BFO level in the detector stage; with the BFO as weak as it is, the '390's AGC range is insufficient to ensure undistorted reception of strong SSB signals. The addition of a single 33-kΩ resistor between the anode of the AGC rectifier tube (pin 6 or 7 of V510) and the grid of the AGC time constant tube (pin 7 of V511) gives the AGC a helping hand, producing excellent SSB quality.

You can test this modification without removing the R-390's IF subchassis as follows: Extend the leads of a 33-kΩ, ½-watt resistor by soldering a length of solid, insulated hook-up wire to each resistor pigtail. Wrap the resistor and its leads with insulating tape. Next, strip both of the extended resistor leads for ½ inch. Remove tube V510 from the R-390 IF subchassis and tightly wrap the bare end of one resistor lead around pin 6 or 7 at the tube base. Reinstall the tube, being careful that the twisted resistor wire remains insulated from the other tube pins and shield base when the tube is seated. Connect the other resistor lead to pin 7 of V511 in the same manner. Excellent SSB performance should be noticed, with no adverse affects on AGC time constant.

A more permanent modification would involve placing the 33-kΩ resistor in parallel with the series combination of resistors R556 and R557 inside the IF subchassis. —*Ken Johnson, N5US, PO Box 10063, Austin, TX 78766*

BETTER SSB FOR THE COLLINS R-390A RECEIVER—REVISITED

☐ Some receiver aficionados think that the R-390 and R-390A are identical except for their method of IF filtering. (The R-390 uses LC IF filtering; the R-390A uses mechanical filters and is generally considered to be more desirable because of this.) The R-390A is actually a pared-down R-390: It has one fewer RF amplifier and two fewer IF amplifiers than the '390. This seems to make the R-390 a little more sensitive than the '390A. The '390 and 390A also differ in their power supplies and tube complements. These differences make circuit modules and most parts non-interchangeable between the two receivers.

My modification concerns the R-390's AGC circuitry; the AGC circuits in the R-390 and R-390A are similar. Both receivers use 12AU7/5814 tubes for AGC-rectifier and AGC-time-constant functions; however, the part numbers and tube-pin references differ between the two receivers for the circuitry that serves these functions. Anyone wishing to improve the SSB performance of an R-390A by trying my modification should consult a schematic diagram of the '390A for circuit details. Please note that I have *not* attempted this modification on an R-390A; the basic idea should be applicable to this receiver, however.—*Ken Johnson, N5US, PO Box 10063, Austin, TX 78766*

CURING DC-TO-DC CONVERTER SPURS IN THE DRAKE TR-7 TRANSCEIVER

☐ Is your TR-7 transmitting and receiving spurious signals 23 and 46 kHz above its tuned frequency? Checking this is easy. With a 50-ohm dummy load attached to your TR-7's antenna jack and the transceiver in a narrow CW mode, turn on the TR-7's 25-kHz **CAL**ibrator and tune in the 1800-kHz marker. Now, tune for a signal at approximately 1802 kHz (1825 − 23). If you find an 1802-kHz signal, turn off the calibrator to see if the signal disappears at the same time. Spurs of the type discussed in this hint disappear when the calibrator is turned off.

In my case, the spurs registered S5 on the TR-7's S meter, while the 25-kHz markers came in at 15 dB over S9. This "multichannel" response degraded my TR-7's ability to receive weak signals. On transmit, other hams heard me at several unexpected places on the band—at reduced strength, but still quite readable.

Replacing C2108, a dc-to-dc converter decoupling capacitor on the transceiver's internal power-supply circuit board (Fig 2-23 in the TR-7 *Maintenance Manual),* reduced the spurs to S2. This is acceptable, but adding another pi filter section in cascade with RFC2101/C2108 (Fig 3) pushed the spurs into the noise.

There's plenty of room on the back of the power supply board to "kludge in" the new parts. The added filter inductor (L1 in Fig 3) is a junk-box ½-inch-OD ferrite toroid filled with no. 24 enameled copper wire.—*Mike Agsten, WA8TXT, 405 W Bogart Rd, Sandusky, OH 44870*

USING THE DRAKE TR-7 AND TR-7A TRANSCEIVERS WITH FULL-BREAK-IN AMPLIFIERS

☐ The Drake TR-7 exhibits a characteristic that makes it difficult to use with several full-break-in (QSK) amplifiers on the market (ETO models Alpha 77, 78 and 86, and the Ten Tec 425). The problem is that there is RF at the TR-7/7A's ANTENNA jack before the transceiver's VOX relay has closed. This condition activates the amplifier's "hot-switch protect" circuitry, causing the amplifier not to amplify the first dot or, in the case of the Alpha 86, to trip the protection latch and not amplify at all. In SSB VOX operation, a similar

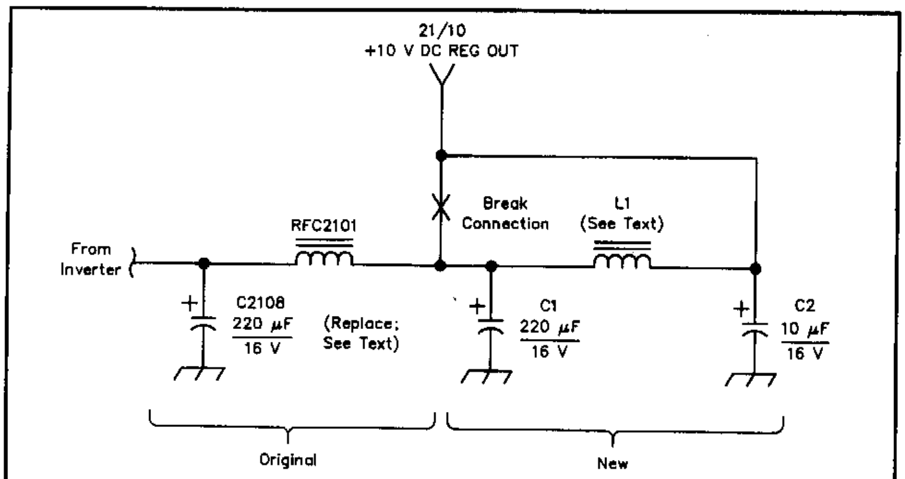


Fig 3—Mike Agsten reduced dc-to-dc converter-related TR-7 spurs by replacing the rig's C2108 and adding three filter components (C1, C2 and L1) as shown here. L1 consists of no. 24 enameled wire wound to fill a junk-box ½-inch-OD ferrite toroid.

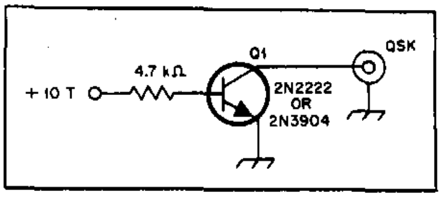


Fig 4—Dick Frey added QSK compatibility to his Drake TR-7 transceiver by adding a 4.7-kΩ resistor, NPN transistor (2N3904 or 2N2222), 5-inch piece of wire and panel label to the rig. The QSK jack is a spare phono connector already installed on the TR-7/7A back panel by Drake. See text and Fig 5.

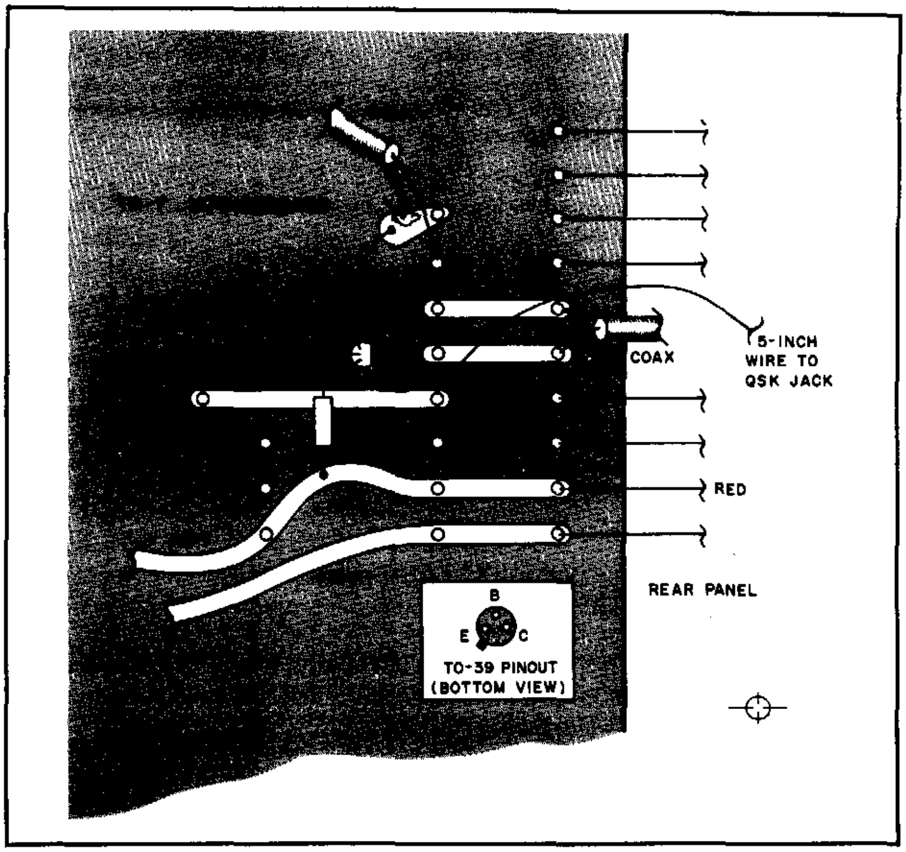


Fig 5—The 4.7-kΩ resistor and transistor are connected to the TR-7/7A motherboard as shown at A. If you use a 2N2222 in a metal can (TO-39, pinout at inset), be sure that the can does not touch other components.

condition exists, but is less pronounced.

The Drake's VOX relay, which takes approximately 10 ms to close, is the cause of this problem. The solution is to add a transistor switch (Fig 4) to the TR-7—a switch that closes immediately on the generation of a transmit command from the key, PTT or VOX. Once this is done, the transistor switch, *not* the TR-7's VOX relay, keys the amplifier. The circuit is easy to build and can be installed by a reasonably competent technician in less than 15 minutes. No familiarity with the inner workings of the Drake is required.

Refer to Fig 4. Circuit operation is simple: The +10T line goes from zero to +10 V when the TR-7 goes from receive to transmit, regardless of the position of the transceiver's MODE switch. This turns on Q1, which keys the amplifier.

Drake has graciously placed a spare phono jack on the transceiver's rear panel; we'll use this jack for the new amplifier-control output. Once you've collected the parts listed in the Fig 4 caption, proceed as follows:

1) Remove the TR-7's cover (slot-head screws) and bottom plate (Phillips-head screws).

2) Remove the six screws that hold the rear center panel. This allows access to the spare phono jack's solder terminals.

3) Solder one end of the 5-inch wire to the center pin of the spare phono jack and route the wire toward the bottom of the panel.

4) Replace the rear panel and its six screws.

5) Turn the TR-7 over and locate the +10T trace on the large circuit board (the motherboard; see Fig 5).

6) Solder the emitter lead of the transistor to the ground pad of the coaxial cable closest to the rear center of the board.

7) Solder the free end of the wire from the QSK jack to the collector lead of the transistor.

8) Solder the 4.7-kΩ resistor between the +10T trace and the transistor base lead. Be careful that the leads of the transistor do not short any traces on the board.

9) Label the new jack QSK with tape or a stick-on label.

10) Check your work. Replace the TR-7's bottom cover (Phillips-head screws) and top cover (slot-head screws).

To use the TR-7 with the amplifier, connect the new QSK jack to the RELAY or KEY IN jack on the amplifier. No other control connections are required.—*Dick Frey, K4XU, 4138 Maine St, Quincy, IL 62301*

USING THE HEATH HR-1680 RECEIVER AS A CW MONITOR

☐ I prefer to monitor my CW signal with the station receiver rather than with a sidetone oscillator because a sidetone doesn't really tell me how my transmitter sounds. Changes in the tonal purity or frequency of the transmitted signal are immediately apparent when the receiver is used as a monitor. (Of course, this assumes that the receiver is stable enough to provide an accurate representation of transmitter stability.) Also, this technique allows me to escape from the monotony of sidetone monitoring because I can change the pitch of the monitor signal at will by tuning the receiver as I transmit.

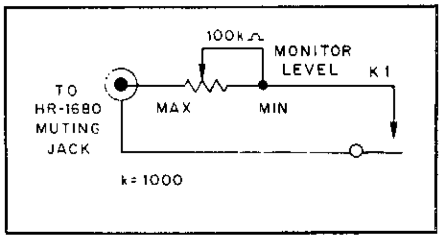


Fig 6—Used in conjunction with a spare set of closed-during-transmit relay contacts (K1) in the station transmitter or TR switch, Terry Lyon's MONITOR LEVEL control allows him to monitor his keying with his HR-1680 receiver.

Using my Heath® HR-1680 receiver for CW monitoring presents a problem, however, because its AGC range can't handle my transmitter's strong signal. This results in the generation of clicks, thumps and spurious signals that aren't present on the transmitted signal. To solve this problem, I installed a simple gain control circuit in the HR-1680's muting line (Fig 6). With proper adjustment of the MONITOR LEVEL control, this circuit drastically (but not completely) reduces the HR-1680's RF and IF gain when the muting line is grounded for transmission.—*Terry L. Lyon, KA3GCQ, 3 McCann St, Edgewood, MD 21040*

A NARROW IF FILTER FOR THE HEATH HW-9 TRANSCEIVER

☐ The Heath HW-9 is a fine CW QRP rig. It features a sensitive, stable receiver with excellent dynamic range and good AGC. For serious CW operation in a high-QRM environment, however, I find it deficient in selectivity. The HW-9 achieves its IF filtering with a four-pole crystal filter that has a −6-dB bandwidth in excess of 2 kHz, and skirts that are 4 to 6 kHz wide at −40 to −60 dB. This is fine for tuning around the band, or listening to SSB, but inadequate for narrow-band CW work. The HW-9's audio filter, selected in the Narrow mode, works well for cutting out adjacent

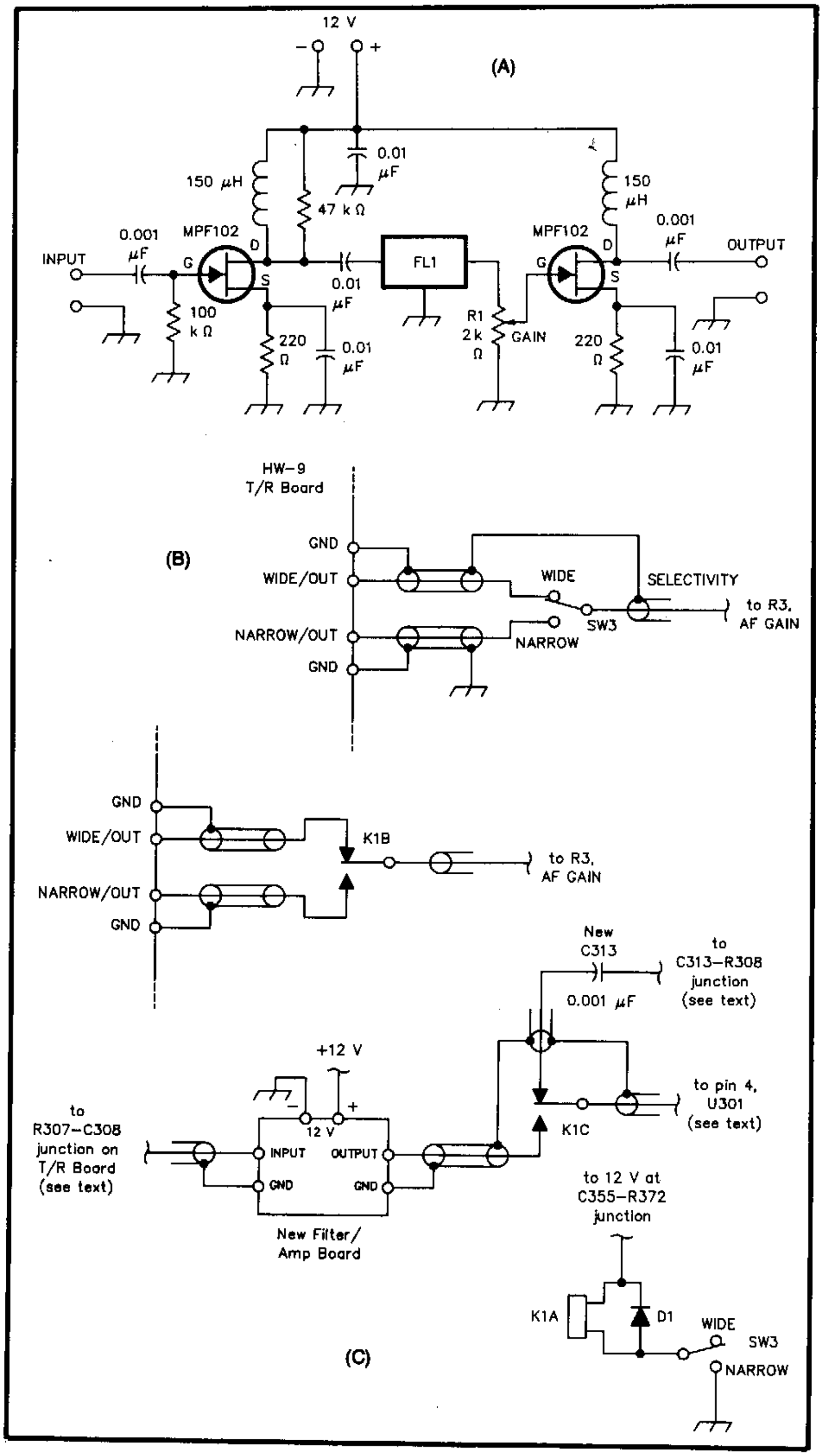


Fig 7—Thomas Niedermeyer added a narrow CW filter/amplifier (A) to his HW-9 transceiver and included this circuit in the HW-9's Wide/Narrow bandwidth switching. B shows the stock HW-9's Wide/Narrow bandwidth switching; C shows the modified circuit. FL1 is a Fox/Tango 2801.1; see Note 4. This modification requires the HW-9's original C313, a 0.001-µF disc, be removed as described in the text. Note that this capacitor is replaced by "New C313" at C. D1 is a 1N4000-series diode.

signals that are relatively weak—but if they are strong enough to activate the AGC (the take-off point for which is ahead of the audio filter), the desired signal often becomes unreadable. This deficiency can be readily overcome by adding a narrow IF crystal filter. Fortunately, Heath designed the HW-9 with an 8.8307-MHz IF, which exactly matches the IF center for CW reception in some Kenwood transceivers—and narrow CW filters are available for this frequency.

I purchased a steep-skirted 250-Hz filter, the Fox/Tango 2801.1,[4] and installed it in my HW-9. It works well, but because it's too narrow for band scanning, I decided to use it only in the HW-9's Narrow mode, keeping the rig's original 2-kHz- wide filter in Wide. The HW-9's narrow audio filter, although not needed when the F/T 2801.1 is in line, does a fine job reducing wideband noise generated by the HW-9's IF amplifier, so I keep it active in the Narrow mode.

Because of the F/T 2801.1's relatively high insertion loss, however, I found that some amplification is necessary to maintain proper gain and S-meter readings. Fig 7A shows the circuit I devised to provide this. A junction FET ahead of the filter provides a high input impedance and some gain, and a similar stage at the filter output supplies additional, and adjustable, gain. This circuit, along with the filter, can be built on a small piece of perfboard (or a circuit board) and is mounted on the side of the chassis below the U302 area of the HW-9's T/R board. I made the modification without removing either of the HW-9's two circuit boards.

The input lead of the filter board connects across R307 (on the HW-9's T/R board) using small-diameter coax. Expose a circuit point suitable for switching between the outputs of the new and original filters by removing C313 (a ceramic disc) by carefully crushing C313 with needle-nose pliers and removing all of its remains except for its leads. Mount a small 12-V-dc, DPDT relay (K1 in Fig 7C) sideways atop of FL301 using double-stick foam tape, so that its pins face U301, the second IF amplifier. Use the closest-to-the-circuit-board set of contacts (K1C, Fig 7C), connected via coax and a 0.001-μF disc, to switch U301's input (pin 4, accessible at the C313 lead closest to C322) between the output of the original filter (the remaining C313 lead) and the output of the new filter/amplifier board. Use small-diameter coax for all RF T/R-board-to-K1 connections.

Next, disconnect the shielded wires from the **WIDE/NARROW** switch (SW3) and connect the inner leads to the second set of the relay contacts so that the Narrow mode is active along with the narrow CW filter. (Rerouting of the shielded-wire braids is unnecessary because they're grounded at their non-SW3 ends. Just cut off their SW3-end braids about ½ inch away from their center conductors.)

Connect one relay-solenoid (K1A) terminal to 12 V dc at the C355 side of R372, and connect the remaining K1A terminal to the center contact of SW3. Install a 1N4000-series diode across the solenoid terminals, cathode to the solenoid's 12-V-supply end. Connect the appropriate SW3 contact to the adjacent ground lug. SW3 now switches the relay between Narrow and Wide according to the front-panel legend.

Check your work, fire up the rig and adjust R1 **(GAIN)** so that in-band signals show the same S-meter reading through either filter. Happy QRPing!—*Thomas Niedermeyer, NK6E, PO Box 301, Fairfield, IA 52556*

[4]The Fox/Tango 2801.1 filter is identical to International Radio's filter no. 97. Both are available from International Radio and Computers Inc.

AN AGC-THRESHOLD CONTROL FOR THE HEATH HW-9 TRANSCEIVER

☐ Strong signals near or in the Heathkit HW-9's IF passband can cause weaker signals in the passband to be distorted or "pumped" by AGC effects in the transceiver's high-gain IF-amplifier stages. As designed, these stages run at full gain, and there is no panel control for adjusting their gain. Here's an easy modification that solves this problem.

During alignment of the HW-9, R329 **(AGC SET)**, a 500-kΩ circuit-board trimmer pot, is set and not adjusted again. Through experimentation, I discovered that R329 allows the transceiver's IF gain to be reduced enough to minimize AGC pumping. I replaced R329 with a chassis-mounted control to allow routine adjustment of the HW-9's IF-amplifier gain.

Remove the original R329 from the PC board and discard it. Mount R329's shaft-driven replacement—I used a 500-kΩ linear control from Radio Shack—on the HW-9 chassis. (There is ample room on the chassis for the control. I elected not to place the control on the HW-9's front panel, instead installing it on the transceiver's side [left, viewed from the front.]) Connect the new control to the R329 circuit-board holes via a piece of RG-174 coax.

The only readjustment necessary after this modification is a slight touch-up of R333 **(METER ZERO)**. Now, your HW-9 can perform better in the presence of strong signals: Using the panel-mounted R329, simply reduce the IF-amplifier gain to the point at which AGC pumping disappears. Adjust R329 for full receiver gain as necessary.—*Jim Douglas, NI2F, 9 Linda Ln, Clark, NJ 07066*

CURING THERMAL DRIFT IN THE HEATHKIT HW-99 TRANSCEIVER

☐ I am a new ham, and my station includes an HW-99 transceiver. As noted in *QST*'s review of the HW-99,[5] this transceiver has a frequency-stability problem. This bothered me because I like to go on the air at the spur of the moment: I don't always have time to let the transceiver warm up for an hour!

I looked into the problem and realized that the can holding the parts that control the HW-99's frequency is awfully close to the pilot lamp—and that lamp gets quite hot. Removing the pilot lamp solved the drift problem. I thought I'd share this hint with you in case other readers who've encountered this HW-99 stability problem might like to try a simple solution.—*Nancy Kott, KB8FAY, PO Box 47, Hadley, MI 48440-0047*

[5]C. and E. Holsopple, "Heath HW-99 Novice CW Transceiver," Product Review, *QST*, Mar 1986, pp 43-45

ELIMINATING DIAL-DRIVE CLUTCH SLIPPAGE IN THE HW-101

☐ After I became the third owner of a Heathkit HW-101 transceiver, I noticed that its VFO occasionally slipped out of calibration at the ends of its range. I discovered the cause after removing the VFO assembly from the rig to inspect the dial-drive clutch: After years of pressure, the plastic clutch (Heath part no. 266-200) had warped. I reversed the clutch disk so that the inside surface of the disk faces outward, making the warpage work in my favor. Now, the dial drive works well. The clutch allows just enough slippage for manual calibration of the VFO dial scale.—*Vernon D. Range, Jr., KA9NBH, Rochelle, Illinois*

IMPROVING RIT AND SPLIT-FREQUENCY OPERATION IN THE HEATH HW-5400 TRANSCEIVER

☐ I found CW operation in the HW-5400's "split-frequency" mode cumbersome because of a delay between key closure and RF output. A call to Heath® confirmed that this delay is inherent in the HW-5400 because time is required to reset the frequencies of various oscillators—in particular, the microprocessor clock—when changing from receive to transmit. Wanting to reduce the delay, I wondered if the oscillator-reset time could be shortened. (I also wanted to be able to operate at splits wider than those possible with the '5400's ±350-Hz RIT [receiver incremental tuning] range; increasing the RIT range by adding diode D701B per a later revision of the '5400's assembly manual did not increase the range enough for my purposes.)

Finally, I hit upon a solution: Use *two* microprocessor clock oscillators—one for receive and the other for transmit—and *switch between them* instead of tuning the '5400's crystal-controlled clock between transmit and receive frequencies. The oscillator circuit I use (Fig 8) was designed by Lyle Audiss, K6PJE, and has given good results. This LC oscillator operates at the same nominal frequency as the HW-5400's crystal-controlled clock (8.04 MHz) and can be switched in to serve as the clock on receive. Because the LC oscillator can be tuned over a wider range than the crystal oscillator, the LC oscillator allows a much wider RIT swing than that possible with the clock. (The clock [Q701 and its associated 8.04-MHz crystal] is retained as the microprocessor clock on transmit.) I use the HW-5400's VOX/PTT switch, SW4, to switch between normal and wide RIT (see Fig 9); I don't operate VOX, and using SW4 avoids the necessity of adding another switch to the rig's front panel. PTT operation of the HW-5400 is unaffected by this modification.

The wide-RIT oscillator circuit is built on a double-sided PC board about 1 × 1½ inches in size. L1 is wound on a junkbox slug-tuned form approximately 1/4 inch long and 1/8 inch in diameter. The winding consists of 17 turns of no. 28 enameled wire; place the tap at 5 turns from the ground end of the coil.

Disconnect the VOX lead (a brown wire) from terminal 5 of SW4, tape the end of the wire, and fold the wire out of the way. Disconnect terminals 3 and 6 of SW4 from ground (the wire that goes to pin 3 of P913). Install a 22-kΩ, ¼-W resistor in series with the TX line to SW4, pin 3. (This resistor drops the TX voltage [approximately 12] to the 5 V necessary for biasing Q701.)

Mount the wide-RIT oscillator board on a standoff at the corner of the Controller board (directly above the 8.04-MHz crystal). Connect the collector of Q5 (the wide-RIT oscillator's output transistor) to the collector of Q701 (on the '5400's Controller board) by means of a short piece of RG-174 coax. Connect point A of Fig 8 to pin A on the Controller board.

Assuming that you've successfully built and installed the wide-RIT oscillator board, and you've completed the necessary wiring modifications around SW4, the only step left is the adjustment of L1. With the HW-5400 on and receiving, switch SW4 to WIDE RIT and adjust L1 so that the RIT control swings the receiver tuning equally above and below the nominal transmit frequency. That's it! The problem I haven't solved is that of labeling SW4 to match the lettering on the HW-5400's front panel. Any ideas?—*Gary Audiss, N6SI, 6540 Birch Dr, Santa Rosa, CA 95404*

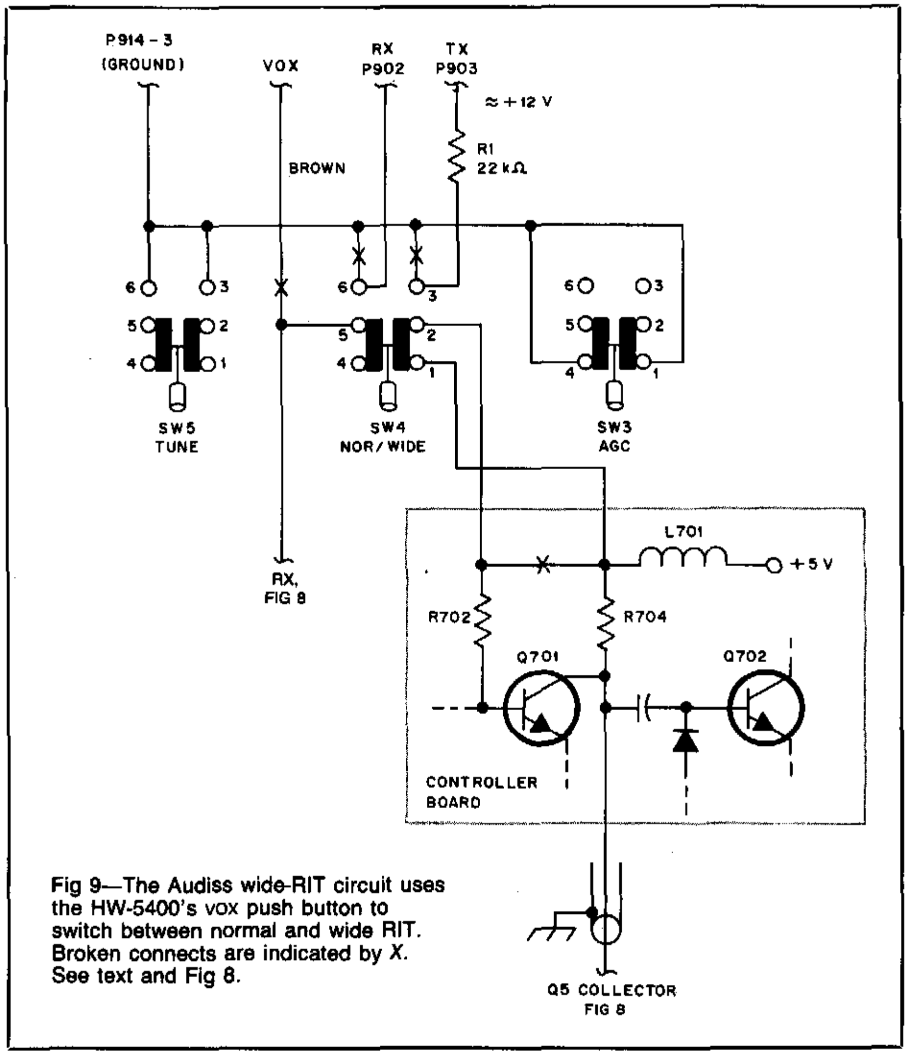


Fig 9—The Audiss wide-RIT circuit uses the HW-5400's vox push button to switch between normal and wide RIT. Broken connects are indicated by X. See text and Fig 8.

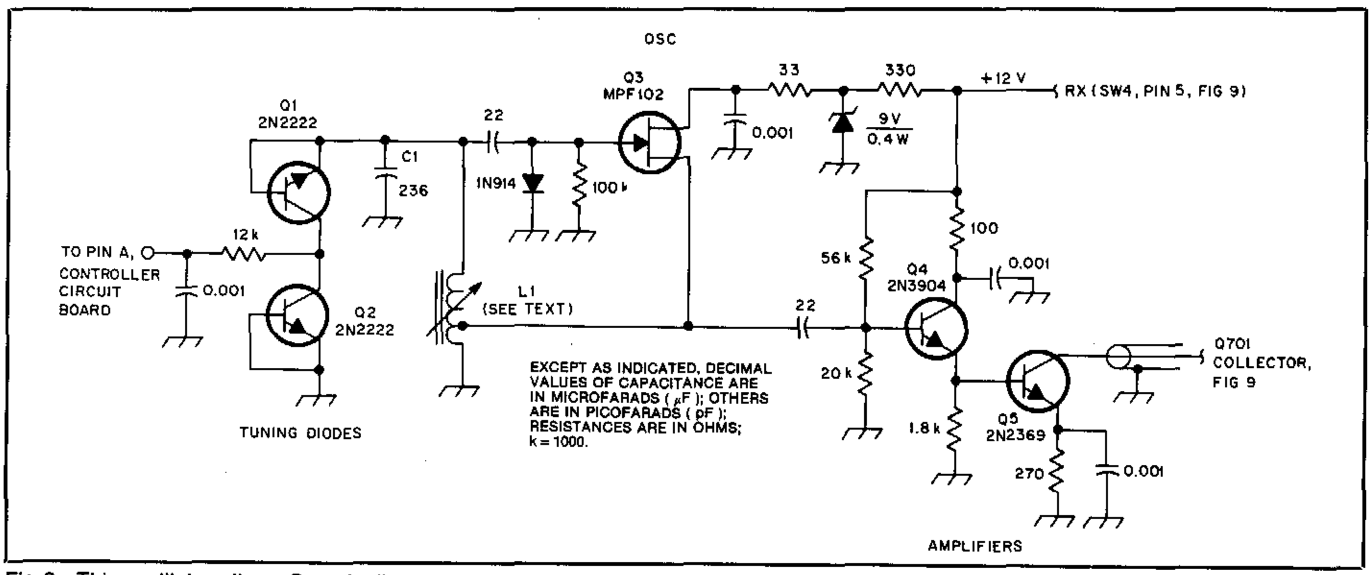


Fig 8—This oscillator allows Gary Audiss to use his Heathkit® HW-5400 transceiver at splits much greater than possible with the rig's RIT circuitry. Decimal-value capacitors are disc ceramic (16 V or greater); the 22- and 236-pF capacitors are NP0 or C0G discs. (Although Gary specifies a 236-pF capacitor at C1, you can use several standard-value capacitors in parallel to approximate that value.) Resistors are ¼-W, carbon-composition or -film units. See text and Fig 9.

HW-5400 SPEEDY TUNE

☐ After working a major SSB/CW contest with my Heath HW-5400 transceiver, I realized that I need a faster and easier method of changing frequency than that allowed by the stock '5400. The circuit shown in Fig 10 is my solution to this problem. Dubbed the Speedy Tune, it provides rapid up/down frequency slewing and is controllable by a momentary, DPDT, center-off toggle switch. The Speedy Tune is easy to build and does not affect the '5400's manual tuning.

The Speedy Tune circuit is based on a 555 timer, U1. The 555 is connected as an astable multivibrator that free runs at eight times the tuning rate (in steps per second) desired. The multivibrator frequency is adjustable by means of RATE control R1. U2 delivers two pulse trains 180° out of phase which, when divided by binary counters U3 and U4, produce two pulse trains *90°* out of phase (in quadrature)—just as does the optical shaft-rotation encoder associated with the HW-5400's tuning knob. These signals are routed to the $\phi 1$ and $\phi 2$ inputs of the HW-5400's controller board by means of UP/DOWN switch S1.

My version of the Speedy Tune is built on a small piece of perfboard and mounted near the HW-5400's Controller board. (Power for the Speedy Tune is obtained from P703 on the '5400's Controller board: Pin 1 supplies 5 V dc and pin 3 is common.) S1 can be mounted on the '5400's front panel—to the lower right or left of the tuning knob—with room to spare. The Speedy Tune circuit may also be usable with any other optically-encoded tuning system that accepts TTL-level inputs from its shaft encoder.—*Dexter King, AB4DP, 6438 Pettus Rd, Antioch, TN 37013*

BATTERY BACKUP FOR THE HW-5400 TRANSCEIVER

☐ The Heath® HW-5400 loses its memory when power fails. To solve this problem, connect three AA NiCd cells in series between pin 4 of U710 and ground, + terminals toward pin 4 of U710, and − terminals toward ground. (Easy access to pin 4 can be had at R744; the NiCd cells can be mounted on the U714-U715 heat sink.) When the rig is on, the battery trickle charges through pin 4 of U710; when the rig is off, the battery supplies 3.6 V for memory back-up. Install a diode—a 1N914 is suitable—between pin 4 of U710 (diode cathode to pin 4) and the HW-5400's 5-V memory-back-up line to keep the batteries from discharging through the memory-back-up power supply.—*Al Smardon, VE3OX, RR 1, Carrying Place, ON K0K 1L0, Canada*

AVOIDING STATIC DAMAGE TO THE HEATH μMATIC MEMORY KEYER

☐ Heath suggests that users of the μMatic Memory Keyer ground themselves to protect the μMatic's components from electrostatic discharge (ESD). ESD danger is especially high on winter days when the relative humidity in heated buildings is low. Fig 11 shows my solution to this problem: a grounded metal strip that I touch each time my hand goes to the μMatic paddles. The strip consists of self-adhesive, stainless-steel tape (available in hobby or "home center" stores). The rubber pad also provides an antislip base for the keyer. —*John DeCicco, KB2ARU, 1816 Ave S, Brooklyn, NY 11229*

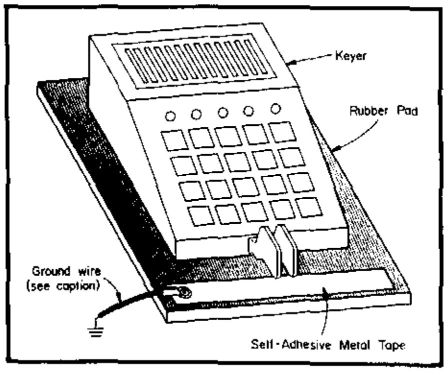


Fig 11—John DeCicco protects his μMatic keyer from static-electricity damage with a grounded length of self-adhesive steel tape. The rubber pad supports the tape and keeps the keyer from sliding on the table. Approaching John's antistatic measures from a commercial angle, computer stores carry "groundable" resistive strips and mats intended to protect computers and keyboards from ESD; such products would also protect the μMatic. Hints and Kinks suggests installing a 1-megohm, 1-watt resistor (or a series-parallel resistor combination of equivalent resistance and power rating) between the metal strip and ground to limit current in the strip ground to an operator-safe level.

AMPLIFIER TR RELAY SWITCHING INVERSION

☐ Because I burned out a relay contact in my Drake TR-5 transceiver by switching the antenna relay in my Heath® SB-200 amplifier, James Hebert's January 1988 article on a solid-state antenna-relay switch caught my attention.[6] I wanted to use

[6]J. Hebert, "Using the SB-220 Amplifier with Solid State Transceivers," page 1-9.

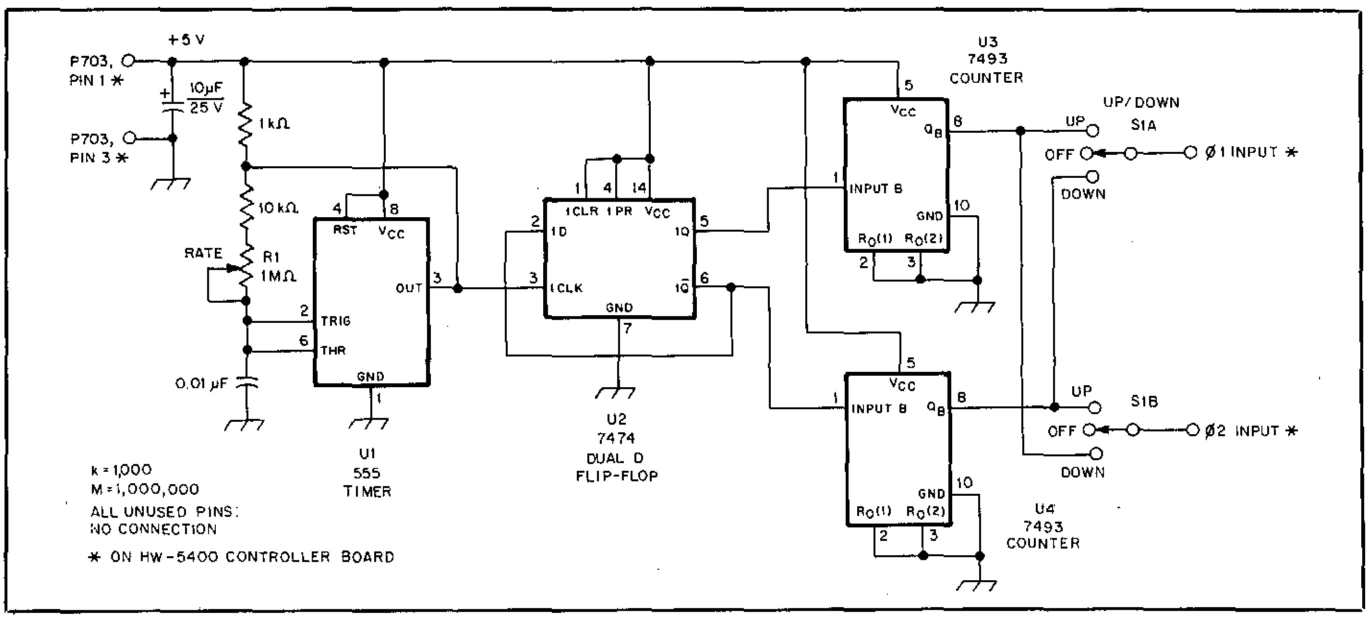


Fig 10—Dexter King's Speedy Tune circuit adds up/down frequency slewing to the Heath HW-5400 transceiver. R1 allows adjustment of the slewing rate.

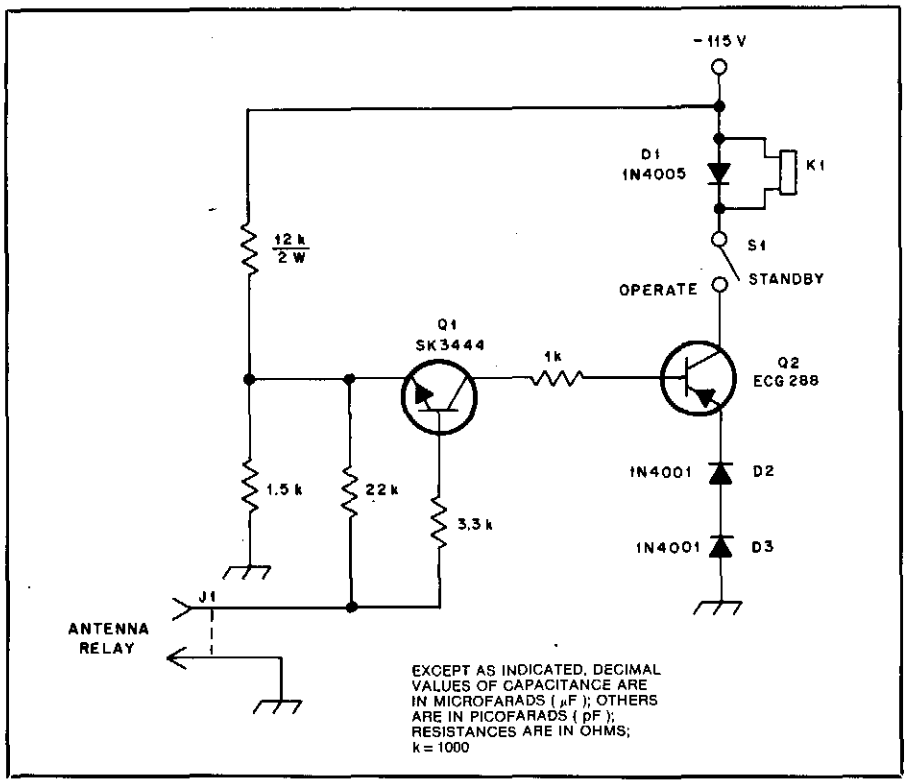


Fig 12—Wilbur Fulton modified the K8SS antenna-relay control circuit for use with the SB-200's negative antenna-relay supply as shown here. J1 and K1 are SB-200 parts; D1 is a 1-A, 600-PIV diode; D2 and D3 are 1-A, 50-PIV diodes and S1 is an SPST toggle. Resistors are ¼-W, carbon-film units unless designated otherwise.

James' circuit, but the SB-200's antenna relay operates at *negative* 115 V dc instead of the +125 V used in the SB-220. With a few modifications, the circuit can key the SB-200 relay:

1) Substitute an SK3444 (PNP) for Q1.
2) Substitute an ECG288 (PNP) for Q2.
3) Reverse the polarity of D1-D3.

Fig 12 shows the revised circuit. The relay in my TR-5 now switches only 10 V at 0.8 mA.—*Wilbur S. Fulton, W2SE, Box 681, 7 Lakes, West End, NC 27376*

MORE ON AMPLIFIER TR-RELAY SWITCHING INVERSION

☐ Wilbur Fulton, W2SE, described a means of controlling a Heath® SB-200 amplifier with his Drake TR-5 transceiver. I built Mr Fulton's circuit because I wanted to drive *my* SB-200 with a solid-state rig—a Kenwood TS-940S—and didn't want to damage the 940's amplifier-control transistor.

When I switched on the SB-200 after installing the modification, I immediately heard relay chatter in the SB-200 without even turning the TS-940S on. Troubleshooting did not uncover a wiring or assembly fault, and what I did to solve my problem may prove helpful to other hams who encounter similar relay chatter.

A slight, built-in resistance in the line from J1 (and inside the TS-940S) is enough to cause a voltage drop large enough to trigger Q1 in the W2SE circuit. Merely swapping Q1's 3.3-kΩ base resistor and 22-kΩ emitter resistor raises the stage's input impedance enough to overcome this problem. Now, my modified-SB-200/TS-940S combination works nicely.—*A. F. Constable, N6QNS, 20201 Parthenia St, Canoga Park, CA 91306*

AN IMPROVED CIRCUIT FOR INTERCONNECTING THE SB-200 AMPLIFIER AND SOLID-STATE TRANSCEIVERS

☐ I encountered a problem similar to that discussed by James Hebert ("Using the SB-220 Amplifier with Solid-State Transceivers,"), when I sought to drive my Heath® SB-200 amplifier with a newly acquired Kenwood TS-940S transceiver. The hot contact of the SB-200's relay-control jack exhibits an open circuit voltage of −130 to ground; the short-circuit current of the SB-200's relay-control circuit is 50 mA. The open-circuit voltage could rise to as high as 170 under fault conditions in the SB-200. The Kenwood manual states that the TS-940's control relay is intended for low-current applications; I infer that "low current" also means "low voltage." As a result, I did not want to connect the SB-200's 130-V control line to my TS-940S. Instead, and in order to get on the air quickly, I used a relay between the TS-940S and SB-200. I wasn't satisfied for long: It seemed ridiculous—and rather noisy—to use the transceiver relay to drive another relay that finally switched *another* relay in the SB-200.

To solve this problem, I designed an interface circuit (Fig 13) that uses a high-voltage, P-channel MOS power transistor—an IRF9612—as a switch. The IRF9612 has a source-to-drain breakdown voltage of 200, can switch up to 1.5 A, exhibits a channel resistance of 4.5 Ω when turned on, comes in a TO-220 plastic package, and costs $3.50/unit in small quantities. The IRF9612 also includes an integral drain-to-source protection diode capable of clamping transients that can result from switching inductive loads.

The circuit is powered by a 9-V battery, which provides enough voltage to drive the MOSFET in this low-current switching application. The 1-kΩ resistor limits the peak current flowing in the transceiver relay to approximately 9 mA and sets the MOSFET turn-on time to approximately 0.3 μs (this assumes that the MOSFET's effective input capacitance is 300 pF). The 470-kΩ resistor sets the turn-off time constant to 140 μs and limits the closed-circuit current to 20 μA. The 15-V Zener diode protects the transceiver should the MOSFET develop a gate-to-drain short circuit. (In that unlikely event, the Zener diode will limit the voltage applied to the transceiver to −24. If you intend to substitute a diode with a different Zener

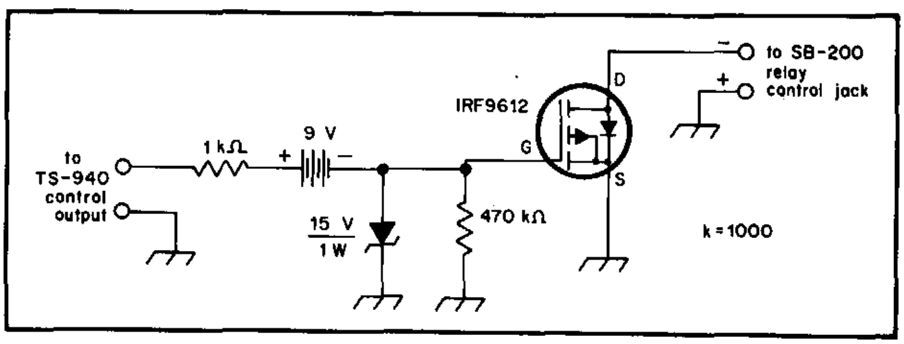


Fig 13—Richard Jaeger's solid-state transceiver-to-amplifier interface uses a power MOSFET instead of a relay for amplifier control. For amplifiers that use a *positive* relay-control voltage, reverse the polarity of the Zener diode and battery, and use an IRF612 N-channel MOSFET instead of the IRF9612.

voltage for this part, remember that the Zener diode's breakdown rating must comfortably exceed the battery voltage [9 in this application]).

I built the circuit on a piece of perfboard, mounted the board in a small metal box, and used shielded cable for connections between the interface box, amplifier and transceiver. Stray-RF problems have not occurred with this arrangement. Because the interface circuit is self-contained, the SB-200 and TS-940S need not be modified for operation with the interface.—*Richard C. Jaeger, K4IQJ, 711 Jennifer Dr, Auburn, AL 36830*

MORE ON INTERFACING SOLID-STATE TRANSCEIVERS AND THE SB-200 AMPLIFIER: A POWER-MOSFET SOURCE

□ My circuit for interfacing the TS-940S with the SB-200[7] has generated a lot of interest. But many people are having trouble finding the IRF9612 power MOSFET I used. The IRF9612 is an International Rectifier product sold under the trademark HEXFET. The IRF9610, 9620, 9630 and 9632 can all be used in place of the 9612, although they are slightly more expensive. My source is Digi-Key® Corp, PO Box 677, Thief River Falls, MN 56701-0677, tel 800-344-4539.—*Richard C. Jaeger, K4IQJ, 711 Jennifer Dr, Auburn, AL 36830*

[7]R. Jaeger, "An Improved Circuit for Interconnecting the SB-200 Amplifier and Solid-State Transceivers," (p 1-8). See also C. Martin, "Feedback: Kenwood Transceivers *Can* Key Commercial Linear Amplifiers," p 1-23.

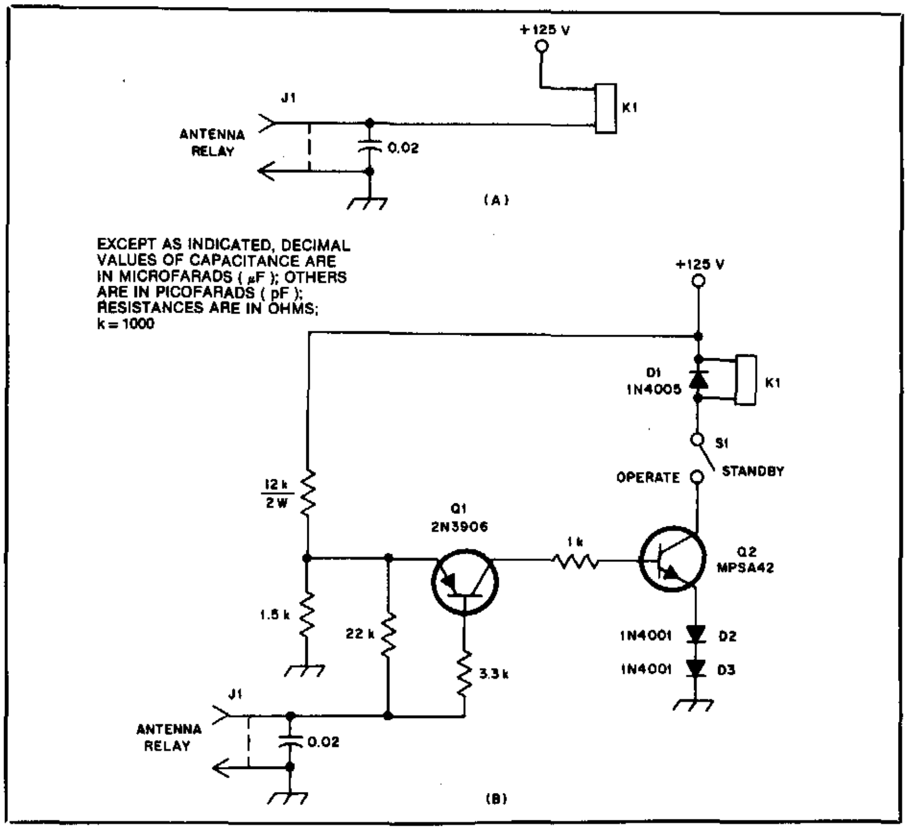


Fig 14—K8SS' SB-220 modification lowers the voltage at the ANT RLY jack, J1, from 125 at A to approximately 12 at B. Short-circuit current through J1 is reduced from 25 mA in the unmodified circuit to 2 mA in the circuit shown at B. J1, K1 and the 0.02-μF capacitor are SB-220 parts. Resistors are ¼-W, carbon-film units unless designated otherwise.

D1—1-A, 600-PIV diode.
D2, D3—1-A, 50-PIV diode.
Q1—General-purpose transistor.
Q2—High-voltage switching transistor, V_{ceo} = 300. ECG287 also suitable.
S1—SPST toggle.

USING THE SB-220 AMPLIFIER WITH SOLID-STATE TRANSCEIVERS

□ The Heathkit SB-220 is one of the most popular amplifiers ever sold. It was designed in an era when most amateur equipment was based on vacuum-tube technology. Because of this, special care is needed if the SB-220 is to be used with a solid-state transceiver.

The SB-220 goes into the transmit mode when the hot contact of its rear-panel ANT RLY jack (J1 in Fig 14A) is shorted to ground, actuating K1, the SB-220 antenna relay. The open-circuit dc voltage at this jack is 125; the short-circuit current is 25 mA. Vacuum-tube-based exciters usually have no trouble switching power at this level. Solid-state rigs are a different story.

My ICOM IC-740 transceiver can't switch 125 V at 25 mA because the maximum ratings for its amplifier-control relay contacts are 24 V/1 A dc. Other solid-state transceivers likely use relays or open-collector transistors of similar ratings for amplifier control. The switching problem is complicated by the fact that the SB-220 antenna-relay solenoid is not shunted by a spike-suppression diode. The transient voltage developed by a solenoid's collapsing magnetic field can exceed the supply voltage. (If you've ever gotten a poke from relay-solenoid back EMF, you know that this voltage is not just theoretical!) With the 24-V rating of the IC-740's control contacts in mind, a direct amplifier-control connection between the SB-220 and the IC-740 seemed to invite trouble.

Fig 14B shows my solution to this problem. With Q1 and Q2 handling the actuation of K1, voltage at J1 is reduced to approximately +12. Short-circuit current through J1 is about 2 mA. Because the SB-220 must be opened to make this modification, now's a good time to install an OPERATE/STANDBY switch, S1, to save switching the SB-220's tube filaments on and off.

There's plenty of room under the SB-220 chassis for mounting the switching components; the entire circuit can be assembled on a tie strip and mounted to an available under-chassis screw. I installed my version of the Fig 14B circuit next to the SB-220's 125-V dc supply, just behind the SSB/CW rocker switch. (Take proper high-voltage safety precautions when you make this modification. Lethal voltages exist in the SB-220.) Dress the wiring for minimal coupling to RF circuits under the chassis and near the antenna relay. As installed in my SB-220, this circuit shows no susceptibility to RFI.—*James Hebert, K8SS, Livonia, Michigan*

"NO HOLES" STANDBY SWITCH MODIFICATION FOR THE HEATH SB-220/221 AMPLIFIER

□ Most of the standby-switch modifications I've seen for the SB-220/221 amplifier require drilling holes in or modifying the amplifier itself. I prefer to keep my ham equipment in its original condition, though, because this helps in reselling the equipment later.

My solution to this problem requires that no holes be drilled—in the amplifier, that is! *My* standby switch is mounted external to the amplifier in a Radio Shack® aluminum box (no. 270-235). The switch opens the SB-220's antenna-relay line to place the amplifier in standby. The pictorial/schematic at Fig 15 shows how I installed such a switch with my Kenwood TS-530S transceiver and SB-220 amplifier. Bought at my local Radio Shack store, the components necessary to add the switch cost under $7.—*Christopher B. Hays, NTØW, 3675 Estates Dr, Florissant, MO 63033*

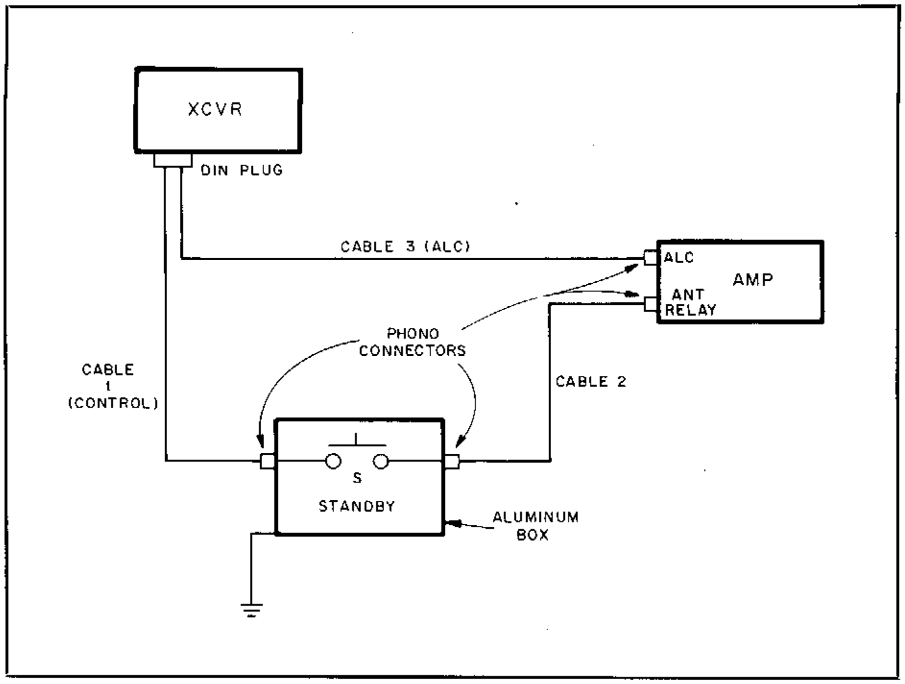


Fig 15—Christopher Hays added this standby switch to his SB-220 amplifier by breaking the '220's antenna-relay control line outside of the amplifier box. Cables 1, 2 and 3 consist of shielded wire (Radio Shack patch cords are suitable; RG-174 coax and phono connectors would provide better shielding). Standby switch S is a SPST push-button type (Radio Shack no. 275-1565), but a toggle is suitable. Hints and Kinks recommends that you keep your transceiver and amplifier turned off when unplugging or plugging in the connecting cables in your standby-switch installation. Otherwise, the open-circuit voltage on the SB-220's relay control line (about 125 V dc) can appear on the exposed center pins of the phono plugs on the transceiver ends of cables 1 and 2.

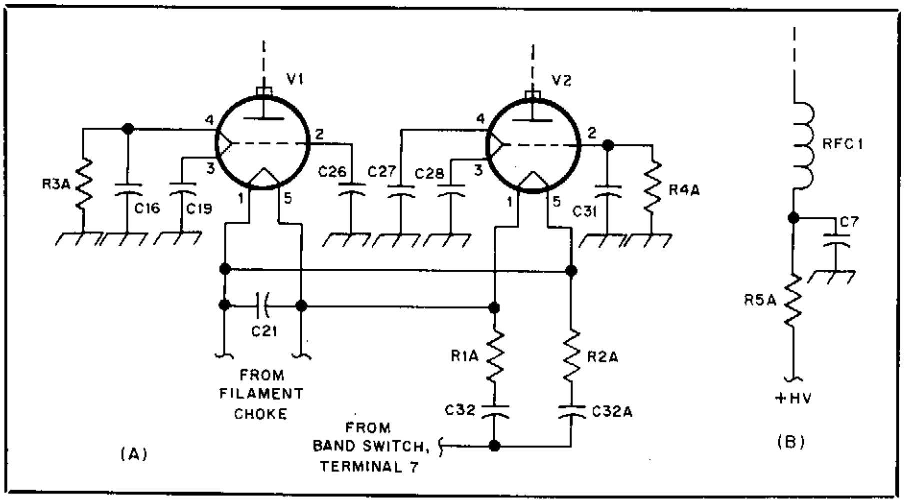


Fig 16—Part of the SB-220 VHF-parasitic-oscillation cure (A) consists of installing Q-damping resistors (R1A, R2A) in the amplifier cathode circuit and replacing the 3-500Z grid chokes with fuse resistors (R3A, R4A). Note that the installation of R1A and R2A also entails the addition of a second filament blocking capacitor (C32A).

Whether or not you apply parasitic-oscillation fixes to your SB-220, the installation of an HV fuse resistor (R5A, at B) is strongly recommended. The resistor protects the amplifier tubes by limiting, and opening in response to, the huge anode current pulse that occurs when the SB-220's 3-500Zs "take off" at VHF.

C32A—0.01 µF, 1 kV, disc ceramic.
R1A, R2A—10 Ω, 2 W, metal film.
R3A, R4A—24 to 30 Ω, ½ W.
R5A—10 Ω, 7 to 10 W, wirewound.

IMPROVING THE HEATHKIT SB-220 AMPLIFIER

□ The life of some of the components in the SB-220 amplifier can be prolonged with simple circuit modifications. These modifications concern:

• *The 3-500Zs:* If 3-500Zs possessing above-average gain are used in a stock SB-220, the amplifier may occasionally oscillate near 110 MHz. (This problem is not unique to Heathkit® amplifiers.) The presence of this condition is indicated by occasional arcing at the TUNE capacitor and/or band switch. If a full-blown parasitic oscillation occurs, the result is usually a loud bang. Sometimes this results in a grid-to-filament-shorted 3-500Z, a shorted Zener bias diode, exploded grid bypass capacitors, open grid-to-ground RF chokes (RFC4 and/or RFC5 in the SB-220 circuit), or any combination of these effects. A full SB-220 parasitic cure includes: (1) installation of Q-damping resistors (R1A and R2A in Fig 16A) in the tube cathodes (necessary because the coaxial cable between the SB-220's band switch and the 3-500Z cathodes happens to resonate near the SB-220's parasitic-oscillation frequency!); (2) installation of low-Q parasitic suppressors in the 3-500Z anodes; (3) installation of a 10-Ω, 7- to 10-W, wirewound resistor in series with the anode-supply lead (R5A in Fig 16B) to serve as an HV fuse should a full-blown parasitic oscillation occur; and (4) replacement of the 3-500Z grid RF chokes (RFC4 and RFC5) with 24- to 30-Ω, ½-W resistors (R3A and R4A in Fig 16A) to protect the tubes from grid-to-filament shorts. Full information on steps 1 and 2, and a discussion of how and why VHF parasitics can cause component failures, can be found in my article, "Improving Anode Parasitic Suppression for Modern Amplifier Tubes," *QST*, October 1988, pp 36-39, 66 and 89.

• *Heat reduction:* The eight 30-kΩ, 7-W resistors (R12 through R19, inclusive) that equalize the voltage drops across the SB-220's electrolytic HV filter capacitors (C10 through C17, inclusive) are a major source of heat: They dissipate about 38 W. The filter capacitors are subjected to this heat. Problem: Over a period of time, this heating can cause the filter capacitors to fail prematurely, and can also cause the capacitors' molded-plastic holders to melt. This problem can be corrected by replacing each of the 30-kΩ equalization resistors with a 120-kΩ, 2-W, 2%-tolerance Sprague Q-line® resistor. This modification reduces the power dissipation of the equalization-resistor string by 75% and greatly extends the life of the HV filter capacitors. (Don't use carbon-composition resistors here; they tend to change value unpredictably with use. This trait could result in [potentially destructive] unequal voltage division across the SB-220's HV filter capacitors.)

• *Pitted contacts in the amplifier-control relay:* A common problem with the SB-220 is that it pits the contacts of the control relay in its associated transceiver after several years' operation. The contact pitting is caused by the repeated short-circuiting of C52 (the 0.02-µF bypass capacitor at the SB-220's ANT RELAY), which charges to +115 V during receiving periods. This problem can be solved by placing a 200-Ω, ½-W resistor in series with the center pin of the ANT RELAY jack to limit the capacitor discharge current (see Fig 17).

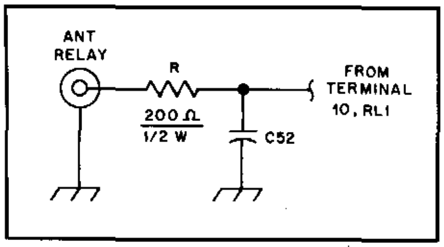


Fig 17—Relay contacts tend to be chewed up after several years of controlling an SB-220 because of the current pulse that occurs when C52 (the bypass capacitor at the SB-220's ANT RELAY jack) is discharged through the contacts. The addition of a current-limiting resistor (R) solves this problem.

• *Fan lubrication:* The fan-motor bearings on early-production SB-220s did not have lubrication holes, and lack of lubrication sometimes led to premature failure of the fan motor. Small lubrication holes can be drilled into the top of the castings that hold the front and rear oilite bearings. This can be done without removing the fan motor.

Ordinary, SF-grade 20w motor oil is a satisfactory fan lubricant; 0.1 cc of oil in each of the two holes once each year is adequate. More oil is not better, just messier.

The SB-220 can be modified for 160-meter operation without sacrificing any of its HF coverage. For details, see "Adding 160-Meter Coverage to HF Amplifiers," *QST*, January 1989, pp 23-28.—*Richard L. Measures, AG6K, 6455 La Cumbre Rd, Somis, CA 93066*

CURING PANEL-LIGHT BRIGHTENING IN MODIFIED-FOR-160 HEATH SB-220 AMPLIFIERS

☐ When the key is mashed down, the SB-220 draws lots of amps, which causes the line voltage to sag a bit and the meter lamps to dim, right? *Fasten your seat belt.* On the 160-meter band *only,* some modified-for-160 SB-220s exhibit just the opposite effect. This blew me away the first time I saw it. Apparently, just enough 1.8-MHz energy gets into the 5-V filament circuit (which also powers the lamps) to make the bulbs get *brighter.* The great puzzle is that the filaments of the SB-220's two 3-500Z tubes, which are powered by the same 5-V source, but at the other end of the filament choke, do *not* get brighter. Adding a bypass capacitor across the 5-V source at the RF-ground end of the filament choke does not prevent the meter lamps from brightening during key down So, apparently the RF gets into the filament wires between that point and the meter lamps. (This is bananas because the RF source is at the other end of the 5-V filament circuit!)

The fix is simple: Install a 0.1- to 0.2-μF, 100-V ceramic capacitor across the 5-V terminals on the meter-lamp terminal strip, next to the SB-220's meters. (Initially, I thought the RF source for this phenomenon was the HV circuit [which passes close to the meters]. To stop the 160-meter RF at this point, I substantially increased the RF-bypass capacitance on the HV feed-through insulator. But this had no effect on the problem.)—*Richard L. Measures, AG6K, 6455 La Cumbre Rd, Somis, CA 93066*

FOUR CUTS MAKE CHANGING IC-2AT BATTERY PACKS EASIER

☐ A good friend of mine and fellow ham, Russ, N8DMK, is blind and lacks the use of one arm. For 2-meter operation, his mainstay rig is an ICOM IC-2AT hand-held transceiver. Problem: Each time the '2AT's battery pack died, Russ' mother had to install a fresh battery for him. (Russ had tried many times, but could not get battery and radio to line up just right. His technique looked good: Sitting down, he held the transceiver between his thighs and worked at pack and radio with his good arm. But success at getting the pack to slide smoothly onto the '2AT continued to elude him.)

On a recent visit, while was I helping him practice putting the battery pack on, I got an idea and asked Russ for the IC-2AT and battery pack. After removing a few bits of plastic with my pocketknife, I handed the pair back to Russ and had him try again. Bingo! After a few tries, he slid the pack right on! Even when he began the change-over operation with the pack in a different position, Russ easily installed the battery on the transceiver. He was overjoyed, and his mother was thrilled with the accomplishment.

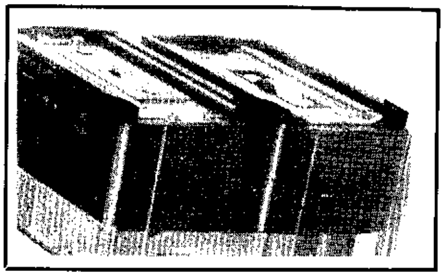


Fig 18—N8FCQ's removal of four bits of plastic takes the frustration out of IC-2AT battery-pack changes for N8DMK. The modification allows the metal shoe on the battery pack (left) to contact the metal rail on the transceiver (right) *before* the plastic rails interlock.

Fig 18 shows how to make the cuts. Remove just enough plastic to allow the mating metal rails of the battery pack and transceiver to catch *before* the plastic rails engage. This requires that the end of each metal rail be undercut slightly. I've modified *my* IC-2AT the same way: Now, I can change battery packs more easily, too!—*Casey Nowakowski, N8FCQ, Berea, Ohio*

OPERATE AND RECHARGE YOUR ICOM IC-2GAT HAND-HELD AT THE SAME TIME

☐ This simple modification to an ICOM BP-7 or BP-70 battery pack allows you to operate your ICOM IC-2GAT from 13.8 V and charge the battery pack at the same time. You needn't buy power adapters or remove the battery from the radio; you can even operate the radio while charging a fully discharged battery pack! The parts required for this 30-minute modification are two diodes (3-A rectifiers, preferably Schottky-barrier types for low forward-voltage drop—1N5820, 1N5821, 1N5822 and ECG586 are suitable), a piece of masking tape, a 3-inch piece of insulated wire, and an inch or so of heat-shrink tubing. Keep a paper and pencil handy for making notes. You'll also need a voltmeter to check out the modification before using the pack. Because accidental short circuits are possible during the modification process, modify only a fully discharged pack. This modification probably voids the warranty on the pack(s) you modify.

Disassembly

1. Remove the battery pack from the radio.
2. Mark the orientation of the charge selector plate on the battery-pack bottom in case the plate comes loose. A piece of tape near the + side screw will do.
3. Remove only these fasteners: the pack's two bottom screws (+ and −), two back screws (black) and four top-corner screws.
4. Remove the pack's plastic front cover. Do not remove the charge selector plate; pull it away from the back plastic cover and leave it stuck to the front cover.
5. Remove the pack's two dust caps (they slide out).
6. Look at the space between the middle of the charger board and batteries to see how much room you have to work in.
7. Carefully slide out the charger board and pull it away from the case. Diagram its connections to the pack in case you break a wire during the modification.

Modification

8. Locate the + side lug terminal at the center of the component side of the charger board. (It's associated with the + screw atop the pack.)
9. Unsolder the + side lug terminal from W9 and bend it 90 degrees away from the board. Do not remove the + screw.
10. Bend and cut the leads of one of your diodes—let's call it D1—to fit between W9 and the bent-up lug terminal. (If necessary, you can extend the diode leads with insulated wire to fit the diode elsewhere.)
11. Solder D1's cathode (banded-end) lead to the + lug terminal, and its anode lead to W9.
12. Cut the anode lead from your second diode (D2) short and solder the 3-inch wire to it. Insulate this connection with heat-shrink tubing.
13. Cut D2's cathode lead short and solder it to the + lug terminal (along with D1's cathode lead).
14. Route the wire from D2 around the pack's charging-indicator LED and solder its free end to the center pin (+) of J2 (**13.8 V DC IN**) on the copper-foil side of the board. J2's center pin connects to the PC-board trace that goes to D12.

Checking It Out

15. Measure the voltage between the large metal plate (−) to the + screw atop the battery pack. Measure the voltage across the screw charging terminals on the pack's bottom. The voltage at both should equal the battery voltage.
16. Connect the battery to its wall charger and plug in the charger. Measure the voltage again at both places. The reading should equal *half* the battery voltage. Unplug the charger.
17. Apply 13.8 V to the **13.8 V DC IN** jack and measure voltage on top of the pack. The reading should equal the input voltage minus the drop across D1 and D2 (0.6 to 1.0 V or so). Measure the voltage across the charging terminals on the pack's bottom; this should be about 8.
18. If any of your measurements differ significantly from the levels mentioned in Steps 15 through 17, recheck your work. Also, check to see if the wire fuse at W12 has opened.

Reassembly

19. Reinstall the charger board in the case.
20. Reinstall the dust caps. Note that they differ in size.
21. Dress the wires in the pack so they will not be pinched when you close the pack, and recheck your work to make sure a short circuit cannot occur.
22. Reinstall the plastic pack top, making sure the pack's charging-indicator LED seats correctly.
23. Reinstall screws, starting with those at the back.
24. Repeat the measurements described in Steps 15 through 17. If all's well, you're done.

When using the modified battery pack, always power the radio from a supply line protected by a 2-A fuse.—*James Cleveland, N5ONI, Temple, Texas*

RESETTING THE CPU IN THE ICOM IC-02AT TRANSCEIVER

☐ On a frosty morning, you shuffle into your station and pick up your hand-held transceiver to call someone; you turn on the rig and hear the chatter, but the frequency display is blank! What has happened is that you've zapped the CPU's frequency-display memory. Don't worry—it's only temporary.

The IC-02AT's liquid-crystal display (LCD) panel is covered by a thin plastic membrane as it comes from the factory. More often than not, this covering is lost during normal use of the transceiver. If the plastic film is missing from your IC-02AT, do *not* touch the LCD panel if you can avoid it! Finger-delivered static electricity can erase the frequency-display memory. In seasons of dry air, the chances of this happening are particularly high.

If you have this problem with your IC-02AT, the following procedure may save you some money in getting the problem solved. [Read this hint in its entirety before working on your IC-02AT; if the reset procedure looks "a bit much" to you, *don't* try it—call ICOM instead. You may void your '02AT's warranty if you do this procedure yourself. If you decide to reset your IC-02AT, remember that the procedure wipes its memories clean, so be sure to record this information beforehand if you won't be able to retrieve it from *your* memory.—*AK7M]*

1) In a clean, clear work area, remove the IC-02AT's battery pack and place the transceiver face down on the work surface. With a "jeweler's" Phillips-head screwdriver, remove the four side screws (two on each side) and the screw near the top center of the transceiver back. The four side screws are longer than the fifth screw; keep this in mind so that you can reassemble the transceiver correctly.

2) With a slightly larger Phillips-head screwdriver, remove the screws that hold the battery-pack latch plate to the '02AT. Underneath this plate, you'll find the battery-pack latch spring and a plastic button; remove them also.

3) Carefully pry up the transceiver back; it serves as the transceiver's heat sink. Near the top of the exposed circuit board, you'll see a shiny plate covered with a greasy, white substance. *Do not* remove this material—it's thermally conductive grease.

4) Carefully *push* the chassis out of the plastic case from the bottom at the battery-contact point, or gently *pull* the chassis from the plastic case, being careful not to tear the PC-board foil connection between the two chassis halves. Open the sandwiched circuit board. In the half containing the IC-02AT's lithium cell (about the size of a nickel), you'll see, down and to the left, the CPU reset switch. (Note: Although this reset procedure isn't described in the IC-02AT user's manual, the illustration on p 42 of the manual shows the location of the reset switch.)

5) Attach a 12-V dc power source to the 12-V input port at the top of the '02AT and turn the transceiver on. Using a nonconductive wand, press the reset switch.

6) Turn off the IC-02AT, disconnect the 12-V dc power source and reassemble the transceiver. Now, the rig's CPU is reset to 144.00 MHz, its display will function normally, and its memories must be reprogrammed.—*Joseph J. Wavra, Jr, WQ5M, 7017 NW Taylor Ave, Lawton, OK 73505*

EASIER RESET FOR THE ICOM IC-02AT CPU

□ There's a much simpler procedure for resetting the IC-02AT CPU—one that does not require opening the radio. (1) Turn the radio off. (2) Press the FUNCTION button on the side of the radio and hold it on. (3) Turn the radio on. That's it! The '02AT's CPU is now reset, and all of the rig's memories are set to their default value (144.000 MHz).—*Pat Maturo, N1DYI, 233 Harvester Rd, Orange, CT 06477*

MORE ON RESETTING THE ICOM IC-02AT TRANSCEIVER MICROPROCESSOR

□ About resetting the IC-02AT microcomputer. Holding the **FUNCTION** button in while turning the radio on will reset the micro only on radios with a serial number above 34,000. On IC-02ATs with lower serial numbers, the internal reset button must be pushed while the radio is powered up. A special technique can make this easier: Remove the battery, and tip the radio straight back so you are looking at the battery slide plate. Remove the upper-left screw from the plate. The reset button is about ¾ inch in from the edge of the screw hole.

Power the radio via the top-panel power jack and turn it on. Insert a small, plastic tuning tool, or a similar tool with a little bend in the end, into the screw hole to push the reset button. You've achieved reset when you hear a tone from the radio speaker. If reset is normal and the radio has not been modified for out-of-band operation, its display will show **140.000** and not **144.00** as described by Maturo.

If the radio has been modified such that its display indicates **0.00**, then you have some work ahead of you. Enter 9.995 and push the ↑ button so the display shows **10.00**. Do this 13 more times to get to 140 MHz.

One more tip: Some early '02ATs (in the 8000 serial-number range) had an experimental reset circuit that allowed reset like that in radios with serial numbers above 34,000. The only way to find out if your IC-02AT is so equipped is to try it. (The circuitry that allows this could not be installed in other '02ATs for various reasons.) An early IC-02AT can be equipped with the external reset feature (and other updated functions) by replacing its CPU with the later version, but ICOM will not do this modification. Another note: The logic unit for radios with serials above 34,000 is laid out a bit differently than that of lower-number units; in radios with serial numbers over 34,000, CPU lock-up from static discharge is greatly reduced compared to earlier units. Enjoy!—*Fred Palmer, WA5WZD, ICOM America, Inc, 3150 Premier Dr, Suite 126, Irving, TX 75063*

BACKUP-BATTERY REPLACEMENT FOR THE ICOM IC-271H

□ Removing the IC-271H's RAM-board lithium battery renders the radio inoperative because the '271H's operating program resides in RAM-board memory. RAM boards deprogrammed in this way must be returned to ICOM for reprogramming. After having learned this the hard way, I recommend practicing preventive RAM-board-maintenance every two or three years as follows: Pull the RAM board and solder another new back-up cell in parallel with the old one. Then clip out the old battery. Don't disconnect the old battery until the new battery is safely soldered in.—*John R. Gruenwald, KØBF, 1112 N 4th St, Sterling, CO 80751*

In a "Tech Talk from ICOM" ad (*QST*, February 1986, pp 150-151), ICOM stated that "ICOM units utilizing the lithium-cell-backed RAM concept include the IC-751 and IC-745 HF transceiver, the IC-271A 2-meter base, IC-471A UHF base, IC-1271A 1.2-GHz base and IC-R71A general coverage HF receiver." The IC-271 and -471 were also available in higher-power versions (IC-271H and -471H).—*Ed.*

IMMUNIZING THE ICOM IC-730 AGAINST HIGH KEY-CONTACT RESISTANCE

□ The IC-730 is a great no-frills HF transceiver, but it does have one weakness that's important to us old-timers who still insist on using bugs [semiautomatic speed keys —AK7M] for CW work. Because the IC-730's keying-circuit voltage is very low, the rig's RF circuitry is sensitive to the

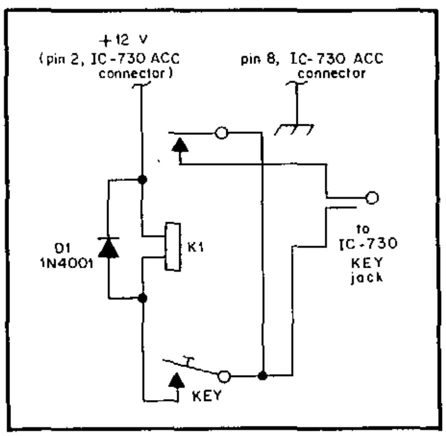


Fig 19—W6ERS overcame the effects of key-contact-resistance-related keying errors by installing a keying relay (K1) between his semiautomatic key and and ICOM IC-730 transceiver. A Radio Shack no. 275-233 12-V reed relay is suitable. Vern didn't mention adding D1 (to clamp the transient that occurs when the key opens and K1's magnetic field collapses), but Hints and Kinks recommends it.

resistance of the closed keying circuit. Reports of missing dots and irregular keying had me burnishing my bug's contacts every other day—or so it seemed—even though the transceiver's sidetone followed my keying faithfully.

An article in July 1982 *QST*[8] addresses the problem of IC-730 keying but doesn't really help the bug user. My good friend Marv Juze, W6FGD, came to my rescue by pointing out that he had cured the same problem by keying his IC-730 with a reed relay. Since implementing this suggestion as shown in Fig 19, I've had no trouble keying my IC-730 properly (any irregularities may be attributed to my Lake Erie swing!). I've since learned that other locals have enjoyed the same success in keying their IC-730s, so it seems worthwhile to spread the word.—*"Uncle Vern" Howard, W6ERS, 733 Plymouth Wy, Burlingame, CA 94010*

[8]D. McClure, "Keying Improvements to the ICOM IC-730," *QST*, Jul 1982, pp 23-27.

CONNECTING AN OLD MICROPHONE TO A NEW TRANSCEIVER

□ After acquiring an ICOM IC-735 transceiver, I found that a desk microphone was desirable for use at the home station in lieu of the hand mike that came with the rig. Since my Astatic D-104 mike had served me faithfully for many years, I wanted to use it with the ICOM.

Examination of the rig's manual revealed that the IC-735 was designed for low-impedance (≈600 Ω) microphones, and that approximately 8 V dc is present on the '735's mike-audio line. Clearly, the D-104 could not be connected to the rig without some modification.

The circuit shown in Fig 20 solves this problem. All components within the shaded dashed lines are mounted on a small piece of perf board and installed in the base of the microphone. The circuit's physical layout is not critical.

This circuit has also been used successfully with an ICOM IC-761 transceiver. During testing with the '761, I found that the mike and PTT ground lines must not be connected together. (If they are, a low-level switching noise will be present on the transmitted signal.) Accordingly, the mike ground line must be isolated from the PTT ground inside the microphone.

Pin 1 of the D-104 microphone head is connected to its enclosure (PTT ground) via its mounting screw. To isolate the grounds, break the connection indicated in Fig 20. This can be accomplished by removing the connector from the top of the microphone stand and rewiring pins 1 and 2 as shown.

This modification can probably be used with other transceivers having similar microphone-interface requirements. Be sure to verify the connector wiring and double check to ensure that the dc supply is not short-circuited. An ohmmeter check is also advisable to verify that the two ground lines (pins 6 and 7 of the mike connector) are indeed isolated from each other for transceivers that require this. —*David R. Fentem, KW4M, 704 Emerald Forest Cir, Lawrenceville, GA 30244*

SWITCH-SELECTABLE SUBAUDIBLE TONES WITH THE ICOM UT-30 TONE GENERATOR

□ I like to work 10-meter repeaters with my IC-735 transceiver, but some repeaters allow access only if my transmitted audio includes a standard subaudible tone.[9] ICOM's UT-30 Programmable Tone Encoder Unit can be installed in the IC-735 (and a number of other ICOM radios) to generate this signal. The UT-30 allows you to solder-select only one of 38 different subaudible tones at a time. Here's how I modified my UT-30 to allow switch selection of its tones.

Remove any solder-blob jumpers at pads P1 through P6 on your UT-30. (New UT-30s include only one—at P4, to set the board to its 88.5-Hz factory default.) Next, wire a 6-inch-long piece of seven-conductor ribbon cable to the UT-30's generator IC as shown in Fig 21. Use a low-wattage soldering iron (15 W or so); a higher-power iron may destroy the IC.

Next, decide where you'll install your **FREQUENCY** switch unit. (I hot-glued mine to the bottom edge of my IC-735's front

[9]The Electronic Industries Association's table of tone-controlled squelch frequencies lists 42 tones from 67.0 through 254.1 Hz, of which the UT-30 can generate all but four (69.3, 206.5, 229.1 and 254.1 Hz). During 1980, the ARRL Board of Directors adopted the 22 tones from 88.5 through 179.9 Hz for voluntary incorporation into 10-meter repeater systems to provide a uniform national system. See page 48 of Jay Mabey, editor, *The ARRL Repeater Directory*, 1991-1992 edition (Newington: ARRL, 1991), for more information.—*WJ1Z*

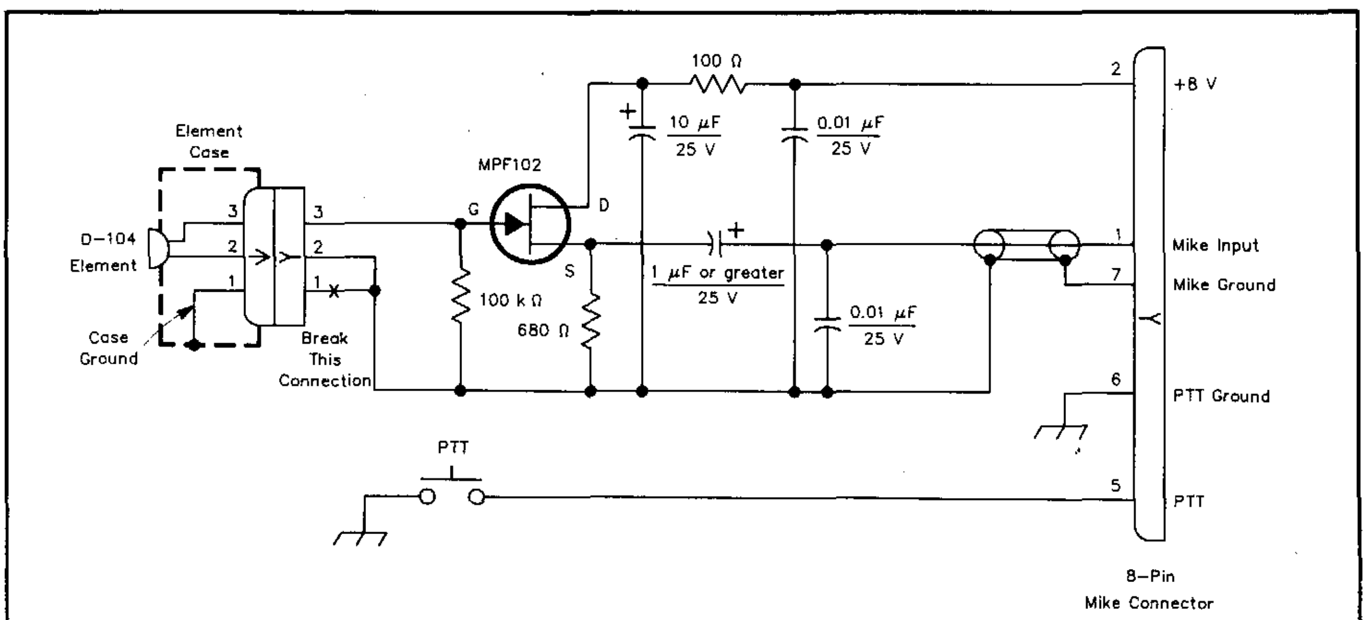


Fig 20—David Fentem connected his high-impedance D-104 mike to an IC-735 and IC-761 transceivers via this circuit, a JFET source follower that acts as an impedance transformer. The resistors are ¼-W, carbon-film units; the components shown within the shaded dashed box are contained on a circuit board mounted in the mike base. With appropriate mike-plug connections, this circuit is applicable to other transceivers.

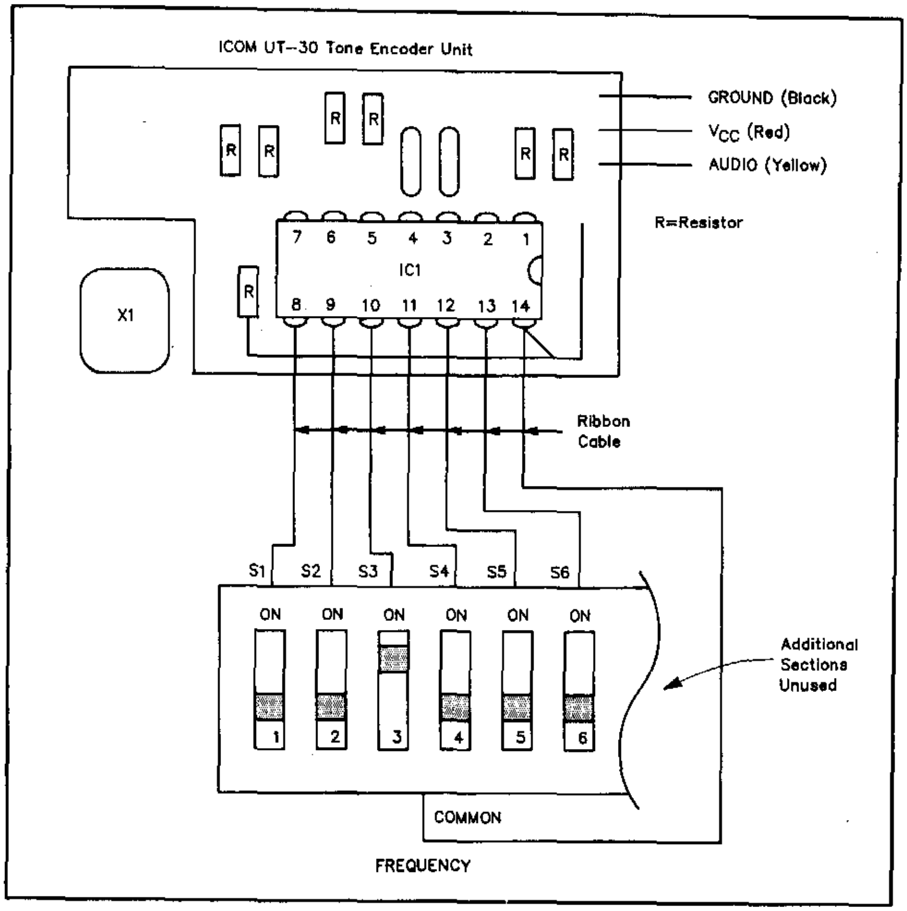


Fig 21—G. Miles Mann added "switchability" to his UT-30 Tone Unit—a subaudible-tone option installable in some ICOM transceivers—by adding S1-S6 as shown here and described in the text. S1 through S6 correspond to the UT-30's solder pads P1 through P6. S1-S6 are part of a DIP (dual-inline-package) switch unit; a Radio Shack 275-1301 is suitable. See the UT-30 instruction sheet for a listing of switch settings versus tone frequency.

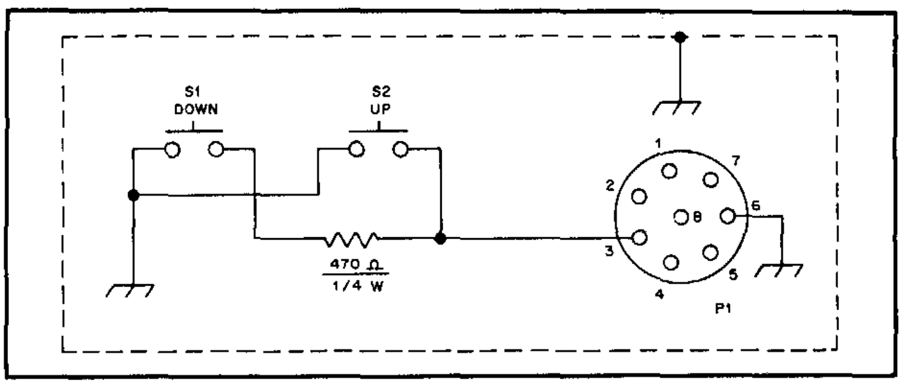


Fig 22—Art Krugaluk's remote **UP/DOWN** switch for the IC-735 transceiver, with suitable wiring/pinout changes, is applicable to other gear. Parts required: P1—8-pin female mike plug; S1, S2—SPST momentary push button (Radio Shack® 275-1751); 1-1/8 × 3-1/4 × 2-1/8-inch (HWD) enclosure (RS-270-230); two-wire cable.

panel; double-stick tape would probably work well, too.) Thread the free end of the cable through one of the vent holes in your transceiver's bottom cover, choosing a hole that allows the ribbon cable to comfortably span the distance between your **FREQUENCY**-switch site and the UT-30 in its installed position. Next, wire S1-S6 as shown in Fig 21. (You can test the UT-30 prior to installing it in your radio by connecting 9 V to the UT-30's red [+] and black [−] wires, an audio frequency counter between the yellow wire and circuit common, and experimenting with S1-S6 per the table on the UT-30 instruction sheet.)

Install the board in the radio as described in the owner's manual and reinstall the radio's bottom cover. Mount the **FREQUENCY** switch unit on the bottom edge of the radio's front panel. This modification does not otherwise affect the UT-30's operation.—*G. Miles Mann, KA1RRW, Billerica, Massachusetts*

REMOTE UP/DOWN FREQUENCY CONTROL FOR THE ICOM IC-735 TRANSCEIVER

☐ The IC-735's remote up/down frequency slewing capability, normally controlled by **UP** and **DOWN** buttons on a mike used with the rig, isn't available during CW operating unless the mike is left plugged in. After consulting the schematic of the mike's **UP** and **DOWN** circuitry (see page 16 of the IC-735 operating manual), I built the remote **UP/DOWN** control box shown in Fig 22. It's more useful than the mike's **UP/DOWN** controls for frequency slewing during CW operation.—*Art Krugaluk, N1BNG, 239 Middlesex Ave, Wilmington, MA 01887*

SMOOTHER RF POWER CONTROL WITH THE ICOM IC-735 TRANSCEIVER

☐ Upgrading from an IC-730 to an IC-735 gave me 160-meter transceive operation and general-coverage receive capability—a worthwhile improvement in the performance of my station. Adjustment of the '735's output power is touchy, however, because the rig's RF POWER control is a small slide potentiometer. I solved this problem by rewiring the '735's SQL (squelch) control—I rarely use the squelch—to act as the RF POWER control. By the same modification, the RF OUTPUT slide control becomes the SQL control.

The IC-735 schematic indicates that although the RF POWER control (R6) and the SQL control (R1a) are both 10-kΩ potentiometers, they act only as variable resistors to ground. (R6 and R1a appear in the lower-left corner of the IC-735 schematic.) Thus, transposing their function entails only the transposition of two wires. (Note: This modification may void the warranty on your IC-735.) Modify the '735 as follows:

(1) Remove the '735's bottom cover. Locate jack 3 (in the upper-right corner of the '735's MAIN circuit board).

(2) Identify pin 4 of jack 3. The wire leading to pin 6 of the associated plug is the wiper (POC brown) lead of the RF POWER control. (If necessary, you can confirm that this is the POC lead with a digital multimeter: The resistance between the POC lead and ground should vary as you adjust the RF POWER control.) Remember the location of this wire, or mark it so you won't forget.

(3) Identify pin 6 of jack 6. (Jacks 3 and

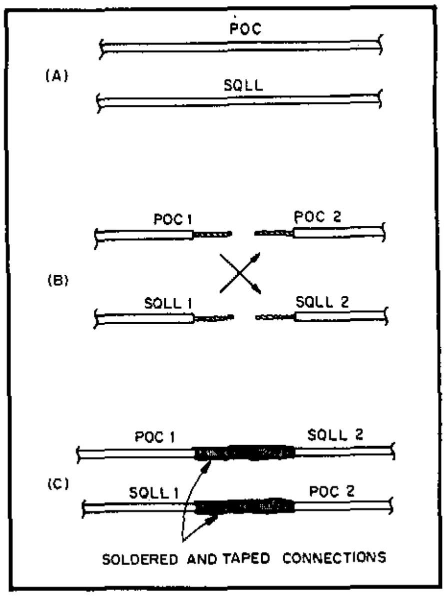


Fig 23—Transposition of the IC-735's POC and SQLL wires for smoother RF-output-power control. This modification exchanges the functions of the '735's RF POWER and SQL controls. See text.

6 are about 2 inches apart on the MAIN board.) The wire leading to pin 1 of the associated plug is the wiper (SQLL white) lead of the SQL control. (If necessary, you can confirm that this is the SQLL lead with a digital multimeter: The resistance between the SQLL lead and ground should vary as you adjust the SQL control.) Remember the location of this wire, or mark it so you won't forget.

(4) Follow the POC and SQLL wires back into the cable harness to a point where they are adjacent to each other. Cut the POC wire and strip the cut ends. Cut the SQLL wire and strip the cut ends.

(5) Transpose the wires as shown in Fig 23, and reconnect them by soldering them together. Tape the connections with electrician's tape and reassemble the IC-735. (As an alternative to electrician's tape, you can use heat-shrink tubing to insulate the connections. If you choose to do this, slip the tubing over the wires between steps 4 and 5, and shrink it after you solder the connections.)

That's it! Now, the SQL ring around the AF gain control adjusts the IC-735's RF output power—smoothly.—*Ted O'Connell, NS6H, Walnut Creek, California*

CONTROL EXTENSIONS FOR THE ICOM IC-735 TRANSCEIVER

□ I'm sure there must be other fat-fingered hams out there who are proud but uncomfortable owners of IC-735s: proud because they own a '735, and uncomfortable when trying to use the tiny slide controls under the rig's front-panel trapdoor. The door can be removed easily: Just flip it to the horizontal position and pull.

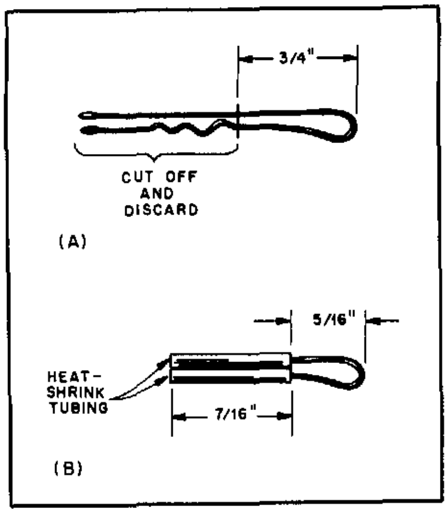


Fig 24—Larry Murdoch increases the "grabability" of his IC-735's slide controls with bobby pins modified as shown here.

Here's how I extended the IC-735's slide controls for easier operation. (These instructions are for one control.) Cut a bobby pin so that its loop end is about ¾ inch long (Fig 24A). Slip small-diameter heat-shrink tubing over the pin ends as shown in Fig 24B. Shrink the tubing. Next, use a small screwdriver to spread the bobby-pin ends and slip the modified pin over one of the IC-735's slide controls. Push the control extender into place until it protrudes for 5/16 inch or so.

This idea works well for me; I put these extenders on the IC-735 slide controls I use most: RF POWER, VOX DELAY, and MIC GAIN. Yes, they are removable!—*Larry D. Murdoch, K6AAW, 14370 Brian Rd, Red Bluff, CA 96080*

TWO NOTES ON THE ICOM IC-745 TRANSCEIVER

A Switchable 20-dB RF Attenuator

□ The IC-745 does not include an RF attenuator, but one can be added easily. The rear panel of the '745 holds connectors for numerous accessory functions. These include an SO-239 ANTENNA socket and phono jacks for RECEIVER INPUT and RECEIVER ANTENNA OUTPUT. The IC-745's TR relay switches the SO-239 between the transmitter output (inside the radio) and the RECEIVER ANTENNA OUTPUT jack (on the rear panel). Normally, a shielded jumper cable connects the RECEIVER INPUT and RECEIVER ANTENNA OUTPUT jacks for single-antenna, transceive operation. This jumper offers the perfect access point to install an RF attenuator without defacing the transceiver.

To construct a 20-dB attenuator, wire and install the circuit shown in Fig 25. This simple addition allows selection of 0- and 20-dB attenuation values at the flip of a switch.

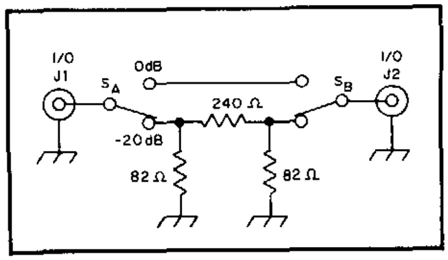


Fig 25—Earle Grandison took advantage of the IC-745's inclusion of RECEIVER INPUT and RECEIVE ANTENNA OUTPUT jacks to add this switchable 20-dB RF attenuator. The circuit is built in a small aluminum box; phono-plug-equipped coaxial cables connect the box to the IC-745. The resistors are carbon-film or -composition units. J1 and J2, phono jacks, are labeled I/O because the attenuator is *bilateral*—either jack can serve as input or output.

If Your IC-745 Seems to Be Lacking in Receiver Gain...

□ My IC-745 transceiver suffered from sporadic, slight changes in overall receiver gain. Moving the radio and tapping its components affected the problem but did not reveal its cause, and no *repeatable* effects were found. I did notice, however, that prodding the wiring around the '745's Main and IF circuit boards had the most effect.

I discovered the cause of the problem by accident. While realigning the receiver, I found that R2, the '745's 22-kΩ TOTAL GAIN trimmer potentiometer, had been set almost to its "no gain" point. Very slight readjustment of R2 during realignment solved the gain-variation problem, and no further abnormal gain shifts have occurred.—*Earle Grandison, K6WS, 11657 Gladstone Cir, Fountain Valley, CA 92708*

PUTTING VARIABLE-BANDWIDTH TUNING BACK INTO LATE-MODEL ICOM IC-751A TRANSCEIVERS

□ When I bought my ICOM IC-751A in March 1990, I was puzzled because the label for one of its front-panel controls differs from that on earlier-model IC-751As. Older IC-751As had a variable-bandwidth-tuning (**PBT**[10]) control in the lower-right front-panel corner. On my rig, this control is labeled **IF SHIFT**, and a fully counterclockwise **IF SHIFT OFF** position has been added. Experimenting, I found that activating IF shift noticeably degraded the transceiver's selectivity and dynamic range. I determined that turning on the IF shift bypasses the IC-751A's 9-MHz IF filter and leaves only a 455-kHz IF filter in line.

An extremely simple modification can restore the function of this control to VBT rather than IF shift, and allow the 9-MHz

[10]Variable-bandwidth tuning is referred to as *pass-band tuning* or *PBT* on ICOM equipment.—*Ed.*

filter to remain in the signal path. Orient the radio so its front panel faces you, and take off its top. Locate the single black wire that is pushed onto terminal J17 on the main board. (J17 is approximately ¼ inch to the left of the left rear corner of FL-80, the IC-751A's 9-MHz SSB filter.) Pull this wire off the terminal and tape it aside so it can't short to anything. That's all there is to it!

Now, the IC-751A's **IF SHIFT** control functions as a variable-bandwidth tuning control, and since you lose no receiver performance when it is active, you can leave the **IF SHIFT** control (now an IF shift/VBT control) at its center detent all the time. You needn't use the **IF SHIFT OFF** position at all.—*John Pelham, W1JA, 1185 Bend Creek Trail, Suwanee, GA 30174*

WJ1Z: Figs 8 and 9, and their supporting text, in G. Collins and D. Newkirk, "Transceiver Features That Help You Beat Interference," *QST*, Mar 1991, pp 16-21, can help explain why turning on the IC-751A's IF shift degrades the transceiver's ultimate attenuation and dynamic range. Fig 9 in that article shows a method of implementing VBT by placing a second IF filter at the *output* of a simple IF-shift circuit (Fig 8 in the article cited). Reverse this process—that is, bypass the filter just added to achieve VBT—and the system reverts to IF shift.

Placing a second filter at the *input* of the IF-shift circuit also results in VBT—and this is, in effect, how ICOM does it (in at least the IC-751A, '761 and '765). Converting such a VBT system to IF shift requires that the *first* filter in the chain be bypassed. The potential snag in this arrangement is that bypassing the first filter subjects the circuitry between the first filter's output and the second filter's input to signals otherwise attenuated by the first filter's stopband. In IC-751As (as evidenced by John Pelham's observation) and IC-765s (as conclusively proven in the ARRL Lab, and enumerated in Table 2 of December 1990 *QST*'s IC-765 Product Review), *enabling IF shift by bypassing the first of two VBT-system filters may significantly compromise the system's close-in dynamic range.* (The system's ultimate attenuation suffers *whichever* filter you bypass.)

John Pelham's statement that VBT does not compromise receiver performance is necessarily true *only when the VBT control is set for the maximum bandwidth afforded by the filters involved.* See this column's Fig 26. Adjusting such a VBT system for narrower-than-maximum net bandwidth may cause at least three effects:

1. Offsetting the passbands creates two zones (Zone 1 and Zone 2 in Fig 26) in which only one filter's stopband provides the system's ultimate attenuation. Depending on the radio's design, construction and filters, blowby from signals within these zones may range from inaudible to objectionable.

2. Strong signals falling in *one* of these two zones—the zone in which the *second* filter's stopband provides the only defense against nearby signals (Zone 2)—may cause blocking or significantly degrade the receiver's dynamic range.

3. In a two-filter VBT system using practical filters—that is, filters that have a shape factor greater than 1—offsetting the filter passbands *unavoidably* degrades the system's skirt selectivity. This is so because the filter's skirt slopes maximally reinforce each other *only when both filters' passbands are superimposed as closely as possible.* Offsetting the filters' passbands to create a narrower net passband forces one filter to provide all or most of the system's *higher-frequency* skirt selectivity; the other filter provides all or most of the system's *lower-frequency* skirt selectivity. In a VBT system based on two good-to-excellent filters, this effect is not serious. If one of the system's filters has significantly poorer skirt selectivity than the other, however, one side of the narrower-than-maximum net passband will exhibit noticeably poorer skirt selectivity than the other. (In Fig 26, both filter curves, and therefore both sides of the net passband, are essentially identical, but such is usually *not* the case in practice.)

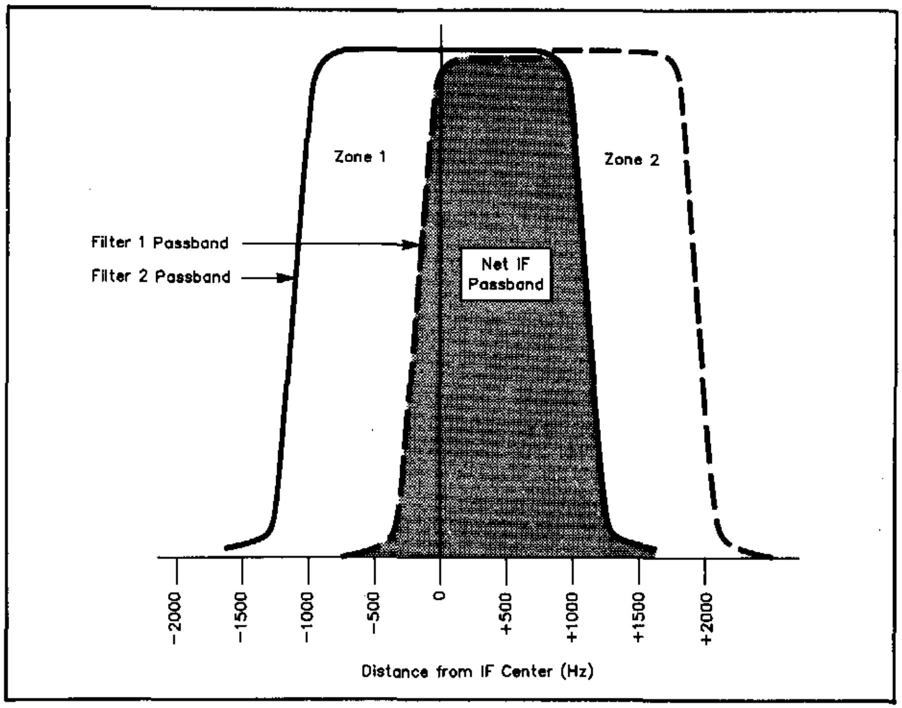


Fig 26—Variable-bandwidth tuning, when implemented in current transceivers by electronically moving the passband of one filter relative to the stationary passband of another filter, can alter a receiver's blowby and dynamic-range characteristics even though cascaded IF filters are present. Offsetting the filters' passbands creates two zones (Zone 1 and Zone 2) in which only one filter provides most of the system's ultimate attenuation. Strong signals that fall within Zone 2—the zone in which the Filter 2's stopband provides the only defense against nearby signals—may significantly degrade the receiver's dynamic range. (The size and shape of the zones, and the numeric values for filter bandwidths, net bandwidth and distance from IF center, shown here are for illustration only. The zone shapes and filter/net bandwidths *you* encounter depend on the VBT-control setting, and the design and construction of your transceiver and its IF filters. The net passband's top is lower than that of both filter curves because filter insertion losses add in a cascaded-filter system.)

Although VBT is a valuable transceiver feature, it doesn't provide something for nothing. Cascaded filters work best when their selectivity characteristics match closely and their passbands are closely superimposed. Offsetting cascaded-filter passbands for VBT compromises that performance to some—hopefully, a small—degree in exchange for variable bandwidth. In today's transceivers, the selectivity flexibility gained is generally well worth that small compromise.

VARIABLE-BANDWIDTH TUNING FOR THE ICOM IC-765 TRANSCEIVER

□ As mentioned in Product Review for December 1990,[11] The IC-765 transceiver does not include the variable-bandwidth-tuning (VBT) feature present in the IC-761.[12] You can change the '765's IF shift to VBT by adding two diodes and an RF choke, or add VBT and gain the ability to select between IF shift and VBT by adding two diodes, an RF choke and a subminiature switch (see Fig 27). Either way, no holes need be drilled in the IC-765, no soldering need be done on any of the '765's circuit boards, and the modification is entirely reversible.[13] (Note, however, that this modification may void your IC-765's warranty.) Here's how to do it; please read and familiarize yourself with all of these steps before proceeding:

1. Disconnect all external leads to the IC-765 including antenna, power and so on.

2. Remove the top and bottom covers as described on page 41 of the IC-765 *Instruction Manual.*

[11]M. Wilson, "The ICOM IC-765 MF/HF Transceiver," J. Healy, conductor, Product Review, *QST*, Dec 1990, pp 52-55.

[12]On ICOM equipment, variable-bandwidth tuning is referred to as *passband tuning* or *PBT.—Ed.*

[13]Since developing this modification, I have become aware that others have implemented various versions of the same basic idea. For example, Gerd Henjes, W2ISB, has described an approach that allows selection between IF shift and VBT with the IC-765's **IF SHIFT** button, a la the IC-761. Gerd's modification requires soldering and desoldering on the '765's Main Unit board. For details, write him at 4065 Pawnee Dr, Liverpool, NY 13090. Be sure to enclose an SASE. The ARRL and *QST* in no way warrant this offer.

3. With the radio upside down and its front toward you, locate wire 31 (W31) on the '765's Main Unit board. W31 is brown and about 5 inches long. It connects the base of transistor Q38 to the cathode of diode D63. These components are in the right, middle area of the Main Unit board above the upper-right end of the 9-MHz-crystal-filter group.

4. Cut W31 at a point about 1 inch from its Q38 end. Carefully strip 1/8 inch of insulation from both wire ends.

5. Install a switching diode (Radio Shack 276-1122, 1N4148, 1N914 or equiv) across the W31 cut, cathode toward Q38. (Hereafter, I'll refer to this diode as D1.)

6. Connect the cathode lead of a second switching diode (hereafter D2) to the cathode end of D1.

7. Solder one lead of a subminiature 0.5- to 1-mH choke (hereafter L1) to the anode end of D2.

8. Solder an 8-inch length of no. 18 hookup wire (hereafter W1) to the free end of L1.

9. Locate J15 on the Main Unit (on the far left of the Main Unit board, about halfway between the radio's front and rear panels; look for the large *31* stamped on the side of its associated plug, P31.)

10. Connect W1 into P31 where the *gray wire* exits P31. This P31 terminal serves as an 8-volt source (for switching purposes) when the IC-765 is in receive mode. Soldering is neither necessary nor desirable for this step. Tape the stuck-in wire to adjacent wires to keep it firmly in place. At this point, you've converted the IC-765's IF shift to VBT. If this is all you want to do, stop here, reassemble your IC-765, and enjoy using VBT instead of IF shift. (Push your IC-765's IF SHIFT button to select VBT.) If you want to be able to switch between VBT and IF shift, go to the next step (Even if you don't intend to use IF shift,[14] consider adding this feature. With it, you'll be able to compare how VBT and IF shift function.)

11. Substitute an 18-inch length of hookup wire for the 8-inch length of wire (W1) in Step 8. Connect a second 18-inch-long length of hookup wire (W2) into P31.

12. Connect a subminiature SPST switch (S1) across the free ends of W1 and W2. When the IC-765's IF SHIFT button is pressed, closing S1 selects VBT, and opening S1 selects the IC-765's stock IF shift switching. I used a small slide switch for S1, mounting it under one of the four screws that support the control board located under the radio's top-cover hatch.

I highly recommend this modification. It makes an already fine radio significantly better.—*Rich Guski, KC2MK, RD 2 Box 541, Red Hook, NY 12571*

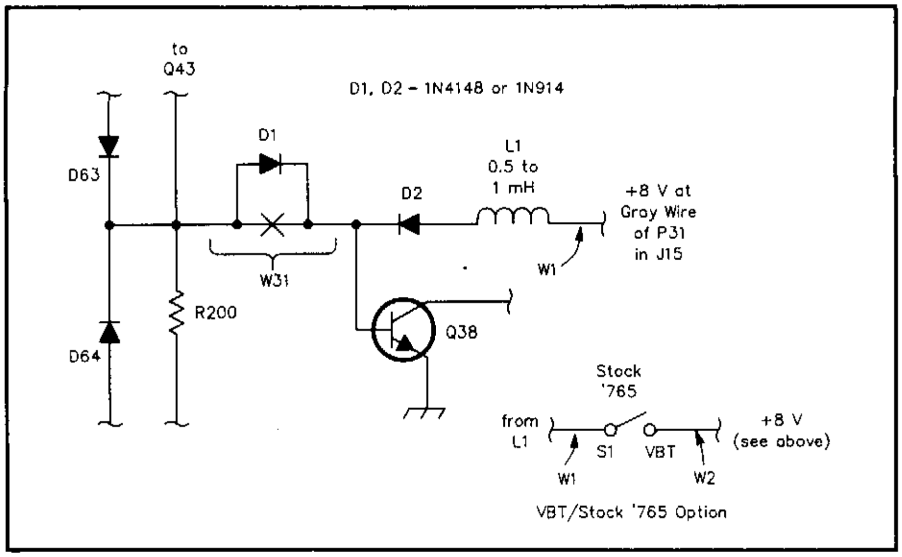


Fig 27—Rich Guski changed his IC-765's IF-shift feature to variable-bandwidth tuning by adding three parts (D1, D2 and L1) and one wire (W1). Adding one more part (S1) and another wire (W2) allows you to select between STOCK '765 and VBT. The remaining part designators refer to IC-765 components; only IC-765 components directly relevant to the modification are shown here. See text.

[14]Table 2 of the December 1990 IC-765 review suggests that the '765's IF-shift capability is best left unused in the presence of strong signals and heavy interference.—*Ed.*

USING THE KENWOOD BS-8 PANORAMIC-DISPLAY MODULE WITH GENERIC OSCILLOSCOPES

☐ You can use your oscilloscope as a panoramic display in conjunction with Kenwood transceivers that have 8.83-MHz intermediate frequencies (IFs) by teaming the scope with a Kenwood BS-8 pan-display module, generally available at Kenwood ham-radio-equipment dealers for about $110.[15]

Connect the adapter as shown in Fig 28. The BS-8 requires 11 V dc (negative ground) and 12 V dc (positive ground); these voltages may be obtainable from the scope if it's solid state. Pick up the transceiver's 8.83-MHz IF signal at the input end of the receiver IF stages. (In the Kenwood TS-430S transceiver, this signal is accessible at jack 6 on the 430's RF board.) Feed the BS-8's output (labeled **to Scope Vertical Input** in Fig 28) into the scope's vertical (Y) input.

Finding a tap to obtain the oscilloscope's sawtooth sweep signal may take a little experimentation. This signal should be available at the scope's horizontal-output driver stage, or at the output of the scope's sawtooth-oscillator buffer amplifier.

Adjust the scope's vertical sensitivity; 0.1 V/div is sufficient. Use the slowest sweep speed that does not produce noticeable display flicker.—*Kurt E. Hunter, WB3AGC, Box 351 Highland Rd, Orefield, PA 18069, and Martin K. Salabes, K3CSV, 1631 Sweetland St, Nokomis, FL 34275*

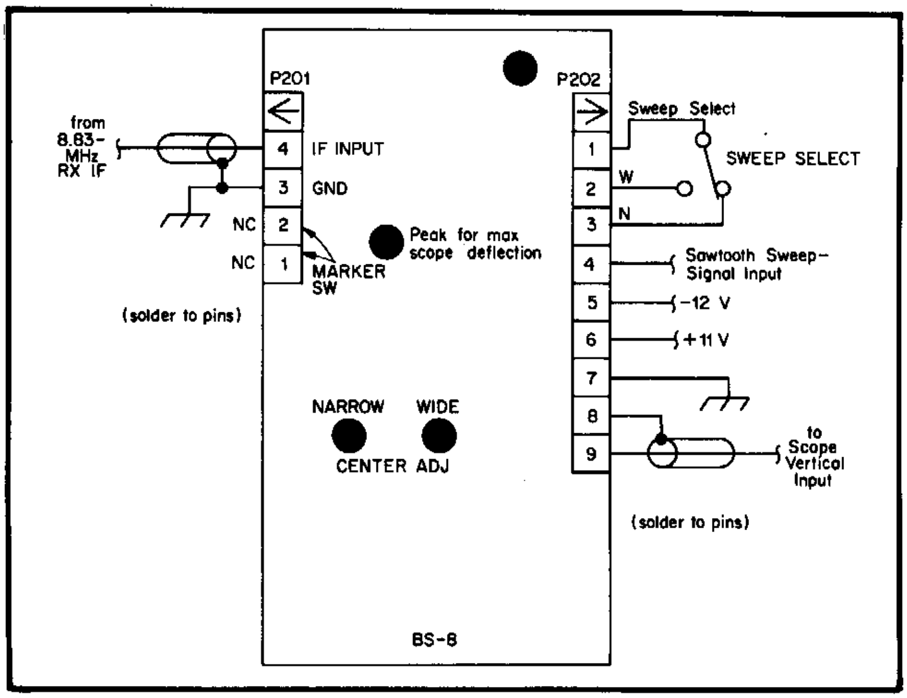


Fig 28—Kurt Hunter and Martin Salabes connect a Kenwood BS-8 pan-display adapter to a generic oscilloscope as shown here. Some Kenwood transceivers include a jack that carries the 8.83-MHz IF signal necessary to drive the BS-8; see the text for one means of obtaining this signal from a TS-430S.

[15]This hint is not for beginners; it requires digging into the innards of an oscilloscope—*danger, high voltage!*—and, in some cases, into the circuitry of the transceiver that drives the BS-8. Hints and Kinks recommends that you obtain, and refer to, service manuals and/or schematic diagrams of the BS-8, and your transceiver and oscilloscope, before putting this hint into practice. The BS-8 schematic appears in documentation for Kenwood's SM-220 Station Monitor.—*AK7M*

NOTES ON BAND-SCOPE OPERATION WITH THE KENWOOD SM-220 STATION MONITOR

☐ I enjoy using the SM-220 station monitor very much. I have, however, found a few rough edges in its operation as a panoramic display.[16] Here are my observations and several suggested solutions.

Using the SM-220 with the TS-830S Transceiver

Plugging the SM-220 cable into the TS-830's **IF1** IF-output jack causes all received-signal levels to drop by about 3 dB. This occurs because connecting the '220 increases the load on the TS-830's 8.83-MHz IF amplifier. I solved this problem by installing a 510-Ω resistor in series with the center conductor of the coaxial cable between the TS-830S and the SM-220. Install the resistor inside the TS-830S as follows: Remove the transceiver's top cover. Unsolder the coax lead to the center pin of the '830s rear-panel **IF1** jack. Install the resistor between the connector pin and the cable center conductor. Reinstall the TS-830's top cover. I found that this change does not detune the IF transformer associated with **IF1** (L2 on the TS-830's IF Unit).

Using the SM-220 with the TS-940S Transceiver

Used for Band Scope operation with the TS-940S, the SM-220 sometimes displays ghost signals that are apparently very strong—but which are inaudible in the TS-940S! (As a result, the many strong shortwave-broadcast signals in the 15-MHz range severely compromised the display's usefulness at 14 MHz.) Turning on the TS-940's 100-kHz calibrator generated markers every 100 kHz and a ghost signal about 10 kHz lower than each legitimate marker. Investigation revealed that each of these ghosts was associated with a strong signal 910 kHz higher than the transceiver operating frequency. (I verified this with a signal generator.)

The TS-940's **IF1** output is heavily damped by a 56-Ω resistor across the signal source connected to the **IF1** jack. The bandwidth of the '940's 45.05-MHz, first-IF amplifier is so wide that signals significantly far from the IF center are present at the **IF1** jack. (A filter later in the TS-940's signal path removes these so they do not affect reception of desired signals with the TS-940S. They appear in the TS-940's **IF1** output, however, and cause image responses [910 kHz removed from the desired signal] when heterodyned to 455 kHz [2 × 455 = 910] in the SM-220.)

The heavy loading on the **IF1** line in the '940 severely damps the input tuned circuit

[16]A *panoramic display* (Band Scope in SM-220 terminology) is a cathode-ray-tube (CRT) display of received signals in terms of frequency (on the X, or horizontal axis, of the display) and amplitude (on the Y, or vertical axis, of the display). Panoramic displays intended for on-the-air use—such as the SM-220 in its Band Scope mode—are generally arranged so that the receiver's operating frequency (the frequency shown on the receiver's digital display) appears at the exact center of the X axis, with signals below and above the operating frequency appearing to the left and right of the operating frequency, respectively. General-purpose panoramic displays capable of being hooked to an Amateur Radio receiver or transceiver are usually usable for little more than checking band activity and noting the relative amplitude of signals on a small segment of an amateur band. Laboratory-quality panoramic displays called *spectrum analyzers* are usually calibrated accurately enough to measure relative and absolute amplitude and frequency characteristics of displayed signals over a wide range of frequency spans. Chapter 25 of *The 1990 ARRL Handbook*, Test Equipment and Measurements, covers spectrum analyzers in detail.—*AK7M*

(T201) in the SM-220, lowering its Q and making it too broad-band. The solution: Install a 24- or 27-pF capacitor in series with the center conductor of **IF1** cable between the TS-940 and SM-220. Next, retune T201 (see the SM-220 manual) to peak a calibrator marker near the display's center frequency. Use a plastic or wooden tuning tool. (Because the slot in T201's core is tiny, you'll probably need to shape the tuning tool to a small, chisel point about 1/16 inch wide.) With the capacitor in place, T201's peak is considerably sharper than in an unmodified SM-220, but is sufficiently wide to allow proper display in the SM-220's ±100-kHz mode.

Modified in this way, my SM-220 displays ghosts of only the very strongest 15-MHz stations. Ghosts that occurred on other bands, and those produced by the TS-940's 100-kHz calibrator, are unnoticeable or unobjectionable in the presence of normal band noise.

Some further comments: Although a 24- to 27-pF capacitor should suffice to reduce the loading on T201, you may need to experiment with the value of this capacitor. Too much capacitance fails to eliminate the images; too little capacitance reduces the amplitude of the displayed signal.

I suspect that further improvement of this image-reduction fix could be made by replacing the TS-940's on-board **IF1** damping resistor with one of a higher resistance. When my TS-940S is out of warranty, I'll probably try this. Meanwhile, I'd appreciate hearing from anyone who tries this.—*Charles J. Michaels, W7XC, 13431 N 24th Ave, Phoenix, AZ 85029*

AK7M: Because the SM-220 contains a CRT and operates from the 120-V ac mains, portions of its circuitry operate at dangerous ac and dc levels. Don't attempt to modify a plugged-in SM-220, don't work on an unplugged SM-220 until its power-supply filter capacitors have discharged, and make "live" adjustments only after taking the precautions specified by Kenwood in the SM-220 documentation.

MORE SM-220 MODIFICATIONS

Automatic Trace Shift During Band Scope Operation

☐ The SM-220's display is most useful in its Osc/RTTY and Moni/Trap modes when centered vertically on the display graticule. In the Band Scope (panoramic-adapter) mode, though, the display is more useful when repositioned two scale divisions below center. This provides more room for display of signal amplitude. A one-resistor modification can provide this shift—when you set the SM-220's **FUNCTION** switch to **BAND SCOPE**, or automatically if you've modified your SM-220 as per Wade A. Calvert's "Automatic TR Switching for the Kenwood SM-220 Monitor Scope" (*QST*, Nov 1988, pp 24-27).

See Fig 29. On the foil side of the SM-220's main PC board, solder one lead of a 1-kΩ, ¼-W resistor to the junction of

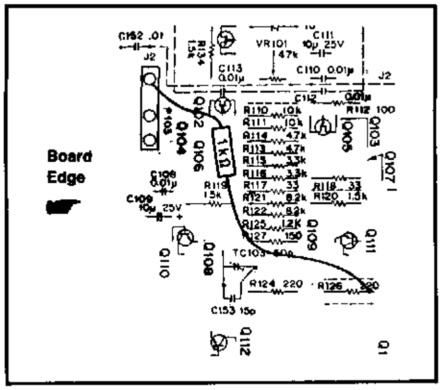


Fig 29—Eldad Benary added Band Scope display shift to his SM-220 Station Monitor by installing a 1-kΩ, ¼-W resistor on the SM-220's main PC board as shown here. See text.

R126 (220 Ω) and VR103 (500 Ω, the **V.POS** control). Solder the other resistor lead to pin 1 of P103. To avoid short circuits, slip insulating tubing over the resistor leads before soldering.

Curing Horizontal Shrinkage of the Band Scope Display

The SM-220's horizontal trace shrinks when its **SYNC/MKR** switch is set to **INT/OFF**. This shrinkage does not occur when **SYNC/MKR** is pressed to **EXT/ON**, but then the Band Scope marker comes on, masking signals at the display's center.

To solve this problem, remove the SM-220's top cover. The **SYNC/MKR** switch is a DPDT unit. The side of the switch with two wires controls the marker; the other side of the switch—with three wires—switches the sync. Disconnect the two outer wires on the sync side of the switch, transpose them, and reconnect them in their transposed positions. Now, you can enjoy shrink-free Band Scope operation with the SM-220. With this modification in place, the functions of the **SYNC/MKR** switch are **EXT/OFF** (out) and **INT/ON** (in).

Calibrating the SM-220's Band-Scope Display

If you adjust the SM-220's ±20 kHz scan width to ±25 kHz, you'll have a very convenient 5 kHz/div scan that simplifies estimation of signal spacing. See pp 18-19 of the SM-220 operating manual, or p 22 of the SM-220 service manual, for how to adjust the SM-220's scan width and display center frequency. The ±20 kHz scan width can be adjusted to ±25 kHz by adjusting the ±100 kHz control (TC201). (This does not much degrade the limited accuracy of the ± 100 kHz range.) Alternatively, installing a 330-kΩ, ¼-W resistor (this value may require experimentation) in parallel with R245 (68 kΩ) on the BS-8 (or BS-5) module should accomplish the same thing.

Quieting an SM-220 Equipped with WA9EZY's Automatic TR Modification

After installing WA9EZY's SM-220-TR-switching modification (*QST*, Nov 1988, pp 24-27), I quickly became annoyed with its relay noise. I use VOX most of the time, and a relay clicking on every TR transition is an unwelcome side effect to a very nice operating convenience. The solution is simple: I replaced the WA9EZY-modification relay with a reed relay.

If you cannot find a 3PDT reed relay (I couldn't), don't despair. You can use three SPDT, or one DPDT and one SPDT, or two DPDT, relays. If you don't have these in your junk box, get them from Digi-Key,® Radio Shack or other suppliers. The combined coil resistance of the added relays should be 200 Ω or more (12-V, SPDT reed relays usually have coil resistances around 1 kΩ; 12-V, DPDT reed relays usually have coil resistances around 500 Ω).

Twelve-volt reed relays generally pull in at about 8 V and up, so you can connect two 12-V, or three 6-V, relays in series and supply their solenoids from the unfiltered +20 V available at the positive terminal of C143, a 220-μF, 25-V electrolytic capacitor in the SM-220's low-voltage power supply.

One of two approaches can be taken to quiet the SM-220's built-in relay, RL101:

(1) Install a 180-Ω, ¼-W resistor in series with, and a 100-μF, 10-V electrolytic capacitor in parallel with, RL101's coil. You can install these components under the PC board and near the relay—the resistor, by cutting the copper trace between D101 and the RL101 solenoid, and soldering the resistor across the cut; the capacitor, by installing it across the solenoid-terminal pads, with its negative lead to ground.

(2) If you want to silence RL101 completely, replace it with a 12-V, SPDT reed relay. You can remove RL101 from the board by desoldering its leads with desoldering braid and working it loose from the board. There's enough space underneath the circuit board for a reed-relay RL101 substitute.—*Eldad Benary, NZ2F, 7510 George Sickles Rd, Saugerties, NY 12477*

AK7M: **See the caution at the end of W7XC's SM-220 item, above.**

RF FEEDBACK IN THE KENWOOD TS-130S

☐ After using my TS-130S mobile for an extended period of time, the following problems suddenly arose: In CW, the transceiver continued to emit a carrier even after the key had been released. In the SSB mode, the transmitter went into oscillation as soon as modulation was applied, producing a continuous output signal even when modulation had ceased. These problems occurred on all bands above 7 MHz—even though the transceiver's power-supply voltage, and the SWR on the antenna feed line, were within acceptable limits.

Because the radio had been subjected to vibration in mobile operation, I suspected that a poor internal ground connection was causing RF feedback. Tightening the mounting screws on the individual circuit boards and reseating all removable interconnecting cables solved the problem.—*Andrew Blackburn, WD4AFY, 307 E 57th St, Savannah, GA 31405, and Philip Neidlinger, KA4KOE, 3331 Louis St, Thunderbolt, GA 31404*

IMPROVED MASTER-OSCILLATOR CALIBRATION FOR THE TS-430S

☐ Here's the technique I use to improve the frequency calibration of my TS-430S transceiver. This method, which sets the TS-430's 36-MHz reference oscillator, assumes that the '430 to be calibrated has been modified for frequency display to 10 Hz.

1) Set the rig for USB or LSB operation, RIT off.

2) Tune the '430S to the highest active WWV frequency (20 MHz is best) so that the frequency display indicates WWV's frequency *exactly*.

3) While WWV is transmitting a continuous tone, adjust trimmer capacitor TC1 (on the '430's CONTROL board) until the demodulated tone is identical in the USB and LSB modes. Toggle between USB and LSB as necessary until the tone pitches match.—*Robert L. Keplinger, NØRK, Kansas City, Missouri*

Editor's Note: The TS-430S frequency-generation scheme depends on the accuracy of *several* oscillator frequencies for overall accuracy, and variation in the frequency of more than one of these oscillators can shift the pitch of received signals. I'm speaking of the '430's carrier oscillator in particular; the TS-430's audio response during SSB reception and transmission also depends on the proper alignment of this oscillator.

Although adjustment of the '430's reference oscillator can serve as a stopgap measure should the rig's frequency display be out of whack, the best way to ensure the *overall* accuracy of such multi-oscillator frequency-generation schemes is to realign *all* of the oscillators involved. The TS-430S *Service Manual* tells how to do this.

CURING ERRATIC POWER OUTPUT IN THE TS-430S TRANSCEIVER

☐ If you've experienced erratic power output from your Kenwood TS-430S transceiver in the transmit mode, here are a couple of quick things that you might want to try before packing it off to the repair center.

First, try exercising the switch on the TS-430's **X-VERTER** connector (J3), an eight-pin DIN socket on the transceiver's rear apron. This switch is part of the chassis-mounted connector and is actuated when a plug is inserted in the jack, removing RF drive from the TS-430S final circuits and routing it instead to the external transverter. The switch can develop poor normally closed conductivity through disuse. Use an appropriate DIN plug for this task, or actuate the switch, which is located at the keyway point on the chassis connector, several times with a small screwdriver. Be sure the TS-430S is turned off when you do this.

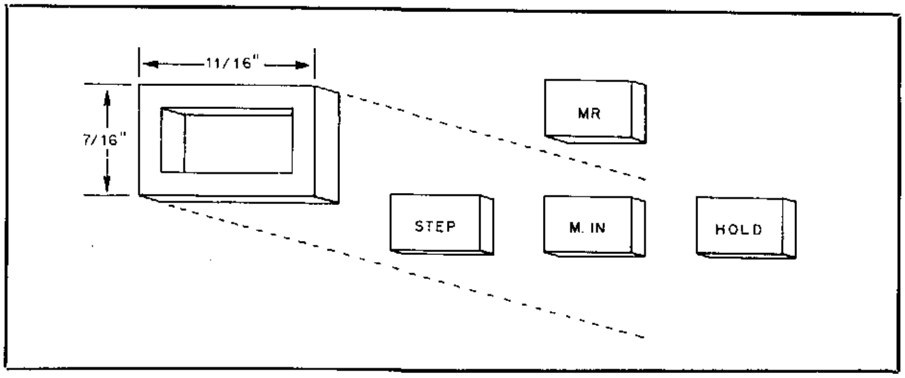


Fig 30—Dave Miller's memory button guard consists of a single piece of 5/32-inch-thick wood veneer. The dimensions shown may need to be changed to fit your situation.

A second possible cause of low or variable power output in the TS-430S is poor conductivity through the single-pin, push-on connector, **DRV**, that provides +13.8 V to the driver section of the final unit. Getting to this connector requires removal of the transceiver's top and bottom covers, plus the six recessed screws around the perimeter of the rearmost chassis lip. Folding the assembly back and away from the main chassis allows limited access to the **DRV** connector, which is located almost midway across the perforated metal shield cover of the final unit. This procedure will probably allow you enough access to inspect this single-pin, push-on connector for tightness; if not, you'll need to remove the shield cover for full access. (This involves removing four more screws, cutting cable ties and temporarily redressing the TS-430's wiring harness. If you decide to do this, study the transceiver carefully before proceeding. Take plenty of time, making notes and sketches as you go to ensure correct reassembly once you've finished.) If the **DRV** connector is loose, crimp it slightly with needle-nose pliers. —*Dave Miller, NZ9E, 7462 W Lawler Ave, Niles, IL 60648*

A GUARD FOR THE TS-430S MEMORY BUTTON

☐ When operating my Kenwood TS-430S transceiver, I had a tendency to hit the rig's M. IN (memory input) push button instead of my intended target (MR, memory recall). This, of course, erases the selected memory channel and stores whatever frequency happens to be displayed at the moment!

I solved this problem by making a small switch guard out of thin wood veneer as shown in Fig 30. (Hobby stores carry such material; plastic is also suitable.) I used model paint to color the guard to match the '430's front panel and stuck the guard to the panel with double-stick tape. (A temporary mounting technique makes the guard removable for later resale of the rig.)

The effect of the switch guard is simple: If I want to push M. IN, I must push the button intentionally and *squarely.—David F. Miller, K9POX, 7462 Lawler Ave, Niles, IL 60648*

A NARROW RTTY FILTER FOR THE KENWOOD TS-430S TRANSCEIVER

☐ For owners of TS-430S transceivers that include YK-88CN 270-Hz CW filters: Connecting pins 1 and 2 of connector 27 on the 430's IF board with a short piece of solid wire (no. 22 is suitable) causes the YK-88CN to be selected in the transceiver's "narrow SSB" modes. When used for LSB reception, the filter is centered on the standard high RTTY tones for 170-Hz shift (2125 Hz mark and 2295 Hz space) and works great. The only drawback to this modification is that the 270-Hz filter doesn't work in the USB mode (necessary for AMTOR operation) unless the **IF SHIFT** control is turned clockwise as far as it can go—and then it passes only the mark tone and attenuates the space tone.—*Kenneth O. Flint, N7IMR, 3600 Data Dr #58, Rancho Cordova, CA 95670*

CW-PITCH-CONTROL MODIFICATION FOR THE KENWOOD TS-440S TRANSCEIVER

☐ Some newer transceiver models have a CW pitch control—a control that changes the pitch of received CW signals while keeping them centered in the IF passband. [Thorough designs also simultaneously adjust the CW-sidetone frequency to match the pitch of CW signals tuned to fall at IF center.—*WJ1Z*] In effect, this amounts to simultaneous RIT and IF shift—an effect you can simulate on the Kenwood TS-440S transceiver by simultaneously moving its **IF SHIFT** and **RIT** controls in opposite directions. Here's a simple TS-440S modification that allows you to "one-track" CW signals by moving the radio's concentric **IF SHIFT** and **RIT** controls together *and in the same direction*. This simulates a pitch control because the TS-440S's IF-shift and RIT tuning rates are very similar. Doing this modification, which involves reversing the TS-440S's **IF SHIFT** control (VR6, front section) wiring, takes about an hour and likely invalidates your TS-440S's warranty; it also renders the TS-440S's **IF SHIFT** + and − markings incorrect. (This modification isn't

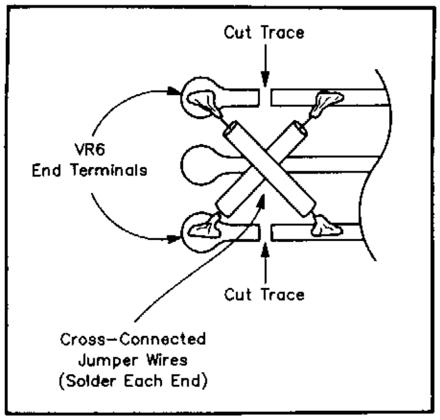


Fig 31—Reversing the TS-440S's IF-shift tuning sense involves two PC-board-trace cuts and two jumper wires. See text.

worth doing if you don't use a 270- or 500-Hz CW filter in your TS-440S, because wider filter passbands allow considerable received-signal-pitch excursions that the narrower filters don't.) You don't even have to remove the TS-440S's front panel:

1. Working on an electrostatic-discharge-protected workbench,[17] remove the TS-440S's top and bottom covers.
2. Pull all four knobs off the **RIT**, **XIT**, **AF** and **RF** controls. Using a socket wrench or long-nose pliers, loosen and remove the control-bushing nuts.
3. Lower the front-panel assembly. (One retaining screw is shorter than the others; be sure to note its location so you can reinstall it in the same place.)
4. Pull the RIT/AF/RF board up far enough to work on the **IF SHIFT** control terminals. They are soldered directly to the board.
5. Isolate both end terminals of the **IF SHIFT** control by cutting the board trace associated with each terminal with a sharp knife. Confirm that the control end terminals are isolated by checking for an open circuit across each cut with an ohmmeter or digital multimeter.
6. Cross-reconnect the control-end terminals with jumper wires as shown in Fig 31.
7. Reassemble the transceiver, taking care to replace the short screw at the spot you noted in Step 3.

When you've completed this modification, the **IF SHIFT** and **RIT** controls track, allowing one-handed pitch adjustment with the TS-440S. Now, you can easily move interfering signals to zero beat—or you can move a desired signal to a more comfortable receive pitch and then individually adjust **IF SHIFT** and **RIT** to drop interfering signals off the filter skirts.

A similar modification might work on another Kenwood MF/HF transceiver (for example, the TS-130S, 430S or 140S/680S) as long as its **RIT** and **IF SHIFT** controls are concentric, and the tuning ranges of these controls are approximately the same.—*Paul R. Signorelli, W0RW, Colorado Springs, Colorado*

[17]See Bryan Bergeron, "ESD—Electrostatic Discharge," *Part 1*, *QST*, April 1991, pages 19-21; *Part 2*, *QST*, May 1991, pages 28-29, 33.

TS-440S SELECTIVITY MODIFICATION FOR CW

☐ The Kenwood TS-440S transceiver's selectivity-switch positions are **AUTO**, **Narrow**, **M1**, **M2** and **Wide**; my TS-440S includes a YK-88C CW filter (bandwidth, 500 Hz at −6 dB). Installing any of the TS-440's accessory crystal filters involves moving a blue or white jumper wire to one of three terminals (**WIDE**, **SSB** or **CW**) inside the radio.

The instructions for installing only the optional 500- or 270-Hz crystal filter advise that the internal white jumper wire be moved to the **CW** terminal and that the blue jumper wire remain on one of the **WIDE** terminals. This done, selecting the **AUTO** selectivity option in the CW mode automatically switches the CW crystal filter into the circuit. Bypassing the CW filter (for quiet or uncrowded band conditions) involves rotating the selectivity knob from **AUTO** and through the **N** and **M1** positions to **M2**—or placing the radio in the LSB or USB mode. (Working a CW station after tuning it in as LSB or USB requires that the CW mode be selected in transmit—*and* retuning the VFO so the '440 transmits and receives on the same carrier frequency.)

A simple modification remedies these inconveniences and allows CW reception—in the **AUTO** selectivity position—through the TS-440's standard 2.2-kHz filter. To use the CW crystal filter, you need only to turn the selectivity knob one position to the right (to the **N** position) *without* retuning the VFO. All other selectivity positions retain their original functions, including the **AUTO** position, for automatic bandwidth selection during AM, FM and SSB operation. (Note: I don't know how this modification may affect filter operation in TS-440s that contain *more than one accessory filter*; my '440 contains only one [the 500-Hz-wide] accessory filter.)

To accomplish this, modify the TS-440S as follows:

1. Remove the TS-440's top cover by removing its nine retaining Phillips-head screws. Careful: The speaker wires are short; don't pull them loose from the circuit board.
2. Locate the white jumper wire on the right rear edge of the IF unit next to the CW crystal filter.
3. Move the white wire from the **CW** terminal to the other pin on the **WIDE** terminal (where the blue lead is located; there are two pins for each terminal position.)
4. Replace the top cover of the radio, being careful not to pinch any wires.

This simple modification makes CW operation with the TS-440S more convenient and sensible.—*Jeff Elson, KR0O, PO Box 342, Brookfield, MO 64628*

HIGHER VISIBILITY FOR TS-440S KEYPAD NUMBERS

☐ The numbers on the keypad of the Kenwood TS-440S transceiver are difficult to read because of their small size, and because of the insufficient contrast between the dark gray keys and the light gray numbers. I solved this problem by applying white 3/16-inch dry-transfer numbers directly over the existing numbers. When carefully applied, they look absolutely factory installed, and are quite visible (to say the least!). The transfers are available at hobby shops.—*Ron Akre, NM4H, 27 Hillside Cir, Lexington, SC 29072*

This hint also applies to the Kenwood R-5000 receiver.—*AK7M*

A SECOND VOX ON-OFF SWITCH FOR THE KENWOOD TS-830S TRANSCEIVER

☐ I always use my TS-830S in the VOX mode—which, as far as I am concerned, is the only way to go. Unfortunately, switching from VOX to MOX necessitates turning the transceiver's VOX GAIN control down or to OFF. I sought a means of modifying my '830 so that VOX could be turned off without disturbing the setting of the VOX GAIN control.

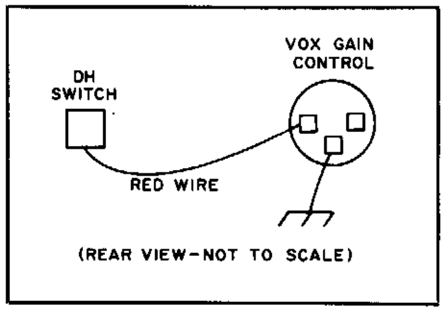


Fig 32—Jack Golden's TS-830S modification allows the transceiver's VOX to be switched on and off without disturbing the VOX GAIN control. See text.

Investigation of the '830's schematic revealed that setting the VOX GAIN control to OFF merely grounds the input to the '830's VOX amplifier circuitry. I determined that the TS-830's DH (digital-display hold) switch could be rewired to do this. With the transceiver off and disconnected from the ac mains supply, locate the red wire that goes to the DH switch. Measuring from the DH switch, cut this wire long enough to reach the left-hand terminal of the switch on the VOX GAIN control. (Tape the free end of the DH wire and tuck it into its associated wiring bundle, out of harm's way.) Strip the DH-switch end of the wire, and solder the wire to this terminal (see Fig 32). This places the DH switch in parallel with the VOX on/off switch. When the DH button is locked in, the VOX is off; the VOX is on with the button out.—*Jack P. Golden, KK2W, 28 S Main St, Portville, NY 14770*

EXTERNAL TS-830 PHONE PATCH CONNECTIONS

☐ Here is a simple external phone-patch mixer for those who bought a Kenwood TS-830S only to find that the phone-patch input to the microphone circuit had been eliminated. Wire the connections as shown in Fig 33. To simplify wiring at the connectors, divide the shield wires of the coax into two groups and solder them into pins 3 and 4 as shown. The resistor value is not critical, but should be as shown or greater. The normal MC-60 microphone output is not reduced and the Heath phone-patch transmit gain (using the high-impedance output) is set at about 5.—*J. T. Kroenert, KA1PL, Barrington, Rhode Island*

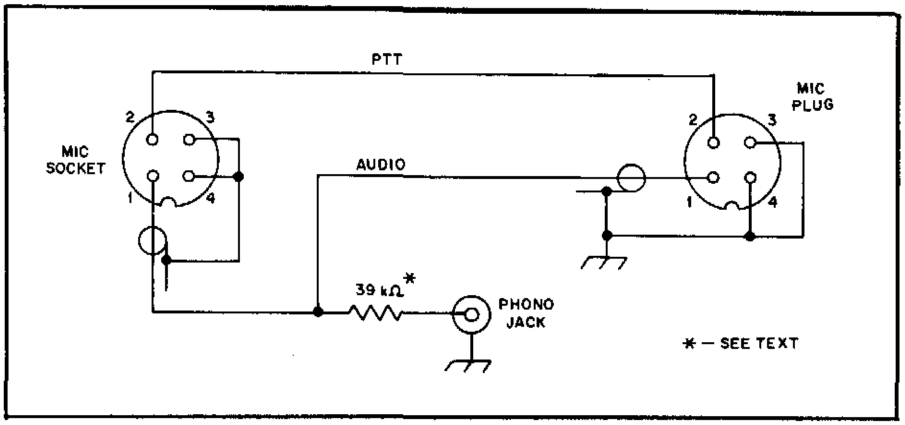


Fig 33—A schematic of KA1PL's phone-patch box. Use shielded cable for the audio lead. KA1PL mounted the mic socket, phono jack and resistor in a 2 × 2¾ × 1½-inch metal box.

FEEDBACK: KENWOOD TRANSCEIVERS *CAN* KEY COMMERCIAL LINEAR AMPLIFIERS

☐ In "An Improved Circuit for Interconnecting the SB-200 Amplifier and Solid-State Transceivers," (p 1-8) Richard Jaeger, K4IQJ, mentions that he interpreted our reference to the low-current capability of the TS-940's amplifier-keying circuitry as meaning "low voltage." We feel that many of your readers might misinterpret Mr. Jaeger's statement. All Kenwood transceivers are capable of interfacing with any commercially manufactured linear amplifier without the need of an external keying circuit. Our reference to "low current" means just that, and was included so that home builders would not try and use an old Dow-Key-type relay. Our linear amplifier, the TL-922A, uses a relay voltage quite similar to the Heathkit® linears, and does not require any special keying circuit!

Please reassure your readers that the use of such relay switching circuits is not required in the TS-940S or any other Kenwood transceiver when connecting any commercially available linear amplifier. This includes amplifiers manufactured by Heathkit, Alpha/ETO, Henry, Ameritron, Kenwood, ICOM, Yaesu, Drake, ARD, AMP Supply, etc.—*Craig L. Martin, KR6T, Customer Service Manager, Kenwood USA Corporation, PO Box 22745, Long Beach, CA 90801-5745*

RECEIVE-ONLY UP/DOWN OPERATION WITH THE KENWOOD TW-4000A TRANSCEIVER AND MC-48 MICROPHONE

☐ Kenwood's MC-48 microphone includes UP and DWN buttons that allow frequency and scanning control in transceivers capable of providing this useful feature. Using the MC-48 with my TW-4000A transceiver, however, I'd often inadvertently push one of these buttons while transmitting. Each time, I discovered the resultant frequency change only after I returned the rig to receive mode.

To avoid this problem, rewire the MC-48 microphone as follows:

1) Open the microphone case and locate the PTT switch.

2) Disconnect the red wire from the C terminal of the PTT switch and disconnect the two black wires from the NO terminal.

3) Solder the red wire to the NO terminal.

4) Separate the two black wires and identify the one that goes to the UP and DWN switches.

5) Solder this wire to the PTT switch on the C (common) terminal.

6) Solder the other black wire to PTT switch NO terminal.

7) Reassemble the microphone.

This modification disconnects the MC-48's up/down switching circuit in transmit but maintains normal up/down operation during receive. It may be applicable to other microphones that have unused normally closed PTT-switch contacts. —*Stanley P. Sears, W2PQG, 188 Concord Dr, Paramus, NJ 07652*

AUTOMATIC SCANNING FOR THE KENWOOD TR-7930/7950

☐ As many radio amateurs do, I frequently operate 2-meter mobile. Whether I'm on a trip, or just tooling around town on my days off, the rig is in the car. I use a Kenwood TR-7930, and every time I start the car, I have to press the SCAN key or hold in the UP button on the microphone to initiate the '7930's SCAN feature. It seemed to me that there had to be a better way to start the rig scanning every time I turned it on!

The '7930's microprocessor senses keystrokes on the rig's 16-button keyboard by means of four input lines and four output lines. A pulse is sent on one of the output lines. To recognize which key was pressed, the microprocessor scans the input lines for the pulse. I developed a means of pressing the '7930's SCAN button *electronically* at power up. The circuit is shown in Fig 34.

U1 is a 4066 CMOS quad bilateral switch. Each of U1's four switches has a control line, an I/O port and an O/I port. When the control line is high, the I/O and O/I ports are connected. The automatic scanning circuit uses the fourth of U1's sections (U1D); control, I/O and O/I lines for the other three switches are grounded. With S1, ENABLE, closed, U1D's I/O and O/I lines are connected to the TR-7930 keyboard lines corresponding to the transceiver's SCAN button (K3 and KD, respectively, in Kenwood nomenclature). R1 and R2, in conjunction with C1, provide the time delay needed to hold U1D's control line high when the circuit (along with the TR-7930) is powered up. This closes the bilateral switch, connecting K3 and KD to start scanning. Once C1 charges, the control line is held low

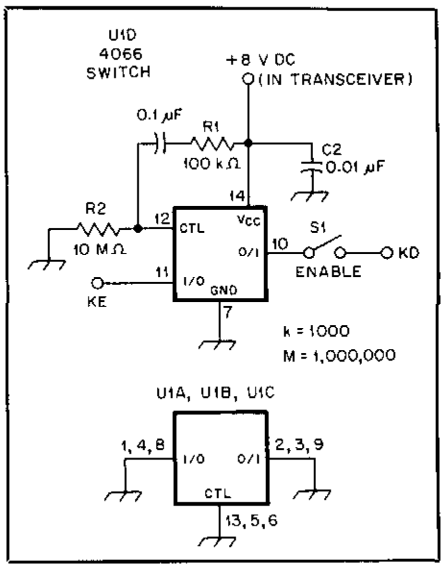


Fig 34—N3BDH's auto-scan circuit for the Kenwood TR-7930/7950. Keyboard lines KD and K3 can be accessed on the rig's control-unit PC board at J8. Dc supply for the circuit (8 V) is available at J17, pin 8C, on the RX-unit board. Resistors are ¼-W, carbon film; capacitors are disc ceramic. S1 is a subminiature SPST toggle. C2, not discussed in the text, bypasses V_{cc} to ground for RF.

by R2, allowing normal operation of the '7930's SCAN button. The circuit draws no current once C1 is charged.

Opening S1 disables the auto-scan circuit by disconnecting the KE keyboard line from U1. (Disabling the auto-scan circuit by lifting the dc line to U1 can cause U1D to behave unpredictably. All unused pins on the 4066 are grounded for the same reason.) In my installation, I mounted S1 on the rear panel of the TR-7930, just below the power connector.

Circuit layout is not critical; you can use a circuit board or point-to-point wiring. The 4066 functions with supply voltages from 3 to 15. If the keyboard on your rig uses matrix switching—8 lines for 16 keys—this auto-scan circuit should work for you.—*Daryl S. Cramer, KD3ED, Duncansville, Pennsylvania*

Editor's Note: Rus Healy, NJ2L, of the ARRL HQ staff, suggests that this modification may also work with transceivers in Kenwood's TM-2500 and -3500 series. This has not been tried, however. Kenwood designations for the SCAN switch lines, and for the RX-unit points across which 8 V dc is available, may differ from those used in the 7930/7950 series.

HAND-KEY INPUT FOR THE MFJ GRANDMASTER KEYER

☐ At the same time I decided to add a hand key to my station, I realized that my MFJ Grandmaster keyer has no hand-key input. A look at the Grandmaster circuit revealed no obvious place to put one in, since there are no active-low points in the circuit that can be "wire-ORed." Even the base of Q4 (the transistor in the grandmaster that drives transistors that switch the keyer's positive and negative outputs) is active high. I finally decided to wire-OR hand-key drive to the input of pin 5 of U7 in the Grandmaster, since this would allow the hand key to control the keyer's sidetone. That point is already decoupled from the rest of the circuit by a 1N4148 diode (D8) and (from the keyer's TUNE switch) by a 24-kΩ resistor.

I added the circuit shown in Fig 35 to invert the hand-key input. Although I have encountered no RF-triggering problems with this circuit, I suggest taking two precautions to minimize RF effects on the hand-key input: (1) Don't omit the bypass capacitor between the hot side of the key jack and ground, and (2) run shielded cable to the key. Many modern small-signal transistors use very small silicon chips and have gain far into the UHF region; they'll amplify dc *and* RF if given half a chance! *—Mark H. Muehlhausen, K9ZXB, 531 Merlin Dr, Schaumburg, IL 60193*

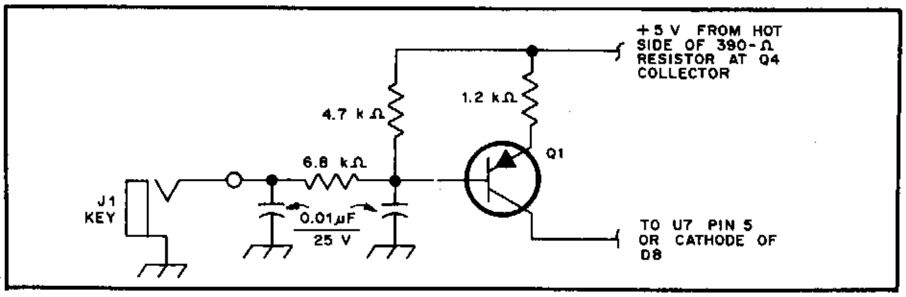


Fig 35—Mark Muehlhausen added a hand-key input to his MFJ Grandmaster keyer by adding this circuit. J1 is a key jack of your choice; Q1 can be a 2N2907, 2N3906 or similar general-purpose PNP transistor; and resistors are ¼-W carbon film. Component designators D8, Q4, and U7 refer to MFJ Grandmaster parts; see your Grandmaster schematic for details.

MAKING THE MFJ-484 GRANDMASTER KEYER A BIT GRANDER

☐ The MFJ-484 is a versatile memory keyer, but after using one of the original versions for several years, I found two features lacking: (1) It has no provision for using remotely mounted push buttons instead of its four panel-mounted memory buttons. Having to reach a distance to hit keyer-mounted memory buttons can be fatiguing during a contest, and the Grandmaster's size usually doesn't allow it to be placed close enough to the log or keyer-paddle to avoid the arm travel necessary to operate the memory switches. (2) The Grandmaster has no provision for a rechargeable memory backup battery. The stock keyer contains a holder for a 9-V alkaline battery, but such a battery lasts only a few hours if power fails. Replacement of this battery involves removing the keyer's top cover and two back-panel screws. This inconvenience, plus the cost of periodic replacement, makes a *rechargeable* backup battery desirable.

My Grandmaster owner's manual did not include a schematic. But examination of the keyer showed that one side of each memory push button is hot and the other side is connected to chassis. These switches can be "remoted" as follows; this modification preserves the function of the Grandmaster's front-panel buttons:

1) Drill a 3/8-inch-diameter hole on the back panel about 1/2 inch to the left of the dc-input jack. Insert a grommet in this hole.

2) Mount a six-lug, two-mounting-hole terminal strip on the inside of the Grandmaster's back panel. Position it so that its mounting holes are on either side of the MFJ label on the keyer's back panel.

3) Cut a 4-inch length of shielded, four-wire cable (four wires plus shield). Attach a suitable connector (five pins or more) to one end of the cable (I used a six-pin Cinch-Jones plug). This will be used to connect a cable to the remote switch box. Snake the connectorless end of the four-wire cable through the grommeted hole in the Grandmaster. Inside the keyer, connect the cable shield to ground, strip the ends of each of the four wires, and wrap each stripped wire around its own (ungrounded) lug of the terminal strip. Bypass each lead to ground with a 0.01-µF, 25-V disc-ceramic capacitor, using the grounded lugs for the bypass-capacitor ground connections. Solder all connections.

4) Using a pencil or ¼-inch-diameter rod as a form, wind four RF chokes, each consisting of 24 close-wound turns of no. 20 enameled wire. Each coil should have pigtails long enough to allow it to be wired between the terminal strip and the back of the front-panel push-button switches.

5) Solder one coil between each ungrounded terminal-strip lug and the hot terminal of its corresponding memory push button. (The chokes and bypass capacitors are *necessary,* by the way; they prevent false triggering problems that can occur if RF rides into the keyer on the 4-wire cable.)

6) The balance of this modification consists of mounting four push buttons in a suitable enclosure that can be firmly mounted to the operating table, and wiring a suitable length of four-wire shielded cable to these switches. [Borrowing a computer term, some operators refer to such a keyer-remote-control box as a mouse; we'll continue with that term here.*—AK7M]* Mount the mate of the connector installed in step 3 at the end of this cable, taking care to preserve proper wiring of the remote push buttons. (Breaking the keyer/mouse cable with mating connectors allows the mouse to be used with other Morse keyers, or a digital voice keyer.)

As an alternative to this procedure, a socket for the mouse cable could be mounted directly on the back panel of the Grandmaster. (There is room for an octal socket to the right of the Grandmaster's KEY jack.) This would eliminate the need for the terminal strip, as the bypass capacitors and the chokes could be mounted directly to the socket terminals.

Those wishing a "no holes" modification—and who can afford to sacrifice one or the other of the Grandmaster's keying outputs (DIRECT or GRID BLOCK)—could remove the double phono jack used for the keying outputs and route the selected keying output via a single-hole-mount phono jack mounted in one of the double-jack holes. The unused hole, lined with a grommet, could be used to pass the mouse cable.

A Rechargeable Memory Back-Up Battery

The Grandmaster's existing 9-V battery

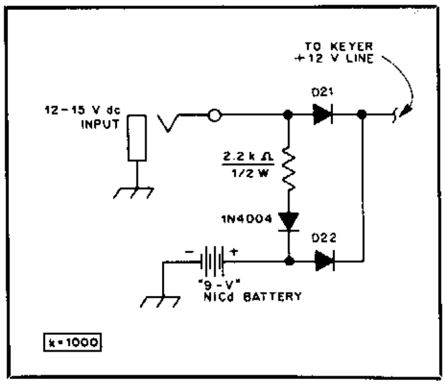


Fig 36—Jon Zaimes installed rechargeable memory back-up in his MFJ Grandmaster keyer by adding three parts: a 2.2-kΩ resistor, a 1N4004 diode and a "9-V" NiCd battery. D21 and D22 are MFJ parts. This drawing does not show the Grandmaster's ac-adapter input. See text.

connector is connected to the keyer's 12-V line via a diode for isolation. Diodes are also used in the lines from the Grandmaster's ac-adapter and dc-input connectors to the 12-V line. The addition of a 2.2-kΩ series resistor and a 1N4004 diode to this circuitry (see Fig 36) provides a charging current of a few milliamperes and allows the use of a "9-V" (actually 7.2-V) NiCd battery (I used a Radio Shack® no. 23-126) when the Grandmaster is powered from an external dc supply. I soldered the new parts on top of the Grandmaster circuit board, just below the two rear-panel power connectors.

Now, I don't have to replace an alkaline 9-V battery every few months, and the keyer doesn't lose whatever is loaded into memory when the power goes off.—*Jon Zaimes, AA1K, 145 Farm House Ln, Bear, DE 19701-2015*

MODIFYING THE MFJ 900 SERIES ANTENNA TUNERS FOR 160 METERS

☐ The instructions for the MFJ 300-watt antenna tuners (models 941-945) state that arcing and excessive heating may occur when the tuners are used for 160-meter operation, and suggest reducing power to a point at which arcing and overheating cease. I believe the cause of this problem is the presence of a ferrite toroidal core at the center of a large, tapped air-core coil. (The toroid increases the tuners' matching network inductance at 160 meters.)

In my tuner, the toroidal coil consisted of six turns of plastic-covered no. 20 copper wire wound on a 1-inch-diam core. This assembly is enclosed within two plastic connector covers (diam 1¼ inches) and mounted in the center of the tuner's large, air core inductor. (Because of the small number of turns [six] on the toroidal core, I believe the core material is ferrite.)

The stock toroid's inductance was insufficient to allow the tuner to match my antenna to my rig at 1.8 MHz. Increasing the number of turns from 6 to 14 widened the tuner's range sufficiently to match my antenna to the radio, but applying 100 W to the tuner caused SWR rise, tuning drift and heating in the toroid.

I solved this problem by replacing MFJ's toroid with an inductor consisting of 35 turns of plastic-covered no. 20 wire on a T-200-2 powdered-iron core [OD 2 inches, Carbonyl E material, available from Amidon, Palomar Engineers, Radiokit and other suppliers—Ed.]. (I determined the number of turns empirically; your matching situation may require more or fewer turns. Also, you can make a better coil/core assembly than mine by covering the core with glass tape, winding the coil and covering the winding with glass tape. If possible, apply Q dope to further protect the winding.) I mounted the completed toroid on a modified thread spool and secured the spool to the tuner base with a long no. 6-32 machine screw, nuts and lock washers.

This modification *works*: I've since used my MFJ tuner in three 160-meter contests with no arcing or overheating problems. —*Thomas Jones, K6TS, 1339 Hillview Dr, Livermore, CA 94550*

QUICK MOBILE SWR MEASUREMENTS WITH RADIO SHACK'S HTX-100 10-METER TRANSCEIVER

☐ The Radio Shack HTX-100 transceiver does not include an SWR meter. Measuring SWR with the HTX-100 means inserting an external SWR meter between the transceiver and its antenna. Doing this at home is one thing; in an automobile, inserting the external meter is inconvenient because it requires groping around on the rear of the HTX-100 and being something of a contortionist. I solved this problem by screwing a male-UHF-to-female-BNC adapter (Radio Shack 278-121) into the HTX-100's ANTENNA jack and installing a male-BNC-to-female-UHF adapter (RS 278-120) in *this* adapter. The antenna cable, which terminates in a UHF plug (RS 278-205), plugs into the 278-120 adapter. The BNC interface between the 278-121 and 278-120 adapters allows quick insertion of an SWR meter equipped with BNC-equipped cables.

A continuous carrier from the HTX-100 was the next thing necessary for SWR measurements. I solved this problem by shorting a 1/8-inch-diameter phone plug (RS 274-286 or -287) and inserting it into the HTX-100's KEY jack as necessary. With the HTX-100 in CW mode, inserting the shorted plug immediately puts the HTX-100 in transmit and provides the steady carrier necessary for SWR measurements.

Because my mobile antenna is not broadband, it presents an unacceptably high SWR to the transceiver above and below certain frequencies. After determining these frequencies with my SWR meter, I use my HTX-100's memory feature as an SWR-limit notepad, entering the lower frequency into memory 1 and the upper frequency in memory 2. This keeps my antenna's high-SWR limits handy for easy reference. —*Manny Kramer, KD3BU, 13820 Arctic Ave, Rockville, MD 20852*

REDUCING "OTHER-VFO" LEAKAGE WITH THE TEN-TEC 243 EXTERNAL VFO

☐ Adding a Ten-Tec 243 VFO considerably improves the operating flexibility of its matching Ten-Tec Omni transceivers. The frequency agility added by the 243 includes a "feature" that engenders a little less than total satisfaction among its owners, however: the problem of leakage from the unused VFO. This trait manifests itself in the form of unwanted emissions on the receive frequency when working split.

Fixing this problem involves understanding its cause. VFO leakage occurs with the Omni and 243 VFOs because both VFOs run all the time to allow rapid, chirpless switching between them—and because the proximity of an Omni's internal VFO to the circuitry it drives allows low-level stray coupling that cannot be circumvented without a major circuit redesign. Thus, this modification concerns only the 243 VFO and reduces the effect only of the leakage that occurs when the 243 is used in the receive mode (modes 1, 3, and 5).

The modification I'm about to describe involves off-tuning the external VFO when the internal VFO is transmitting. The unused offset port on the 243's PTO is employed for this purpose. This does not cure the leakage, but moves it about 20 kHz down and away from the receive frequency.

The Modification

Please take the time to read through the instructions first! If, after reading these instructions while looking at your VFO, you have any questions on how to proceed, you probably should have someone do the modification for you. New parts required: Two 10-kΩ resistors, ½ or ¼ W, any tolerance; a 2N2222, 2N3904, MPS6514 or equivalent NPN transistor; and 6 inches of small-diameter insulated hook-up wire. Tools required: a soldering iron, 50 W or less; a no. 2 Phillips screwdriver; a 1/4-inch flat screwdriver or 3/16-inch nut driver; small, diagonal wire cutters; small needle-nose pliers; rosin-core solder; and electrical tape.

Modification Instructions

1. After unplugging the VFO, remove the four screws holding its top cover in place. Lifting the back edge first, slide the cover off.
2. Observe the orientation of the 80505 Amp/Switch PC board: blue potentiometers on the left.
3. Using the flat screwdriver or 3/16-inch nut driver, remove the two screws that hold the Amp/Switch board in place.
4. Grasp the board firmly and pry it up from its sockets. Do not disturb the potentiometer settings.
5. Turn the board over and check to see if there is a trace leading from the center pin of the left row of pins, and if the corresponding socket has a red wire attached. If it does, go to Step 6. If not, go to Step 7.
6. After the initial 243 production run—the first 100 units or so—a circuit change was made that really helped to reduce the Omni/243 VFOs' leakage. If your 243 is from that first run, make the changes to the 243's Amp/Switch board 80505 as shown in Fig 37. (If not, skip to Step 7.) The board layout, as viewed from the top, follows the 243 schematic very closely. This mod requires making three PC-board-trace cuts and adding two jumper wires. The resulting circuit powers VFO buffer amplifiers Q1 and Q2 from the same switched line that selects the Omni or 243 VFOs by means of PIN diodes (D1 and D2, respectively), rather than running all the time on 13.8 V dc.

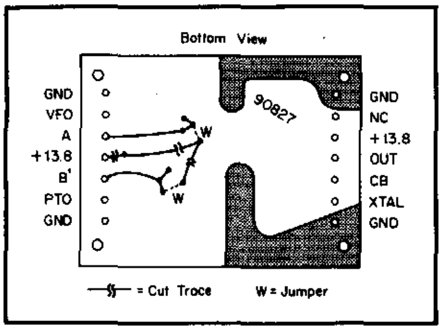


Fig 37—Leakage from first-run Ten-Tec 243 VFOs can be reduced by cutting three circuit traces and adding two jumpers on the 243's 80505 Amp/Switch Board as shown here. See text.

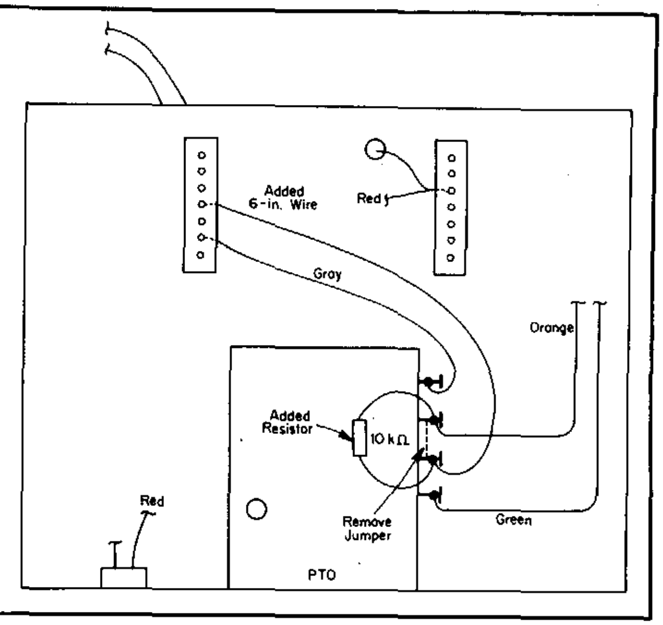


Fig 38–This diagram of the 243's chassis shows where to make the modifications described in Steps 7 through 12 of the text.

7. See Fig 38. Locate the row of pins on the right side of the PTO enclosure, and the jumper that connects the two center pins. The jumper is an orange wire on the rear of the two pins.

8. Cut the jumper. Replace it with one of the new 10-kΩ resistors after shortening the resistor's leads to ½ inch each.

9. Using the soldering iron and solder, connect the new 6-inch piece of wire to the front end of the 10-kΩ resistor installed in Step 8.

10. Cut each lead of the remaining new 10-kΩ resistor to ¼ inch.

11. If a red wire is attached to the center pin of the left board socket, disconnect it from the left board socket and tape its free end. This wire is not needed.

12. Solder the other end of the new 6-inch-long wire to the center pin of the left board socket.

13. Refer to Fig 39. Solder the emitter lead of the new transistor to the **GND** pin on the front left corner of the board.

14. Solder the transistor's collector lead to the unused center pin on the same side of the board.

15. Connect one end of the short-lead 10-kΩ resistor to the base lead of the new transistor.

16. Connect the other end of the 10-kΩ to the **A** pin, third from rear, on the left side of the board.

17. Check your work.

18. Replace the insulator under the board and plug the board back in, new transistor and blue potentiometers *on the left.*

19. Replace the two board-retaining screws.

20. Replace the VFO top cover. This completes the modification.

Once the modification is done, operate according to this rule: *Use the Omni's internal VFO for transmit.* (This is a good idea whether or not you do the modification, by the way.) Table 1 lists VFO leakage specifications for combinations of latest-production 243s and Omnis. Modified as described here, an earlier-production Omni/243 combo should perform comparably.

Table 1

VFO Leakage Specifications, Latest-Production Ten-Tec Omni/243 Combinations

243 Mode	*Leakage Relative to Transmitter Output*
1, 3 and 5	−85 dB
2, 4 and 6	−60 dB (these modes are not recommended)

These leakages meet the purity-of-emissions standards set by the FCC in §97.307(d) for transmitters emitting more than 5 W on Amateur Radio frequencies below 30 MHz.

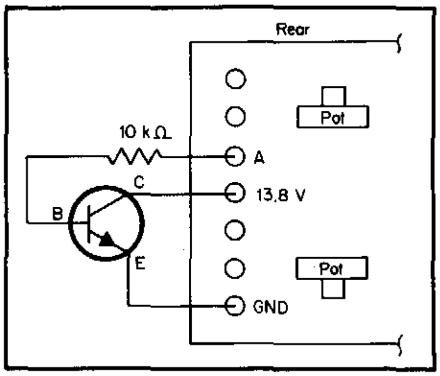


Fig 39—The added transistor and one of the new 10-kΩ resistors connect to the 80505 Amp/Switch board as shown here. See the text, and the photo on p 10 of Ten-Tec's Model 243 Owner's Manual.

I have made every effort to make this as painless as possible for the typical ham. If you think it reads like a Heathkit® manual, thank you! Ten-Tec has a company policy of not modifying their gear except for certain additions for blind hams. If a piece of gear that has been modified by the owner is returned to the factory for repair, Ten-Tec reserves the right to remove the modification if, in the technician's opinion, the mod might have something to do with the malfunction for which the radio was returned, or if there is insufficient description of the mod for the tech to follow. A copy of this modification has been sent to Ten-Tec.—*Dick Frey, K4XU, 2927 Curtis Creek Rd, Quincy, IL 62301*

CURING MECHANICALLY INDUCED FREQUENCY JUMPS IN THE TEN-TEC ARGOSY 525

☐ If you push with a finger on the top of the panel or case of an Argosy 525, the frequency of the rig's permeability-tuned oscillator (PTO) may change by 200 Hz or more, seldom returning to the original frequency. Here's how I eliminated this problem in my '525.

Remove the rig's bottom cover. Careful! The speaker leads are not very long and have no strain relief, so take care not to pull the leads out of the speaker. Check the left front foot screw for excessive length; mine was digging into the plastic portion of the '525's phone jack. Pressure on the ends of the front panel results in pressure on this screw; the resultant panel twist is coupled to the PTO. If this condition is present in your rig, snip off the end of the screw with cutters.

With the '525's cover removed, I discovered that touching the PTO cover or bringing part of the '525's bottom cover near the PTO cover can cause wide frequency changes. This suggests that the PTO shielding is inadequate. To correct this condition:

1) Remove the small bracket on the side

of the PTO housing that normally receives one of the mounting screws for the transceiver bottom cover.

2) Loosen the PTO cover by backing the PTO-cover retaining screw out a few turns.

3) Remove the piece of fiber board that insulates the PTO cover from the PTO aluminum housing.

4) Cut a piece of household aluminum foil a little wider than the length of the fiber board and about 10 inches long. Wrap the fiber board with about three thicknesses of foil. Cut a hole in the foil corresponding to the hole in the fiber board to permit access to the PTO alignment coil slug.

5) Slip the foil-wrapped fiber board back into its original position and tighten the PTO-cover retaining screw to clamp the foil to the PTO housing.

6) Reinstall the bottom cover of the '525, omitting the screw that formerly engaged the PTO bracket.

This completes the modification. Note: This procedure shifts the Argosy 525's tuning calibration somewhat, so you may need to reset the tuning dial to restore proper calibration. If you find that the tuning shift is excessive or the dial tracking is off, consider realigning the PTO as described in the '525's manual.—*Charles J. Michaels, W7XC, 13431 N 24th Ave, Phoenix, AZ 85029*

MORE "LOW POWER" POWER OUTPUT FOR THE YAESU FT-23R TRANSCEIVER

☐ Having owned a Yaesu FT-23R handheld and PA-6 mobile dc adapter/charger for a few months, I found I needed more punch than the maximum RF output (about 5.5 W) the rig produced when powered by the car electrical system. To solve this problem, I purchased a "brick" at a local hamfest—and discovered that the FT-23R's 5.5 W overdrove it. Set for low power, the rig put out about 0.5 W—too *little* to drive the amplifier!

I called Yeasu and learned that the FT-23R's low-power output is adjustable. Here's how. *Carefully* open your radio as per the illustration on page 17 of its operating manual, and fold the radio in half. Look down the side of the half containing the antenna connector to locate two small trimmer pots. The uppermost one small (closest to the antenna connector) sets the transceiver's RF output power. Output increases with clockwise rotation of this control.

Connect the transceiver to a dummy antenna via an RF wattmeter. Using a power supply set to supply the voltage at which you'll use the transceiver in the field or car, adjust the rig's low-power output to the level you need. Reassemble the FT-23R.

Because this adjustment also increases the FT-23R's high-power RF output, be sure to keep the transceiver in its low-power mode to keep from overdriving the amplifier—and to avoid stressing the FT-23R's output-amplifier transistor.[18]—*Hank Hanburger, K3YDX, 2265 Misthaven Ln, Gambrills, MD 21054*

[18]Hints and Kinks recommends against using the FT-23R at output powers above its rated maximum in the high-power mode. Component damage, and emission of spurious signals at levels above those allowed by FCC purity-of-emissions rules, may result.—*AK7M*

RF/AUDIO FEEDBACK IN THE YAESU FT-101Z AND ZD TRANSCEIVERS

☐ In Oct 1986 *QST*, Bruce L. Mackey refers to RFI in the FT-101Z and ZD transceivers ("FT-101ZD Modifications," Hints and Kinks, p 49). Bruce suggests bypassing the mic input leads, and so on. In my experience, this modification only partly cures the '101Z/ZD RF problem and—if a phone patch is used—does little to clear up the audio distortion caused by the RFI.

I suggest checking the '101Z/ZD's rear-panel phone-patch jack ground terminal. Although this terminal may appear to be grounded directly to the chassis, it wasn't—at least on my transceiver. Connecting the phone-patch-jack ground terminal to chassis *at the jack* cleared up the RFI in my case. —*Peter Gamble, VE4TZ, 295 Harcourt St, Winnipeg, MB R3J 3H4*

CURING FREQUENCY DRIFT AND INDICATOR-LIGHT DIMMING IN THE YAESU FT-101ZD TRANSCEIVER

☐ Frequency drift and indicator-light dimming after a few minutes of operation with early-production FT-101ZDs can be solved, in most cases, by moving the PC14305 voltage regulator from the inside to the outside of the '101ZD's counter-unit enclosure. This is a heat-related problem. The counter unit is mounted atop the VFO unit (see page 33 of the FT-101ZD owner's manual).

Just undo the PC14305's mounting bolt, slide the regulator out of the enclosure through the nearby rectangular slit, and remount the regulator at the same position on the top of the enclosure. (Apply heat-sink grease between the regulator and counter cover before tightening the regulator-mounting bolt.) None of the IC's three leads (orange, black, and red-white) need be disconnected during this process. —*Peter Gamble, VE4TZ, 295 Harcourt St, Winnipeg, Manitoba R3J 3H4*

THAT FT-102 RECEIVER-INPUT FUSE

☐ If, all of a sudden, your Yaesu FT-102 transceiver sounds like its antenna is disconnected, and all you get is hash no matter how much you increase the AF gain, the cause may not be as serious as it first appears.

Not long after my '102 went out of warranty a few months ago, this very thing happened. After checking the antenna connection, tuning up the transmitter (no problem there), and checking the '102 operating manual for a solution (none found), I decided to put off shipping the rig to Yaesu for a checkup and seek an answer on the air (with another transceiver!). In conversation with Larry Oldham, WAØHHB, I got some advice and a great suggestion:

"Inside the final-amplifier tank cage, there is a relay board attached directly to the SO-239 coax connector at the rear of the rig. On this board, there is a 'grain-of-wheat' incandescent lamp connected across two vertical pins. This little monster acts as a fuse and has a habit of either lasting forever or just going poof. It is in the receiver antenna line."

With the rig unplugged from the wall and its high-voltage filter capacitors safely discharged, I removed this useless component and replaced it with small-diameter wire (a resistor or capacitor pigtail will do) and have been back in business again—no problems, no aftereffects.—*Tom Galante, WA1PWZ, RFD 1 Nichols Rd, Center Ossippee, NH 03814*

AK7M: Hints and Kinks is uncomfortable with passing along this hint without comment. "Either lasting forever or just going poof" describes the action of a fuse to a T! In my opinion, it's far better to replace the FT-102's incandescent-lamp antenna fuse with *another incandescent lamp of the same type.*

CURING KEY CLICKS IN THE YAESU FT-102 TRANSCEIVER

☐ My FT-102 had quite a case of key clicks. In supplemental information indicating that this could be a problem in units serial-numbered between XX030001 and XX069999, Yaesu also provided an answer: Cut the white wire at J4017 on the local-unit board (accessible from the bottom of the transceiver) and add a 1-µF, 50-V electrolytic capacitor between G1 and ground (*positive* lead to ground) on the FT-102's RF-unit board. (The necessary ground connection can be made at the R1045 lead nearer to the 12BY7A driver tube.) Although this modification certainly made an improvement, I felt that I could further improve on the FT-102's keying. Increasing the value of the capacitor suggested by Yaesu from 1 to 4 µF is part of my solution; adding the circuitry shown in Fig 40 completes the fix and results in a textbook-perfect keying-waveshape decay.

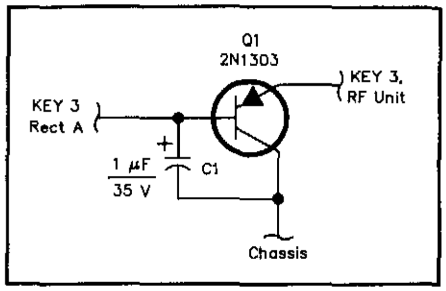


Fig 40—Pat Lacey cured key clicks in his Yaesu FT-102 by increasing the value of a capacitor called for in a manufacturer-suggested fix and adding the circuitry shown here. Pat used a 2N1303 at Q1 because it was handy; he writes that many general-purpose PNP switching transistor types should suffice. See text.

Find the single white wire at KEY 3 on the FT-102's RF unit board, trace it back up the harness about 3½ inches and cut the wire. Connect the Q1-C1 assembly between the two wire ends as indicated in Fig 40. (The ground lead can be a 4½-inch wire clamped beneath the head of one of the final-amplifier-cage screws.)

Now, on-the-air comments on my modified FT-102 range from "good copy" to "beautiful signal."—*Pat H. Lacey, VE3DIT, 114 Merner Ave, Kitchener, ON N2H 1X6*

USE THE KENWOOD VFO-520 WITH A YAESU FT-707 TRANSCEIVER

☐ [Editor's note: Although this modification is very specialized, WØZH's setup is a good example of how we can adapt equipment to meet our needs. Those who do not wish to build entire radios can "wet their feet" in home building with

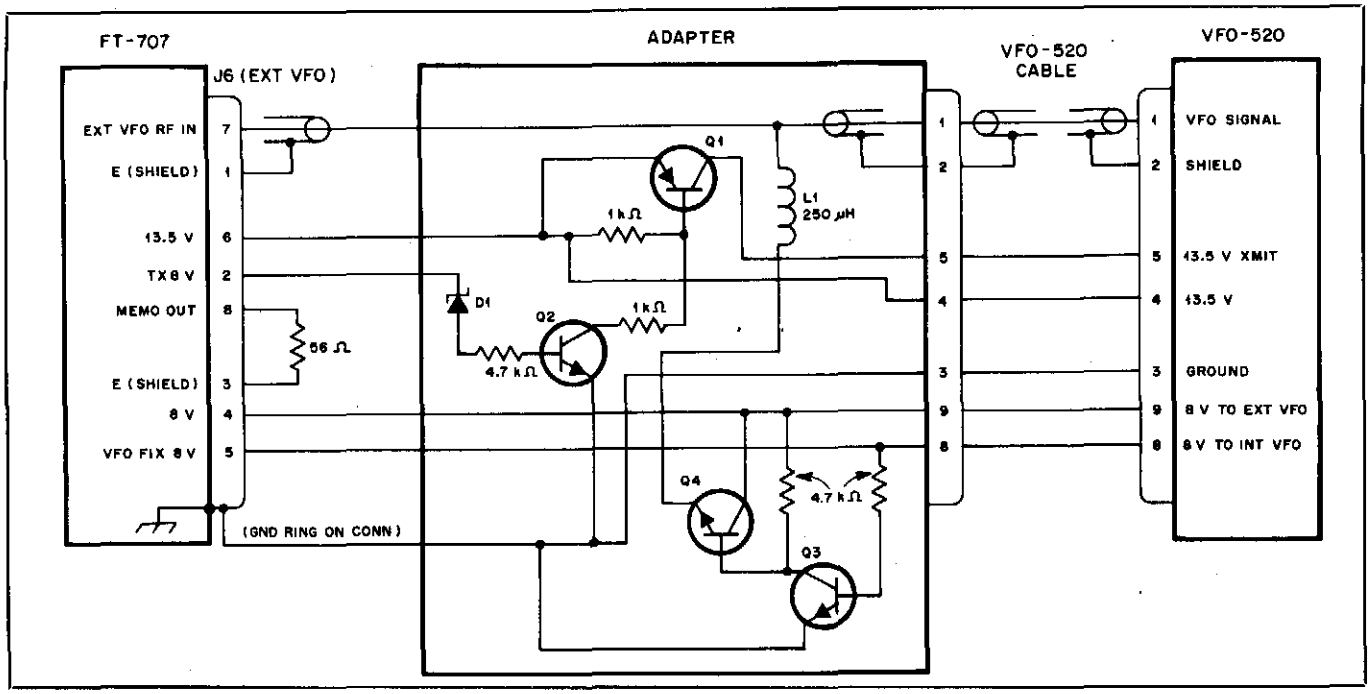


Fig 41—A schematic of WØZH's adapter circuit for the Kenwood VFO-520 and Yaesu FT-707.
Q1—2N3906.
Q2, Q3, Q4—2N3904.
D1—1N761, 5.4-V Zener diode (Zener voltages from 2 to 5 are suitable).
L1—250-μH RF choke (value not critical).

simple adapter and connector projects. Also, the use of pill bottles or film cans to house such small circuits is an old idea that bears repeating.]

I recently replaced my Kenwood TS-520 transceiver with a Yaesu FT-707, but kept my Kenwood VFO-520 external VFO. Since the tuning range of the VFO-520 covers the same range as the '707 (5.0-5.5 MHz), my intention was to integrate the two units for split-frequency operation. My goal was to provide the same capability as with the TS-520, but not modify either unit. Except for spotting the two VFOs together, the adapter of Fig 41 accomplishes this goal. Either VFO can be used to control the transmit, receive or transceive frequency. The '707 digital readout displays the frequency of the selected oscillator. RIT operates normally.

First, the VFO-520 was tested to verify operation at 8 V dc from the '707 instead of 9 V dc as supplied by the TS-520. Oscillation is stable, and only a slight (1-kHz) frequency shift was noted. The dial is recalibrated satisfactorily using the '707 marker generator.

The VFO-520 transmit relay operates at 12 V. The Q1/Q2 circuit was added to boost the TX-8V signal (8 V during transmit) from the '707 to 13.5 V. Since TX 8V is around one volt during receive, a Zener diode, D1, was added to give this circuit a threshold of at least 2 V.

The '707 has several LED indicators to display which VFO is in operation. To light the EXT indicator, the '707 must receive 8 V (dc) with the EXT VFO RF signal on J6, pin 7. The Q3/Q4 circuit inverts the logic of VFO-520 pin 8 (8 V dc to power the '707 internal VFO) and provides 8 V to the '707, through RF choke L1, anytime the VFO-520 is oscillating.

A 56-Ω dummy load is also provided for the '707 unused MEMO OUT signal at J6, pins 8 and 3.

The adapter was built using an 8-pin DIN connector to mate with the '707 and a 9-pin tube socket to accept the VFO-520 interconnect cable. The circuit was assembled on a small piece of perforated circuit board and housed in a plastic pill bottle. The socket is installed on the bottom of the bottle. A six-inch wire bundle extends out of the lid with the DIN connector attached to the end. (I have used pill bottles to make several "tweenies" such as headphone and microphone connectors or impedance transformers.)

This approach could also be used to interface other Kenwood VFOs to the FT-707 if the tuning range and switch provisions are similar. If frequency memory and scan features are not necessary, adapting the VFO-520 to the FT-707 is an ideal way to obtain split-frequency operation.—*Myron A. Kern, WØZH, Manchester, Missouri*

FINE TUNE THE SPEED OF YOUR YAESU FT-757GX TRANSCEIVER'S INTERNAL KEYER

☐ The FT-757's keyer SPEED slide control is difficult to use because it crams the keyer's 5- to 30-WPM range into only 3/8 inch of travel. The 757's SPEED control is also quite nonlinear, covering the range from 20 to 30 WPM in the last fraction of its travel. Here's my solution to these problems—and how I modified the FT-757GX's keyer-speed-control circuit for operation at speeds higher than 30 WPM.

Investigation of the FT-757GX schematic shows an 82-kΩ resistor in series with the speed-control line. This resistance sets the maximum keying speed: The lower the resistance, the higher the maximum keying speed. I decided to increase my 757's maximum keyer speed by bridging a resistor across the 82-kΩ unit.

Implementing a fine-resolution SPEED control is easy, too. Because I rarely use the 757's noise blanker at my location, I decided to rewire its NB control to act as a FINE KEYER SPEED control and retain the slide SPEED control for coarse speed adjustments.

You can do either or both of these modifications. You'll need a Phillips screwdriver for the FT-757's cabinet screws; a low-wattage soldering iron with a small tip; solder; needle-nose pliers; two feet of light-gage, stranded, insulated hookup wire; and plastic tape suitable for insulating splices in light-gage wire.

1) *Open the cabinet.* Remove the four screws that hold the top half of the radio to the main chassis. Gently raise the front of this assembly until you can reach and unplug the speaker leads. (A third hand is helpful here.) Lay the top half upside-down behind the bottom half of the transceiver, being careful not to strain the wires that connect the two sections. (If you don't want to increase the maximum keyer speed, skip the next step and go to step 3.)

2) *Increase the maximum keyer speed.*

Remove the 11 screws that hold the sheet-metal shield to the top section of the transceiver. Lift the adhesive-backed padding that holds several small wires to this shield; then, remove the shield and set it to one side. You now have access to the keyer circuit board (mounted right below the speaker). Locate R08, an 82-kΩ resistor, on the circuit board. Tack-solder a high-value resistor across R08 to raise the maximum keyer speed. (In my transceiver, paralleling a 100-kΩ resistor with R08 gave a maximum speed of somewhat more than 60 WPM; a 1-MΩ resistor gave a maximum speed of about 42 WPM.)

After you've completed this step, replace the shield, taking care not to pinch any wires. (If you want only to increase your FT-757's maximum keyer speed, reassemble the transceiver now. If you want to rewire the '757's NB control as a fine-resolution SPEED control, proceed to step 3.)

3) *Turn the NB control into a fine-resolution SPEED control.* The small yellow wire that comes from the keyer PC board is the speed-control line. Unsolder it from the SPEED-control PC board, solder a 1-ft length of hookup wire to the yellow wire, and insulate the splice. Strip 1/8 inch of insulation from the free end of the extension wire. We'll call this W1 from now on.

Solder a 1-ft length of light-gage stranded wire to the SPEED-control-board terminal where the yellow wire had been connected. Strip 1/8 inch of insulation from the free end of this wire, and mark it W2 for later reference.

4) *Reassemble the top part of the transceiver.* Carefully lower the upper section of the transceiver into place, reconnecting the speaker leads as you do. At the same time, feed W1 and W2 between the lower circuit boards and the FT-757's front panel. With the top section back in place, replace the four mounting screws that you removed in step 1 (the two longer screws go in the back). You've completed the hard part of the modification; the rest is a piece of cake.

5) *Connect the NB control into the keyer-speed-control line.* Place the transceiver upside-down with its front panel facing away from you. Remove the eight screws that hold the bottom cover in place. Grasping the rig's carrying strap with one hand and steadying the rig with the other hand, remove the cover by gently pulling out and up on the strap as if the cover were hinged on the opposite side. Set the cover aside.

The PC board visible with the cover off is the RF Unit. Locate J06—a small, plastic, two-conductor jack mounted near the edge of the RF Unit, just behind and between the '757's headphone jack and MODE switch. Its accompanying plug terminates two wires; one wire is brown, the other, red. Carefully remove the plug from J06 by pulling on the plug body and not the wires. Locate W1 and W2, and pull them toward the plug until they just reach it.

Assuming that you want your FT-757's keyer speed to increase with clockwise rotation of the control, insert W1 into the brown-wire socket of the J06 plug. Insert W2 into the red-wire socket of the plug. (Lightly tin the ends of W1 and W2 if the wire you used isn't stiff enough for insertion into the J06 plug.) Once you've made these connections, tape the plug, W1 and W2 together so they won't come apart, and tuck them out of harm's way.

6) *Jumper the noise-blanker level-control circuit to minimum.* Short J06's two recessed pins by wrapping light-gage bare wire around them. (I used needle-nose pliers to do this; a wire-wrapping tool might be better.) Place a small piece of insulating tape over J06 when you're done; this will keep the jumper from coming loose and causing a short circuit in the transceiver circuitry.

7) *Try out the modification(s).* Using the coarse and fine keyer SPEED controls is easy: Just set the original SPEED control to the approximate speed you want and make fine adjustments with the NB control. Because I like to know my approximate sending speed, I calibrated my '757's FINE KEYER SPEED née NB control for a speed of 30 WPM at 12 o'clock by using computer-generated code as a standard. Calibrated in this way, my FT-757's FINE KEYER SPEED control allows me to vary the keyer speed from about 18 to 42 WPM—and the hash marks around the control skirt correspond to keyer-speed increments of about 2.5 WPM.—*Roger Burch, WF4N, Rte 3, Box 235, Central City, KY 42330*

ANOTHER ONE-MOSFET CONVERTER

Almost fifteen years ago, *QST* published a 10- and 15-meter converter that used a 40673 dual-gate MOSFET as mixer *and* crystal oscillator—a *converter* stage (see Fig 42).[19] Despite the article's report that the circuit oscillated reliably with ten different crystals, I recall having heard that some builders had trouble getting the circuit to work.

A variation on the single-MOSFET converter appears in the December 1987 issue of the Japanese magazine *CQ Ham Radio*. The Japanese configuration differs from McCoy's *QST* circuit in that a parallel tuned circuit (resonant at the crystal frequency) between the MOSFET drain and the output tuned circuit (resonant at the IF) is used to keep the drain impedance high at the crystal frequency. With sufficient separation between the crystal and intermediate frequencies, this drain *trap* should not unduly attenuate the converter's IF output. Fig 43 shows the circuit, along with component values for the working model I built in the ARRL Lab.

The values shown in Fig 43 have not been optimized; the tuned-circuit reactance values, in particular, were pulled out of thin air with the intent of constructing a working model quickly. The first crystal I found in my "junk box" was a 4-MHz microprocessor-clock unit; I chose the converter input and output frequencies (14 and 10 MHz, respectively) because they "work" with a 4-MHz LO.

Yes, it works. Dynamic range? I have no idea. Sensitivity? You've got me, although disconnecting my indoor antenna from the converter made most of the received background (not line) noise disappear (the "low tech" sensitivity test!). Image rejection? Not so hot; but this simple prototype has only one tuned circuit between the antenna and gate 1 of the MOSFET, after all.

How does the *CQ Ham Radio* circuit compare with McCoy's? Well, my Fig 43 prototype doesn't oscillate if the 4-MHz drain trap (L1 and the 82-pF capacitor) is shorted; shorting the drain trap of the *CQ Ham Radio* circuit approximates McCoy's hookup. (I suspect that the impedance of T2's resonant secondary is too low at 4 MHz to allow Q1 to "take off" without the drain trap. At some combinations of intermediate and LO frequencies, this may not be a problem. Crystal characteristics undoubtedly play a part.) The McCoy circuit uses positive bias on gate 2 of the MOSFET, and keeps gate 1 and the source at the same dc potential. The Japanese circuit returns both gates to ground; in conjunction with the voltage drop across the 270-Ω source resistor, this biases both gates negatively relative to the source. Even with positive bias applied to gate 2 of the MOSFET, however, my prototype does not oscillate with its drain trap shorted. Message: The drain trap is important! (*CQ Ham Radio* carried one version of this converter in which the gate-2-to-ground resistor was 10 kΩ instead of 100 kΩ; in that circuit, Y1 was a 41-MHz crystal, and a

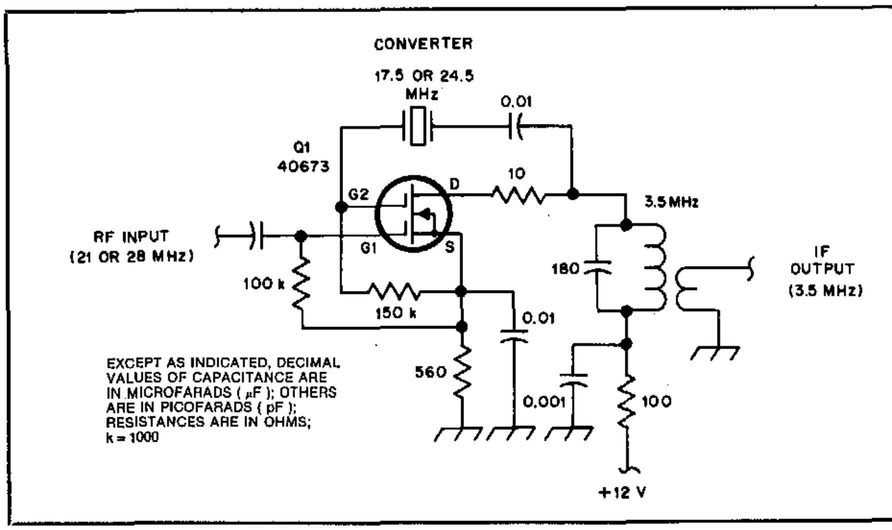


Fig 42—This one-transistor converter stage (RF amplifier not shown) appeared in March 1974 *QST*. Q1 acts as a Pierce oscillator and mixer. The 10-Ω drain resistor may have been included to suppress VHF parasitic oscillations in Q1.

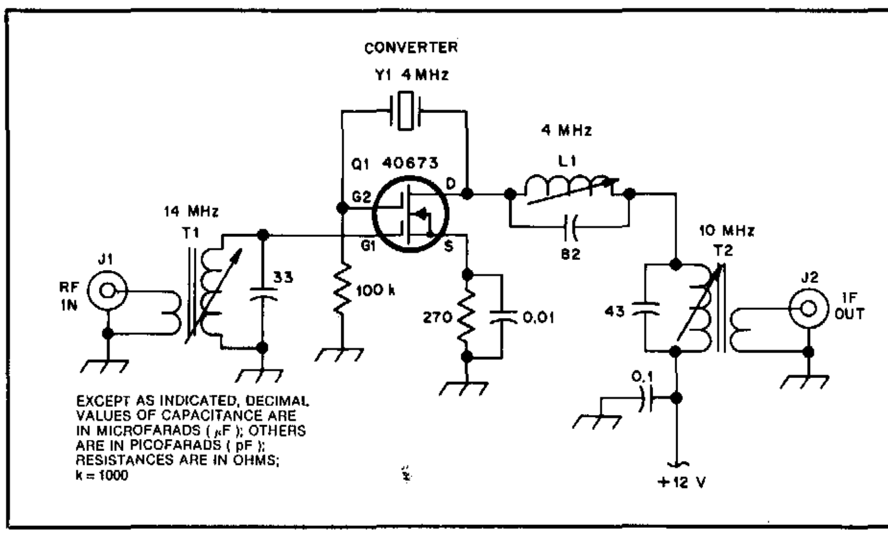


Fig 43—A one-MOSFET converter based on a *CQ Ham Radio* design. The principal difference between this circuit and that shown in Fig 42 is the drain trap (L1 and the 82-pF capacitor). Solenoidal slug-tuned inductors and transformers were used only because they were handy; their toroidal equivalents should work as well or better. See text.

J1, J2—coaxial RF connectors.
L1—14.8- to 31-μH slug-tuned coil (Miller 4407) set to approximately 19.3 μH. Reactance: approximately 485 Ω at 4 MHz.
T1—2.7- to 4.2-μH slug-tuned coil (Miller 4307) set to approximately 3.9 μH; primary: three turns of no. 26 enameled wire over cold end of secondary. Reactance of secondary: approximately 344 Ω at 14 MHz.
T2—4.7- to 6.8-μH slug-tuned coil (Miller 4407) set to approximately 5.9 μH; secondary: four turns of enameled wire over cold end of primary. Reactance of secondary: approximately 370 Ω at 10 MHz.

[19] L. McCoy, "Improving Your Receiver Performance on 15 and 10 Meters," *QST*, Mar 1974, pp 26-27.

5-pF feedback capacitor was connected from gate 2 of Q1 to ground.)

It pays to make L1, or its resonating capacitor, variable. In my prototype, the crystal oscillated on several frequencies at once and generated broadband hash unless the drain trap was tuned just so. But it *was* possible to find an L1 setting at which Q1 oscillated cleanly. In my opinion, this merely means more fun for the experimenter! (I also point out that we're perhaps being a bit unkind to the MOSFET in this circuit: Amplitude limiting—essential in any oscillator that does not destroy its active device[s]—obviously occurs *somewhere* in the circuit, but not by design! [Unlike the cathode-grid diode in a vacuum-tube oscillator, a MOSFET's gate-source insulator can't conduct without instantly destroying the device. Perhaps drain saturation is the amplitude limiter in this case.] McCoy reported that the highest RF voltage measured on gate 1 in his circuit was 4—well within the ratings of the 40673. I did not measure the gate 1 voltage in the *CQ Ham Radio* circuit.)

Might this single-MOSFET converter work with overtone crystals? I dunno; *you* experiment, and tell us about it! How about configuring Q1 as an LC, instead of a crystal, oscillator? Great idea! Let me know your results.

The circuit does what I wanted: It works—it "makes noise"—and it's interesting to fiddle with. Maybe you can find a good use for it. You might even have some fun along the way!—*AK7M*

PUTTING THE MINI-MISER'S DREAM RECEIVER ON 7 AND 10 MHz

☐ Here's how to modify Doug DeMaw's Mini-Miser's Dream (MMD) receiver[20,21] for 40- or 30-meter coverage with a 4.0-MHz intermediate frequency (IF). The modifications involve four main changes: (1) Reworking the crystal filter to a half lattice[22] and moving the MMD's IF amplifier and beat-frequency oscillator (BFO) to 4.0 MHz; (2) reworking the receiver's variable-frequency oscillator (VFO) and its π output filter to cover the 40- or 30-meter bands; (3) adding a 10-MHz input circuit in the 30-meter version; and (4) adding a two-pole, doubly terminated band-pass filter in the MMD mixer's 50-ohm input line. So far, I've modified two MMDs: one for 40 and another for 30 meters.

Crystal-Filter, IF-Amplifier and BFO Modifications

I graded a batch of surplus, 4.0-MHz, HC33/U-holder crystals by frequency with the test oscillator described by Hayward[23] and selected three crystals for each receiver: two differing by about 210 Hz (suitable for a half-lattice filter), and a third (for the BFO) about 250 Hz lower than the average frequency of the first two crystals. The measured crystal frequencies for one receiver were 3999.283, 3999.071 and 3998.988 MHz, respectively; for the other receiver, 3999.291, 3999.079 and 3998.895 MHz. (Remember, the filter crystals function in the series-resonant mode. In the MMD's BFO—and in Hayward's test

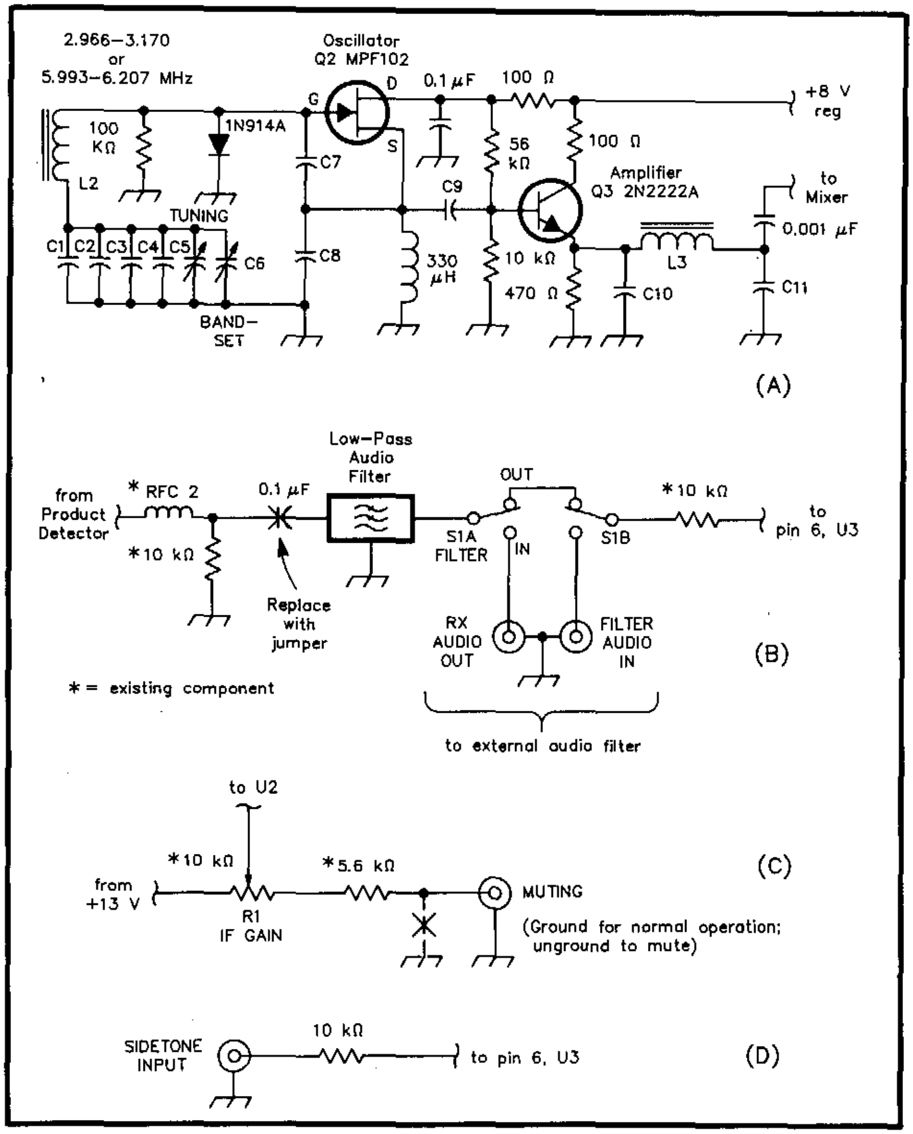


Fig 44—Herb Ley modified the Mini-Miser's Dream VFO for 40- or 30-meter operation as shown at A. The VFO tunes from 2.966 to 3.170 MHz for 40 m and 5.993 to 6.207 MHz for 30 m. B shows Herb's added audio-filter switching, and C and D show muting and sidetone-input modifications not described in the text. All numbered capacitors are NP0 (C0G) ceramic.

C1, C2—100 pF.
C3—Not used at 40 m; 47 pF at 30 m.
C4—Not used at 40 m; 4.7 pF at 30 m.
C5, C6—30 pF.
C7, C8—940 pF (2 × 470 pF in parallel) at 40 m; 470 pF at 30 m.
C9—47 pF.
C10, C11—100 pF at 40 m; 47 pF at 30 m.
L2—18.1 µH (62 turns of no. 28 enam wire on a T-68-6 toroidal core) at 40 m; 5.12 µH (33 turns of no. 24 enam wire on a T-68-6 core) at 30 m. To allow for variation in capacitor values, wind this inductor with 10% more turns than necessary and remove turns, one at a time, until you achieve the desired tuning range.
L3—13.6 µH (17 turns of no. 26 enam wire on an FT-50-61 toroidal core) at 40 m; 6.8 µH (12 turns of no. 26 enam wire on an FT-50-61 toroidal core) at 30 m.

[20]D. DeMaw, "The Mini-Miser's Dream Receiver," *QST*, Sep 1976, pp 20-23. Also see Feedback, *QST*, Nov 1976, p 22.
[21]Circuit boards and kits for this receiver are available from Circuit Board Specialists.
[22]For more on crystal filters, including a description of the half-lattice configuration, see *The 1989 ARRL Handbook*, pp 12-26 to 12-28.—*AK7M*

[23]W. Hayward, "A Unified Approach to the Design of Crystal Ladder Filters," *QST*, May 1982, pp 21-27. Also see Feedback, *QST*, Jul 1987, p 41.

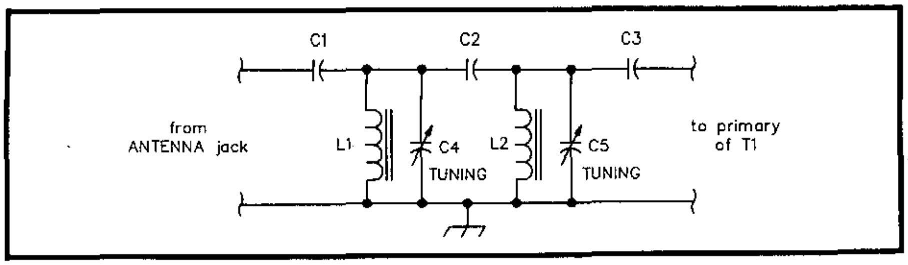


Fig 45—Herb Ley added this doubly tuned filter between the antenna and mixer in his modified Mini-Miser's Dream receivers for improved spurious-signal rejection.
C1, C3—40 pF at 40 m; 24 pF at 30 m.
C2—4.6 pF at 40 m; 2.6 pF at 30 m.
C4, C5—Nominal values: 188 pF at 40 m; 159 pF at 30 m.
L1, L2—2.16 μH (19 turns of no. 22 enam wire on a T-50-2 toroidal core) at 40 m; 1.34 μH (18 turns of no. 22 enam wire on a T-50-2 core) at 30 m.

oscillator—the crystal functions in the parallel-resonant mode. The actual IF is higher than the measured oscillation frequency—slightly higher than 4.0 MHz.) I installed the second filter crystal in place of C3 (the original circuit's filter phasing capacitor), and rewound the MMD's bifilar crystal-filter inductor, L1, with 8 bifilar turns of no. 28 enameled wire. A 10-kΩ resistor installed across RFC1 provides a defined resistive termination for the filter. The measured 6-dB bandwidth of the half-lattice filter is 400 Hz; this gives good single-signal selectivity.

I also modified T2, the MMD's IF-amplifier output transformer, rewinding its primary with 10 center-tapped turns of no. 26 enameled wire to give greater leeway in adjusting T2's tuning trimmer. (As for 3.3 MHz, T2's secondary consists of 3 turns of no. 26 enameled wire).

Aside from installing a 4.0-MHz BFO crystal, the MMD BFO modification involves replacing the BFO's 100-pF fixed capacitor (in series with Y2, the BFO crystal) with a 15- to 150-pF, ceramic-dielectric variable capacitor to allow BFO-frequency adjustment.

Reworking the VFO and Its π Output Filter

After studying the articles by Hayward and Lawson,[24] and Lewallen,[25] I measured the frequency drift of a prototype oscillator containing various combinations of polystyrene and NP0 ceramic capacitors, and T-68-2 and T-68-6 toroidal inductors. The results confirmed Lewallen's observations of the better stability of NP0 capacitors and T-68-6 inductors. I also followed Lewallen's recommendation (attributed to Hayward) to anneal the toroids in boiling water for a few minutes after winding and coating the coils with Q-dope.

[24]W. Hayward and J. Lawson, "A Progressive Communications Receiver," *QST*, Nov 1981, pp 11-21. Also see Feedback, *QST*, Jan 1982, p 47; Apr 1982, p 54; and Oct 1982, p 41. This receiver also appears on pp 30-8 to 30-15 of *The 1989 ARRL Handbook*.

[25]R. Lewallen, "An Optimized QRP Transceiver," *QST*, Aug 1984, pp 14-19. Also see Feedback, *QST*, Nov 1981, p 53.

The modified MMD's VFO must tune from 3.0-3.17 MHz to cover 40 meters, or 6.0-6.2 MHz to cover 30 meters. Corresponding changes must be made in the VFO output filter. Fig 44 shows a schematic of the modified MMD VFO. For greater frequency stability than that possible with polystyrene capacitors, I used NP0 ceramic capacitors for all fixed capacitors in the VFO tuned circuit. Each of two MMD VFOs modified in this way drift approximately 80 Hz during the first 15 minutes after turn-on.

Using a toroidal inductor instead of the original slug-tuned MMD VFO inductor, L2, makes room for a 30-pF, air-dielectric variable capacitor (a Hammarlund APC-30 in my MMDs) on the right rear side of the VFO enclosure. This bandset control, the shaft of which projects near C3, allows me to set the VFO range to cover 100-kHz band segments and does away with the need to do tedious cut-and-try experimentation with the inductance of L2. I chose a tuning range of 100 kHz as a compromise between reasonable bandspread, the MMD's selectivity and the suboptimal quality of my receiver's vernier drive.

New Mixer-Input Transformer for the 30-Meter Version

For 30 meters, the secondary winding of T1 consists of 17 center-tapped turns of no. 24 enameled wire on a T-50-6 toroidal, powdered-iron core. The primary is 3 turns of no. 24 enameled wire over the secondary winding. This modification was described by Collins.[26]

Input Band-Pass Filters

I calculated component values for the antenna-line band-pass filters from the formulas in *Solid-State Design for the Radio Amateur*[27] using a computer program and K values (from Amidon's data sheets) that differ slightly from those used in *Solid-State Design*. Fig 45 shows the filter circuit. The most difficult component to find for either filter is the coupling capacitor, C12. Radio Shack® currently stocks an assortment of low-capacitance disc-ceramic capacitors (RS no. 272-806); this assortment may contain capacitors close to the values you need. Short pieces of RG-174 coax can also serve as this capacitor, as discussed in *Solid-State Design*. Still another alternative is to use low-capacitance trimmer capacitors adjusted to the necessary value by measurement or estimation. To align these filters quickly, tune in a signal at the center of the MMD's tuning range and adjust C1 and C2 for maximum output. A more refined method involves adjusting C1 for maximum response on a signal 25% from one end of the band, and C2 on a signal 25% from the other end of the band.

[26]G. Collins, "Getting Started on VHF: A Tunable I-F for VHF Converters," *QST*, May 1982, pp 32-34.

[27]W. Hayward and D. DeMaw, *Solid State Design for the Radio Amateur*, 2nd printing (Newington: ARRL, 1986), pp 237-241.

Comments and Conclusions

The Mini-Miser's Dream lacks audio filtering. I mounted the input band-pass filter on the receiver's rear wall in the spot formerly occupied by the original receiver's 20-meter converter, and mounted an active, low-pass audio filter[28] on the right wall of the enclosure. (I chose not to use the 20-meter converter originally presented with the receiver because its MOSFET mixer is susceptible to intermodulation distortion; instead, I use an external converter with a low-gain RF stage, doubly balanced diode mixer and post-mixer amplifier. If you prefer to use the inboard 20-meter converter, you can mount it on the receiver's rear wall.) Next, I rewired the old **40/20-M** switch to select, when needed, an external band-pass active audio filter.[29] These filters, which are switched into the audio output line of the receiver, may overload when the receiver gain is increased enough to drive low-sensitivity, hi-fi headphones; they work very well with 8-Ω phones. (The filters are too noisy to be inserted between the MMD's diode product detector and audio amplifier without low-noise AF preamplification between the product detector and the filter.)

I am very pleased with my modified MMDs. Their basic design is good, and their stability, sensitivity and selectivity are excellent when they have been modified as I've described. The input and active audio filters provide a major improvement in MMD performance. Either receiver can be used on other bands with an external converter having "good" IMD characteristics. I have several spare sets of crystals and other components for these modifications. Send an SASE with your inquiry or comments if you want a reply!—*Herb Ley, N3CDR, c/o Herbert L. Ley Assoc, Inc, PO Box 2047, Rockville, MD 20852*

[28]See Note 24.

[29]D. DeMaw, "Understanding and Using Audio Filters," *QST*, Apr 1983, pp 45-48.

TWO BANDS, SHORTWAVE-BROADCAST, UTILITY AND WWV COVERAGE FOR THE NEOPHYTE RECEIVER

☐ I built my version of John Dillon's Neophyte Receiver (*QST*, February 1988, pages 14-18) with altered frequency coverage because I already have an amateur-band transceiver. With slight changes in component values, I obtained a two-band receiver that covers WWV, two broadcast bands and several utility[30] bands. The modification I'll describe provides coverage of 60-meter tropical broadcasting (4750-4995 and 5005-5060 kHz), the standard-frequency-and-time allocation at 4995-5005 kHz, 49-meter international broadcasting (5950-6200 kHz) and frequencies used by the aeronautical mobile, maritime mobile and fixed services between 4520 and 6250 kHz.

See Fig 46 and Table 2. C21, a 220-pF capacitor, and S2, an SPST toggle switch, are new components. S2, **BAND**, switches C21 in parallel with the original Neophyte's C10 to select my added "low-band" option. By installing the components listed in Table 2 and adjusting T2 (the Neophyte's oscillator inductor), I obtained coverage from 4520 to 5995 kHz with S2 set to **LOW** (closed), and 5775 to 6250 kHz with S2 set to **HIGH** (open).

Installing S2 and C21: Ignoring cosmetic issues, I soldered a pair of no. 36 insulated wires to the leads of C10 on the component side of the Neophyte board and ran them as a twisted pair to S2 (mounted on the front panel) and C21 (one lead of which is soldered directly to S2). The capacitance between these wires very slightly lowers the maximum oscillator frequency from what it would be without the wires, but does not cause frequency instability.

Calibrating the tuning dial: I used a signal generator and frequency counter to determine the frequency represented by each multiple of 10 on my Neophyte's **TUNING** dial (which is calibrated from 0.0 to 100.0). Then I interpolated between these known values (with a short computer program) to obtain an estimated frequency for every dial reading. This piecewise-linear assumption introduces some error; the error is not obtrusive, however. After generating a tuning table for each of the modified Neophyte's two bands, I ran the computer printouts through a reducing photocopier until they were just big enough

[30]Shortwave listeners have long used *utility* as a general term for nonbroadcast, nonamateur radio services.—*Ed.*

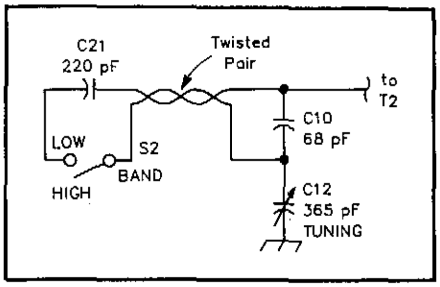


Fig 46—Bob Cromwell modified his Neophyte Receiver to cover 4520 to 6250 kHz in two bands by changing its oscillator circuit (above) and replacing some of its components with those shown in Table 2. S2 is an SPST toggle or slide switch. See text.

Table 2

Neophyte Component Values for 4520- to 6250-kHz Coverage

C1—100 pF, ceramic.
C7, C8—390 pF.
C9—200 pF.
C10—68 pF.
C11—Not used.
C21—220 pF.

C1's temperature stability is noncritical; it can be a ceramic disc. The other capacitors listed here should be NP0, polystyrene or silver mica for lowest drift.

All component designators except C21 refer to parts in the original Neophyte circuit.

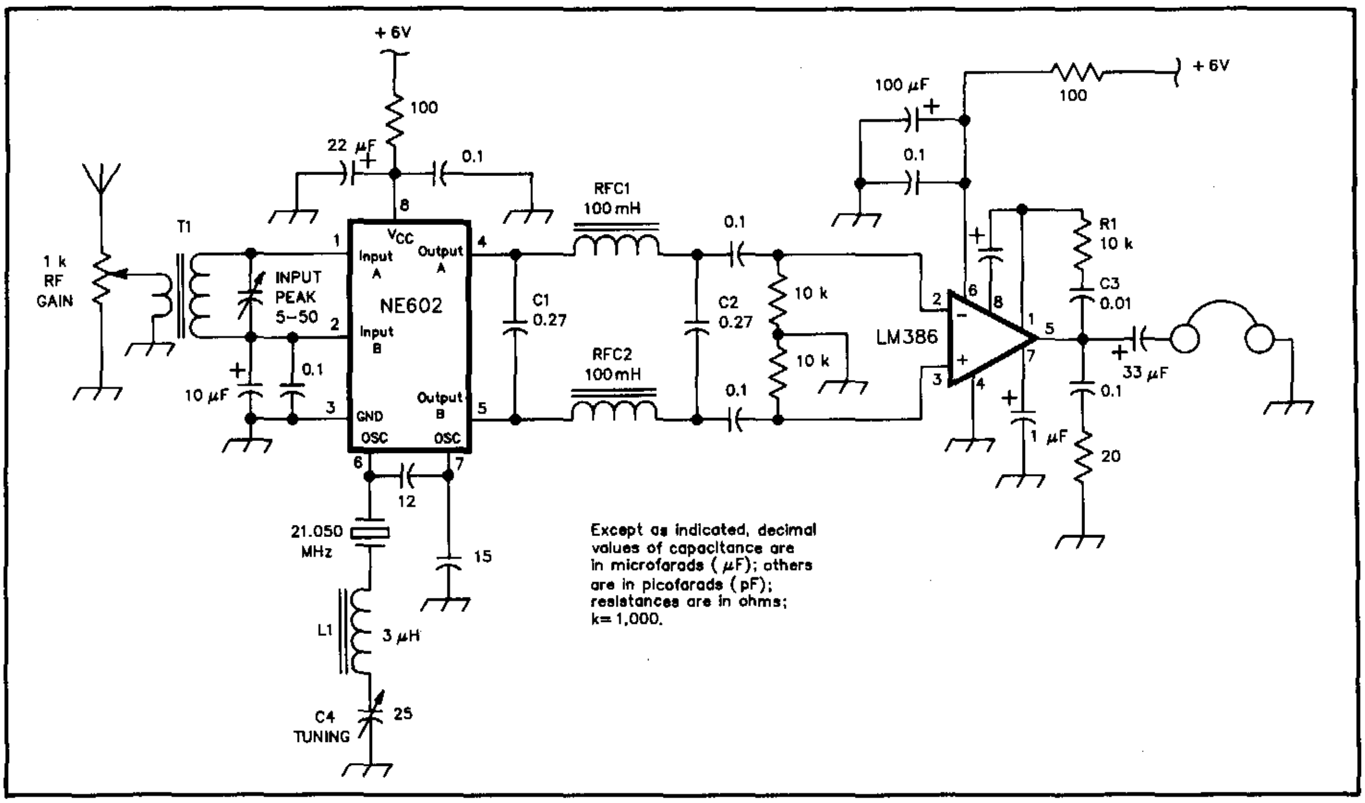


Fig 47—Wayne Burdick put his Neophyte receiver on 15 m and modified its audio response for better CW reception as shown here. The parts associated with U1's pins 6 and 7 serve as frequency-determining and feedback elements in U1's local-oscillator subcircuit; C1, C2, RFC1 and RFC2 reduce the receiver's audio response above 1 kHz; and R1 and C3 reduce hiss by decreasing U2's response at higher audio frequencies.

T1's secondary winding consists of 26 turns of #24 enameled wire on a T-50-6 toroidal core; the primary is 2 turns of #24 enameled wire over the secondary's pin 2 end. L1 consists of 26 turns of #24 wire on a T-50-6 toroidal powdered-iron core; RFC1 and RFC2 are Mouser Electronics 43LJ410 chokes. All electrolytic capacitors are 16 V; component designators not mentioned here and in the text duplicate those of the original Neophyte. See the text and Note 32.

to read and just small enough to fit on the Neophyte's front panel.

These modifications provide a Neophyte receiver that supplements the functions of my transceiver. The Neophyte's NE602 mixer is surprisingly sensitive, as evidenced by the many utility signals I've heard and identified (with help from Ferrell's *Confidential Frequency List*[31])—including airliners en route over the Atlantic and barges on the Mississippi River.

I encourage others to undertake this modification, and I await the announcement of the first Neophyte that covers 100 kHz to 30 MHz, or more!—*Bob Cromwell, KC9RG, 240-8 S Salisbury, W Lafayette, IN 47906*

[31]G. Halligey, comp (Park Ridge, NJ: Gilfer Associates, 1988). Available from the ARRL Bookshelf (no. 2206).

15 METERS AND BETTER CW AUDIO FOR THE NEOPHYTE RECEIVER

☐ John Dillon's Neophyte receiver (February 1988 *QST*, pages 14 through 18) is a good starting point for receiver construction projects. Here's how to use the Neophyte at 15 m and improve its audio performance for CW reception.

See Fig 47. The on-chip oscillator in U1, the Neophyte's NE602N mixer, isn't stable enough to be inductor/capacitor-controlled at 21 MHz, so I used a variable crystal oscillator (VXO). L1 should be high-Q; winding it as described in the figure caption assures this. (Although you can get a wider tuning range by increasing L1's value over 3 μH, doing so sacrifices stability and allows strong signals to *pull* the VXO [change its frequency]. The more inductance at L1, the less Y1 controls the oscillator frequency.) If you intend to use the VXO to drive transmitter stages, use an off-chip FET VXO, lightly coupled to the NE602, instead of the NE602's inboard oscillator.

I replaced the Neophyte's original resistor/capacitor audio-filter circuit with a balanced, inductor/capacitor low-pass filter. This filter cuts off around 1 kHz, greatly improving CW reception. The inductors I use at RFC1 and RFC2 have a dc resistance of about 180 Ω, and thus an unloaded Q of only around 4 at 1 kHz. Mouser Electronics[32] 43LJ410 inductors (also 100 mH) should work as well or better. You can decrease the values of RFC1, RFC2, C1 and C2 proportionally to increase the filter's bandwidth for SSB reception; 88-mH telephone toroids may be usable for this purpose.[33]

Finally, I added bandwidth limiting to the audio output stage. R1 and C3 limit the LM386's high-audio-range gain to reduce hiss.—*Wayne Burdick, N6KR, Attleboro, Massachusetts*

[32]Telephone 800-346-6873.

[33]Wayne adds that because the audio filter shown in Fig 47 may make 60-Hz ac hum noticeable, this modified Neophyte works better with a battery, instead of ac, power supply. I suspect that the hum may come from ac induction by solenoidal 100-mH audio-filter inductors. You may be able to reduce or eliminate this effect by using toroidal inductors for RFC1 and RFC2.—*WJ1Z*

18-MHz COMPONENT VALUES FOR THE *HANDBOOK* VXO CW TRANSMITTER

☐ Yes, the *1989 ARRL Handbook*'s 6-watt, VXO-controlled CW transmitter[34] works well at 18 MHz. Here are component values necessary for using the rig on this band; the component designators listed are those shown in Fig 48 of the *Handbook* write-up:

C1—VXO tuning capacitor; 50 pF.

C2—Limits the VXO tuning range to ensure that the crystal, and not L1 and C1, controls the oscillator frequency. I omitted this capacitor in the version I tested; if you try this and your crystal loses control, use 10 pF.

C3, C4—VXO feedback capacitors; 39 pF, silver mica or NP0 ceramic.

C6—Interstage coupling capacitor; 39 pF, silver mica or NP0 ceramic.

C17, C18—Output filter capacitors; 190 pF, silver mica (10 pF in parallel with 180 pF).

[34]B. Hale, ed, *The ARRL Handbook for the Radio Amateur*, 1989 ed, (Newington, ARRL, 1988), "A VXO-Controlled CW Transmitter for 3.5 to 21 MHz," pp 30-43 to 30-45.

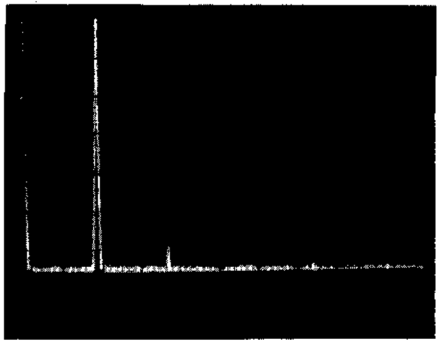


Fig 48—Spectral display of the *ARRL Handbook* 6-W VXO transmitter operating at 18.09 MHz. Each horizontal division represents 10 MHz; each vertical division represents 10 dB. The spike at far left (the spectrum analyzer's first-local-oscillator signal) serves as a convenient "0 MHz" reference. This spectrogram was taken with the VXO transmitter producing 6.2 W of RF energy. All harmonics and spurious emissions are at least 57 dB below peak fundamental output. Modified for 18 MHz as described in the text, the 6-W VXO transmitter complies with current FCC specifications for spectral purity.

L1—VXO inductor; 28 turns of no. 26 enameled wire on a T-37-6 toroidal, powdered-iron core (measured inductance, 2.5 μH). Space the turns on this coil, and those on L3-L5, to allow a 30° gap between the beginning and end of each winding.

L3, L5—Output filter inductor; 16 turns of no. 24 enameled wire on a T-37-6 core (measured inductance, 0.85 μH).

L4—Output filter inductor; 20 turns of no. 24 enameled wire on a T-37-6 core (measured inductance, 1.28 μH).

Y1—Parallel-resonant fundamental crystal, 20- or 32-pF load capacitance. An 18.07-MHz crystal borrowed from Zack Lau's QRP Three-Bander (see pp 25-30 of October 1989 *QST*) provided a VXO swing of 10.8 kHz with 39 pF at C3 and C4.

Powered with a 12.0-V dc supply, my version of the VXO transmitter draws 1.26 A dc while producing 6.2 W output at 18.09 MHz. Fig 48 shows the transmitter's output spectrum under these conditions.—*AK7M*

CHAPTER 2
Batteries and Generators

A SOURCE OF BATTERY PACKS

☐ Recent advances in instant photography have required the development of special power packs to run the camera electronics responsible for auto-focus, exposure control, film advance and warning lights, in addition to flash. The new Polaroid® Spectra™ cameras have film packs especially designed for this purpose, and the battery contained in each film pack may serve as a uniquely shaped power pack for Amateur Radio use. The Polaroid Polaplus™ battery measures about 2-3/4 × 3-1/8 × 1/8 inches, and has an output of 6 V at 60 mA. At my station, I've used the Polaplus battery to power an electronic keyer, clocks and light bulbs.—*Ivan Shulman, WC2S, Malibu, California*

Editor's Note: I recall that a "Radio Equipment Forum" contributor in a mid-1980s issue of *Review of International Broadcasting* reported getting several hours of shortwave reception out of a film-pack battery or two. Receiver: a Sony ICF-2002 portable.

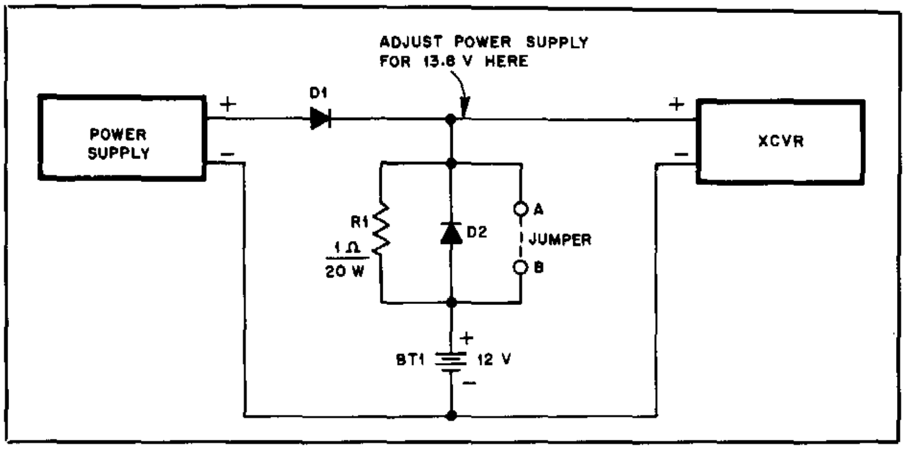


Fig 1—KF6GL's power supply/charging circuit. In this application, D1 and D2 are 6-A, 600 PIV diodes (Motorola MR756, ECG5815 or equivalent), R1 is a wirewound unit and BT1 is a size 27, deep-cycle, lead-acid storage battery. The jumper is used only during power failures (see text). The power supply is normally turned on only while the station is attended. In tailoring this circuit to your application, use conservatively rated components.

MORE ON REUSING POLAROID POLAPULSE BATTERIES

☐ Ivan Shulman's "A Source of Battery Packs" interested me because I have been using eight Polaroid® Polapulse™ batteries to power a portable depth sounder on my fishing boat. I've found that these batteries can be recharged and used for a large number of discharge/charge cycles. According to John A. Kuecken, a consulting engineer from Rochester, New York, for best results, a Polapulse battery should be charged from a regulated 6.8-V source via a 50-Ω series resistor.

I use eight series-parallel-connected Polapulse batteries to get 12 V for my depth sounder. The sounder requires 12 V at 165 mA, and the Polapulse pack lasts for about two hours before it needs recharging. Not bad for a power source that's normally thrown out with exhausted film packs! —*William L. Kimbell, W2TYO, 105 Highridge Dr, Syracuse, NY 13215*

FREE NiCd CELLS

☐ Many cities and towns have an electric razor repair shop that replaces NiCd batteries in rechargeable electric razors. The razors I've seen contain two NiCd cells. Often, only one of these cells has failed, but both cells are replaced when repair time comes. I talked a razor repair person out of a box of such rejects and got 40 NiCd cells. Twenty of these charged perfectly on the first try! Brief application of heavy overcharging current to the rest of them netted another dozen usable cells. Free NiCd cells? Check your friendly electric razor repair shop.—*Bob Baird, W7CSD, Klamath Falls, Oregon*

VCR BATTERIES FOR HAM GEAR

☐ VCR batteries can be a good source of 12-V power for emergency use. These usually come complete with case, shoulder or belt strap, wall charger, and—best of all—a standard lighter socket. I've used one of these with a Yaesu FT-208R hand-held for over a week at a time and still had power to spare.—*Dorth Falls, W4NTD, 1529 Granville Rd, Rock Hill, SC 29730*

A DEEP-CYCLE BATTERY AS AN EMERGENCY POWER SOURCE

☐ After I acquired a size 27, deep-cycle lead-acid battery as an emergency power source for my 2-meter transceiver, hams on the local repeater advised me on how to keep the battery charged. "Connect a variable dc supply in parallel with the battery and set its output voltage to 13.6," they said.

The current capability of my power supply is insufficient for such service. The supply can source the 4.8 A required by the rig during high-power transmit, but is rated at only 3 A for continuous duty. Connecting the supply directly in parallel with the battery *and* the transceiver would, at times, result in current drain exceeding the supply's continuous-duty rating.

Fig 1 shows my solution to this problem. Charging current with this circuit is 1 A or less, and the supply can still power the transceiver. Installation of a jumper across points A and B applies the full battery voltage to the transceiver if this is needed during an extended power failure. —*George Hopkins, KF6GL, Sunnyvale, California*

A ONE-SHOT TIMER FOR BATTERY CHARGING

☐ One of the problems associated with rechargeable batteries is that of charging duration. This is particularly evident when the charging period is longer than the interval between "home from work" and "back to work"! In such cases, another member of the family must remember to unplug the charger at the appropriate time. My solution to this problem is a one-shot timer. Here's how to build such a timer for around $10.

Two parts are required: a 120-V neon lamp assembly and a motor-driven lamp timer capable of a timing interval at least as long as the charging period required by your battery. (Both are available in several forms from Radio Shack®.) The motor in such timers usually actuates a switch that breaks the hot side of the ac line for appliance control. Modify the timer as shown in Fig 2. Open the timer and locate the motor lead connected to the hot side of the ac line (point A in Fig 2). Move this lead to the appliance-socket side of the timer switch, S1 (point B in Fig 2). Next, mount the neon lamp assembly at any convenient place on the timer housing, and connect it between the hot and neutral terminals on the timer's appliance outlet. Reassemble the timer.

Connect your battery charger to the timer. Set the timer's on and off actuators to turn on the charger for the charging time required by your battery. To turn on the timer motor and your battery charger, rotate the timer dial until DS1 lights. When the set time has elapsed, your charger *and* the timer motor switch off. Result: a charged battery that won't be overcharged if forgotten.—*Dennis Cripps, N3FIW, Newark, Delaware*

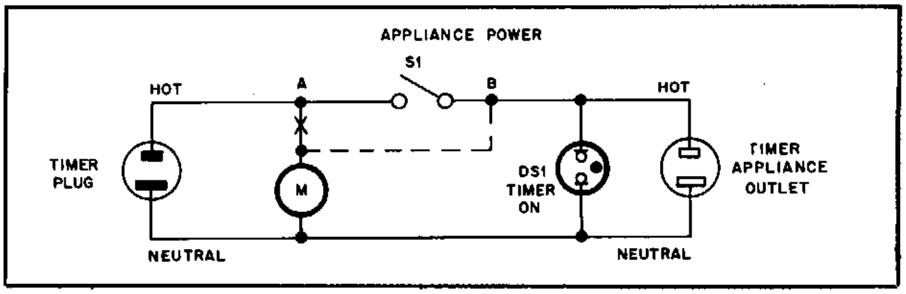


Fig 2—Dennis Cripp's modified timer turns itself and its associated battery charger off at the end of the charging period. Modification of the timer consists of moving the hot motor lead from point A to point B, and installation of a 120-V neon lamp, DS1, between hot and neutral on the timer's appliance outlet.

AN EMERGENCY CHARGE ADAPTER FOR NiCd BATTERY PACKS

☐ Fig 3 shows a simple charge adapter I use to charge batteries for my hand-held transceivers. The adapter allows both fast and slow constant-voltage charging with a regulated 13.8-V dc power supply.[1]

Charge rates for several ICOM battery packs are shown in Table 1. The BP2 and BP5 have internal temperature sensors to protect them from excessive heat during charging. When the pack becomes warm, DS1 will go out. After a cool-down period of about a half hour, the DS1 will flash, indicating that the pack is ready for use.

Construction of the charge adapter is not critical. Mount the potentiometers on metal to help dissipate heat. I made a drop-in charger by cutting the metal lid of a Radio Shack® (RS 270-230) box to fit the battery packs. Use two machine screws as contacts. Adjust the potentiometers so that the current is at the level indicated when the pack is near full charge.—*Joseph J. Janus, KB3WZ, New Castle, Pennsylvania*

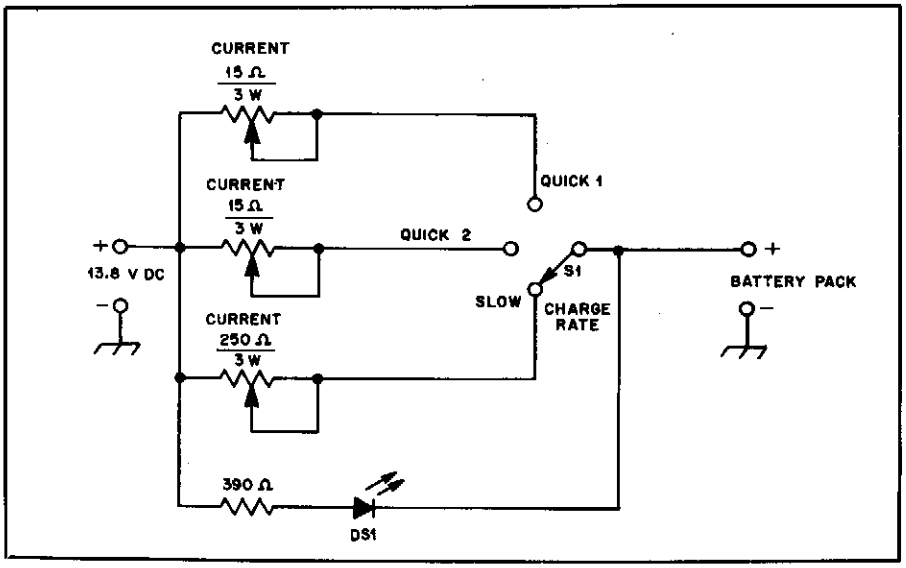


Fig 3—KB3WZ's emergency charge adapter for NiCd battery packs. S1 is a three-position, single-pole rotary switch. DS1 is any common LED.

Table 1
Charging Rates for Several ICOM Battery Packs

Pack	*Current (mA)*	*Duration (hrs)*
BP2††	600	1-1.5
BP3	25	15
BP4†	45	15
BP5†	500	1-1.5

†Recharge only NiCd batteries in the BP4.
††Do not quick charge batteries without internal thermal protection.

[1]Generally, NiCd batteries last longest if charged with a constant current, which is limited to about one-tenth of the cell capacity. Charging should stop when a voltage of 1.3 V per cell is reached. Constant-voltage charging results in a quick charge (approximately one hour), but the voltage should be limited to about 1.5 V per cell (nominal battery voltage is 1.2 V per cell), and charging should continue for about three hours. Packs being quick charged should be switched to the low-current rate when the LED goes out and charged for a few more hours.

There are trade-offs for quick charging a NiCd cell. Some references claim a cell life of up to 1000 cycles for constant-current charging. My quick-charge experience is with Kenwood's PB-26 battery and ST-2 base charger (a 1-hour, 600-mA, quick charge). Kenwood claims a 300-cycle life for that equipment combination.

Operation of NiCd batteries is explained in "Those NiCad Batteries and How to Charge Them!" Oct 1981 *QST*, p 34. More sophisticated chargers appear in "Build the AA6PZ Power Charger," Dec 1982 *QST*, p 17, "Any-State Ni-Cad Charger," Dec 1979 *Ham Radio*, p 66, and *The ARRL Handbook*.—Ed.

AAA NiCds IN AN AA CHARGER

☐ My 2-meter hand-held uses AAA NiCds, but my charger only takes AA cells. Although adapters are available, I found a cheap and easy way to fit AAA cells into my AA charger.

Remove a piece of the outer jacket—a section slightly longer than an AAA cell—from a length of scrap RG-8 cable. Slit the piece lengthwise and slip it over the cell to be charged. The jacket acts as an expander and allows the AAA cell to fit snugly in an AA charging well. As necessary, adjust the expander's length (perhaps with the addition of a metal spacer between the negative end of the cell and its corresponding charger electrode), to assure solid contact between the cell and the charger electrodes.

This technique can also be used to install AAA cells in AA-cell battery cases. —*Fred Devenish, G5UP/VE7BBD (SK)*

Once you've successfully fitted AAA cells into an AA-cell charger, the next thing to ensure is that the AAA cells charge at a rate appropriate for their capacity.—*Ed.*

BATTERY-CHARGE LABELS

☐ With three battery packs for my hand-held transceiver, it has been a problem to keep track of which pack is charged or discharged at any particular time. A common solution is to use some kind of sticker to label the packs. Many stickers, however, are not easy to peel from the battery pack.

I found an answer in 3M® Post-it™ note pads. Post-it notes have a strip of weak wax-like adhesive along one edge. They are meant to be repeatedly placed and peeled away without damage. I cut several pieces small enough to fit inside the top of the battery pack. When a pack is discharged, I place the sticky strip so that the paper covers the battery terminals. After charging, I move the strip so that the terminals are exposed. The strips can be used repeatedly, and there is no damage to the battery packs.—*Bob Schetgen, KU7G, ARRL HQ*

REPLACEMENT BATTERY-PROTECTION PLATE INDICATES STATE OF CHARGE

☐ If you're tired of looking for the slide-in plastic plate for your extra hand-held batteries, try the replacement shown in Fig 4. Made from a 2-inch Pendaflex folder tab, it protects the battery terminals against short circuits *and* allows you to slide in a label indicating the battery's state of charge. My label says *HOT* on one side and *RECHARGE* on the other.—*Greg Lane, K7SDW, 3970 Coronado Cir, Newbury Pk, CA 91320.*

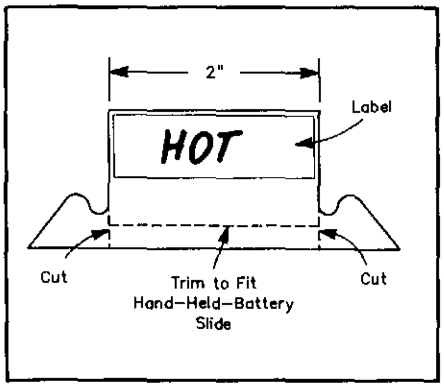


Fig 4—Greg Lane replaced his battery-protection plate with a hanging-folder tab modified as shown here. The slide-in label indicates state of charge.

ONE PROTECTIVE CASE FOR MANY BATTERY PACKS

☐ Dissatisfied with the performance of the rechargeable battery pack provided with a newly purchased hand-held, many people purchase optional battery packs with energy capacities more suited to their needs. This often means that the overall height of the hand-held and new battery pack differs from that of the stock configuration—a problem if you want to keep the radio in a protective case. To avoid the expense of purchasing a protective case for each transceiver/battery pack combination, I suggest the following solution:

Purchase the protective case designed to accommodate the hand-held and its largest optional battery pack. When you use battery packs smaller than maximum size, insert soft plastic-foam blocks cut to fit the extra case space. To avoid short-circuiting charging contacts on the pack, *be sure to use nonconductive foam.* Size the blocks to permit normal access to the hand-held's controls.—*Marc Norikanè, N7MBE, 19005 4th Ave SW, Seattle, WA 98166*

CONDUCTIVE PLASTIC CAN DISCHARGE BATTERIES

☐ Recently, I purchased a pair of lithium cells for backing up CMOS memory. Two ½-inch-long radial leads protruded from each cell. To prevent the cell leads from shorting together against metallic objects in my junk box, I placed the cells, leads first, into the black conductive foam I use to protect static-sensitive integrated circuits.

My haste to protect the cells resulted in their demise! Later, before installing one of the cells in my circuit, I checked its terminal voltage: 0 volts! I thought for a moment—and then I realized that antistatic foam isn't also called "conductive foam" for nothing. An ohmmeter check revealed that the resistance of the foam over a distance equivalent to the cell's lead spacing was about 500 ohms. In effect, I had plugged the lithium cells into a battery *dis*charger.—*Otto Cepella, VE3HCD, Ottawa, Ontario*

☐ The memory backup cell I ordered by mail arrived before I had time to install it in my VHF transceiver, so I put the cell—packing material and all—aside for several weeks. The shipper had placed plastic foam over the cell terminals to protect them during shipment. You guessed it: The foam was *conductive*, and my "new" battery was dead before I could install it!—*Bruce E. Lackey, WB3HAE, Rockville, Maryland*

Editor's Note: It doesn't pay to put a powered-up PC board down on a piece of conductive foam, either: A friend of ours had to replace a 40-pin microprocessor chip after such a maneuver. And conductive foam may not be the only plastic that poses a short-circuit hazard: Conductive plastic-bubble packing material may do in an energy cell or short a live circuit, too.

REPLACING BATTERY-CIRCUIT FUSIBLE LINKS

☐ The battery circuit of many hand-held transceivers includes a protective fuse choke that prevents catastrophic damage in the event of a battery short circuit. Unlike a panel-mounted fuse, however, a battery fuse choke is not intended for easy replacement by its user. My first experience in having a burned-out fuse choke repaired by an authorized repair facility cost me $27—$7 for the fuse choke, and $20 for labor. I decided to repair the choke myself the next time!

Investigation of my next burned-out fuse choke revealed a component consisting of 14 turns of no. 33 magnet wire wound on a glass form about the size of a ¼-watt resistor. A table in my *Physics Handbook* indicated that no. 33 wire melts at 5 A—the rating of the fuse choke.

I made my own choke by winding 14 turns of Formvar-insulated no. 32 magnet wire on a 1-kΩ, ¼-W resistor. (No. 32 was the closest to no. 33 I had on hand. The fusing current of no. 32 is 7 A—close enough to no. 33's 5-A rating for my purposes.) I insulated the replacement choke with heat-shrink tubing before installing it in my transceiver.

Some fuse chokes include a ferrite bead on one lead. If this is so with your fuse choke, be sure to remove the bead from the burned-out choke and install it on your home-made replacement.—*George H. Klaus, W2CJN, 140 Mill Dam Rd, Box T, Centerport, NY 11721-0619*

A 12-V DC POWER SYSTEM FOR FIXED-STATION USE

☐ The 12-V power system that we now use in our shack was created like many other projects—the need finally overwhelmed the laziness. My father (Ed Kabak, KA3DRD) and I share the same shack. After many years, we had accumulated many rigs, but never enough power supplies to operate them. The most direct solution would have been to buy more supplies, but this has certain disadvantages: Power supplies are costly in quantity, especially supplies capable of operating high-power transceivers, and are unusable during main-power failures.

We assembled our present power system (Fig 5) after carefully considering our options. It was somewhat costly and time-consuming to build, but its payoff is smoother operation of our ham shack. We no longer waste time trying to "find the power" for each of our 12-V-dc-powered rigs. Each rig now has a permanent position and a permanent power feed. We also have uninterrupted power when commercial power is lost, with no switching circuitry. The system is intended to be used in a reasonably permanent installation; we have lived in the same location for many years.

Most of the Fig 5 components are housed in the bottom of a 5-ft-high, 19-inch-wide rack. For energy storage and power-supply time averaging, we use an automobile battery (BT1) retired from service in my car. It's connected as if it's a power supply: It has an isolation switch (S1, BATTERY OFF) and is externally fused. BT1 is located external to the rack because of space limitations and the possibilities of acid spills and gas buildup if the battery is charging. (Automotive lead-acid cells must be handled with care because of their acidic electrolyte and their ability to source dangerously high currents when shorted.) The advantage in using an old battery is its low cost (its trade-in value when you have to buy a *new* battery), its relative simplicity, and its large energy-storage capacity. We can operate our station for several hours without commercial power; how long depends on exactly how much transmitting we do. Higher battery capacity translates into more operating time, of course.

A plastic utility box (represented by the shaded line in Fig 6) serves as a distribution panel local to the individual rigs. Each distribution circuit is limited to 10 A, maximum, and the circuit fuses (F5-F8), Fig 5) are located in the rack, with a pilot lamp (DS3-DS6, Fig 5) on each to indicate that output circuit power is available. (We used pilot lamps, but if power consumption is a factor, LEDs can serve as indicators.) Each rig's power plug includes an in-line fuse (F10-F13, Fig 6) of the appropriate rating in its positive lead. These in-line fuses allow each rig to be moved elsewhere (such as into mobile use) accompanied by its fuse. For this purpose, we selected a fused connector assembly (Radio Shack® no. 270-025) that is simple, sturdy, and polarized. All of our 12-V rigs now use this same connector.

The power supplies (Power Supplies 1 and 2, Fig 6) are connected so that they can be enabled or disabled at any time with little impact on the system. Each supply must have internal protection—fuses, circuit breakers, crowbars or other protective circuitry—and is connected to the bus via a switch (S2 and S3, Fig 6), an isolation diode (D1-D4, Fig 5), and a fuse (F1-F4, Fig 5) in the rack. The rack fuses provide additional protection, and the combination of the diodes and supply-output switches allow the power supplies to be connected to or disconnected from the power bus at any time. The diodes are *necessary;* they prevent current flow back into a turned-off supply—especially important when the power fails. Pilot lamps (DS1 and DS2, Fig 5) indicates that power is being fed to the bus. We match the power-supply output voltages (the output voltage of one supply is adjustable). The isolation diodes allow a variety of different power sources to feed the bus at the same time—all of those creative Field Day ideas can now follow you home!

We use Power Supply 2 to keep BT1 charged, or when we have only small loads operating. Supply 2 is capable of sourcing 1.75 A and is frequently left on line, but is occasionally turned off when the system is unloaded and the battery is fully charged. Our present Power Supply 1 is a much larger, regulated, surplus, computer power supply, and is only brought on-line during transmitter operation. We shut it down when we're not using our rigs, or when the rigs are on but we don't intend to transmit. With both supplies on line—that is, operating in parallel—much more current is available than our transceivers require in receive, and the battery does not supply current; if necessary, it can charge during these periods. As the load on the system increases beyond the capacity of the supplies, the battery provides the balance. This

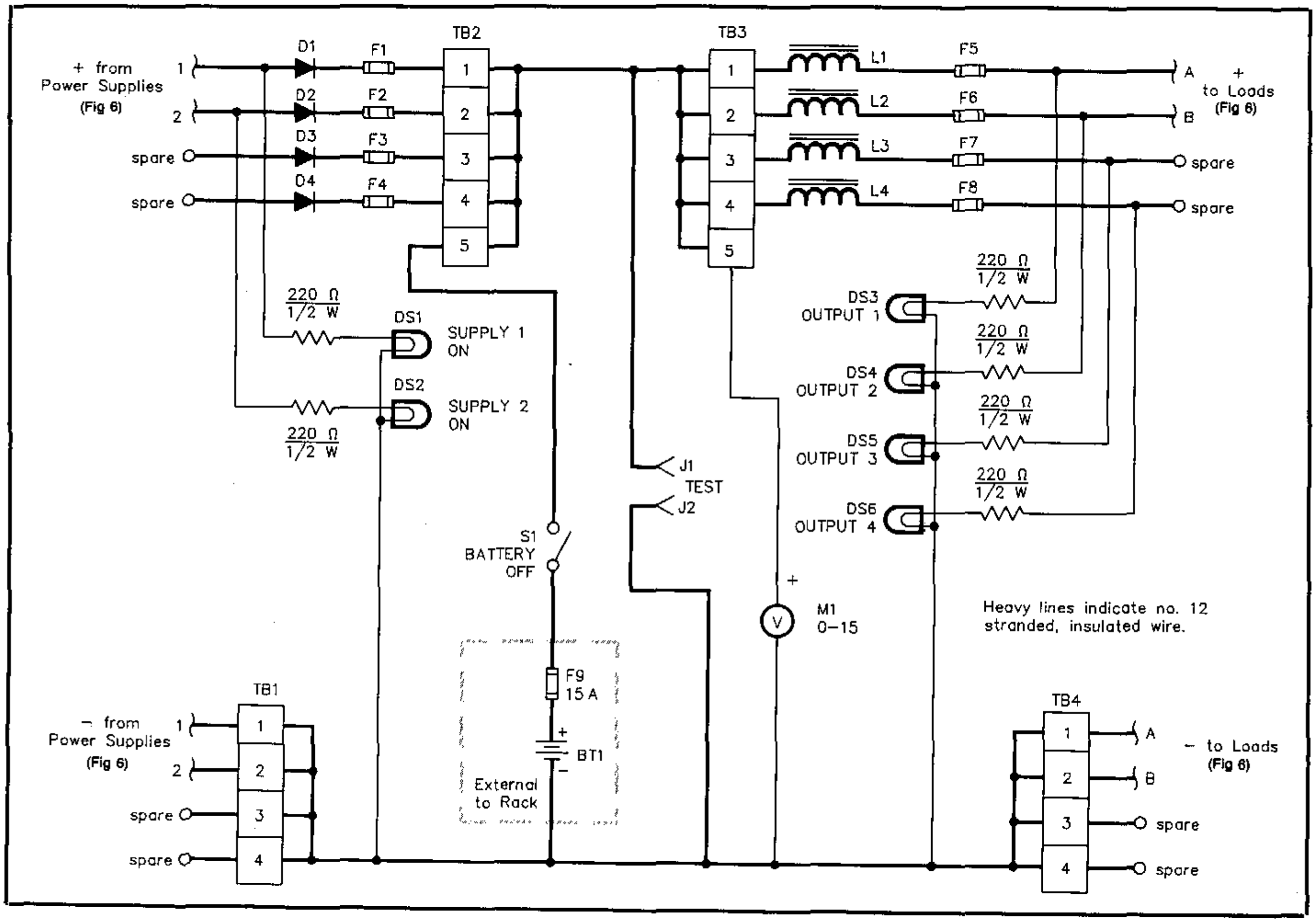


Fig 5—Schematic of the 12-V dc power system. Except for the components shown in the screened box, this circuitry is housed in an equipment rack. See text and Fig 6.

BT1—Used, 12-V lead-acid automotive battery.
C1, C2—0.1-μF, 50-V, disc-ceramic capacitor (Radio Shack® no. 272-135).
D1-D4—Power-rectifier diode capable of safely handling load current, 15 A minimum.
DS1-DS6—12-V, high-brightness, incandescent-lamp assembly (RS no. 272-331).
F1-F8—Dc fuse rated to provide protection at the bus load current.
J1, J2—Nylon binding post (RS no. 274-662).
L1-L4—Approximately 100 mH, 10 A: As many turns of no. 12, insulated, stranded wire as can be wound on a snap-together, toroidal choke core (RS no. 273-104).
M1—0-15 V dc voltmeter (RS no. 270-1754).
S1—SPST toggle switch, rated at 20 A or more at 12 V (or more) dc.
TB1-TB4—Heavy-duty barrier strip with no. 8 screws.
F1-F8 are held in four-position fuse blocks (RS no. 270-742).

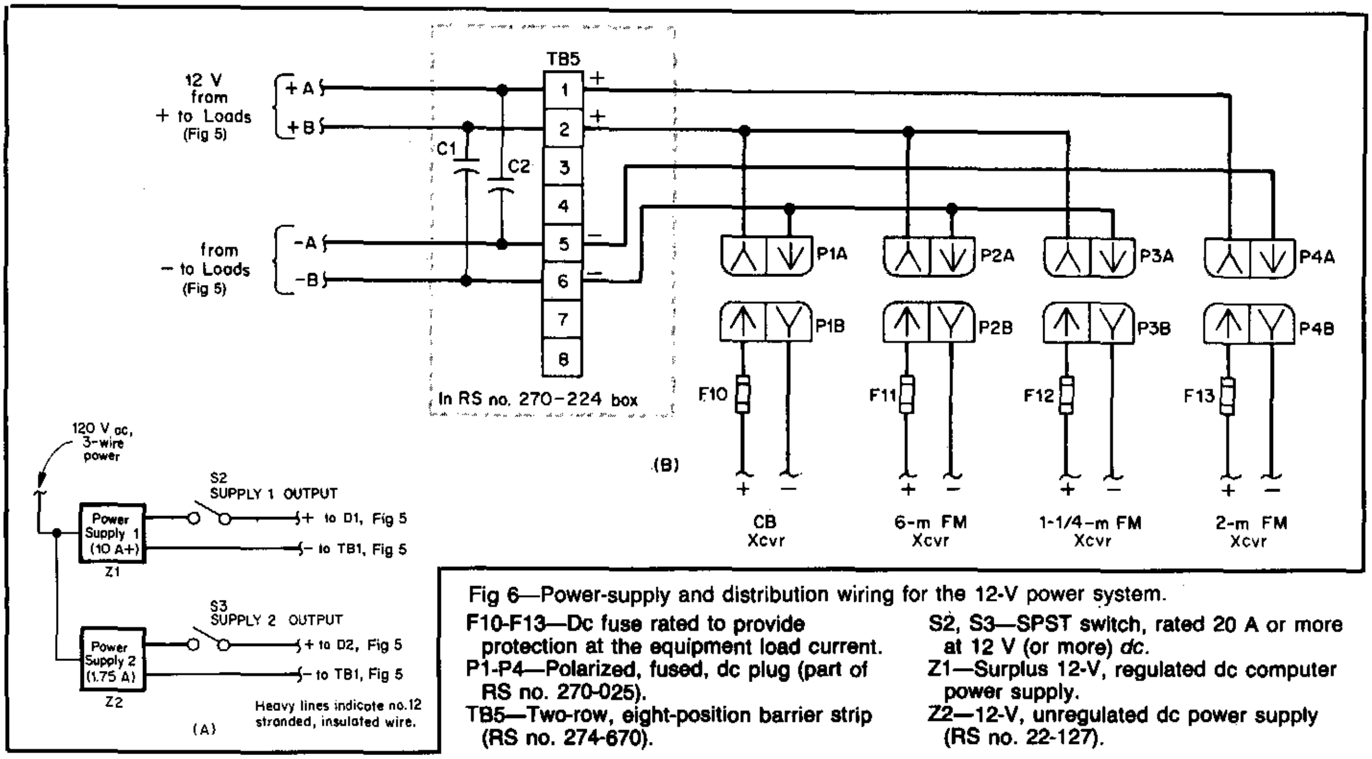


Fig 6—Power-supply and distribution wiring for the 12-V power system.

F10-F13—Dc fuse rated to provide protection at the equipment load current.
P1-P4—Polarized, fused, dc plug (part of RS no. 270-025).
TB5—Two-row, eight-position barrier strip (RS no. 274-670).
S2, S3—SPST switch, rated 20 A or more at 12 V (or more) *dc*.
Z1—Surplus 12-V, regulated dc computer power supply.
Z2—12-V, unregulated dc power supply (RS no. 22-127).

arrangement allows us to time-average the power from smaller supplies, rather than buying large-capacity power supplies just to meet the transmitters' instantaneous current drain. The battery normally remains connected to the bus at all times, so a power failure disables only the supplies. In such a situation, the battery supplies all of the current. With external power available, the battery takes current from or supplies current to the bus as needed.

The only routine maintenance the system requires is an occasional check of the supplies, batteries and other components; routine voltage monitoring—especially after any changes are made in the system; and routine testing of the system's emergency capability by shutting the power supplies off. Usually, a few hours operating independently of the mains is enough to prove the system's soundness.

Before building a system similar to this one, consider your power needs and priorities. Our system is a compromise between cost, flexibility, current-handling capability at various points in the system, and battery capacity. I encourage that you thoroughly read Chapter 6, Power Supplies, in *The 1990 ARRL Handbook*. It explains the power-supply basics and contains good information on batteries.

Many good power-supply and battery-charger schematics have been published; we decided to keep our system simple and take a more brute-force approach. Our power-supply system is very much like that in an automobile: It's relatively foolproof, but it requires more operator attention—especially to voltage levels—than a smart system. Most "12-V" gear should not be operated below 10.5 or 11.0 V, nor above 15 V, for instance; we monitor this manually, but a voltage-warning alarm, and low-voltage shut-off circuit, are features that may be worth adding.

In our daily operating, we have come to rely on this system. It's intentionally easy to operate, simple and flexible. We built it specifically for our ham shack, but it can be modified as our needs change. We also have sufficient spare capacity to add our future hamfest conquests to the system! *—Edward R. Kabak, N3AZE, 551 Arch St, Royersford, PA 19468-2530*

POWER-OUTAGE POWER-SUPPLY DISCONNECT FOR FLOAT-CHARGED SYSTEMS

☐ Here's a circuit (Fig 7) that's been most useful during power outages. With it

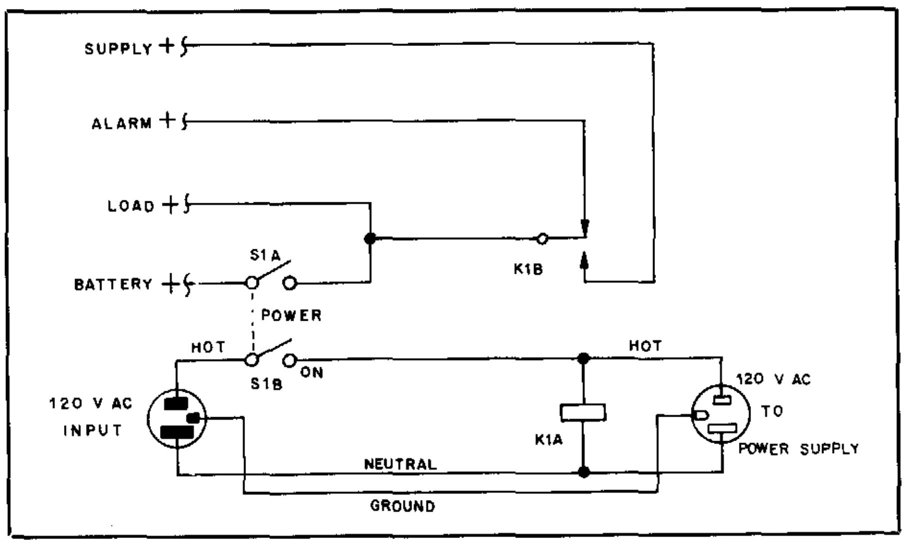
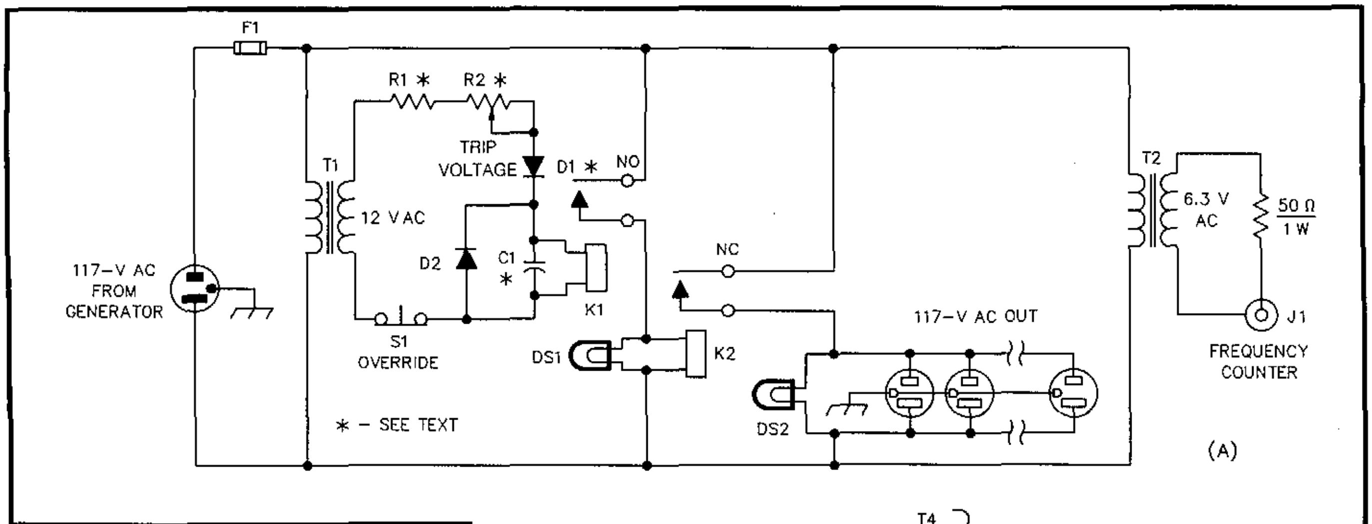


Fig 7—Willie Waite's circuit disconnects the power supply from his float-charged 12-V system when ac mains energy fails. S1 is a DPST switch rated for ac operation at 120 V, and K1 is a SPDT 120-V ac relay with contacts capable of handling the dc output of the power supply and the current drawn by the device(s) connected to the ALARM output. This drawing does not show the common negative of the 12-V system, nor does it show the precautions Willie takes—proper ventilation, and safety practices related to the presence of sulfuric acid and hydrogen near a potential source of sparks and high-current short circuits—when dealing with the lead-acid battery in his system. Safety *first!*

(assuming that ac mains energy is present), closing S1 connects the battery to the load (via S1A) and routes ac mains energy (via S1B) to the power supply and K1A, actuating K1. Closed, the normally open contacts of K1 (K1B) connect the power supply to the load and battery. When ac mains energy fails, K1B opens, connecting the battery and load to an alarm or indicator. (I use a motorcycle lamp as an "alarm;" it provides emergency lighting as well!) When ac mains energy returns, the power supply is again connected to the battery and recharging begins.

I use an old car battery in my system, and it has been satisfactory for a couple of years' use with 25-W FM gear. For a really prolonged outage, the battery would have to be recharged by some other (perhaps automotive) means.—*Willard W. Waite, W8GDQ, 45310 Webster Rd, Wellington, OH 44090*



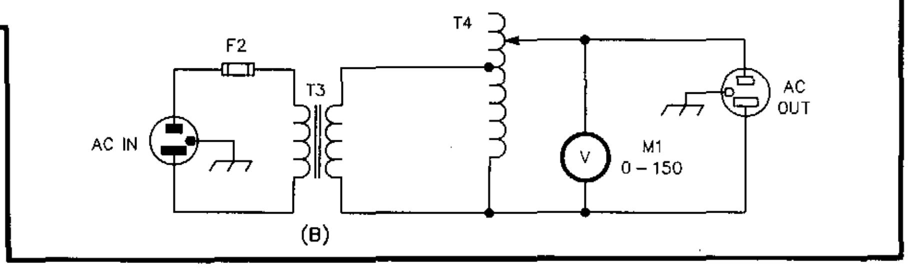


Fig 8—A schematic for W8ZCQ's Field Day overvoltage protector (A). The test and adjustment circuit appears at B.

C1—4000-μF, 25-V, Electrolytic capacitor (see text).
D1, D2—Silicon diode, 1-A, 50-V PIV (minimum).
DS1, DS2—117-V pilot lamp.
F1, F2—Fuse (20 A).
J1—Coaxial jack.
K1—12-V, SPST relay, 117-V contacts (see text).
K2—117-V, SPST relay, 117-V contacts (see text).
M1—ac voltmeter (use a VTVM or other *accurate* meter).
R1—5-W resistor (see text).
R2—25-W potentiometer (see text).
S1—Normally closed momentary-contact switch.
T1—Transformer, 117-V primary, 12-V 1-A secondary.
T2—Transformer, 117-V primary, 6.3-V 200-mA secondary.
T3—117-V isolation transformer.
T4—150-V variable autotransformer.

GENERATOR OVERVOLTAGE PROTECTION FOR FIELD DAY

□ Many operators who have taken part in Field Day operations strongly suspect that it is scheduled on Murphy's birthday. Murph celebrates with fiendish glee and invokes his laws in every direction: Antennas fall down, keyers won't key, it always rains—he whistles up all the static he can muster. There is no end to his mischief.

His one trick that hits hardest is excessive generator voltage. This problem plagued the Columbus ARA four years in a row, and with decent transceivers costing over a kilobuck, people got a bit "antsy" about bringing their "little jewel" out for Field Day use. Our club decided to see if we could do something better than hang witch-bane on the generator.

So-o-o, if Murph speeds up the generator, we reasoned, let's shut down the power before the rigs start to smoke. Since no one recalled anything of this nature in past *QST*s, we built our own prototype generator-overvoltage protector.[2] It is successful, and we would like to make it public domain. Here it is!

We set several design goals for our protector: (1) it should be uncomplicated; (2) it should be reproducible; (3) it should be built from junk-box parts to reduce cost. The parts specifications are loose and flexible so that you can adapt parts on hand. Nothing is so irritating as finding that a critical component was the only one in existence, and there is no substitute! After considering many alternatives, we settled on a dc power supply, "pilot" relay and power relay as the basic circuit. (See Fig 8.)

The dc power supply samples the line voltage and applies it to the coil of any convenient 12-V dc pilot relay. The pilot relay should have a normally open contact capable of switching the 117-V ac coil of the power relay.[3] Begin your construction by choosing the power relay, then choose a pilot relay that meets the control requirements of the power relay. The normally open relay contact should close consistently at some potential less than 12 V. (Thus, the relay serves as a crude voltage reference.)

In our case, a randomly selected 12-V dc relay was tested with a variable power supply and found to pull in reliably at 8.8 V.

[2][Here are some references on related projects.—Ed.]
N. Johnson, W2OLU, "An AC Line Monitor," *QST*, Jan 1976 p 27.
R. Kaul, W1FLM, "Field Day Generators" (Waveforms), *QST*, May 1975, pp 44-45.
R. Mason, W8NN, "Expanded-Scale Power-Line Voltage Monitor," *QST*, Dec 1979, pp 40-41.
W. Stump, WB4AHZ, "Is Your Generator Genin' the Way It's Supposed To?" (a generator frequency monitor), *QST*, Mar 1982, pp 38-39.

[3][CARA used a 20-A relay for their power control, but the power relay need only switch the full generator output. For example, a 650-W generator supplies a maximum current of about 6 A. Radio Shack® sells a 12-V dc DPDT relay (no. 275-218) capable of switching 10 A at 117 V. That relay could perform all the functions required of both relays in the CARA circuit for generators up to about 1 kW.—Ed.]

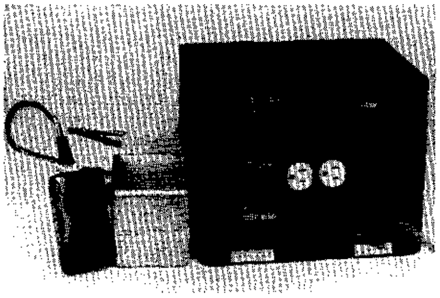


Fig 9—A photo of W8ZCQ's complete system.

Hence, we built an adjustable dc power supply that provides from 8.1 to 10.7 V at the pilot-relay coil when the input line voltage is 117 V.

The most suitable potentiometer in our junk box was 25 ohms, rated at 25 W. It requires a series combination with a 12-Ω resistor to produce the desired voltage range for the pilot relay. The potentiometer and R1 values must be determined experimentally for each relay.

Our unit was built in a Bud 8 × 8¼ × 10½-inch cabinet, but there are no firm construction rules. A three-inch shelf inside the box holds the relays. The rectifier diode is rated at 1 A and 1000 PIV. The filter capacitor is 4000 μF at 25 WVDC, but any capacitance greater than 500 μF should do.

An ac voltmeter is the final indispensable component; the pilot lights and components related to the frequency counter are optional. Such options were incorporated because the parts were available and the features useful: Since a Heathkit frequency counter was available, an outlet was provided for it.

Test and adjust the circuit by driving it through a variable-voltage transformer. Change R1 and the potentiometer, if necessary, to allow adjustment of the trip potential from about 117 to 130 V ac. In the case of our prototype, the range was from 100 to 135 V. Once you have established the component values, mark the front panel.

At the outset, we only intended to protect one rig. After some of our club "authorities" examined and blessed the new circuit, we decided to protect all CARA Field Day equipment. Out came the hole punch, and another outlet was added for an extension that would serve the rest of the camp.

Field Day soon arrived and passed. The generator output varied from 122 to 128 V and 58 to 62 Hz during the contest (frequency changed in direct relation to the output voltage), and the protector shut down the power twice. Each time, the voltage had reached the 130-V setting, but Murphy had been defeated—no rigs were damaged.—*Dan Umberger, W8ZCQ, Columbus, Ohio*

REDUCING THE CHANCE OF GENERATOR FIRE ON FIELD DAY

☐ Don't refuel a running generator without taking special precautions. Gasoline's ignition temperature is low enough for a fuel spill on a running engine to result in disaster for the engine and the person filling the fuel tank!

Falmouth Amateur Radio Association member Jim Leavitt, KC1KM, suggests this means of keeping gasoline-driven generators fire-free on Field Day: Remove the generator fuel tank from the engine and mount it on a stanchion at a distance from the generator. Run a hose (rated to carry gasoline) between the tank and generator. For added safety, equip the hose with a drip loop at the tank, mark the hose with ribbons at intervals, and ensure that no one can trip over or walk into the hose. Have another club member stand ready with a fire extinguisher when the tank is refueled—and don't refuel the generator alone, or when you're tired or sleepy.—*James J. Priestly, KA1LIK, ARRL PIA, 55 Neshobe Rd, New Seabury, MA 02649*

CHAPTER 3

Mobile Stations

(this photo and Fig 1 by David Head, K8DH)

MILK-CRATE MOBILE

☐ Half the fun of ham radio is the ability to operate from somewhere other than home. Today's 12-volt transceivers offer unprecedented opportunities to work the world from out in the world. But why wait to get to another operating site when you can operate on the way? Getting a mobile station running at VHF/UHF *and* MF/HF is easy, and need not involve attacking your car with a drill. Magnetic- or bumper-mount antenna systems work well without car modification, and a good antenna tuner (manual or automatic) can help offset a mobile MF/HF antenna's narrow SWR bandwidth. The only problem left to solve is keeping all the equipment from bouncing around in the car!

My solution? RF in a box! See Fig 1. Jim (WD8JCI) Orihood and I mounted all my equipment in a plastic milk crate.[1] (He did most of the work; I assisted.) We laid the crate on its side and cut an 11-inch square out of its bottom. The cut-out crate bottom, with its 1-inch rim, becomes the box's back. The cutout allows access to the gear's rear-panel connectors. The crate's open top serves as the box front. A piece of ¼-inch plywood, fastened with screws to the box bottom, serves as a base for the bottom-most rig (a Yaesu FT-757GX in my setup).

Fig 1—Charlie Cotterman and his milk-crate mobile, in place and operational. The milk crate holds MF/HF and 2-meter transceivers, straight key, and speakers in a compact package that's as useful—and fun—at home as it is on the road. Charlie's "Salt, Sentiment and Solid-State" (*QST*, July 1990, pages 52-53) described just one of the adventures he's had with this setup.

Small-diameter bungee cords, hooked through screw eyes driven into the board, hold the '757 in place.

Another piece of ¼-inch plywood, held in place with wood screws and two ½-inch-square wood-molding rails, serves as a shelf two-thirds of the way above the box bottom. This shelf supports my 2-meter transceiver (a Kenwood TR-7850, underslung in its mounting bracket) and an MF/HF antenna tuner (an MFJ-949D, force-fit into place between the shelf and box top, as allowed by the box's flexible plastic). Placing the tuner flush with the box's right side leaves just enough space to bolt a small straight key (yes, I operate mobile CW) to the shelf between the tuner and the left box wall. (You can't see the key in Fig 1 because I also use this space to hold notepads.) The '7850's bottom clears the '757's top by about ½ inch. I positioned the '7850 to allow access to the '757's top-mounted keyer controls.

This compact installation blocks both radios' internal speakers. Two car-stereo speakers, one for each rig, installed on a

[1]Available in various colors at home-improvement, kitchen and variety stores.

piece of plywood cut to clear the crate's handle holes and secured to the crate top with wood screws, take their place and provide good mobile audio.

Power for the station box comes directly from the car battery via #12 wire, with a holder-mounted 30-ampere fuse installed in series with each lead as close to the battery terminals as possible. Two terminal strips on a small piece of plywood (kept under the dashboard on the package tray in front of the passenger seat) provide access to this bus. All of the box's 12-volt feeds come off this board via connectors made from General Motors alternator-cable extenders.[2] These are insulated, locking polarized plugs with color-coded #14 leads. I cut the stock assembly in half and lock its plugs together.

The station box sits in the passenger seat and can be secured with the seat/shoulder belt. The angled speaker enclosures direct sound toward me, and operating the equipment controls doesn't distract me from driving. (With safety in mind, however, I preset as many equipment functions as possible before starting a trip.)

When I come home, all the radios stay in the crate—the whole thing sits on the shack table as is! My station power supply's connectors duplicate those used between the station box and the car electrical system, so nothing needs to be removed or rearranged.—*Charlie Cotterman, KA8OQF, Dayton, Ohio*

[2]Sold in auto-parts stores, in bubble packs, usually on the accessories rack. The cables are made by Motormite Manufacturing.

HUMP MOUNT FOR MOBILE RIGS

☐ Most of us have a hard time deciding where and how to mount a mobile transceiver in a new vehicle. It seems that car manufacturers generally overlook radio operators when laying out cockpits and dashboards! Fig 2 shows how I solved this problem for vehicles I've purchased in recent years: a simple way to mount a small transceiver over the car's transmission hump—*without* drilling holes in the dashboard or front-seat floor.

Use a fairly thick piece of sheet metal to form a U-shaped base capable of straddling the hump. Bolt the rig's mounting bracket to the base's top surface. Proportion dimension C to be slightly narrower than the hump width at floor level. This permits you to spring out the mount's sides when installing it over the hump.

The first time I used this mount, I did not think to install the six sheet-metal screws shown in Fig 2. Consequently, the transceiver-and-mount combination tilted forward when I braked! The sheet-metal screws bite into the car's floor mat or carpeting, keeping the entire package solidly in place.

You may want to make dimension B shorter than dimension A. This allows the transceiver's front panel to tilt upward, making its controls and display easier to see.

I use this transceiver-mounting technique in my 1989 Grand Marquis, and found it to be entirely satisfactory in a Pontiac Bonneville and a 1986 Buick Century Ltd. Mounting your rig this way offers another advantage: You can easily remove transceiver and mount from the car to prevent theft while keeping your gear in good shape. (Normally, constant removal and reinstallation of a mobile transceiver and its mounting bracket leads over time to scratches and mars on the rig's case. The system shown in Fig 2 avoids this.)—*Doug DeMaw, W1FB, Luther, Michigan*

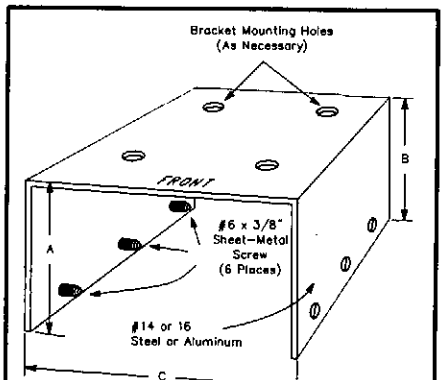


Fig 2—Doug DeMaw's hump mount keeps a mobile rig in place with the help of sheet-metal screws that prevent the mount and rig from sliding during speed changes and turns. No dimensions are shown because you'll need to tailor the assembly to the size of your car's floor hump.

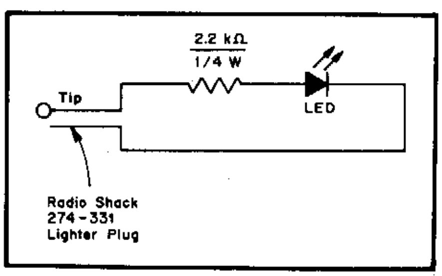


Fig 3—Lin Cook's cigar-lighter polarity tester uses just three parts.

A CIGAR-LIGHTER POLARITY TESTER

☐ Before you plug your equipment into the cigar lighter of your new (or an unknown) car, it's a good idea to test the lighter polarity. Fig 3 shows a simple means of doing this. The circuit tests for a center-positive condition at the lighter; if the lighter is powered, and +12 volts is connected to its center contact, DS1 lights. Carry this gadget with your "pluggable" 12-V gear; it could save your transceiver from a quick demise!—*Lin Cook, W1JRS, 788 Highland Ave, S Portland, ME 04106*

MOBILE COOLING FAN SENSES RF

☐ Some compact, high-power VHF transceivers get very hot when transmitting and can benefit from forced-air cooling. The simple circuit shown in Fig 4 helps such radios cool themselves. It senses RF leakage from coaxial cable and turns on a cooling fan whenever the radio is transmitting.

I tested this circuit with Belden RG-58C and Tandy RG-8M (foam-dielectric miniature RG-8) cables. The Tandy product exhibits about twice the leakage as the Belden; about 5 watts into such coax at 2 meters turns the fan on reliably.

Inductor L1 consists of 10 turns of insulated hookup wire—#20 to 24—wrapped tightly around the coax and taped into place. You need not alter the coax in any way. (Although my test circuit worked well with 10 turns, your version may work better with more or less turns. You can optimize L1 by connecting a voltmeter across R1 and adjusting L1 for a peak reading while transmitting.)

D1 rectifies the signal. C1 filters the resulting dc, which is applied to Q1's base to turn Q1 on. R1 keeps Q1 turned off during no-drive periods by pulling Q1's base to ground.

Q1, a National Semiconductor ultrareliable power transistor, has built-in thermal-overload protection and current and power limiting, making it almost impossible to destroy. The LM395 is available from Digi-Key, 701 Brooks Ave S, Box 677, Thief River Falls, MN 56701-0677 (telephone 800-344-4539, fax 218-681-3380).

B1 can be any small dc fan, such as Radio Shack's 273-243 or 273-244. I've

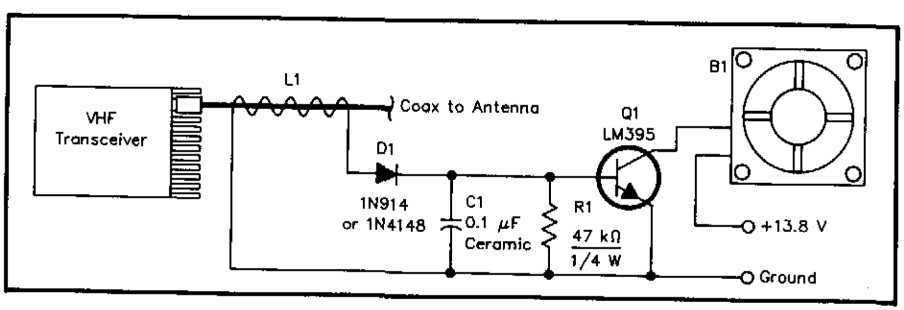


Fig 4—Jay Hamlin's circuit senses coax RF leakage—and perhaps outside-of-shield currents—to drive a transistor that turns on a cooling fan. The text tells more about the parts and what they do.

found that even a tiny fan can cool a small radio.

The circuit has other uses. For instance, it could drive a **TRANSMITTER ON** indicator to warn you that your mobile mike is jammed between your car's seats with its push-to-talk button held down. Or, combined with a timer, it could serve as part of a transmitter-time-out warning circuit. —*Jay F. Hamlin, WB6HBS, Capitola, California*

BUILT-IN GRILLE EASES MOBILE-SPEAKER MOUNTING

☐ The first day I drove my new pickup truck at work, I realized that my mobile rig needed an external speaker. After considering places to hang one, I noticed two unused speaker grilles in the truck interior. (The truck's broadcast radio uses only the dash speakers, leaving an unused grille in each back corner.) Positioned right about at ear level, they looked perfect for my application. I popped off the driver's-side grille and found that it was made for a 4- × 6-inch speaker. I drilled two mounting holes, fastened such a speaker in place with sheet-metal screws, and popped the grille back in place. My truck still looks exactly as it came from the factory, but now I can easily hear what's happening on the local repeater.—*Michael K. Clemons, KE5NU, Rte 1 Box 2380, Warner, OK 74469*

NOISE CURED IN FORD TAURUS MOBILE

☐ My 1987 Ford Taurus sedan generated strong electrical noise at HF and weaker noise at VHF. Although the noise resembled ignition interference, it did not change pitch with engine speed. I discovered that the noise came from the car's electric fuel pump. Eliminating the noise was easy once I determined how to access the pump power leads.

The Taurus's fuel pump is mounted inside the car's fuel tank. The pump power leads pass through the floor under the right end of the rear bench seat. You can identify the pump leads as heavy-gauge wires, one red and one black, in a four-wire harness that can be accessed by removing the bench seat and lifting the carpet under the seat.

I eliminated the noise by carefully stripping short sections of the pump power leads and soldering a 0.47-μF, 100-volt polyester-film capacitor from lead to lead. (I also grounded the black lead by connecting it to the car frame with about a foot of insulated #14 copper wire fastened underneath a nearby bolt that holds the seat back to the frame.) Wrap the capacitor connections with electrical tape and position the wires and capacitor to avoid short circuits. —*Jack Schuster, W1WEF, Glastonbury, Connecticut*

WJ1Z: Such modifications may void your car's warranty. If in doubt, check with your car's manufacturer before proceeding. A factory-authorized fix may exist for the problem.

FORD'S FIX FOR IN-TANK-FUEL-PUMP NOISE

☐ Having spent 23 years in the two-way-radio field, and because I own a Ford Taurus, I've seen the problem described by Jack Schuster ("Noise Cured in Ford Taurus Mobile") many times. Caution: The cure Jack describes may cause fires in rare cases. Luckily, Ford offers a fix for the noise—a fix that must be handled and installed by a Ford dealer. Have your dealer call Ford's RFI section at 313-323-2014 and ask for Mr. Pat Quinn; Quinn [who's WD8JDZ, by the way!—*WJ1Z*] and the dealer will take it from there. I have seen these filters installed in over 100 cars in the past three years; when the filter is correctly installed, the noise goes away. (This is not only a Taurus problem; all Ford cars with in-tank fuel pumps are affected. Ford's fix can be applied to all of them. The heater-fan motor in some Ford cars also causes noise; a Ford fix also exists for that, but I've been unable to determine Ford's contact person for it. In most cases, the dealer can cure this noise by changing the heater-fan motor.)

Without the filter, fuel-pump noise in my Taurus was 10 dB over S9 from 160 through 15 m; with the filter, I can copy S2 signals. In three years of mobile operation I have worked 5BWAS, WAC and DXCC—and my country total from the mobile now stands at 257. The filter works!—*Ronald E. Hesselbrock, WA8LOW, Cincinnati, OH*

A DC ADAPTER FOR HAND-HELD-TRANSCEIVER MOBILING

☐ My Kenwood TR-2500's battery pack wouldn't take a full charge: one of its cells was reversed, and "zapping" the defective cell made no improvement. What to do with a dead NiCd pack? Turn it into a dc adapter for mobile use! With a pocketknife, I separated the halves of the battery-pack case. I pulled out the cells, a PC board and a tiny switch. Then I built the circuit shown in Fig 5.

The LM317T regulator dissipates 2 or 3 W in this application, so I mounted it on a heat sink (a 1- × 2-inch piece of 1/8-inch-thick aluminum). I wired C1, C2, R1 and R2 of Fig 5 between the '317's pins and a two-terminal strip mounted on the heat sink. (No large filter capacitors are needed in this application because the input to the regulator is reasonably pure dc.) No fancy installation for this module: I just dropped it into the case!

I used thin microphone cable for the dc connection between the adapter and my car's cigarette lighter, passing it out of the adapter case through the hole formerly occupied by the battery-pack switch. At the cigarette-lighter end of the cable, I installed a fused lighter connector (Radio Shack no. 274-335) equipped with a 2-A, fast-blow fuse. (Note: After I finished constructing the adapter, I realized that I could have left the battery-pack charge connector in the case and used a Radio Shack dc power plug [274-1569] on the adapter end of the 12-V cable.)

Now, when I use the HT in the car, I rest my remaining battery pack and use the transceiver without having to worry when its battery pack will run down! If this idea appeals to you and you *don't* have a defunct NiCd pack, obtain a BT-1 or BT-3 battery case for the adapter and save your NiCds. A note on noise: Using the dc-adapter-powered HT in conjunction with a magnetically mounted "rubber duck" antenna, I've heard no spark plug or alternator noise on transmit and receive in the car.—*Evan H. Boden, N3DEO, Emporium, Pennsylvania*

MAGNETIC REED SWITCH ILLUMINATES HAND-HELD FOR MOBILE USE

☐ Most manufacturers of our hand-held transceivers have (wisely) made the display-

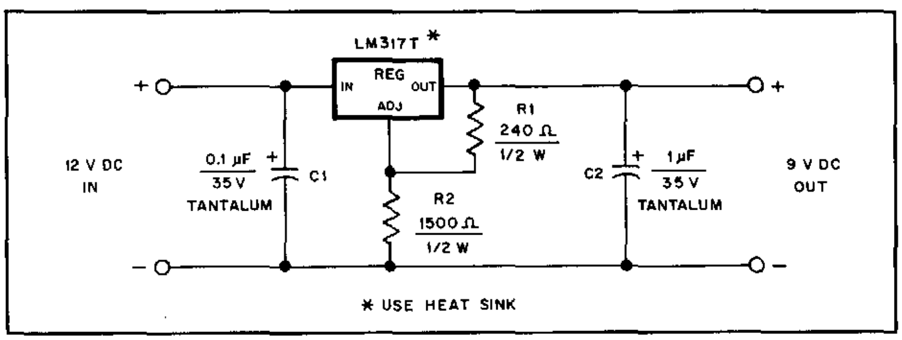


Fig 5—Evan Boden's dc adapter provides a regulated 9-V source for operating his Kenwood TR-2500 hand-held transceiver in the car. See text for information on the connectors he used at the input and output of the adapter, and details on the LM317T heat sink. (Note: The LM317T's mounting tab is electrically connected to its output pin, so take this into account as you construct your version of the adapter. Author Boden did not use an insulator between the LM317T and heat sink because his adapter module is safely insulated in the plastic case of a defunct NiCd battery pack.)

light switches in these rigs momentary so that we do not accidentally drain our batteries and find ourselves out in rabbit country without radio communication. Because my LCD-equipped Yaesu FT-411 hand-held serves in base-station, portable and mobile roles, its momentary-display-lighting feature is not always necessary or desirable. Continuous display lighting is particularly valuable during mobile operation at night. I decided to fiddle with my FT-411's lighting circuitry to make it momentary *and* switchable on/off. Studying the FT-411's service manual, I debated installing a subminiature phone jack, wired in parallel with the momentary display-lamp switch, along the side of the transceiver case, smothering the jack in silicone sealant and using a wired-shorted subminiature plug to turn my light on. It would work, but...

In a miniature blinding flash, a better idea struck me. I installed a tiny magnetic-reed switch, wired in parallel with the display-lamp switch, inside the FT-411's case. Then I taped a magnet to the rig's mobile mounting bracket to activate the switch. Now, when I slip the radio into its holder, its display light automatically comes on without any further action on my part. And I didn't have to drill any holes in the FT-411's case! The lamp generates slight heat, but this has caused no problems in my transceiver. The small magnet I use to activate the switch has no effect on programming or any other transceiver function. I intend to mount a magnet on a hinge at my base station so that I can select continuous display illumination at will, depending on the time of day.

Here are a few installation tips: Undertake this project only after acquiring and studying your transceiver's service manual; installing the reed switch may require tricky disassembly and reassembly. Pre-wire your reed switch very carefully and coat it and its leads with heat-shrink tubing to guard against vibration and short circuits. With careful soldering and a bit of luck, you'll just have sufficient room to install the switch inside your hand-held.—*Tom Turner, VO1TV, 7 Jervis Pl, St John's, NF A1A 3Z1*

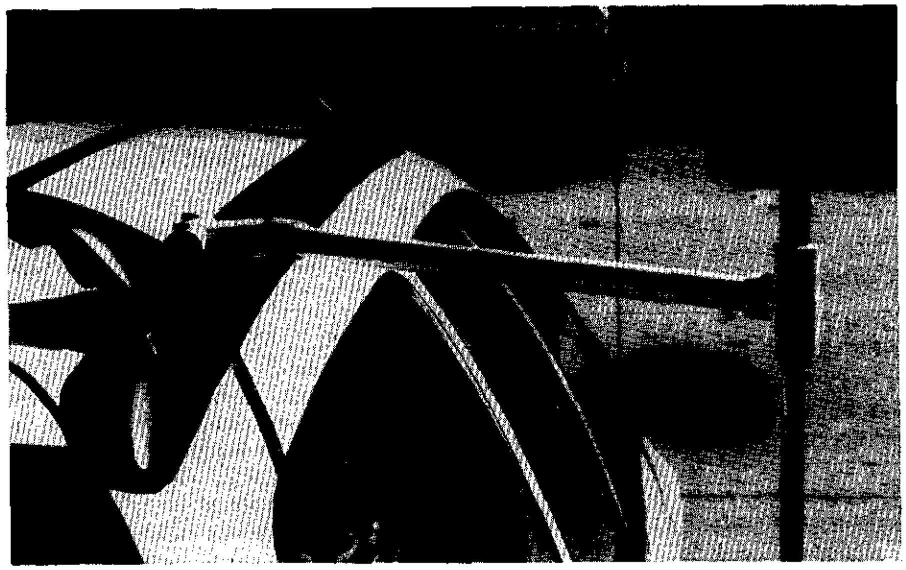
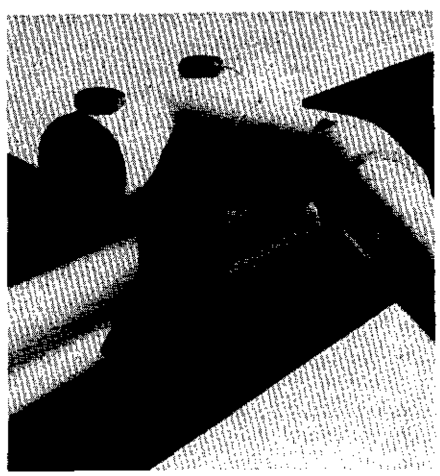
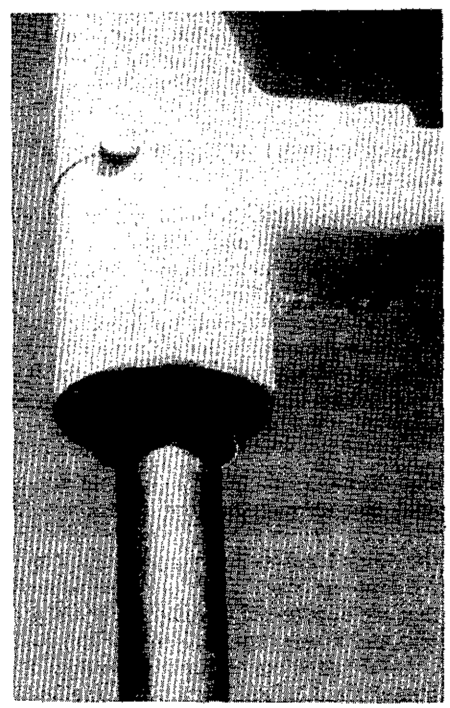


Fig 6—The ham antenna on Warren Gregory's station wagon looks like just another mobile vertical until a closer look reveals a PVC-pipe support at rooftop level. This arrangement keeps the antenna vertical regardless of driving speed, but still allows the antenna to be folded for garage and car-port parking. That 45° fitting at the roof rack angles the support arm backward to meet the Hustler just below its folding point. **T** fittings connect the arm to the roof rack and antenna. See the text and Fig 7.



(A)



(B)

Fig 7—At A, a close-up of the roof-rack end of Warren Gregory's mobile-antenna support arm. B shows the tight fit between the Hustler's slip lock and the antenna-mounted PVC **T**. This photo also shows the smaller-diameter PVC pipe Warren slipped inside the **T** to obtain that tight slip-lock-to-**T** fit.

STABILIZING THE MOBILE WHIP

☐ One of the problems faced by Amateur Radio operators who operate MF/HF mobile is keeping a car-mounted whip antenna vertical and stable while driving. In this contest with the wind, a vertical antenna may be more horizontal than vertical much of the time!

Some hams just surrender and work only VHF/UHF mobile. More-persistent MF/HF mobileers remain on the low bands, guying their antennas with monofilament fishing line or small-diameter cord. (I tried this with my rear-fender-mounted Hustler mobile antenna. It worked, but my wife disapproved of the practice, and often the string sang as I drove at highway speeds. When the front guy broke on Interstate 70, I thought very strongly of going to 2 meters!)

With the help of Werner Dolder, AA4IX, I devised a solution to this problem. See Fig 6. A PVC-pipe arm, attached to my station wagon's roof rack, supports the Hustler at its fold-over point, holding the antenna vertical and immovable.

I began constructing the support by carefully measuring the distance between the Hustler's fold-over point and the roof rack—at a 45° angle relative to the car body and to the antenna. After figuring where the arm would attach to the roof rack, I prepared a PVC **T** to fit the roof rack by filing a flat on one side of the **T** for a closer fit with the rack. To make this **T** more resistant to the pressure of its mounting bolts, I force-fit a piece of smaller-diameter PVC pipe through the **T**'s cross bar and glued it into the **T**. After the glue hardened, I drilled two mounting holes through the **T**'s cross bar—one near each of the cross-bar ends. I didn't have to drill holes in the car or the roof rack to mount this **T** to the car: I just dropped two square nuts into the roof-rack track and turned two stainless-steel bolts through the PVC **T** into the nuts. So far, so good!

Next, I glued a 45° PVC joint to the leg of the **T**, with the angled joint pointing back toward the antenna (Fig 7A).

I reinforced a second PVC **T** by forcing a piece of smaller-diameter PVC pipe through the cross bar, gluing it in and drilling it to fit the Hustler's slip lock. Then I slid this **T** up the antenna mast to the antenna's fold-over point, pushing the slip lock inside the cross bar (Fig 7B). (The slip lock must fit very tightly in the **T**.) I glued the slip lock in place.

I completed the support arm by cutting a piece of PVC pipe to connect the roof-rack- and antenna-mounted **T**s and gluing this pipe into place at both ends.

I have used this PVC-pipe-supported Hustler on my car for six months—many times with all five resonators installed at once—with fine results. The support holds the antenna vertical and allows very little movement; yet, the antenna can still be folded at its fold-over point by tapping on the PVC cross bar to slide the slip lock down. Total cost of the project: under ten bucks.—*Warren Gregory, W4ZYZ, 1006 W Recess Rd, Hanahan, SC 29406*

A HORIZONTALLY POLARIZED 2-METER MOBILE ANTENNA

☐ Other amateurs may be interested in this mobile antenna I use for SSB operation. Mine is mounted on a mast 19 inches above an old "mag mount." When leaving the car, I simply place the antenna and mount in the back seat—out of harm's way.

Brass tubing is available in some hardware and hobby stores.[3] It comes in sizes from 1/16 to 21/32 inch outside diameter (OD), in 1/32-inch steps. Each size slip fits within the next larger size. It is usually sold in 12- or 36-inch lengths.

The antenna is made from two 12-inch lengths of 5/32-inch tubing and two 12-inch lengths of 1/8-inch tubing. A V-shaped horizontal dipole is formed when the tubes are mounted through a short piece (6 inches or so) of 7/8-inch OD plastic pipe (see Fig 8). I made it V shaped to reduce the overall size and provide a better match to my 50-Ω coax.

Begin by drilling two 5/32-inch holes through the plastic pipe at right angles to each other. (Position one hole slightly below the other so that the dipole elements cross inside the plastic pipe without touching.) Enlarge the holes of two solder lugs and force each over one end of the 5/32-inch tubes and solder them in place.

[3]You can also mail order the tubing from Small Parts Inc.

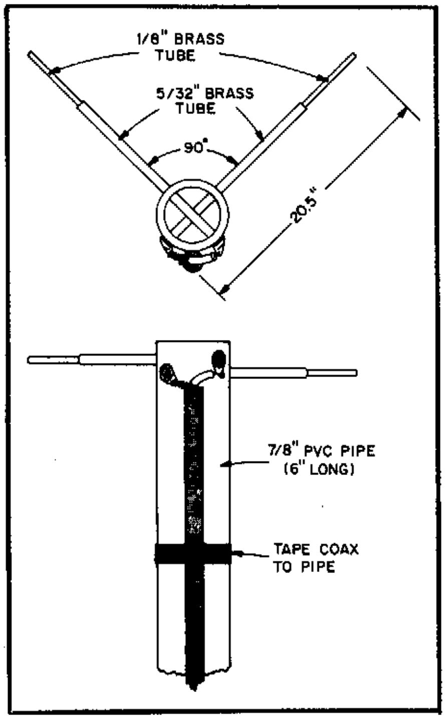


Fig 8—W5LAN's 2-meter mobile antenna.

Push the other end of those tubes through the holes in the plastic pipe until the solder lugs are flush against the pipe. Strip the end of a length of coax, then solder the braid to one solder lug and the center conductor to the other. Use sealant to weatherproof the coax end and feed point.

The antenna is adjusted to resonance by sliding the 1/8-inch tubing in and out of the larger tubing to achieve minimum SWR. If the fit is too loose, nick the end of the smaller tube slightly with diagonal cutters, and force it into the larger tubing. After performing the adjustment, cut the smaller tube to a length that leaves about an inch inside the larger tube and solder it to the larger tube. The element lengths on my antenna are about 20.5 inches each, and the SWR was near unity over most of the 2-meter band, with a slight rise at the high-frequency end.

My antenna was once mounted on the mast of an existing HF mobile bumper mount. It worked well in both locations, but I prefer the mag mount.

I have used this antenna, on numerous occasions, to maintain contact with my XYL on trips of 150 miles or so (with an 80-W amplifier at each end and a 45-ft-high 12-element beam at the fixed station). —*Marland M. Old, W5LAN, New Boston, Texas*

A WINDOW-MOUNTED TAPE ANTENNA FOR 440-MHz MOBILING

☐ How could I have 2-meter and 70-centimeter mobile capability *and* keep my new Camaro from looking like an antenna farm? I tried a dual-band antenna, but it was relatively massive and did not have a low-enough profile. I reinstalled my window-mount 2-meter antenna and devised a 440-MHz antenna—made of self-adhesive copper tape and mounted in the rear window of the Camaro!

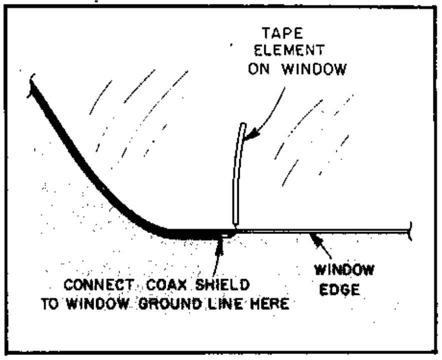


Fig 9—Carl Sorensen's copper-tape antenna works well and unobtrusively at 440 MHz. The tape element may require pruning; see "Burglar-Alarm Tape Antenna" (on p 7-28) for details on how to do this. Carl reports that later installation of rear-window louvers on the Camaro required only that the antenna be retuned; antenna performance was unaffected.

See Fig 9. Actually, only the vertical element consists of tape. The end of the coax shield is connected to the car's window-edge ground line; this serves as a ground-plane. Result: a simple 440-MHz antenna that works quite well for local use. It doesn't even look like an antenna when examined closely: Most people think the copper tape has something to do with a car alarm!—*Carl G. Sorensen, KA7ANM, Meridian, Idaho*

REPLACE THE CONNECTOR, NOT THE ANTENNA

☐ The BNC plug on my magnetic-mount antenna's cable became defective, but I couldn't locate a suitable replacement. (BNC plugs are common for RG-58 and RG-59 size cables, but not for RG-122 [outer diameter, approximately 5/32 inch]).[4]

I solved this problem by installing an F connector, with an external crimp ring, to the RG-122 cable. First, I tinned the cable's stranded center conductor to make it rigid enough for insertion into the center pin of the F-to-BNC adapter. (You may need to slit the cable jacket to make room for the F connector. If so, use black heat-shrink tubing to improve the connector's appearance and seal the slit jacket against weather.) An F-female-to-BNC-male adapter (Radio Shack number 278-251) completes the replacement.

Although this new connector arrangement is slightly bulkier than the original BNC, it works well. It costs a lot less than replacing the whole antenna!—*Howard T. Atlas, NE2I, Massapequa Park, New York*

[4]Amphenol BNC plugs 31-3303 (a clamp connector), 84975 (clamp) and 31-4425) (crimp) match RG-122 cable, but seem not to be commonly stocked for purchase in small quantities.—*WJ1Z*

A MAG-MOUNT PLATE FOR NONFERROUS VAN AND RV BODIES

☐ Mag-mount antennas are very handy as they can be quickly removed from a vehicle. Such antenna mounts, however, do not work with aluminum or fiberglass RVs, trucks, trailers or truck "caps." I added a steel panel to the roof of my aluminum RV so that I can now use a mag-mount antenna.

First, find a suitable steel sheet to become the mag-mount plate. (Mine was salvaged from an old VFO cabinet.) Choose an easily accessible spot for the steel plate on the vehicle body. Thoroughly clean both the plate and its new home on the RV top. Use a heavy weight to hold the plate in place and seal the edges with a thick epoxy (I used one called "PC-7"). When the epoxy has cured, the steel plate and the aluminum roof will be firmly bonded together. Protect the steel panel from rust by painting it after the epoxy has cured.

A friend who works in a body shop assures me that a steel panel may be fastened to a fiberglass body in the same fashion. The plate and the spot where it is to be affixed should be roughened prior to bonding, and the epoxy should be applied over the entire metal surface, rather than just around the edges. Also, the plate should be of adequate size to form a reasonable ground plane.—*Leslie Sterling, K7GL, Bigfork, Montana*

PREVENTING SCRATCHES FROM MAGNETIC-MOUNT ANTENNAS

☐ For many years, I accepted car-finish scratches caused by my magnetically mounted 2-m mobile antenna because the victim was my old station wagon. The purchase of a new car, however, made me reexamine this problem! Some newer magnetic mounts incorporate protection for the vehicle finish, but I didn't want to purchase a new mount for this reason alone. The solution is simple: Place a small polyethylene bag around the magnetic mount. If necessary, cut a small hole in the bag to pass the antenna element.

Before taking the antenna for a drive, test it to be sure that the magnetic attraction between car roof and mount is strong enough to secure the antenna with the plastic bag in place.—*George G. Manning, K2RRR, Amberlands #27-E, Croton-on-Hudson, NY 10520*

PREVENTING MORE SCRATCHES FROM MAGNETIC-MOUNT ANTENNAS

☐ I agree that a surface protection (consisting of polyethylene or another material) can help keep a mag mount from scratching car-finish paint (G. Manning, "Preventing Scratches from Magnetic-Mount Antennas"). But I've found that the *real* problem is grit and dirt that accumulates between the mount and the auto body. After having tried new protective materials with numerous magnetic mounts, I think the best solution is to start with a new surface protector and clean the dust off the paint and protective material *daily*.

Plastic bags won't scratch clean paint. New magnetic mounts won't scratch clean paint. Even old, rusty magnetic mounts won't scratch paint very much if there is no dust or dirt between them and the body surface. Keeping your car and the magnetic mount clean is the best insurance against scratches.

One more hint: *Don't ever* place a mag mount across a body joint (such as that between the hood and fender). No matter how well-built your car is, its adjacent surfaces vibrate relative to each other when the engine is running. A mag mount placed across body joints will scratch down to the undercoat in less than a week on an average car!—*Howard M. Lang, KB6NN, 3124 H St, Eureka, CA 95501*

MAG-MOUNT SURFACE MAINTENANCE

☐ Although magnetic antenna mounts are intended to serve as temporary antenna supports, many hams use them for permanent installations. As a result, stories of mag-mount-related paint damage abound. You can minimize such damage and, with a little care, keep the paint beneath a magnetic mount free of scratches for many years. Here's how.

First, prepare the mounting surface by wiping any grit away with a damp cloth or soft rag. Wipe it again with your hand. (Your sense of touch may be able to detect small, sharp particles that might be present.) Next, apply a coat of clear, hard automobile wax to the mounting surface.

Wipe the waxed mounting surface as just described. Check the bottom of the mount to ensure that metal filings or anything that might scratch your car's paint hasn't been trapped by the mount magnet or under the magnet's protective surface coating. If in doubt, clean the bottom of the mount, and clean the waxed mounting surface again. Install the mount.

Wipe the mount and mounting surface regularly (daily or weekly, depending on how dusty or dirty your commute is). This lessens the chance of grit getting trapped under the magnet and scratching the surface from normal vibration. Clean the mount and mounting surface as soon as possible after driving through a dusty or sandy region, or on roads used by sand or gravel trucks.

Don't rotate the mount when removing it from the car. Force it *straight up* from the car by its edge. This reduces the lapping-wheel effect that occurs if you rotate the mount to remove it.—*John G. Boles, KA6LWC, San Jose, California*

CHAPTER 4

Portable Stations

MAKE YOUR OWN QRP CARRY-ALL

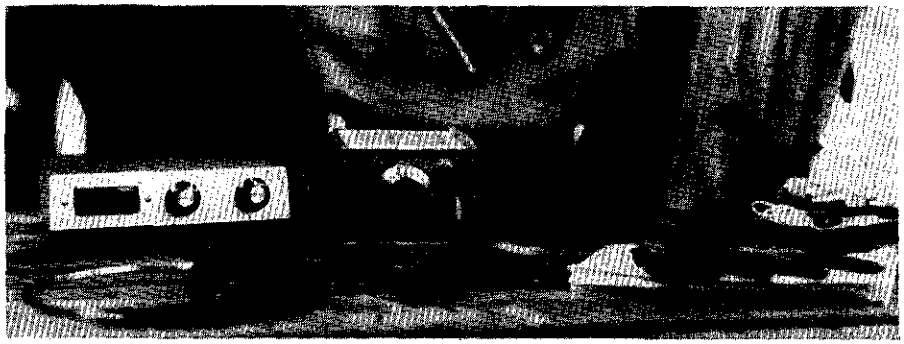
☐ One of the great things about QRP is that it really opens up the possibility of go-anywhere operation. Recently, I've been taking my gear with me in style in my QRP Carry-All bag (Fig 1). Besides holding my gear, it's a great way to "fly the flag" because it displays the League diamond and a Michigan QRP Club patch. The Carry-All makes a home construction project that requires absolutely no debugging and no test equipment!

An uncle in England gave me a British school bag—similar to an American canvas knapsack—that was just the right size for my W7EL transceiver, battery box and assorted portable-operation-materials kit that I've assembled for my QRP ramblings. I based the QRP Carry-All on this bag. The assembly instructions? Simply dress it up with a couple of patches!

You don't even need to sew. Acquire a suitable bag or day pack. Then, using iron-on adhesive (intended for hemming garments, and available at fabric stores and variety-store notions counters), apply ham-radio-related patches to the bag. Such patches are available from many sources; ARRL sells an eye-catching ARRL-flag patch, as well as ARRL-diamond patches of two different sizes. The Society of Wireless Pioneers and other organizations also offer beautiful patches.

When not toting a portable station, the QRP Carry-All is also great for holding small hamfest purchases. Carried during air travel, the bag invariably attracts the attention of other traveling hams, who stop by for conversation. Combined with my windbreaker, which sports Society of Wireless Pioneers patches, the QRP Carry-All has sparked many impromptu meetings.—*Doug Stivison, NR1A, 45 Norman Rd, Upper Montclair, NJ 07043-1933*

Fig 1—Doug Stivison's QRP Carry-All is just the thing for toting a compact, battery-powered QRP station (below) into the sticks. Those ham-radio-related patches aren't just for show: Especially on air trips, their "Amateur Radio Spoken Here" message lets other traveling hams know that another of their own is near.



A TRAVEL CASE

☐ I transport my Kenwood TS-130S transceiver and accessories in a discarded typewriter case. It came from a Smith Corona® of mid-1960s vintage, and seems ideal. A "tricked-up" mount lets the TS-130 lock in place just as the typewriter did. Since the case is much taller than the radio, I store logs, connecting cables, a paddle key, "homebrew" keyer and so on inside the case with the radio.—*Timothy N. Colbert, Burton, Ohio*

A CHEAP, CRUSHPROOF CARRIER FOR DXPEDITION ANTENNAS

☐ A recent trip to the Caribbean forced me to come up with an inexpensive solution to transporting an antenna. A dipole and coax fit nicely into a suitcase, but taking a multiband trap vertical or small tribander requires a different arrangement.

Airlines seem to consider anything over six feet long as oversized baggage, and sometimes charge extra for special handling of such items. Ideally, then, a DXpedition antenna should be less than six feet long, broken down. If an antenna is shippable via United Parcel Service, its longest component *will* be less than six feet long, but its shipping carton *will not* be suitable for travel on airport baggage trucks. (Watching from my plane seat at a Caribbean airport, I saw a cardboard box on a baggage truck literally fall apart in the rain.)

The solution to this problem can be found at your local building-supply store. Buy a 10-foot piece of 4-inch-diameter solid (not slotted) PVC pipe and two end caps. Cut the pipe to the size you need (remember that 6-foot baggage limit!). Put the end caps on the pipe and drill two ¼-inch holes, 180° apart, through the caps and pipe at each end of the pipe. Pass no. 14 (or so) steel wire through one of these assemblies to secure the cap to the pipe. (See Fig 2.) (Once you've loaded your antenna into the pipe, of course, you'll need to wire the other end shut, too.)

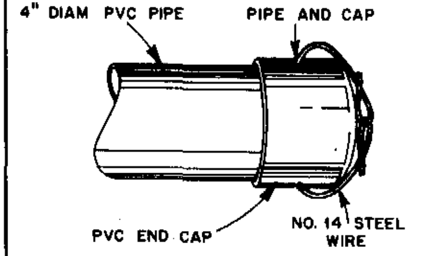


Fig 2—K1KI's crushproof carrier for DXpedition antennas consists of less than $6 worth of PVC pipe, end caps and wire. This drawing shows one end of the assembly.

You may need to experiment to get everything to fit into one of these containers. For example, a Hy-Gain 18AVT multiband vertical with an extra five-foot mast fits fine except for the base bracket (I carried the bracket in my suitcase). Next time, I'll try a small tribander! Hint: Don't forget to take a photocopy of the antenna manual and the tools you'll need to assemble and disassemble the antenna.

The PVC pipe I purchased carries the message "2000 LBS MIN CRUSH," so even the airlines aren't likely to damage it! The total cost for all materials: under $6.—*Tom Frenaye, K1KI, Unionville, Connecticut*

MORE ON A CHEAP, CRUSHPROOF CARRIER FOR DXPEDITION ANTENNAS

☐ Concerning Tom Frenaye's antenna carrier ("A Cheap, Crushproof Carrier for DXpedition Antennas), I offer these suggestions:

Domestic airlines limit baggage length to 6 ft, but, having flown the Pacific carriers, I caution that:

1) International flights generally accommodate only *two* pieces of baggage;

2) *Total* dimensions of *both* pieces cannot exceed 107 inches (width + height + length); and

3) Neither of the two pieces can exceed 64 inches (so 6-ft pieces are *out).*

I use PVC-pipe antenna carriers on all of my DXpeditions, and suggest using 6-inch OD pipe 52 inches long (for a total carrier length of 64 inches) to be safe. A 6-inch-OD carrier can contain a three-element beam if you carry the beam traps, mounting plate and guys in your second piece of luggage. (You can remove manufacturer's lettering from PVC pipe with acetone, by the way. Also, it may be worth your while to ask around at building sites for carrier material; you may be able to obtain usable scrap pipe free of charge.)

Instead of pipe end caps, I seal my antenna carrier with ¾-inch-thick plywood disks and self-tapping screws. These add strength to the assembly and reduce its weight over that of a pipe-cap-sealed version.

To make the carrier more "carryable," attach an inexpensive luggage handle (or a piece of rope) to the carrier with stainless-steel hose clamps. If you expect to walk a considerable distance with the carrier, carry a suitable shoulder strap in your luggage and attach it to the carrier as appropriate. —*James Sansoterra, K8JRK, 801 S Oxford, Grosse Pointe Woods, Detroit, MI 48236*

AK7M: A call to ARRL's travel agency netted the following: Although the "no more than two pieces" limitation is more or less standard for international flights, baggage size and weight limitations may vary with the carrier and route, and with the aircraft used. Bottom line: If you're planning a DXpedition, work closely with your travel agent to be sure you can bring the gear you need.

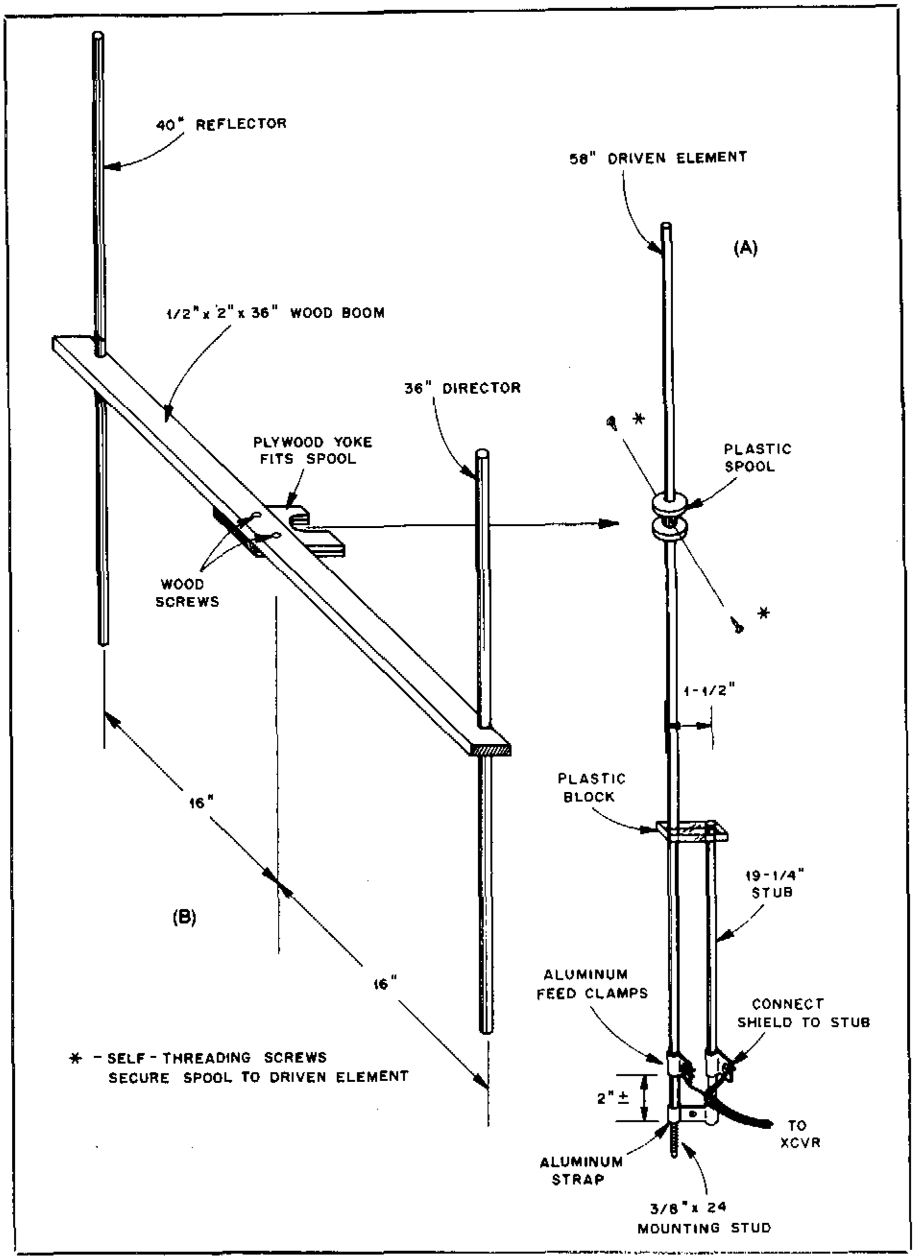


Fig 3—NT4B's beam antenna. The J pole is used without the parasitic elements for normal mobile operations (A). A plastic spool is attached to the J pole with screws. A wooden boom (B) with parasitic elements slips onto, and rotates about, the spool. The base of the J pole has a 3/8-24 stud to fit common ball antenna mounts, an aluminum tie strap and sliding clamps at the J-pole feed point. Adjust the clamps for the best SWR without the boom attached. All tubing is ½-inch-diameter aluminum. Varnish all wood parts to protect them from weather. Secure the parasitic elements to the boom and the plastic block to the J with silicone caulk.

A PORTABLE 2-METER BEAM ANTENNA

☐ As a RACES member, I need a quickly assembled 2-meter beam antenna. This could be accomplished easily by adding parasitic elements to an existing mobile antenna. Fig 3 shows a novel, portable, 2-meter antenna based on that premise.

I begin with a homebuilt J-pole antenna that has several features to recommend it: (1) It performs as well as a commercial roof-mounted 5/8-λ whip; (2) it is small enough to clear highway obstructions; and (3) it requires no ground plane for proper operation. It is made of a 58-inch piece of ½-inch aluminum tubing. A 19¼-inch piece of similar tubing makes up the matching section (stub). The J pole is constructed by mounting a strap of aluminum to the bottom of each piece of tubing and an insulator made from a scrap of plastic at the top of the stub. Keep 1½ inches between element and stub. I forced a mounting stub from a broken mobile mast section into the bottom of my J pole to make for easy attachment to an existing ball mount.

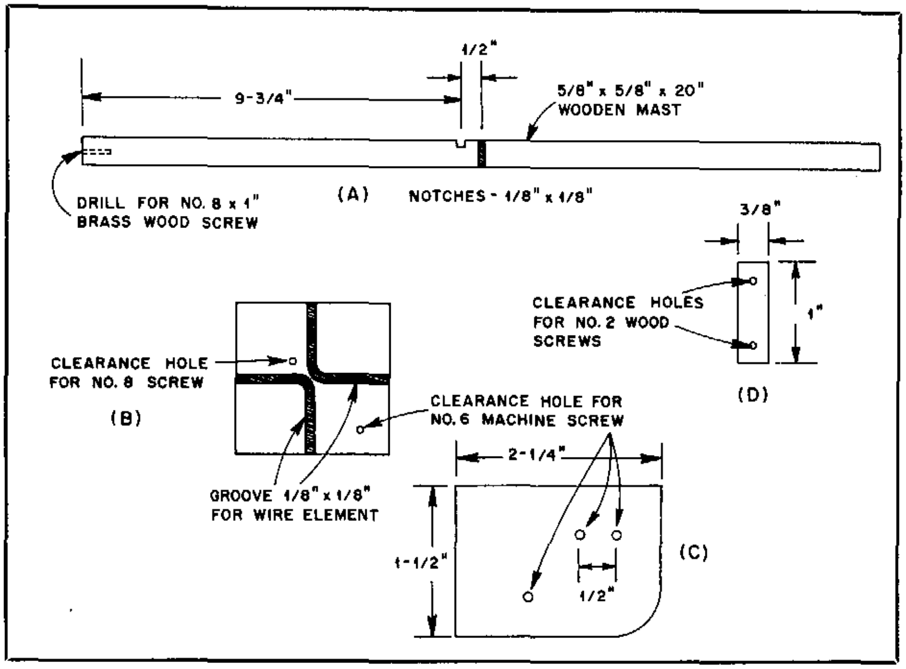


Fig 4—Construction details of the mast (A), top mount (B), feed-point insulator (C) and lower element clips (D) of WA8ZVT's compact 1λ 2-meter antenna.

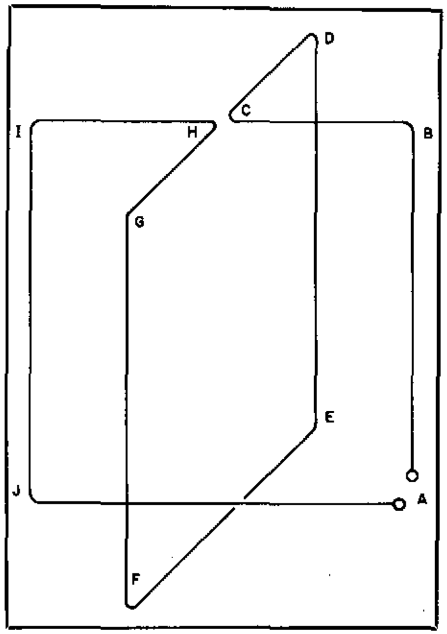


Fig 5—The wire element of the Egg-Beater antenna. Position the bends thusly: A to B, 10 in; B to C, 5 in; C to D, 5 in; D to E, 10.5 in; E to F, 10 in; F to G, 10.5 in; G to H, 5 in; H to I, 5 in; I to J, 10 in; J to A, 10 in. The bends at points H and C should fit the grooves in the top mount.

The antenna is not fed from the ball, however, but with a separate feed line attached to the stub with straps made of scrap aluminum. Vary the tap point on the stub until the best SWR is achieved (about 2 inches up from the bottom on my antenna).

The reflector and director elements are fastened to a 36-inch boom. Also connected to the boom is a small plywood yoke that fits snugly into a spool mounted on the driven element. The parasitic elements easily clear the body of my compact, hatchback car as the beam is rotated.

For emergency or portable operation, it is easy to pull into a rest stop and attach the boom to give your signal a significant boost. It is a big help to work that distant repeater or get back to the RACES control station when far out in the field. The antenna can be used on Civil Air Patrol frequencies as well. It seems to operate well from 146 to 148 MHz.—*Jim Brenner, NT4B, Ocala, Florida*

A FULL-WAVE 2-METER ANTENNA

□ In 1972, as the 2-meter band was becoming popular, I was looking for an omnidirectional antenna that was small in size. I considered a λ/4 monopole, but did not use it because I prefer full-wave antennas. My experiments began with a full-wave length of no. 8 (AWG) aluminum wire. After bending it into several different shapes, the "Egg Beater" emerged. It is a full-wave antenna that fits inside an 11-inch cube. But it was *not* omnidirectional; my search turned to other options.

Two years later, I found the Egg Beater in my workshop and started to experiment with it again. After a few changes, I came up with the antenna shown in Figs 4 and 5. It is small and provides both horizontally and vertically polarized radiation components. It is easy to build and small enough to use in an apartment window. Try building one—it's great!

A 5/8-inch-square, 20-inch-long wooden mast supports the wire element. Notch the mast and fabricate the top mount, clips and feed-point insulator as shown in Fig 4.

The top mount clamps curves C and H of Fig 5. Cut 1/8-inch-deep grooves into a 2-inch square of ¼-inch-thick Bakelite™ for the lower plate of the mount and a similar (ungrooved) square of 1/8-inch-thick scrap plastic for the top plate. [Mine was three layers of 1/8-inch plastic (glued together) with the center layer composed of four small squares arranged to hold the element.—Ed.] Use 1/8-inch scrap plastic for the feed-point insulator and element clips as well. Hole locations are not critical in any of the antenna parts.

Cut an 82-inch-long piece of aluminum

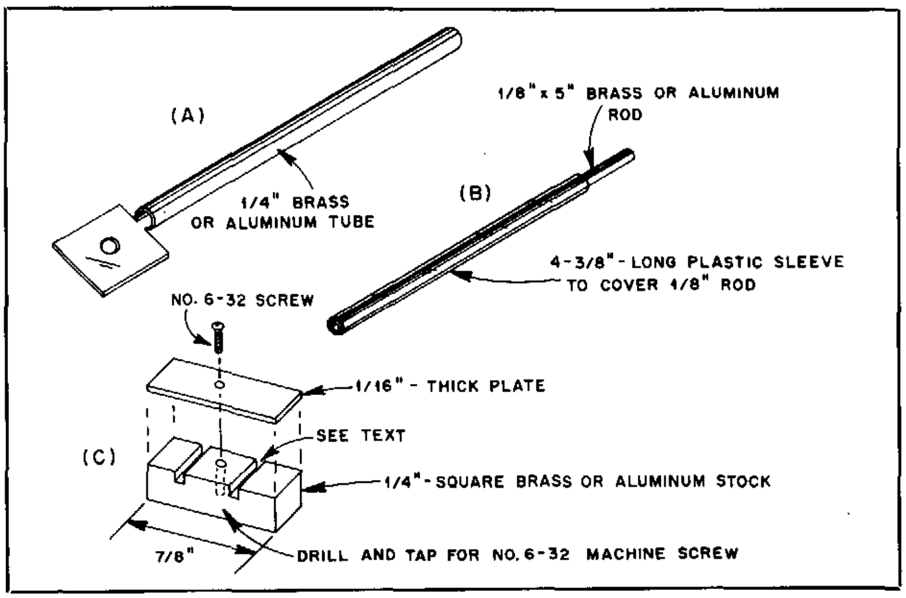


Fig 6—The matching system consists of an outer tube (A), inner rod with insulating sleeve (B) and rod-to-element clamp (C).

wire, and clamp one end in a vise. Tighten the other end in the chuck of an electric hand drill. Pull on the wire, and twist it straight by running the drill in short bursts.

Bend the wire into shape as shown in Fig 5. Assemble the top mount around the element and mount the feed-point insulator at the element ends. Mount the element on the mast so that its lower parts rest in the mast notches and fasten the top mount to the mast end with a brass machine screw. Install the plastic clips (using no. 2 × 3/8-inch brass wood screws) so that they hold the element into the mast notches.

Fabricate and assemble the parts of the matching system as shown in Fig 6. (The tubing and rod needed for the matching system can be salvaged from a "rabbit ear" TV antenna if you have one laying around.) To make the outer tube, measure about 5/8 inch from one end and make a partial cross cut so that the small end section is not removed, but can be flattened without distorting the rest of the tube. Flatten the tube end and drill it to clear a no. 6 machine screw. Insert the small rod into the insulating sleeve and the sleeve into the large tube. Fasten the large tube to the third hole in the feed-point insulator with a no. 6 machine screw and nut. Size the grooves in the rod-to-element clamp to provide a snug fit for the rod and element. Install the clamp on the rod and element. Connect the feed-line center conductor to the no. 6 screw at the large tube and the shield to the other end of the element. Adjust the clamp location for minimum SWR. Finally, paint the antenna well to weatherproof it. *—Joseph Masek, WA8ZVT, Garfield Heights, Ohio*

Editor's Note: WA8ZVT's antenna is very intriguing. Imagine, for example, a 20-meter antenna that fits in a 9-ft cube! I built a 2-meter version in the ARRL Lab. It is fairly sensitive to nearby objects, but the SWR stayed below 2:1. Outside, at a height of 2λ, the SWR was 1.8:1 at the band edges and about 1.7:1 at the center of the 2-meter band.

WA8ZVT's matching system is not a conventional gamma match. Since the moving rod is one "plate" of the capacitor, there is a distinct value of capacitance associated with each setting of the rod. I have tried a standard gamma matching arrangement and others (series C, series L) based on the MININEC analysis (339 − *j*539 Ω). The other systems provided no better performance than WA8ZVT's original.

MININEC analysis of loop antennas sometimes yields questionable results. With this in mind, plotted data shows a nearly omnidirectional pattern ranging from −3 dBd to −7 dBd for the vector sum of the horizontal and vertical components. A plot of the vertical component is similar to the vector-sum plot with −5 dBd maximum. The horizontally polarized component is a figure-eight pattern with a peak of −7 dBd oriented between the antenna loops. (If a top view of the antenna were drawn on a rectangular coordinate system with the feed point on the +X axis, the major lobe would be in the lower-left quadrant.)

Personally, I would expect current loops at points A and F (Fig 5); hence, the radiation to be elliptically polarized and the pattern omnidirectional.

KEEPING BEAMS ON PORTABLE MASTS AIMED CORRECTLY

□ A problem with hand-rotated portable masts is holding the mast in place during contacts. Often, the stiffness of the feed line determines the antenna direction! I find that a Styrofoam® block at the base of the antenna provides enough friction so that the antenna doesn't move on its own. Forcing the mast base into a tight-fitting hole in the foam block provides sufficient "grab."*—Zack Lau, KH6CP/1, ARRL Lab Engineer*

CHAPTER 5

Construction

DESIGN HINTS

RESISTOR SUBSTITUTION FOR BEGINNERS

□ While repairing an instrument that had a burned-out 10-kΩ, 1-W resistor, I found that I did not have a single replacement part of that resistance and wattage. I did, however, find two 5-kΩ, ½-W resistors in my parts box. Wired in series, their resistance would total 10 kΩ—but would they provide the necessary power dissipation?

Using the formula $P = I^2R$, we can solve for I to find that 10 mA (0.010 A) of current results in the dissipation of 1 W in the 10-kΩ resistor:

$$I = \sqrt{\frac{P}{R}} = \sqrt{\frac{1}{10{,}000}} = 0.01 \text{ A}$$

where
P = power in watts
I = current in amperes
R = resistance in ohms

Each of the 5-kΩ resistors must then dissipate

$$P = 0.01^2 \times 5000 = 0.5 \text{ W}$$

Yes, the two ½-W, 5-kΩ resistors are a suitable substitute for the 10-kΩ, 1-W resistor.

Because the power dissipated in each resistor depends on current *and* resistance, this "½ W + ½ W = 1 W" substitution is only valid for two resistors of *equal* resistance. If one were 7.5 kΩ and the other 2.5 kΩ, the larger resistance must dissipate

$$P = 0.01^2 \times 7500 = 0.75 \text{ W}$$

This much power would overheat a ½-W resistor quickly.

A parallel combination of two 20-kΩ, 0.5-W resistors would also work as a substitute for a 10-kΩ, 1-W resistor. I leave the proof of this one to you! (Hint: In this case, the current through each resistor is 5 mA, rather than 10 mA.)—*Joe Rice, W4RHZ, Covington, Kentucky*

Editor's Note: W4RHZ has taken proper care to refer only to resistor *substitution* in his hint and not resistor *specification*. In his substitution of two "seriesed" 5-kΩ, ½-W resistors for a 10-kΩ, 1-W unit, Joe makes the safe assumption that the equipment designer's specification of a 1-W resistor was sound. Joe's replacement of a 1-W resistor with two ½-W resistors of equal value should do the trick, assuming that the cause of failure of the 1-W resistor has been identified and cleared.

Ohm's Law and the power formula don't give us the last word in resistor specification because sound engineering practice dictates that power-dissipating components be *derated*—run at levels significantly below their maximum ratings—as a matter of routine. On paper, a 5-W resistor is capable of dissipating 5 W of power. In practice, however, the resistor will last longer if it is allowed to dissipate no more than, say, ½ to ⅔ of that power at room temperature. If the surrounding air will be warmer than room temperature, the resistor should be derated further.

When specifying resistor power ratings, it's a good idea to choose *the next higher value* when your calculations suggest that a resistor may have to dissipate anything near its maximum rating. For example, if your calculations indicate that a 2-W resistor will dissipate 1.75 W in your circuit, use a 5-W resistor instead. When *replacing* a resistor, you need only duplicate the power rating of the original part—unless your investigation reveals that the original part was routinely overloaded to begin with!

A SIMPLIFIED FORMULA FOR RESONANCE

□ The standard formula for calculating the resonant frequency of an LC circuit is

$$f = \frac{1}{2\pi\sqrt{LC}} \qquad \text{Eq 1}$$

where
f = frequency in hertz
L = inductance in henrys
C = capacitance in farads
π = 3.14

The arithmetic required for the solution of this equation is difficult for people unaccustomed to using powers of 10 in their calculations because of the mixture of very large numbers (f) and very small numbers (L and C). Rewriting the equation in terms of practical units for f, L and C gives us a formula that is easier to use:

$$f^2 = \frac{25{,}330}{LC} \qquad \text{Eq 2}$$

where
f = frequency in MHz
L = inductance in microhenrys
C = capacitance in picofarads

This is particularly useful when you know f and need to solve for L or C. If you know L and C, and wish to solve for f, rewrite the equation this way:

$$LC = \frac{25{,}330}{f^2} \qquad \text{Eq 3}$$

Equations 2 and 3 can be done on the simplest of calculators—even in your head in some cases!—*Melvin Leibowitz, W3KET (SK)*

ROLLER-INDUCTOR SLIDER SWITCHES OUTPUT CAPACITANCE

□ Lew Howard, W4LHH, Stone Mountain, Georgia, submitted Fig 1 among many photos of a 160-10-meter amplifier he built himself. The photo shows the rear end of the rig's output-network roller inductor. In Lew's circuit, 160-meter operation requires full tank inductance *and* additional output capacitance. The three doorknob capacitors, right, provide this capacitance. One end of the C-shaped metal strap immediately to the left of the doorknobs is common to the ungrounded ends of the capacitors. The other end of the strap isn't connected to anything—yet.

Fig 1—When W4LHH's roller inductor is set for maximum inductance, the tongue on the traveling contact switches in more tank capacitance. See text.

Set the inductor into motion in your mind's eye. As the roller inductor reaches maximum inductance (sliding contact moving to the right), the tongue on the inductor's traveling contact meets and lifts the C strap, connecting the doorknob capacitors into the circuit. Now, inductance is at maximum, capacitance has been added and W4LHH's homemade amplifier is ready to be tuned up on 160.—Ed.

QUICK POWER SUPPLY FOR 24- TO 28-VOLT RELAYS

□ Wanting to use a 28-V relay in a project otherwise powered by a center-tap rectifier and three-terminal 12-V regulator, I came up with the circuit shown in Fig 2. Two additional diodes furnish a negative voltage approximately equal in magnitude to the regulator's positive supply. The potential difference between the two supplies is about right for powering 24- to 28-V relays. If the resulting voltage is too high, use a dropping resistor or try moving the positive end of the relay to the *output* of the positive regulator (if there is one in your circuit). Two warnings: (1) Both ends of the relay solenoid, and any associated switching lines, must be kept *above ground* to avoid short-circuiting the secondary of the power

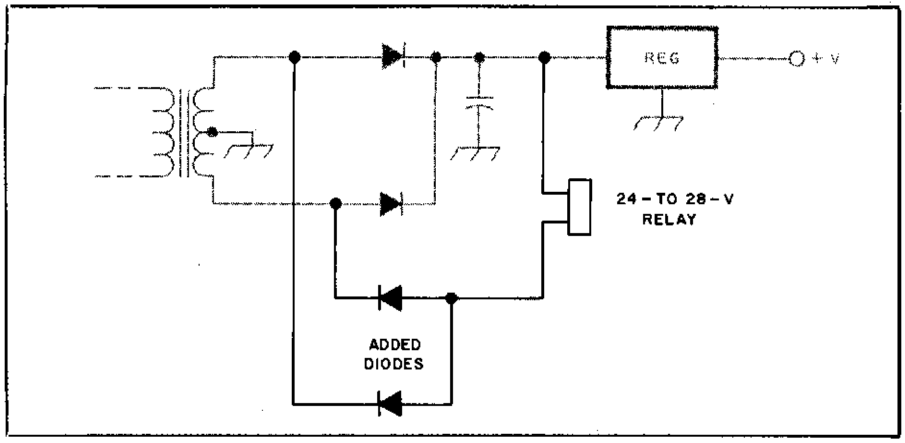


Fig 2—Two diodes add a negative 12-V supply to the positive 12-V power supply shown here. The potential difference between the two supplies can be used to power 24- to 28-V dc relays. The PIV rating of the added diodes should be equal to or greater than that of the diodes in the existing supply; the current rating of the added diodes should be sufficient to handle the current drawn by the relay, plus a safety factor. In this drawing, relay switching is omitted for clarity, and the components of the original 12-V supply are shown in gray. This hint will *not* work with a positive supply that uses a full-wave *bridge* rectifier; see text.

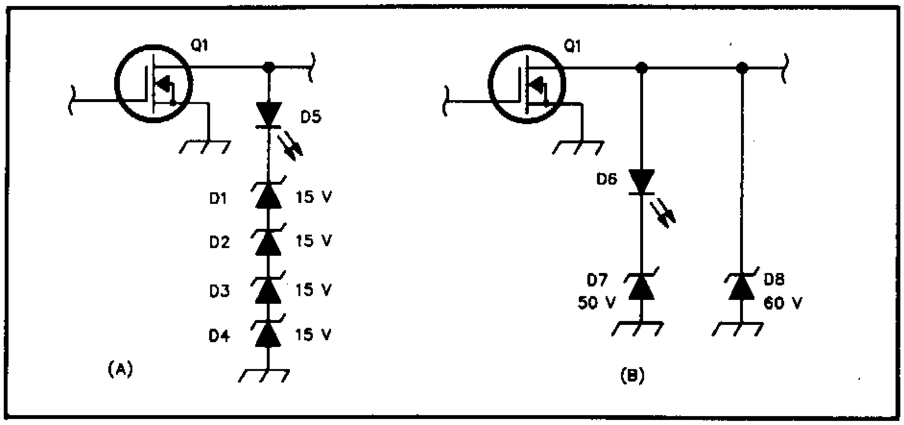


Fig 3—Sherman Lovell adds an LED indicator (D5) to a Zener-diode (D1-D4) protective clamp as shown at A. An LED open-circuit failure would disconnect the protective diode(s), though, so Sherman suggests the circuit at B as an alternative: D8 protects Q1 if D6 opens. The voltage ratings shown for D1-D4, D7 and D8 are for illustration purposes only. At D1-D4 and D7, use diode(s) equal in total voltage and dissipation ratings to the diode(s) replaced. D8's dissipation rating should equal that of the diode(s) replaced; see text for its voltage rating.

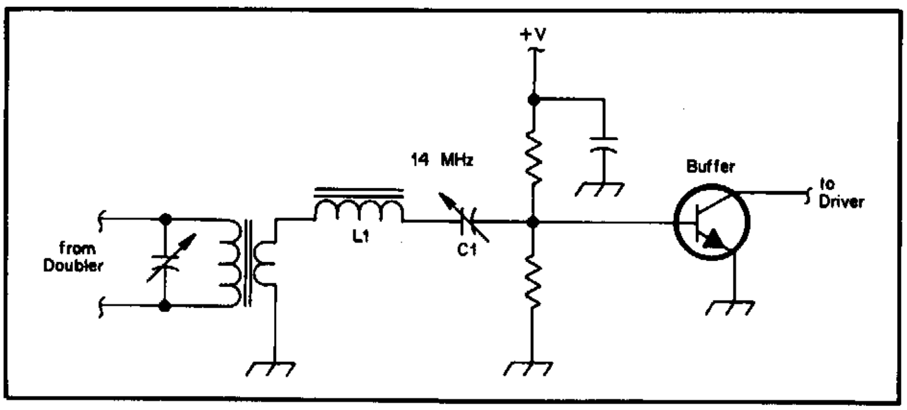


Fig 4—Bob Kuehn added this 14-MHz series-resonant circuit (L1C1) to clean up the output of a push-push doubler in his homemade QRP transmitter. L1 consists of 44 turns of no. 24 enameled wire on a T-68-2 powdered-iron toroidal core. C1 is a small air-dielectric capacitor capable of being set to about 11.5 pF.

transformer. (2) This circuit cannot be used with a full-wave *bridge* power supply. —*Wally Boller, W9OBG, Cheyenne, Wyoming*

LED OVERVOLTAGE INDICATOR FOR ZENER-DIODE PROTECTIVE CLAMPS

☐ Zener diodes, either singly or in series, are sometimes connected across the output of an RF power amplifier transistor to protect the device from overvoltage. So used, they *clamp* the overvoltage—caused by impedance mismatches, parasitic oscillations or operator error—to the value determined by the diode. An LED connected in series with a Zener clamp provides a visual indication of current flow in the clamp circuit, thus warning that overvoltage is occurring in the protected circuit.

When adding an LED to a Zener clamp circuit, add the LED's forward voltage drop (1.6 to 4) to the Zener diode voltage to obtain the approximate clamping level. For example, four 15-V Zener diodes (D1-D4 in Fig 3A) connected in series across the output of an IRF511 power MOSFET (Q1, V_{DS} = 60) should adequately protect the device if each diode's *actual* Zener voltage does not exceed 15. (Remember also a given diode's actual Zener voltage may fall within ±10% of the marked value.) The voltage drop added by an LED might push the clamp circuit's conduction threshold voltage far enough over the IRF511's maximum voltage rating to allow transistor destruction before the LED begins to glow. In this situation, a single 50-V Zener in series with the LED would be a wiser choice. (In any case, keep the diodes' leads short, lest your protective circuit itself cause instability.)

When you first apply power to the circuit, do so carefully. Bring up supply voltage and RF drive slowly while watching the LED and monitoring circuit current. LEDs can typically dissipate 75 to 100 mW; this equates to forward currents no higher than about 80 or 90 mA.

Snag: LED failure in Fig 3A disconnects the Zener diodes(s) and removes transistor protection when it's most needed. Fig 3B presents a safer, though more complex, alternative: Connect a second Zener diode (D8), one with a slightly higher voltage rating than D7, in parallel with D6-D7. If D6 fails open, D8 protects the transistor.—*Sherman M. Lovell, WY7F, 4722 15th Ave NE #9, Seattle, WA 98105*

SERIES-RESONANT CIRCUIT ENHANCES DESIRED SIGNAL IN QRP RIG

☐ During cut-and-try construction of a QRP CW rig that uses push-push doubling to produce 14-MHz drive from a 7-MHz VFO, I discovered that the stages following the doubler had output everywhere *except* 14 MHz! I solved this problem by installing a series-resonant tuned circuit between the doubler and its buffer stage (Fig 4). I have also successfully used series-resonant circuits between the antenna and output stages of monoband rigs to minimize TVI. (By the way, I first submitted something for Hints and Kinks in *1932*, but *QST* didn't publish that hint. I have since recovered from my feeling of rejection and decided to try again!)—*Bob Kuehn, W0HKF, 1871 Silver Bell Rd, Apt 313, Eagan, MN 55122*

HOW CAPACITORS CURE HUM FROM POWER-SUPPLY DIODES: ONE EXPLANATION

AK7M: In an editor's note appended to Michael Dees's "Bypass Capacitors Cure Power-Supply Noise" (p 10-7), I described how I'd cured a hum-on-received-signals problem by bypassing the rectifier diodes in a transceiver power supply. Here's one ham's response to my request for an explanation of this phenomenon:

□ The hum phenomenon described by N3EZD and the editor was well known in medium-wave radios built in the 1930s. The hum occurs when amplitude-modulated RF enters the receiver mixer stage via two paths: (1) Energy from the short antenna enters the mixer via the receiver RF stage; (2) the power line, working as an antenna, also supplies RF to the radio via more or less uncontrollable paths (by means of conduction and stray capacitance). The power-line-conducted RF is amplitude-modulated at the line frequency and its harmonics in the power-supply rectifiers, which act as modulators.

Strong signals cause the receiver automatic gain control to reduce the RF-amplifier gain, reducing the level of signal that reaches the mixer via Path 1, whereas the hum-modulated RF from Path 2 remains nearly unaffected and becomes the dominant input signal at the mixer.

The cheapest way to avoid this effect is to short-circuit the "modulator" diodes for RF with capacitors. Indeed, many 1930s-vintage radios had bypass capacitors in parallel with their rectifier tubes. Such capacitors must be able to withstand considerable high-voltage stress. During WW II, and for a period after the war (when capacitors were in short supply), radio repair personnel cured the problem of a destroyed rectifier-bypass capacitor by just removing it from the radio. The radio owner had to tolerate the resulting hum. (Our radio language adopted a new word in those days: *Blinddarmkondensator* [literally, "appendix-capacitor."])

The better way to solve this hum problem is to RF-filter the power supply input and output leads, and to shield the line(s) between the power supply and receiver. —*Helmut Zurneck, DL4FBI, Ritterstrasse 26, 6110 Dieburg, West Germany*

And K4GXY used power-supply-diode bypass capacitors to solve another RF-related problem:

□ My Heath® HW-5400 transceiver and Tenna Phase III power supply had bad transmit and receive audio problems (distortion and hum) until I bypassed each of the power supply's diodes with 0.01, 0.1 and 1-µF capacitors. The Tenna Phase III power supply does not include ac-line bypassing; connecting capacitors from hot to neutral, and from hot and neutral to ground, did not solve the problem.

SWR-related RF feedback seems to cause the problem. I speculate that RF is rectified and superimposed as AF on the power supply's dc output; I arrived at this conclusion by observing that the superimposed voltage increases with SWR.

Like the ICOM IC-735 and Kenwood TS-430S, the HW-5400 contains a step-tuned PLL VFO.—*John W. Gallagher, PE, K4GXY, 411 S Elm Rd, Lakeland, FL 33801*

DON'T BE FOOLED BY TALKING CAPACITORS

□ Plugged into the ac line at a Glastonbury, Connecticut, location, a power supply emitted acoustic energy that sounded like line noise coming over an AM radio. At first, I suspected arcing in the power transformer (or, more fantastically, one of the surplus filter chokes in the supply), but a bit of directional listening with a cardboard tube revealed that the sound was coming *from the supply's bridge-rectifier components!*

The sound changed character when I used a plastic tool to push on any of the disc-ceramic capacitors bypassing the bridge diodes. I turned off the supply, unplugged it, and made sure its filter capacitors were discharged. Then I removed the bypass capacitors and powered up the supply. *The noise was gone!*

How could this be? Albert Helfrick's "Microphonics in Capacitors" (Technical Correspondence, *QST*, June 1984, p 42) provides a clue: The ceramic dielectrics of some capacitors exhibit piezoelectric properties, generating electricity in response to vibration. To Al's discussion I add that because piezoelectricity often works both ways, a capacitor that produces electricity in response to mechanical stress may be able to transduce electrical into mechanical energy. The ceramic diode-bypass capacitors in my power supply—0.01-µF, 1-kV discs—had acted as piezoelectric *speakers,* emitting line-noise transients as acoustical noise!

Thinking back, I realize that this effect must have caused the occasional buzzes and ticks I'd heard coming from the supply when it was plugged into quieter ac at a Newington location—and of similar noises emitted by several other power supplies, including a Yaesu FP-757HD used in an ARRL product review, at various locations over the years. (Once—chagrin speaks—I even replaced the power transformer concerned because I thought it was the source of the noise.) Now I know that power-supply ticking and buzzing beyond normal transformer noise do not necessarily indicate defective components.—*AK7M*

CHARACTERIZING DIODES AT LOW APPLIED VOLTAGES

□ For many years, the *ARRL Handbook* has featured a diode probe suitable for measuring RF voltages down to the millivolt level. The accuracy and sensitivity of such probes has been the subject of prior investigations in Hints and Kinks;[1] generally, however, it's safe to say that the sensitivity of such probes is determined by the junction-barrier voltage of the probe diode. The lower the junction-barrier voltage, the higher the probe sensitivity.

From the standpoint of RF probe sensitivity, germanium diodes are better than silicon diodes for the *Handbook* RF probe because the barrier voltage of a germanium PN junction (about 0.3) is lower than that of its silicon counterpart (0.7). Because junction-barrier voltage may vary from unit to unit among diodes of a given type, it's worthwhile to grade prospective probe diodes in terms of barrier voltage. Diodes intended to be used in RF probes should be tested at an applied voltage much lower than the junction-barrier voltage. This is so because low-level RF measurements depend on the occurrence of diode conduction at applied voltages in the millivolt region. (*Some* forward current flows through a diode at applied voltages somewhat below the junction-barrier level; how much current flows at a given applied voltage varies from diode to diode.) Fig 5 shows a simple means of characterizing diodes at applied voltages of this magnitude.

To characterize a diode at a forward current of 0.1 µA (for example), set the voltmeter (in my case, an FETVOM) to read 10 mV at full scale, install a 100-kΩ resistor at R_{SH}, and adjust the power supply to indicate 10 mV on the voltmeter. (According to Ohm's Law [I = E ÷ R], the diode current is 0.1 µA [0.01 V divided by 100 kΩ].) To find the forward voltage at which the diode conducts the calculated current, subtract the voltage drop across R_{SH} (10 mV in this case) from the voltage

[1]See S. Mann, "Match Your RF Probe to Your Meter," Hints and Kinks, *QST*, May 1985, pp 44-45, and G. Hardman, F. Swan and J. Kronvich, "RF Probes Revisited," Hints and Kinks, *QST*, Mar 1986, pp 47-48. The three pieces that constitute "RF Probes Revisited" also appear on pp 7-7 and 7-8 of the 12th edition of *Hints and Kinks for the Radio Amateur.*

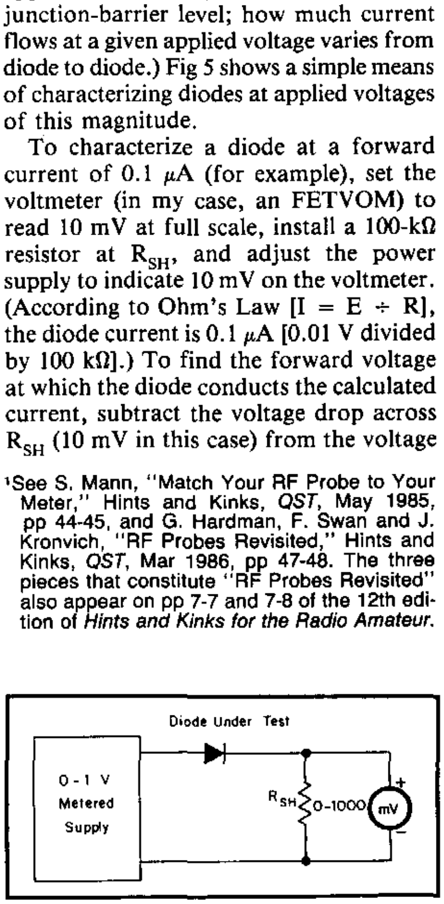


Fig 5—George Klaus characterizes diodes below their junction-barrier potential with this setup. The power supply must be capable of stable, voltage-metered output from 0 to 1 V or so. See text.

Table 1
Two Diodes Compared

Forward Current (μA)	Test Voltage (mV) 1N270	Test Voltage (mV) 1N914	R_{SH} (Ω)
1000	380	814	10
100	202	625	100
10	122	538	1 k
1	60	470	10 k
0.1	15	405	100 k
0.01	1.2	340	1 M
0.001	0	271	open
0.0001	0	235	open

indicated on the power-supply voltmeter. Table 1 lists the results of tests on one 1N914 (silicon) diode and one 1N270 (germanium) diode. Similar comparisons among germanium diodes can be made to find the best diode for an RF probe, or to match diodes for special purposes. *—George H. Klaus, W2CJN, 140 Mill Dam Rd, Box T, Centerport, NY 11721-0619*

DIODES FOR RF PROBES

□ Concerning the Hints and Kinks item "RF Probes Revisited" (March 1986 *QST*), I have a few comments regarding the RF sampler shown in Fig 3 on page 48 of that issue. The 1N4007 power diode used in the sampler is a poor choice for an RF rectifier because of its relatively slow reverse recovery rate[2] (t_{rr}): around 30 μs. At radio frequencies, the 1N4007 cannot clear out its minority carriers in time to operate properly on the next cycle of the applied signal.

A somewhat better choice for an RF-probe rectifier would be one of the silicon fast-recovery diodes used in the TV industry. These silicon diodes, used to rectify RF ac (at 15.734 kHz in standard TV power supplies), may have a PIV rating as high as 1.5 k and a t_{rr} of around 1 μs.

Some catalogs list high-voltage, fast-recovery diodes that have a t_{rr} of 0.2 μs. Such diodes are suitable for use at frequencies up to 250 kHz—certainly better than the power-line-frequency speed of the 1N4007! A 0.2-μs diode is worth trying in an RF probe. (By the way, I cross-referenced the in-house part number of a typical fast-recovery, TV-power-supply diode in a semiconductor reference guide published by a well-known electronics chain. The recommended replacement was a 1N4007 equivalent! Such a diode would rectify poorly, if at all, in an RF-driven portion of a TV or VDT power supply.)

Incidentally, I've had great results using *vacuum-tube* diodes in in-line RF probes. The types I've used include the 9004, 9005, 9006 and 559. These work perfectly up past 432 MHz and can be built into a short section of transmission line; if the line is flat, the peak power on the line can easily be computed from the diodes' voltage output. *—Harold Isenring, W9BTI, 10850 Amy Belle Rd, Colgate, WI 53017*

REDUCING AM DETECTION IN DIRECT-CONVERSION RECEIVERS

□ While building equipment for the 40- and 30-meter bands, I discovered that AM detection is a common problem in D-C receivers. I used a singly balanced, four-diode detector followed by 85 dB of audio gain and a conventional RC active filter with additional gain. When the receivers were completed, both would detect any AM signals above about 200 μV in level. This is a problem because there are many such signals in the neighborhood of our 30- and 40-meter bands.

I went to some lengths to decouple and shield each receiver's LO, and to provide RF decoupling between the detector and the audio amplifier. Neither of these changes made any improvement.

Oscilloscope display of the detected AM signal showed an interesting peculiarity: At the receiver input, most signals exhibited symmetrical noise—but the *detected* AM signals showed only *negative-going* noise. This led me to suspect that the detection was actually taking place in the audio amplifier. Further, working with a receiver with no front-end selectivity, I found that sensitivity to AM detection decreased with increasing separation between LO and AM signal frequencies. This strengthened my hunch.

I solved the problem by installing a passive L-network filter, with a bandwidth of several hundred hertz, between the detector and the audio amplifier. I used a design similar to that shown in Fig 12 on p 77 of *Solid State Design for the Radio Amateur* with good results. With the filter installed, the modulation on AM signals of several thousand μV is inaudible with a 10-kHz LO/signal spacing. *—Denton Bramwell, K7OWJ, St Joseph, Michigan*

SCHOTTKY DIODES *DO* IMPROVE PRODUCT-DETECTOR PERFORMANCE—BUT WHAT ABOUT AM DETECTION?

□ In November 1984 Hints and Kinks, the Rev Doug Millar, K6JEY, described how he replaced the 1N60 point-contact diodes in a TS-830S product detector with Schottky mesh diodes.[3] I recently made this modification to my Kenwood TS-820 transceiver and want to add my enthusiastic endorsement.

Rebalancing the product detector is simple. Connect an oscilloscope to the '820's rear-panel IF OUT connector. Set the scope sensitivity to 50 mV/div. With the '820's RF GAIN control at minimum, adjust trimmer potentiometer VR3 and trimmer capacitor TC5 (both near the product-detector diodes on the IF board) for minimum deflection on the scope. *—Dick A. Mack, W6PGL, Santa Cruz, California*

[3]D. Millar, "Diode-Ring Product Detectors," *QST*, Nov 1984, pp 55-56.

Editor's Note: Many hams use their general-coverage transceivers for shortwave broadcast reception and listening to WWV and CHU, and this often means using an AM envelope (signal rectification) detector. What about replacing a radio's *AM* detector diode with a Schottky diode of some type? The Rev Millar's 1984 H & K item sparked controversy on this question in shortwave listening circles to such a degree that a number of shortwave equipment dealers now offer a Schottky-diode AM detector modification for some receivers.

In the February 1986 Canadian International DX Club *Messenger*, Technical Talks editor Don Moman, VE6BOD, wrote of modifying his ICOM

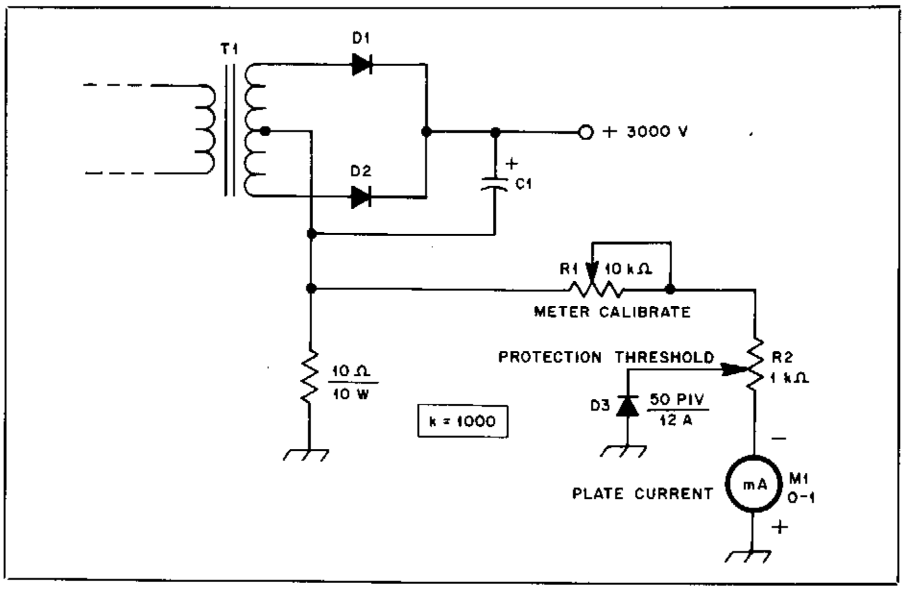


Fig 6—Plate-current meter protection at KN5S. R1 adjusts M1 calibration, and R2 sets the current level above which D3 protects M1. C1, D1, D2 and T1 are components in the amplifier plate power supply.

[2]*Reverse recovery time* is the time a diode takes to recover to a specified value of reverse current or voltage after switching from the on state.*—AK7M*

IC-R71A receiver for A/B comparison between passivated Schottky and point-contact rectification detectors: "Yes, background noise did drop roughly 3 dB, but so did the [recovered] audio level of weak signals. Using a Hewlett-Packard HP-606 generator cranked down to under 0.1 μV, I could never create a situation where there was any difference. On the HF bands, with weak or strong signals, again there was no advantage to the HCD [hot-carrier diode]. . . I don't have equipment to measure audio distortion, so I can't say much [about that] here. I couldn't note any improvement."

Have any H & K readers had quantifiable success using Schottky diodes as rectification detectors?

PLATE-CURRENT METER OVERLOAD PROTECTION

☐ A short circuit or arcing in a high-power RF deck using vacuum tubes, or in its high-voltage power supply, may burn out the plate-current meter if the meter is unprotected. The usual meter-protection circuit places a pair of diodes connected as a clipper across the meter. This technique does not always provide sufficient protection, however, because appreciable current can still flow through the meter at the voltage level set by the diodes. The circuit at Fig 6 provides better protection.

M1 in Fig 6 is calibrated to read 1 A full scale, but need not indicate higher than 800 mA in my application. The meter protection circuit, D3-R2, is adjusted to protect the meter above this level. *With the high-voltage supply off and filter capacitors fully discharged,* adjust the protection circuit as follows: (1) Set R2 all the way to its M1 end. D3 does not affect the meter calibration at this setting. (2) Using an adjustable bench power supply capable of producing 10 V at 1 A, adjust R1 to calibrate M1 at 800 mA. Confirm M1's calibration at other points between zero and 800 mA, particularly at the reading corresponding to the amplifier idling current. (3) Adjust the bench supply for an indication of 800 mA on M1. (4) Adjust R2 for a barely perceptible decrease in M1's indication. This sets the protection threshold at 800 mA.

With the protection circuit adjusted in this way, only 1.5 mA flows through M1 with 6 A flowing in the amplifier plate supply. Peak currents during a short circuit may reach 300 A, but I do not have access to the equipment necessary to check the circuit at this current level. The protection circuit should limit current through M1 to only a few milliamperes when short-circuit currents reach several hundred amperes. The values shown for R1, R2 and D3 in Fig 6 apply to my particular application; they may be adapted for other voltages and currents.—*Mark Mandelkern, KN5S, Las Cruces, New Mexico*

STABLE HIGH-VOLTAGE METERING

☐ K1FO's comments on drift in high-voltage (HV) metering circuits[4] brought to mind the initial troubles I had with my 3-kV plate supply, built 27 years ago and still in daily use. The original carbon resistors drifted so much that "accuracy in measurement" took on a wholly new dimension: If the meter read zero, the HV was probably off, but if the meter read anywhere upscale, the HV was probably on!

[4]S. Powlishen, "Improving the K1FO 8874 432-MHz Amplifier," *QST*, Jul 1987, pp 20-23.

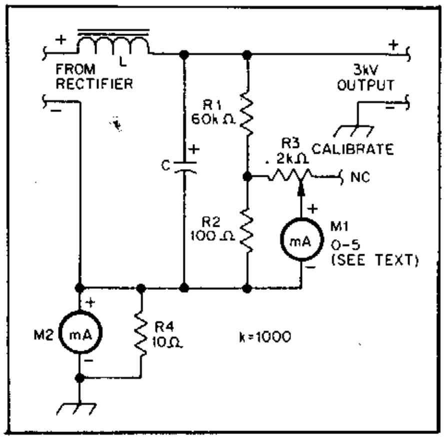


Fig 7—Mark Mandelkern's stable HV metering circuit. M1 meters voltage (0-5 kV) through the action of R1 (the existing supply bleeder), R2 (an added meter shunt) and R3 (an added meter multiplier, here made adjustable to allow calibration of the meter). M2 meters HV supply current, R4 is the existing anode-current meter shunt, and L and C compose the HV filter. See text.

R2—100-Ω, 10-W wirewound. Although this part dissipates less than ¾ watt in this application, using a high-wattage, wire-wound unit ensures stability, safety and bleeder reliability.

R3—2-kΩ, 2-W wirewound potentiometer.

After a few years of this, I thought of using wirewound resistors. When I considered the values available, the cost involved and the space required, adding a wirewound-resistor metering circuit took on the aspect of adding another power-supply bleeder! That's when it occurred to me that the bleeder *already present in the supply* could serve as a bleeder and meter voltage multiplier *at the same time.* Reworking the bleeder to do double duty only involved the addition of one small wirewound resistor at the ground end of the bleeder string (to develop a low voltage proportional to the full supply output) and a small potentiometer for meter calibration. The circuit is shown in Fig 7. Its calibration hasn't drifted in over 20 years.

Fig 7 shows typical values for a meter capable of reading 5 kV full scale. For other HV levels, bleeder currents and meter ranges, adjust the values accordingly. The bleeder (R1, 60 kΩ) draws 50 mA at 3 kV; at the hypothetical 5 kV level (the desired full scale capability of M1), the bleeder would draw about 83 mA. Adding R2 causes a voltage drop (8.3 V at 83 mA) suitable for use in HV metering. This voltage is applied to M1 (5 mA full scale) via a multiplier resistor (R3, the CALIBRATE control). Solved for R with 8 V and 5 mA, Ohm's Law indicates that R3 should be 1.66 kΩ. The 2-kΩ control used at R3 allows ample leeway for variations in the values of R1 and R2, and for the slight shunting effect the meter and multiplier have on R2. If a suitable HV meter is unavailable as a calibration standard, temporarily install a variable-voltage autotransformer in the HV power transformer primary. Use the autotransformer to reduce the supply output voltage to a level at which calibration is feasible.

This metering method is safer than connecting a multiplier directly to the HV bus—a technique that requires special attention to the meter ground lead and can present a dangerous voltage at the meter (probably on the equipment front panel!) if the meter fails open. The metering circuit at Fig 7 can also indicate bleeder failure, a safety feature not usually included in HV supplies: If R1 fails open, M1 does not deflect.[5]—*Mark Mandelkern, KN5S, 5259 Singer Rd, Las Cruces, NM 88005*

[5]This brings up a high-voltage safety point: A zero HV indication does not necessarily mean that a given power supply is safe to work on. Switch the supply off, watch the HV meter indication drop to zero and *unplug the supply from the ac mains.* Then, short the supply's filter capacitors with a shorting stick—a heavy grounded cable secured to a long, dry wooden handle.

INCREASED GAIN FOR SOURCE-FOLLOWER AMPLIFIERS

☐ The output of a source-follower amplifier working into a high-impedance load can be greatly increased (a stage voltage gain of about 3 instead of the slight voltage loss normal for a source-follower circuit) by tapping the source terminal into one section of the RF choke as shown in Fig 8. The additional output voltage is

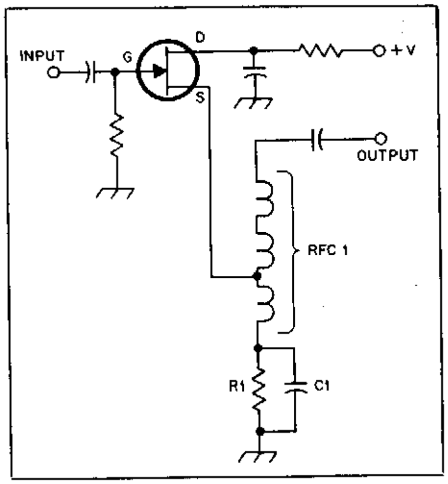


Fig 8—VE6EI uses an RF choke to step up the voltage at the output of a source-follower amplifier. RFC1 is a three-section, 2.5-mH choke. See the text for how the circuit works, and for notes on C1, R1 and RFC1.

sometimes advantageous, such as when working into a frequency multiplier stage. *—Gordon Crayford, VE6EI, Lacombe, Alberta, Canada*

Editor's Note: The RF choke in VE6EI's circuit provides a voltage step-up because it functions as an *autotransformer*. A four-section choke might be worth trying if you need a voltage step-up of 4.

Capacitor C1 in Fig 8 can be considered optional when the resistance of R1 is only a few percent of the reactance of the bottom third of RFC1. For example, at a frequency of 7 MHz, the reactance of one of three equal sections of a 2.5-mH RF choke will be about 1/3 of the choke's total reactance— 36,600 Ω. (In practice, field interaction between the choke sections renders this division by three approximate.) If R1 = 560 Ω (for example), it need not be bypassed because its resistance is only 1.5% of 36,600 Ω. Common RF chokes are usually manufactured to inductance tolerances much wider than this. The unnecessary capacitor may be more useful somewhere else! In some cases, omission of C1 may actually improve circuit performance because R1 tends to "kill the Q" of RFC1, reducing the likelihood that resonance in the choke will cause instability in associated stages. These comments also apply when the reactance of the *entire* RF choke is between R1 and the FET source—when the choke is used only as a choke, and not as an autotransformer.

CHOOSING TOROIDAL CORES FOR LESS OSCILLATOR DRIFT

☐ ARRL's *Solid State Design for the Radio Amateur* suggests the use of SF material (yellow-coded, or "Mix 6") powdered-iron toroidal cores for low-drift VFO inductors all the way down to 80 and 160 meters.[6] A few (too few) temperature-stable *ferrite* materials exist that are useful in this range. One example of this is Stackpole's Ceramag 11. The permeability v temperature curve for this material is essentially flat from about 5 to 55 °C. The high permeability of Ceramag 11 has enabled me to wind coils that exhibit much higher unloaded Qs than are possible using SF iron cores. I've also found this material, in rod form, to be quite useful for building stable permeability-tuned oscillators. *—George Hermann, N9BNH, Box 348095, Chicago, IL 60634*

Ceramag 11 looks like an interesting material, but I haven't been able to locate a source of the stuff for ham use. Anybody know of one? As a consolation prize for Hints and Kinks readers, I offer this: Instead of using a Mix 6 powdered-iron toroid in your next VFO, give a *Mix 7* toroid a try. Mix 7 material is coded white and has a slightly higher permeability—9.0—than Mix 6's 8.5. Mix 7 material is optimum for use in tuned circuits from 1 to 20 MHz; Mix 6, 2 to 30 MHz.

With a permeability stability of +35 ppm/°C, Mix 6 material was the most stable powdered-iron core commonly available to hams when *Solid State Design for the Radio Amateur* was written in the 1970s. Now, Mix 7 material is the stability winner at +30 ppm/°C. Thus, Mix 7 material appears to be a better choice than Mix 6 for use in stable tuned circuits at frequencies between 2 and 20 MHz. Palomar Engineers stocks Mix 7 toroids in T-37, 44, 50 and 68 sizes; Amidon Associates may be able to get Mix 7 cores for you, too.*—AK7M*

6W. Hayward and D. DeMaw, *Solid State Design for the Radio Amateur* (Newington: ARRL, 1986), p 33.

TRANSISTORIZING SURPLUS VFOS

☐ Building stable tunable oscillators for home-brew projects can be difficult. VFOs are available on the surplus market, however—as subassemblies from disassembled vacuum-tube military equipment. Collins Radio, for instance, designed and built many excellent VFOs over the years; many of these are now available as surplus. These VFOs, sometimes also called linear master oscillators (LMOs), use special permeability-tuned coils and cam assemblies to achieve stable, wide-range, linear tuning. Although these VFOs use vacuum tubes, they can easily be "solid-stated" by replacing their vacuum tubes with 40673 dual-gate MOSFETs.

One such surplus VFO is the master oscillator from the T-195 transmitter. This unit, often available from Fair Radio Sales, covers 1.5 to 3.0 MHz in somewhat over 12 shaft revolutions (a tuning rate of about 125 kHz/r). In the discussion that follows, I'll cover how to "MOSFETize" a T-195 VFO. (Note: The unmodified T-195 VFO can oscillate at B+ voltages as low as 24.

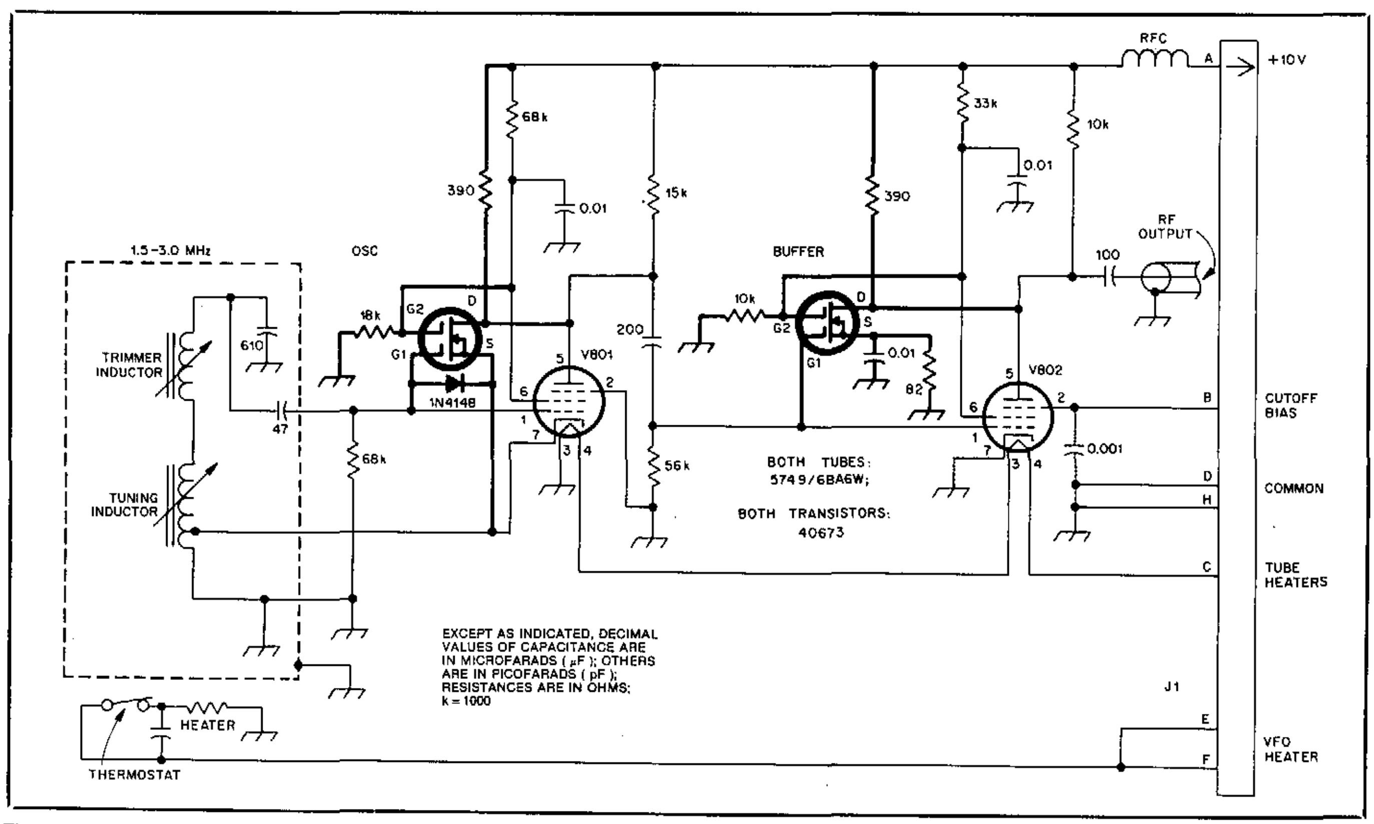


Fig 9—Schematic of the MOSFETized T-195 VFO. Added components are shown in heavier lines. Although vacuum tubes and transistors are shown simultaneously in this circuit for clarity, the tubes must be removed for proper operation of the VFO after transistors have been installed. The 610-pF capacitor in the V801 grid circuit actually consists of a 580- and three 10-pF capacitors; it is shown as a single unit for clarity. J1 mates with an Amphenol 126-192 connector. When vacuum tubes are used in the VFO, pin B of J1 allows the application of cutoff bias to the suppressor grid of V802 during receive periods. See text.

If you have a 200-mA dc supply that can furnish this voltage [25.2 V is optimum because the tube heaters are connected in series], you can replace the 5749/6BA6Ws with 12BA6s and run the VFO at 25.2 V dc.[7])

Most of the T-195 VFO's volume is occupied by a sealed cylindrical housing that contains the oscillator tuned circuit. The two VFO tubes, and most of their associated circuitry, are contained in a small subassembly in front of the tuned-circuit housing. Removing the hexagonal screw on the front of the housing—between the two tubes—gives access to the slotted shaft of the VFO frequency-trim inductor. (Do not open the housing if you can avoid it; a key factor in Collins' achievement of short- *and* long-term stability in these oscillators is the hermetic protection of the VFO's frequency-determining components against temperature and humidity variations. Once you break the hermetic seal, that protection is lost.)

Fig 9 shows the schematic of the modified T-195 PTO. Components added to replace the tubes with MOSFETs are drawn with heavy lines. The MOSFETs are wired to the tube sockets. The 1N4148 diode (a 1N914 is also suitable) replaces the cathode-grid diode of the oscillator tube (V801). The 10- and 18-kΩ gate-2 resistors serve as counterparts to the screen-grid dropping resistors of the 5749/6BA6Ws.[8] The 40673s have higher transconductance than the 5749/6BA6W tubes, and draw more supply current. The 390-Ω resistors in the MOSFET drains offset these differences.

I operated the MOSFETized VFO from a well-regulated 10-V, 7-mA supply (yes, this low current requirement signifies that I don't use the VFO's oven feature!). At this supply voltage, the VFO's output is about 1 V P-P into a high-impedance load. The output waveform is rich in harmonics because it is more like a series of pulses than a sine wave.

The MOSFETized T-195 VFO is very stable. When set to 3 MHz (and operating at a regulated supply voltage of 10), the VFO drifted 16 Hz in the first 10 minutes after warm-up. During the next 40 minutes, the VFO drifted an additional 10 Hz. The output frequency changed 10 Hz as the supply voltage was varied between 8.8 and 9.6; adjusting the supply over the 9.6- to 12.1-V range resulted in a frequency change of only *1 Hz*.

Mechanically, the T-195 VFO is very smooth: Equipped with a 2¼-inch-diam knob, it can be adjusted to within 20 Hz of a desired frequency. With patience, it can be set to within 1 Hz. (My VFO exhibits a slight mechanical bumpiness or backlash, and seems to "prefer" settings at 10- to 20-Hz intervals. This may be caused by the cams used to linearize its tuning.) *—Peter Traneus Anderson, KC1HR, 990 Pine St, Burlington, VT 05401*

AK7M: I've had similar success in MOSFETizing a Collins 70E-8 permeability-tuned oscillator (PTO): After a warm-up drift of a few Hz, it stays within *1.5 Hz* of its set frequency for hours on end.

A note of caution regarding the T-195 VFO (Collins nomenclature, 70H-3) was sounded by Don Chester, K4KYV, in "Collins Stability for Under $10," *The AM Press/Exchange*, June 1987: "*Never* attempt to tune the PTO all the way to either extreme end of its tuning range. There is no mechanical stop on the mechanism, and if the tuning shaft is turned beyond the limits of its intended frequency range, *permanent damage* will be done to the mechanism that moves the powdered iron slug in and out of the oscillator coil . . . . *If the shaft is turned far enough that you begin to feel resistance to further motion, permanent damage has already been done.*" Don adds that this problem is compounded when a reduction drive is used: By the time you feel the 70H-3's end-of-travel resistance through a reduction drive, it's *much* later than you think!

ADJUSTING THE POWER OUTPUT OF JFET VFOS

☐ The output of a JFET VFO is determined largely by the device standing current—the JFET's drain current with dc bias applied and ac feedback removed. In many VFO designs, this is equivalent to I_{DSS}—the zero-gate-voltage drain current. Generally, the relationship between I_{DSS} and oscillator output is simple: The higher the device I_{DSS}, the greater the VFO output.

According to the *Motorola Small-Signal Transistor Data* book, I_{DSS} for the popular MPF102 can fall anywhere within the wide range of 2 to 20 mA. This wide I_{DSS} specification explains why some VFO builders have good luck with the MPF102 and others build MPF102 VFOs that deliver less output than that claimed for the circuit involved. The "premium" 2N4416 has an I_{DSS} range of 5 to 15 mA, making the '4416 generally better than the MPF102 if you want more power output. The best commonly available JFET for lots of VFO output is the 2N5486, which has an I_{DSS} range of 8 to 20 mA.

It's important to keep another rule of thumb in mind: Oscillator frequency stability generally *decreases* as power output increases. If you're willing to sacrifice VFO output for greater frequency stability, the 2N5484 (I_{DSS} of 1 to 5 mA) and 2N5485 (I_{DSS} of 4 to 10 mA) are good choices.

By the way, the resistance of the JFET channel is a good relative indicator of device I_{DSS}. With this in mind, you can grade your JFETs for VFO power output merely by measuring their channel resistance (source to drain) with a DMM. (Caution: The measuring instrument you use must not apply a destructively large current to the device under test.) Generally, the lower the channel resistance of a given device, the more power output it will furnish as a VFO.*—Zack Lau, KH6CP, ARRL Laboratory Engineer*

A DIODE-BASED QRP TR SWITCH

☐ After purchasing Doug DeMaw's *QRP Notebook*,[9] I built a QRP transceiver. Finding a suitable TR-switch circuit was difficult: The circuits I tried seemed to exhibit one weakness or another, including loss (evident as poor receive sensitivity or reduced transmitter output power), undesirably sharp selectivity in the receiver-input band-pass filter, complexity, too much power consumption for battery operation, or harmonic generation. Doug and other builders may wish to try the TR switch I devised. Fig 10 shows the circuit.

During receive, D1 and D2 are biased on. (The output winding of the transmitter-PA output transformer, and the input winding of the receive transformer, serve as dc returns for D1 and D2, respectively. RF chokes and blocking capacitors could serve this purpose in another application.) In transmit, D1 and D2 are biased off, isolating the receiver from the antenna. The switch affords good isolation at 7 MHz.

I connected the circuit on the antenna side of the transmitter-output low-pass filter; installed on the PA side of the filter, the switch caused noticeable received-signal loss. Even though no low-pass filtering follows the switch, it produces no harmonic TVI because D1 and D2 are biased off during transmit.

D1 and D2 are 1N914s; they seem to work well at QRP (5 W or less). To minimize current drain, I chose R1 to pass the least diode bias current that did not noticeably decrease receiver sensitivity. (If you don't intend to use the circuit in a battery-powered rig, you can use a smaller

[7]Another approach to retubing one of these VFOs for lower-voltage operation might be to replace the 5749/6BA6Ws with 12EA6 (remote cutoff) or 12EK6 (sharp cutoff) pentodes. (5749/6BA6Ws are remote-cutoff tubes, so the 12EA6 would probably be the better replacement.) These tubes have 12.6-V, 190-mA heaters, and were designed to operate at plate/screen voltages of 12.6 (absolute maximum, 16) in "hybrid" (tube-and-transistor) auto broadcast radios. Assuming that 12EA6s worked properly with no other circuit changes, a "12EA6ed" VFO would require, say, 12.6 V for its plates and screens, and 25.2 V for its heaters. Wiring the 12EA6 heaters in parallel would allow them to be operated at 12.6 V as well. Current drain during all-12.6-V operation of the VFO would be considerably higher than that of a "40673ed" unit, of course: two 12EA6s require 380 mA at 12.6 V just to heat their cathodes! 12EA6s and 12EK6s are available as "new old stock" from Antique Electronic Supply.*—AK7M*

[8]Nonetheless, it's important to keep in mind that gate 2 of a MOSFET is *not* the solid-state equivalent of a vacuum tube's screen grid. A screen grid can function as a control element or an anode; a MOSFET gate can function only as a control element. That screens *and* gate 2s are commonly operated at fixed positive voltages lower than those applied to their associated anodes is coincidence.*—AK7M*

[9]D. DeMaw, *QRP Notebook* (Newington: ARRL, 1986).

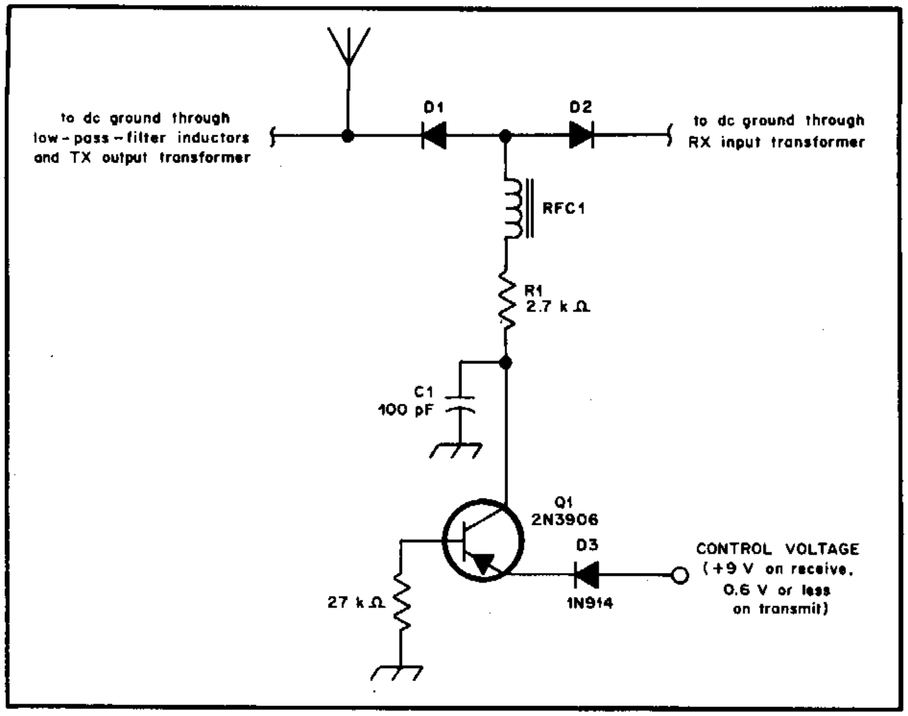
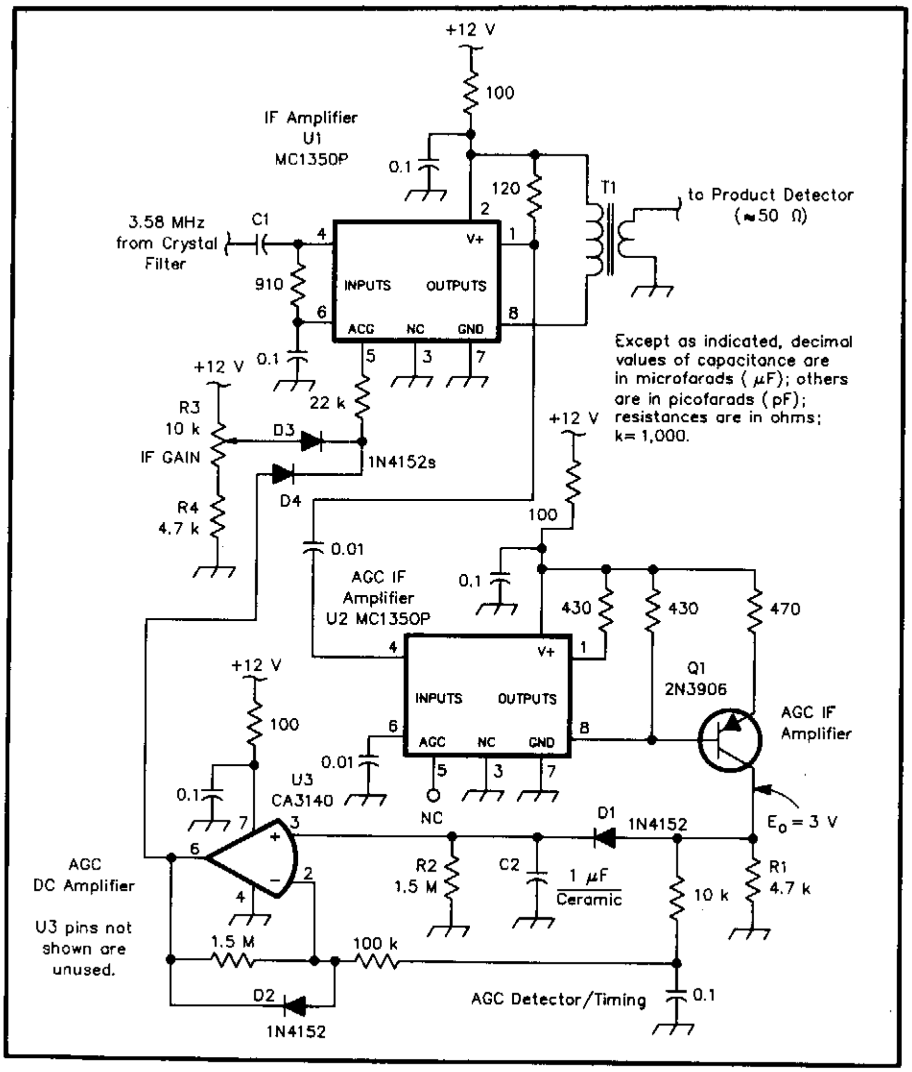


Fig 10—Ronald Carr reports success in using this TR switch in a battery-powered, 7-MHz QRP transceiver. See the text for a discussion of component values.



value at R1.) C1 charges to the negative peak of the transmitter RF-output voltage during transmit. Q1 and C1 must be able to withstand this voltage without breakdown; keep this in mind if you try to redesign this circuit for higher power levels. (As a side benefit, a high-impedance voltmeter connected between Q1's collector and ground provides an indication of power output during transmit.) D3 ensures that Q1 turns off during transmit. RFC1's value is not critical; I used an uncharacterized choke from my junk box.

Control the switch carefully. My transceiver supplies a receiver control voltage that is properly sequenced during keying; assuming that you are keying about +12 V to ground, you may be able to connect the CONTROL VOLTAGE terminal directly to the key in your application. Some delay on key up might be desirable, however, to ensure that the receiver remains isolated from the antenna until the transmitter actually stops transmitting.—*Ronald Carr, WA1VGB, RR1 Box 1235-A, South China, ME 04358*

A FAST-ATTACK AGC SYSTEM FOR QSK CW

☐ A recently constructed CW transceiver used a fast TR system, running nearly at QSK rates. An AGC system with an attack fast enough to follow the data extremes was needed. The resulting circuit is shown in Fig 11.

The signal-path IF amplifier, U1, is an MC1350P. The 910-Ω input resistor parallels the input resistance of the IC to provide a 700-Ω termination for the 3.58-MHz crystal filter used in the receiver. C1 is the crystal-filter output capacitor. Two outputs are available from U1: One, from pin 8, is transformer-coupled to the product detector. The other comes from a low-resistance load attached to pin 1. This drives U2, a second MC1350P, the output of which is applied to Q1, a PNP low-gain amplifier. Q1 sets the dc output level (E_0) to about 3 volts. (E_0 can be adjusted, if required, by changing the value of R1. U2's gain can be set at pin 5 by a duplicate R3/R4 gain-control network; as shown, its gain is maximum.)

E_0 establishes the dc operating conditions for U3, and, ultimately, for pin 5 of U1, the IF-amplifier AGC input. E_0 is applied, after processing, to the U3's inverting and non-inverting inputs. D1 is forward biased by current flow through R2. The rectified IF sample appears at pin 3 of

Fig 11—The decay time of this IF-derived QSK AGC system is set by R2 and C2; values as high as R2 = 6.8 MΩ and C2 = 10 μF have been used at AK7M without noticeably slowing the attack time. T1 consists of (primary) 15 turns of no. 28 enameled wire on an FT-37-43 toroidal ferrite core and (secondary) 3 turns of no. 28 enameled wire over the primary.

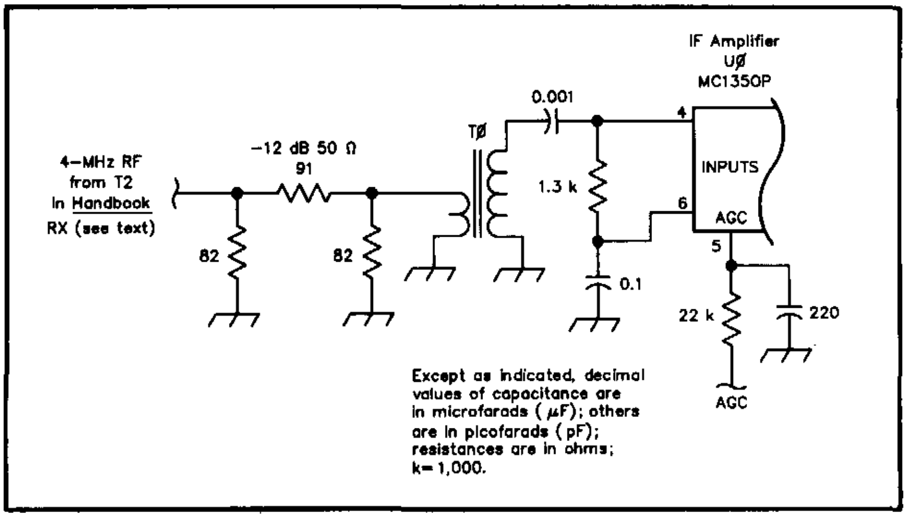


Fig 12—The AGC circuit as applied to *The 1990 ARRL Handbook* 10- and 18-MHz receiver (after adding a second MC1350P, UØ, to the receiver's IF strip). The 10/18's AGC threshold is presettable by means of a gain control at pin 5 of the AGC-amplifier MC1350P (U2 in Fig 11). TØ consists of (primary) 3 turns of no. 28 enameled wire on an FT-37-43 toroidal ferrite core over the secondary (15 turns of no. 28 enameled wire). The remainder of the 10/18's AGC circuitry is identical to that shown in Fig 11.

U3; C2 serves as a hold memory. E_O is low-pass-filtered before it reaches pin 2 of U3; although the dc component of E_O reaches the op amp, the ac components do not.

The voltage drop across D1 causes an offset that tends to bias the op-amp output (pin 6 of U3) toward ground. D2 inhibits this, however. U3 provides a dc gain of 15. Diodes D3 and D4 isolate the AGC voltage from that coming from the manual IF GAIN control, R3.

This AGC system is no more complicated than an audio-derived one. Its performance, however, is far superior to even the best audio-derived systems I've encountered. A fast attack, limited only by the rise time of the signals from the crystal filter, is possible. The dc biasing scheme chosen allows the loop to be easily adapted to other receivers. It is also tolerant of changing supply voltages—an important consideration for portable applications. For some of us, all of Amateur Radio is merely a prelude to a perpetual Field Day.—*Wes Hayward, W7ZOI, 7700 SW Danielle Ave, Beaverton, OR 97005*

AK7M: I added this AGC system to the band-imaging (10- and 18-MHz) CW receiver described on pp 30-1 to 30-7 of *The 1990 ARRL Handbook*. Because of that receiver's compact packaging and modular construction, adding AGC circuitry and a second signal-path MC1350P IF amplifier (for a wider gain-control range, not more overall IF gain) required impedance matching (Fig 12) that would have been unnecessary had I designed AGC into the "10/18" from the beginning.

As I anticipated, "kludging" another MC1350P (UØ) to the 10/18's IF strip caused instability. Modest AGC-line bypassing, and a 12-dB, 50-Ω attenuator between the 10/18's two IF-path MC1350Ps, solved this. (Too much AGC-line bypassing can audibly slow the loop's attack time; 0.001-μF bypasses at U1 and UØ, for instance, caused noticeable popping. Because of this, I replaced the 0.005-μF bypass at pin 5 of U2 in the *Handbook* receiver with a 220-pF disc.) The 12-dB pad is merely a convenience: Had I been designing from scratch, I would have RC-coupled the two IF-path MC1350Ps, doing away with the need for T2 (in the *Handbook* receiver) and TØ (Fig 12). Such an IF strip—one using an MC1530P sibling, the MC1590G—appears on p 30-23 of *The 1990 ARRL Handbook*. Reducing the gain of an RC-coupled pair of MC1350Ps is easy: Just use a lower-value collector resistor at the output of the first IF-path MC1350P. But such stabilizing fixes should not be required in a two-MC1350P IF amplifier designed and laid out as such from scratch.

MAKING BOXES FROM PC BOARD

☐ As the uncontested expert staff circuit-board-box builder, I've accumulated several ideas toward making the ultimate RF module out of copper-clad, glass-epoxy board.

Idea 1: Use thin strips of board with tapped screw holes to hold box covers in place (Fig 13). Although tapped glass-epoxy board is not as strong as plated steel hardware, it can hold screws securely. I've never stripped the threads in any of my projects. (If I did, I'd just retap the stripped hole[s] with a larger tap size.) You can easily move strips to accommodate misplaced holes; for *really* misplaced holes, make new strips.

Idea 2: Build the box with an inset bottom cover—in effect, a partition (Fig 14). Leave at least ¼ inch between the partition and box bottom and install tapped strips for mounting. This technique can help thermally isolate temperature-sensitive circuitry (VFOs and so on), allows a variety of chassis-mounting techniques, and seems to waste less volume than other techniques.

Idea 3: It's easy to mount connectors that need **D**-shaped holes, like some BNCs, to the solderable walls of circuit-board boxes. Just drill a round hole of the right diameter and solder a wire across it to form the **D** (Fig 15).—*Zachary Lau, KH6CP, ARRL Lab Enginner*

More ideas: Soldered-in nuts don't work too well as PC-board-box cover fasteners because they easily pull away from box walls when their associated screws are driven beyond finger-tight. Solution: Make the *screw* captive instead of the nut (Fig 16).

Cutting the board is easy if you have a PC-board or sheet-metal shear, but how many hams do? N1FB uses a pair of tin snips, NJ2L scores the board and breaks it along the scored line, and WJ1Z has been known to labor long with a metal nibbler to cut the pieces he needs. N1FB finished tin-snipped board edges by placing a file in a vise and running the PC-board edges across the file.

Handle PC-board material with care. Don't breathe its dust, handle its edges as little as possible, and wash your hands after working with it.—*WJ1Z*

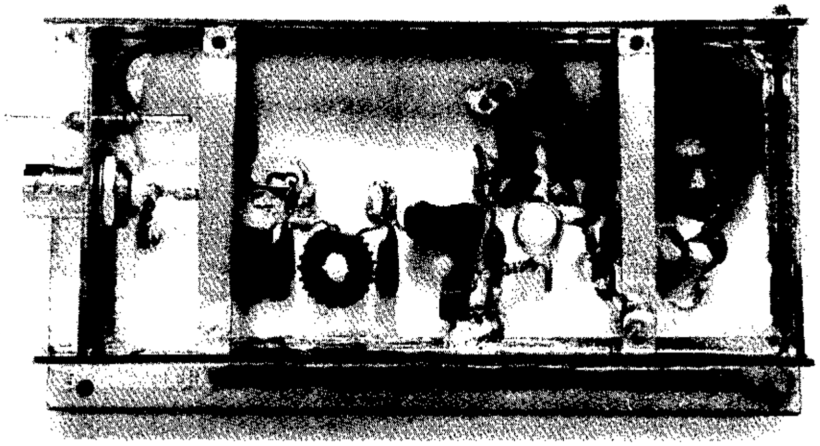


Fig 13—Zack Lau holds covers on PC-board boxes using tapped cross strips.

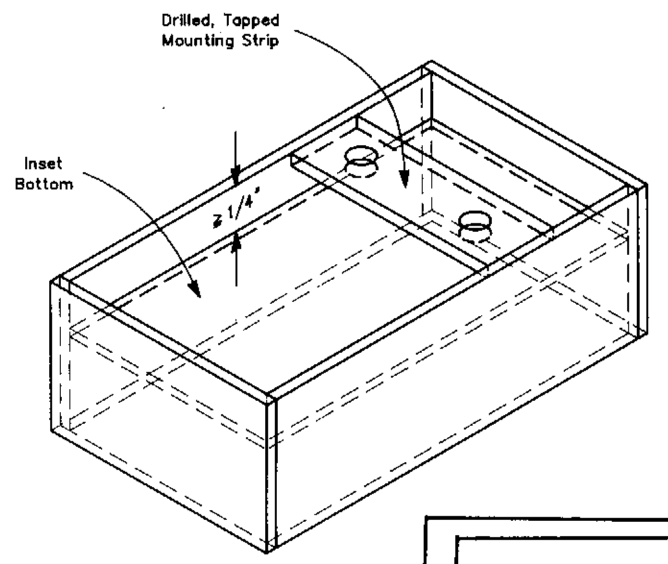


Fig 14—Insetting the box bottom cover provides thermal insulation between circuitry in the box and the mounting surface beneath it, and makes room for fasteners that protrude through the mounting surface. This is a bottom view.

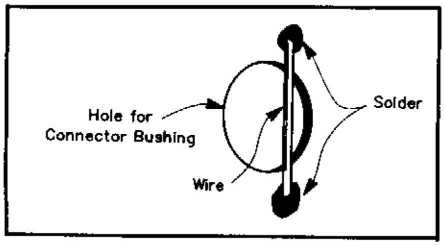


Fig 15—Solder a wire or piece of brass sheet across a round hole to make **D** holes for connectors with flatted bushings.

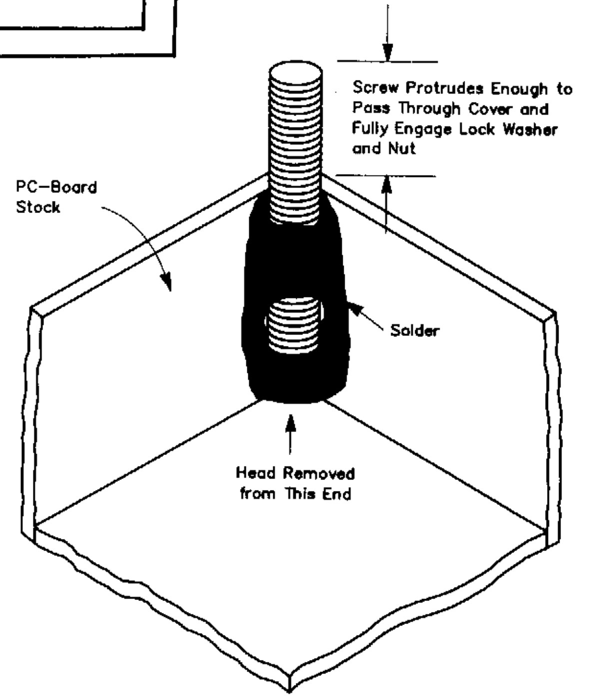


Fig 16—You can make higher-torque solder-in fasteners for PC-board boxes by soldering beheaded screws into box corners and driving nuts onto the captive screws. For easier soldering, use brass screws instead of steel, file plated screws to base metal, and tin each screw before soldering it into the box.

USE IC SOCKETS TO PRESERVE PLUG-IN BREADBOARDS

☐ Fig 17 shows an inexpensive DIP socket used to preserve the holes of a plug-in breadboard fixture. I have found that heavy use weakens the contact clips in such boards. (Some of my older boards no longer grip wire smaller than no. 16 AWG.) An inexpensive DIP socket protects the expensive plugboard from excessive wear. When the socket no longer provides good contact, simply replace it with a new one.—*David Polen, W8FRB, Canton, Ohio*

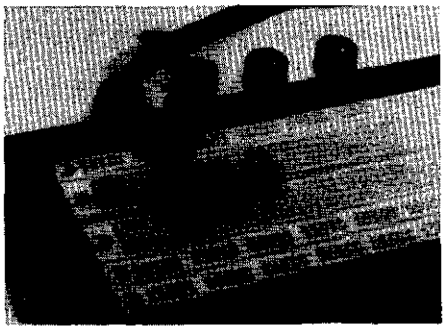


Fig 17—W8FRB uses a DIP socket to prolong the life of his plug-in breadboards.

IDENTIFYING IC PINOUTS ON CIRCUIT BOARDS

☐ Building IC projects on perforated board can be frustrating because device identity, orientation and pinout are confusing on the wiring side of a board. Troubleshooting a perf-board IC project is difficult for the same reason. My solution to this problem requires only a piece of masking tape for each IC, a pocketknife and a pen or pencil. The description of the technique assumes that the IC to be identified has already been placed on the board.

Cut a piece of masking tape slightly longer than the footprint of the IC. Using the pocketknife blade, push the tape down over the IC pins until it sticks to the board. Run the sharp edge of the knife blade along the IC pins to smooth the tape, and finish the job by passing the unsharpened edge of the blade between the IC pins to ensure firm adhesion. Next, write the IC's function and pin numbers on the tape. I usually identify only the corner pins of the chip—pins 1, 7, 8 and 14 for a 14-pin device, for instance.—*Gene Shapiro, WØDLQ, Prairie Village, Kansas*

Editor's Note: So acute are the problems of IC pinout and identification in the construction of complex digital prototypes that a number of manufacturers now offer preprinted identification tags that can be slipped over the pins of *wire-wrap* IC sockets. (One such product is the Wrap-ID, manufactured by OK Industries, Inc.) Because these tags are intended for wire-wrap use, they may not withstand soldering heat. Nonetheless, wire-wrap identification tags may be worth investigating for soldered projects, especially for circuits containing many ICs.

DOUBLE-STICK TAPE KEEPS COIL WINDINGS IN PLACE

☐ Before I began rewinding a coil for my dip meter, I wanted to make sure the turns would stay in place as I wound the coil. The necessary inductance required many turns of small-diameter wire, and I didn't want the winding to loosen and scramble if I dropped the coil during the winding process.

To keep the turns in place, I wound double-stick transparent tape on the coil form before beginning the winding. Even though I relaxed my pull on the wire several times during the winding process, the turns stayed put!—*James Herb, W3SHP, Selinsgrove, Pennsylvania*

TIDBITS FOR THE STATION AND SHOP

☐ Kodak® sells 35-mm photographic film in 50- and 100-ft bulk packs, which come in tin-plated steel cans suitable for small electronic projects. The 100-ft can is about 4 (diam) by 1¾ inches deep, while the 50-ft can is about 3¾ (diam) by 1-5/8 inches. The cans are easily soldered, and the 50-ft can nests inside the 100-ft can. Paint the cans to prevent rust.

• You can add a spring-open feature to pliers not so equipped by the maker. Spread the tool handle fully open, clean the insides of the handles near the pivot and place a big dab of silicone caulk there so that it contacts both handles. Once the plastic cures, it will cause the handles to spring back to the open position. If the return action is too strong, cut a "V" in the caulk and remove some of the material.

• I affixed a sponge to my Ungar® soldering-iron holder by putting a loop of no. 22 AWG wire through both the sponge and the holes in the holder legs.

• "Travel Pak" QSL labels are handy for labeling your radio gear. They are inexpensive and can easily be placed anywhere—like inside a hand-held (transceiver) battery pack or a cabinet. I use the same labels to identify camera gear and other valuables. —*Timothy N. Colbert, Burton, Ohio*

☐ You can straighten short pieces of kinked-up wire by placing one end of the wire in a vise and the other in the chuck of a variable-speed hand drill. Then turn the drill motor slowly while holding tension on the wire. When done, polish the wire with steel wool and give it a coat of clear acrylic paint. I've used pieces of no. 8 and no. 10 AWG wire straightened by this method for VHF whips.—*Harold F. Keenan, KA1FJR, Danbury, Connecticut*

☐ Loose coil slugs can be tightened by removing the slug and trapping a short piece of rubber band between the slug and hole as the slug is screwed back into the hole.—*Boris Golovchenko, KB2TN, Delray Beach, Florida*

☐ A handy solder dispenser can be made from a container used for 35-mm photographic film. Wind a coil of solder to the appropriate size using a screwdriver handle as a form. Punch a hole in the container cap, insert the coil in the container and feed a few inches of solder out through the hole in the cap. I have a number of these containers—each contains a different size or formulation of solder.. —*Hal Simmerman, KE4OR, Marietta, Georgia*

☐ Empty Solder Wick™ spools make excellent dispensers for small-diameter solder. Just pull a few feet from a large roll and wind it on the empty spool.—*David A. Brown, W6NBM, Wildomar, California*

☐ Fishing-tackle stores sell plastic float beads that are good element tips for home-built antennas. Simply heat the end of the element and push it halfway through the bead. The plastic beads can't prevent corona discharge like a metal ball, but they do prevent injuries from sharp element ends.—*Jack Demaree, WB9OTX, Versailles, Indiana*

PIN MARKINGS FOR COMPUTER CONNECTORS

☐ DB25 and similar computer-cable connectors have molded-in pin numbers, but the labels are difficult to read. You can increase the visibility of the numbers by rubbing a pencil or ballpoint pen over them. [A fine-tip, permanent marker works well, too.—Ed.] This hint was suggested to me by Tom Gilmer, my system manager and occasional "Elmer."—*John V. Hedtke, KD7WS, Seattle, Washington*

KEEPING TRACK OF SCRAP WIRE LENGTHS

☐ By winding moderate lengths of wire on an 8-inch-diam form, it is easy to know the approximately total length of the wire (in feet) just by counting the number of turns and multiplying by 2. (Each turn is slightly longer than 2 ft, because the circumference of a circle is equal to π [about 3.1416] multiplied by the circle's diameter.) I do this before putting wire away for storage in the junk box by using an 8-inch kitchen pot as a temporary coil form. —*James A. Herb, W3SHP, 23 E Pine St, Selinsgrove, PA 17870*

GAUGE FINE WIRE SIMPLY

☐ As an alternative to using a micrometer or dial caliper close-wind 10 to 20 turns of the wire, (how many turns doesn't matter as long as you know the number) on a pencil and measure the length of the winding. Calculate the number of turns per inch and check *The 1990 ARRL Handbook's* Copper Wire Table for the wire gauge that matches this turns-per-inch figure.—*Zack Lau, KH6CP, ARRL Laboratory Engineer*

HOW TO STRIP LIGHT-GAGE ENAMELED WIRE

☐ The small wire wheels available for hobby motor tools can be used to "skin" small-diameter stranded wires. (Standard, designed-for-application skinning devices are apt to break or cut some strands.) Simply place the wire up against a fairly hard surface (a block of wood will do) and wire-brush the insulation off.—*Willard Bridgham, W1WF, Box 103, Windsor, MA 01270*

WINDING LARGE COILS ON A MOTORIZED BARBECUE SPIT

☐ Evenly winding large coils of no. 16 or heavier-gage wire can be tricky. Such a job may require three hands! Winding evenly spaced coils with lighter-gage wire is also a chore, even if you use string for spacing the turns. Winding such a coil often involves several tries, and the result rarely looks professional.

I wind large coils on a motorized barbecue spit with a set of mandrels made from plastic irrigation tube. End washers, made from PC-board material and cut to fit the square spit, cap the mandrels. "Instant" glue holds the washers to the mandrels.

This arrangement allows me to wind large coils for power-amplifier tanks, Transmatches, and so on, from wire up to no. 12. For air-core, self-supporting coils, I use a mandrel ¼ inch less in diameter than the final diameter of the coil. The motor is slow enough for the turns to be wound against firm thumb pressure below the rotating mandrel, which limits "spring-out" when the wire is cut.

Thin-wire, space-wound coils can be wound with great accuracy on slip-on forms. With patience, you can even wind Litz-wire and π-wound chokes. For plug-in transmitter coils, 1¼-inch-diam plastic-pipe couplers are fine—and cheap. They can be drilled and mounted on 14-gage-wire legs passed through two holes in a terminal strip and soldered to form plug-in pins.

Although large, solenoidal coils are less in vogue than they once were, they are still useful in antenna tuners and vacuum-tube power amplifiers. My rotisserie technique allows me to fabricate such coils professionally and cheaply.—*Alex Comfort, MD, KA6UXR, 121 S Evergreen, Ventura, CA 93003*

USE YOUR SOLDERING GUN TO DEMAGNETIZE TOOLS

☐ If you have a screwdriver or other small tool that's become magnetized (as mine did after I used it to work on a magnetic-mount 2-meter antenna), turn on your soldering gun and pass the tool slowly between the arms that support the soldering tip. Instant demagnetization!—*Julian N. Jablin, W9IWI, 9124 N Crawford Ave, Skokie, IL 60076*

INEXPENSIVE WORK LAMPS

☐ Work lamps need not be expensive. I buy discarded high-intensity lamps at garage and rummage sales. There must be a half-dozen of these, most of which cost 50 cents to $1, knocking around my basement.

Usually, a given lamp is in working condition when I get it; sometimes, it requires a new bulb. Major surgery might involve replacing the lamp's line cord. Used-lamp goosenecks are almost always in good shape; a loose rivet-joint gooseneck can be quickly and easily repaired with no. 4-40 hardware.

If you're worried about your lamp's gooseneck or reflector coming into contact with a bare live conductor, a wrap of plastic electrical tape insulates things nicely.

Finally—although I haven't tried this—a couple of magnets, epoxied to the lamp base—should hold the lamp to a steel surface, should the need for this arise. —*Julian N. Jablin, W9IWI, 9124 N Crawford Ave, Skokie, IL 60076*

USE AN END MILL TO REMOVE COPPER FROM PC BOARDS

☐ In some cases, the stability of RF PC-board circuitry can be enhanced by using the component side of a double-sided board as a groundplane. This construction method requires an extra step, however, because copper must be removed around component-lead holes to avoid short circuits to the groundplane. A drawing in a January 1985 *QST* article[10] shows how to do this with a drill or countersink (Fig 18A).

For me, the easiest method of doing this is to use a homemade end mill rather than a countersink. An end mill is fast, accurate and cheap. In addition, an end mill is less likely to damage a PC board by over-drilling (Fig 18B).

You can make an end mill simply by using a grinding wheel to grind off the point of a standard 1/8- or 3/16-inch-diameter drill bit. The result is a flat-ended bit. I suggest modifying an inexpensive dime- or hardware-store bit; these are easier to grind. (Don't even consider using a *carbide* bit, of course!)

When your homemade end mill shows signs of dulling (burrs instead of clean removal of PC-board foil), you can re-sharpen it easily: Just touch it up quickly with the grinding wheel.

I've used this method successfully for years to make test boards in a research lab—not because end mills aren't available, but because ground-down drill bits are much less likely to walk off in someone's pocket!—*Dick Edwin, KD2FU, Northport, New York*

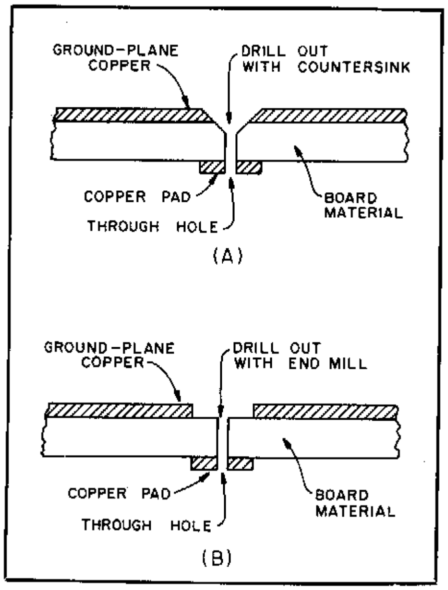


Fig 18—When you use one side of a double-sided PC board as a groundplane, the ground-plane copper must be removed around each through-hole. You can remove the foil with a drill or countersink (A), but overdrilling with these tools can easily ruin the board. An end mill allows removal of foil with little or no damage to the underlying board material (B). Dick Edwin suggests using a homemade end mill; see text.

[10]Jonathan F. Towle, "A Simple 10-Meter FM Receiver," *QST*, Jan 1985, pp 19-21.

BLENDING CIRCUIT-BOARD FABRICATION TECHNIQUES FOR SUCCESS

☐ In his August 1987 article on homemade circuit boards,[11] Doug DeMaw mentioned the unsuitability of mechanically etched boards for use with ICs or other components with close pin spacings. (Generally, mechanical etching isn't precise enough to make traces suitable for the 0.1-inch pin spacing standard with ICs.) I've been getting around this limitation by making a gridded sub-board for the IC and mounting to the main (mechanically etched) circuit board with the piggyback method described in Doug's article (see Fig 19). Jumper wires connect the IC sub-board pads to the main circuit board; glue holds the IC subassembly in place.—*John Evans, K3SQO, Box 84, RD #1, Kingsley, PA 18826*

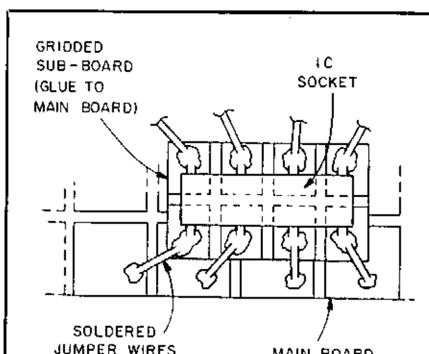


Fig 19—John Evans gets around the incompatibility of mechanically etched boards and ICs by mounting his ICs on gridded, single-sided sub-boards. (Here, the main board is also gridded for clarity.) The sub-boards are mounted to the main board using the piggyback technique described by Doug DeMaw. See text.

[11]Doug DeMaw, "Homemade Circuit Boards—Don't Fear Them!," *QST*, Aug 1987, pp 14-16.

ETCH-RESIST PENS FOR HOME-MADE CIRCUIT BOARDS

☐ Because I've been fabricating circuit boards at home for some time, Doug DeMaw's circuit-board article[12] was of more-than-usual interest to me. In particular, I've been involved in "longhand" PC-board production (a general term for boards produced with resist applied by hand with a brush or marking pen) for quite some time.[13] Most problems with boards made by the longhand method are caused by uneven ink flow from the pen. Marcus referred to this problem in a *CQ* article.[14] This uneven-flow problem can be corrected by opening the pen and adding a solvent that is compatible with the ink. (Usually, the ink vehicle is an alcohol-based solvent.)

The ink in most felt- or fiber-tip pens is stored in a fiber cylinder enclosed in a thin plastic sheath. Add 10 to 15 drops of alcohol or a similar solvent (rubbing alcohol [70% isopropyl], lacquer solvent [denatured ethyl alcohol] and butyl acetate [thinner for model paints] are satisfactory) to the cylinder end that contacts the pen tip. (Stop adding alcohol if it appears that the next drop will cause leakage from the bottom of the cylinder.) Replace the ink cylinder in the pen and allow a few minutes for the rejuvenated ink to migrate into the pen tip. Now, the pen should produce opaque black lines without smearing. If the lines appear to be almost *too* fluid, that's ideal. (By the way, overapplication of alcohol to the ink cylinder can cause leakage through the pen's tip vent hole. Watch out for this so you don't generate profanity when a vent drop hits the board and spoils your work!) Using this method, I've successfully rejuvenated *10-year-old* pens!

The best resist pens I've found for circuit-board work are produced in Germany and sold in art stores under the name Staedtler Lumocolor. Medium (no. 317) and fine (no. 318) points are available. (I recommend the no. 318 pen for most circuit-board work.) These pens contain a high-quality waterproof ink and can be opened by removing the top cap (pliers may be necessary in some cases). Most of these pens can be used for circuit-board fabrication *without* the solvent-addition treatment just described.

For builders who do not have easy access to an art supply store, I recommend the 0.4-mm, extra-fine-point version of Sanford's® Sharpie® marker. This model has a removable top that allows easy access to the ink cylinder. Many supermarkets stock this pen with stationery supplies or laundry products.

Two types of *medium*-point Sharpie pens are available. That labeled PERMANENT MARKER is definitely better for circuit-board work than the no. 3000 "highly water-resistant" model; the permanent marker has the further advantage of easy "openability." (The tip end of the permanent pen is pressed into the barrel assembly portion and held snug with several small rings. If the two parts are simultaneously bent slightly and pulled, the two pieces separate, allowing easy removal of the fiber ink cylinder. Once you've disassembled one of these pens, shave the rings with a file or knife to make subsequent assembly/disassembly cycles easier.) The second-choice (no. 3000) pen is cemented shut; if you must use one of these, I suggest sawing off the top end of the pen to add solvent to the ink cylinder. Reassemble the pen with tape if you do this.

My *ham radio* letter suggests use of a commercial metal-marking lacquer (DYKEM®) as etch resist for the portion of the circuit-board copper intended to remain as a ground plane. If you have trouble locating this product, I recommend thin lacquer, model paint or fingernail polish as a substitute. Be sure the resist you use flows easily so that it can be worked quickly. Also, the resist should be easily removable after etching. (I suggest using acetone as resist-removal solvent.)

Be sure to take proper safety precautions when working with any of the chemicals I've discussed here: Don't breathe their fumes and keep them out of contact with your skin. Further on the subject of chemicals, I add this: As a retired chemist, I cheerfully object to the characterization of home etched-PC-board fabrication as requiring "messy chemicals." *Chemicals* aren't messy, but *the people who use them* may be!—*Robert J. Grabowski, W5TKP, Rte 1, Box 388, Ozark, AR 72949*

NAIL POLISH AS ETCH RESIST FOR CIRCUIT BOARDS

☐ Here's the quickest, simplest method I've found for making one-of-a-kind circuit boards. Once you've settled on a circuit for a particular project, draw the board layout full size on a piece of paper (discarded computer printout paper works fine!). Once you've determined the component layout and board size, cut a piece of single-sided circuit board stock to the exact size of the layout and polish the copper side with steel wool to brighten it. Then, coat it with a layer of nail polish. Once the board is fully coated, set it aside to dry until the nail polish is shiny and fairly hard.

Next, trim the layout sheet to make it fit the board and tape it over the board, taking care that the board and layout paper edges meet on all sides. Transfer the circuit to the nail polish by tracing around each conductor with a ball-point pen or soft (no. 2 or 2½) pencil, bearing down hard enough to make an impression in the nail polish coating. When you've finished transferring the pattern, remove the layout paper from the board. The impressions in the nail polish layer should be clearly visible. Next, using a scriber or sharp-pointed knife, remove the nail polish along the circuit traces—not in the traces themselves—down to the bare copper. Make sure there are no bridges between circuit elements and etch the board as usual.

Once the board has been etched and rinsed, remove the nail polish that remains on the board with lacquer thinner or nail polish remover. (As usual, don't breathe the fumes of these chemicals, use them in a well-ventilated area and don't get them into contact with your skin.) Check for short circuits with an ohmmeter; if you find any, clear them with a knife or scriber. Drilling the board comes next.

Using this method, traces can pass as close to each other as 1/64 inch. This allows successful mounting of DIP ICs if the ICs are mounted as surface-mount devices *on the foil side of the board.* I've made dozens of boards using the technique described here; most were completed in a single evening.—*John Stonitsch, W2KXG, 5 Karen Rd, Glen Cove, NY 11542*

ADHESIVE PADS MAKE QUICK PROTOTYPING EASY

☐ Have you ever noticed that the mechanical part of any construction project is always much harder and more time consuming than wiring and testing the device? In particular, I've found that a project gets even more complicated than usual if a component designed to be mounted directly onto a chassis must also be isolated from ground. This is often necessary when mounting variable capacitors in antenna tuners, noise and resistance bridges, shielded DF loops, and so on.

My solution to this irritating problem is to mount such devices with the thick, double-stick pads normally used to mount devices such as compasses to automobile dashboards (see Fig 20). Surprisingly, controls mounted in this way don't feel spongy at all.

As near as I can determine, the dielectric constant of this tape is not a problem at frequencies up to 14 MHz or so. The capacitance between the device frame and ground can be reduced, if necessary, by using multiple pads to increase the spacing between the mounted part and chassis. The longevity of the pads is more than adequate for the intended service life (10 to 15 years) of the devices that I normally construct. The pads easily withstand the dc and RF voltage levels present in solid-state receiving and QRP transmitting equipment.—*Glenn Yingling, W2UW, 28 Lawrence Ave, Newark Valley, NY 13811*

[12] Doug DeMaw, "Homemade Circuit Boards—Don't Fear Them!." *QST*, Aug 1987, pp 14-16.
[13] Robert J. Grabowski, "longhand printed-circuit layout," comments, *ham radio*, Jun 1979, p 6.
[14] Alan Marcus, "A Printed Circuit Board Primer," *CQ*, Oct 1982, pp 44 and 47.

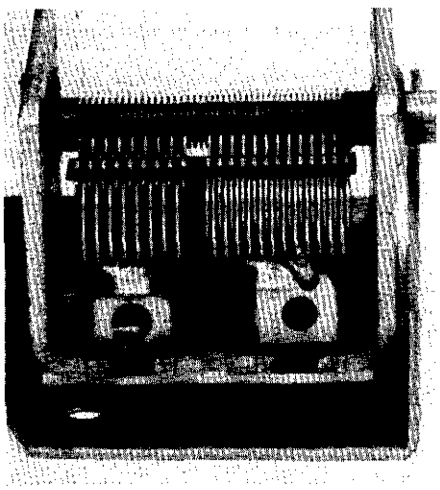


Fig 20—Glenn Yingling uses double-stick pads to mount components that must be isolated from the chassis. This photo shows pads at the front and bottom of a mounted part; pads need not be used in both places if mounting to one surface provides a strong enough bond.

PC BOARD FABRICATION WITH PREDRILLED HOLES

☐ I enjoyed Doug DeMaw's August 1987 article on PC board fabrication.[15] I have made piles of boards and developed my own style, an important facet of which I've not seen others use: I drill my holes *before* etching the board. This technique is useful for several reasons: (1) predrilled holes can speed the process of transferring the layout to the boards; (2) several boards can be drilled at the same time; and (3) predrilled holes can serve as guides for registering double-sided boards. Here are the steps in my process:

1) On 0.1-inch-grid paper, draw a full-sized board pattern (as seen from the copper foil side of the board).

2) Clean the foil side of the board (or the bottom foil for a double-sided board) and glue the pattern to the foil. (Rubber cement works well for this purpose. Also, it's a good idea to make a full-sized photocopy of the layout before gluing if you intend to use the layout again later on.)

3) If you're only doing one board, skip this step and go to step 4. If you want to drill more than one board at a time, glue several pieces of board together. (I suggest doing no more than four boards at once to keep drill drift errors to a minimum when the holes are drilled.)

4) Using the glued-on pattern as a guide, drill the board(s). (Drill a small pilot hole first for large holes.) The pattern paper helps center the bit.

5) Peel off the pattern and clean the board(s) of rubber cement and burrs. Chemically clean the boards with copper-pot cleaner.

6) Using a pencil, draw the traces on the board(s), using the holes as a guide. (The presence of the holes at this point results in automatic registration of double-sided boards.)

7) Redraw the traces with etch-resist pens or paint.

8) Etch the boards and clean them of resist as usual.

I've been making fast circuit boards this way for about 27 years. The method is okay for 0.1-inch pin spacing, but not for work much finer than that.—*S. Premena, AJ0J, PO Box 1038, Boulder, CO 80306-1038*

[15]D. DeMaw, "Homemade Circuit Boards—Don't Fear Them!," *QST*, Aug 1987, pp 14-16 and 23.

GENERIC FILM FOR THE FILM-AND-PHOTOCOPIER PC-BOARD METHOD

☐ In his article on PC-board fabrication,[16] Doug DeMaw mentions Meadowlake Tec 200 film, a commercial product useful in making photocopier-transferred PC-board patterns. I've had good results replacing Tec 200 film with 10-mil Mylar® film. Such film is often available from paper suppliers or transformer manufacturing companies.—*Peter Robson, 18 Washington Tr, Hopatcong, NJ 07843*

[16]D. DeMaw, "Homemade Circuit Boards—Don't Fear Them!," *QST*, Aug 1987, pp 14-16 and 23.

ISOLATED-PAD DRILLS STILL AVAILABLE

☐ The easiest way to rework or to fabricate a single- or double-sided PC board *mechanically* is to use a specially made tool—an *isolated-pad* drill bit—such as those made by the Stahler Co, 5521 Big Oak Dr, San Jose, CA 95129. These bits are available in three ODs; the approximate sizes are 0.109, 0.150 and 0.2225 inch. Used by itself, the isolated-pad bit removes a ring of copper from the board, creating an isolated foil pad. Used in conjunction with a no. 60 or 61 bit, the tool creates an isolated pad with a component-lead hole at its center (see Fig 21).—*Paul Atkins, K2OZ, 56 Ormsay St, Park Ridge, NJ 07656*

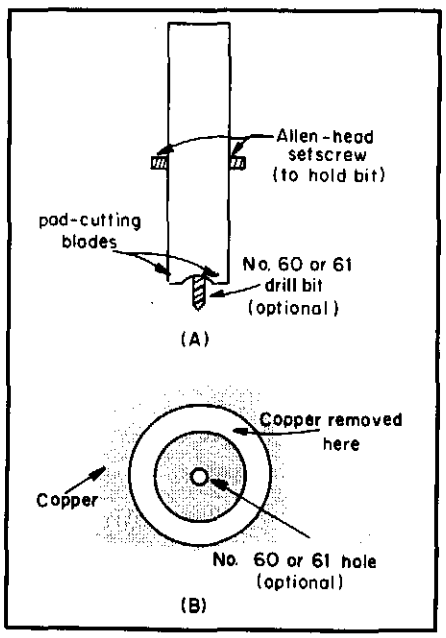


Fig 21—Isolated-pad drill bits (A) create isolated pads in circuit-board foil by removing a ring of foil (B). Isolated-pad construction has previously appeared in *QST*; for example, see Alfred F. Stahler, W6AGX, "Isolated-Pad Circuit-Board Construction," Gimmicks and Gadgets, *QST*, May 1973, p 44. Vector also makes isolated-pad drills; the Vector 138 C is an example.

PUTTING KNOBS ON 3/16-INCH SHAFTS

☐ Controls with 3/16-inch-diameter shafts seem to be more common than knobs to fit them! A suitable 3/16-to-1/4-inch adapter can be made using 1/4-inch-OD diameter copper tubing (available from hardware stores). Cut the tubing with a hacksaw, and deburr the inside edge of the cut if necessary.

Make a set-screw hole as follows: Drill a ¼-inch hole within an inch of one edge of a block of scrap wood. Stuff the tubing into the wood. Drill the set-screw hole through the wood and into the tubing. You may need several tries to perfect this technique, but a foot of tubing contains enough material for many practice runs! —*Zack Lau, KH6CP, ARRL Lab Engineer*

A NEW FACE FOR A RECALIBRATED METER

☐ In "A Simple and Accurate QRP Directional Wattmeter," (Feb 1990 *QST*, pp 19-23 and 36), I described a QRP wattmeter that uses a standard 0-1 milliammeter modified with a custom, nonlinear scale calibrated directly in power and SWR according to the values shown in Table 2. Making new scales for a stock meter is one solution; adding markings to

Table 2
Meter-Recalibration Data for the QRP Wattmeter

Power	*Meter*	*SWR*	*Meter*
0.0	0.0	1	0.0
0.05	0.224	1.5	0.200
0.1	0.316	2	0.333
0.2	0.447	3	0.500
0.3	0.548	4	0.600
0.4	0.633	5	0.667
0.5	0.707	7	0.750
0.6	0.775	10	0.818
0.7	0.837	∞	1.0
0.8	0.894		
0.9	0.949		
1.0	1.0		

The *Meter* column expresses fractions of full-scale readings on the original meter scale. For example, the new SWR = 3 mark should be placed at the same place as the half-scale (0.5) mark on the original meter face.

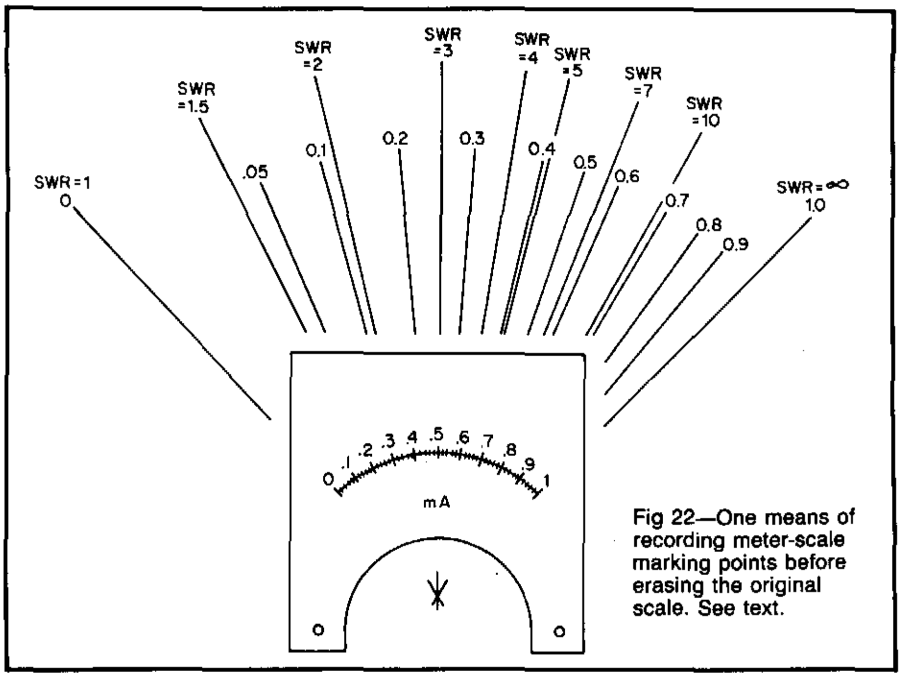


Fig 22—One means of recording meter-scale marking points before erasing the original scale. See text.

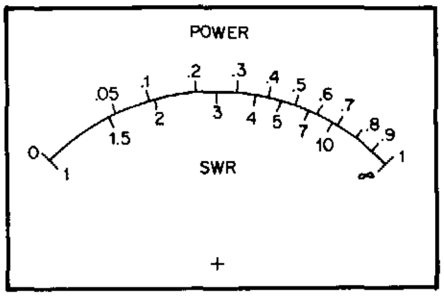


Fig 23—Example of a finished meter face. This scale is that of the meter used in "A Simple and Accurate QRP Directional Wattmeter."

the existing meter scale is another. It's fairly easy to make the new scales readable, and somewhat harder to make them look nice. If you decide to make new scales rather than add marks to the existing scale, you'll want to record the correct places to make the new marks before you obliterate the old scale. One way to do this is as follows.

Refer to Fig 22. Attach the meter face to a large piece of paper. Trace around the face so you can exactly reposition it later. Find the meter pivot point by extending the tick marks at the scale's ends, and verify this point by extending a couple of other points on the scale. Then draw lines from the pivot point through the meter face to an area beyond the face, labeling them appropriately, as shown in Fig 22. Then you can remove, repaint and replace the meter face. The new scale and marks can be hand-drawn; press-on letters and numbers can be used; or the face may be made with a photographic process.

A caution: Anyone who sees my home-built equipment immediately realizes that, although I'm willing to spend a lot of time on functionality and performance, I don't devote much time to beauty! So you'll have to look elsewhere for advice on how to make a meter face good-looking. When finished, the meter face should resemble Fig 23.—*Roy Lewallen, W7EL, 5470 SW 152 Ave, Beaverton, OR 97007.*

TOOTHPASTE AS A POLISHING AGENT

☐ After accidentally scratching the digital readout on my Kenwood TR-2600A hand-held transceiver, I wondered if the scratch could be removed. On a hunch, I discovered that the readout face could be polished to its original smoothness with toothpaste—by briskly rubbing a small amount of paste over the scratched area with tissue paper. Since then, I've found that this method works well on many soft plastics.—*Ronald E. Wright, N9ADJ, 612 Forest Ave, Alton, IL 62002*

STOP THAT DRILL

☐ To avoid overdrilling holes in sheet metal, find a piece of metal tubing about ¼ inch shorter than the bit. Slip the tubing over the bit before drilling. The tubing limits the bit's travel and keeps the bit from damaging components behind the drilled surface. A stack of rubber grommets works well, too.—*Frank A. Reed, Jr, W6PWQ/7, PO Box 275, Langlois, OR 97450*

USING WATER-BASED MARKERS ON GLOSSY SURFACES

☐ Many glossy surfaces won't take ink from water-based markers. Typists' correction fluid is a solution to this problem: Just brush a patch of the white stuff on the surface to be marked. Once the fluid dries, it can easily be written on with water-based markers, such as Flair® pens and their equivalents.—*Scott Gray, K7WPC, PO Box 12, Toledo, OR 97420*

APPLYING DRY-TRANSFER PANEL LABELS

☐ Applying dry-transfer labels to a panel *after* controls have been mounted can be frustrating because manipulating label sheets between control shafts and mounting bushings is difficult. To get around this, I tried cutting the desired labels from the carrier sheets, but my 10 thumbs aren't nimble enough to hold such small pieces in place for burnishing!

Here's how to solve this problem. Cut the desired label from the carrier sheet with scissors or a knife and place it face down (so that it reads properly) on a sheet of the label-backing paper (supplied by the label manufacturer to separate the carrier sheets). Place a piece of Scotch® Magic™ tape on the label. It will stick to the label but not to the backing paper. Lift the assembly and position the label—which can be read through the tape—in the desired place and press it to the panel. Now use a ballpoint pen to burnish the label. The Magic tape accepts ink, so you can easily see when the burnishing job is complete. When the label is fully burnished, pull away the tape. There you are: As neat a labeling job as you could wish for. For crowded panels, I find that 1/16 inch of tape around the edges of the label is enough to hold the label in place for burnishing.

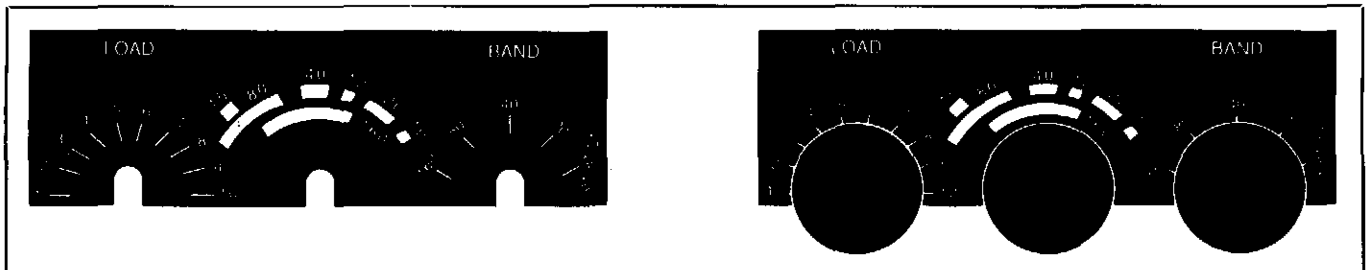
Whatever technique you use to apply dry-transfer labels, be sure to clean the panel first with a solvent capable of removing oil without damaging the panel surface. Residual oil, human or otherwise, can prevent dry-transfer labels from adhering properly to the panel. Do this cleaning shortly before applying the labels.—*Harold J. Read, ex-W9HBW, -W9HBX, -W9LHP, Grove City, Florida*

SOME THOUGHTS ON PANEL LABELING

☐ When commercial ham equipment is modified sufficiently to require front-panel marking changes, or homegrown gear is to be polished up a bit, it's usually difficult to make the front panel labeling look decent and fit in with the rest of the station. I faced this problem after I modified my Heathkit® SB-200 amplifier to cover the 160- and 12-meter bands.[17] As a result of my modifications, the SB-200's TUNE and BAND switches required relabeling, and I wanted the amplifier to look as good as it performed.

My solution to this problem was to cut

[17]S. M. North, "Putting the Heath SB-200 on 160 Meters," *QST*, Nov 1987, pp 33-35.



(A) (B)

Fig 24—Safford North relabeled his SB-200 amplifier without modification by using a labeled pasteboard subpanel. Installation is easy: The slotted pasteboard just slides into place behind the amplifier controls.

a rectangular piece of black pasteboard large enough to cover the scales around the SB-200's LOAD, TUNE and BAND controls. I used white ink to draw the band arcs around the TUNE control and white dry-transfer lettering for the LOAD and BAND scales, and for labeling the band arcs (Fig 24A).

With suitable slots cut to pass the LOAD, TUNE and BAND control shafts, the labeled subpanel slides neatly into place on the SB-200 (Fig 24B). The white-on-black appearance of the subpanel is striking and the controls are properly labeled—all without modifying the equipment front panel itself in any way.—*Safford M. North, KG2M, 1426 Riverbend Dr, Baldwinsville, NY 13027*

MATTE FINISH AND PANEL LABELS FOR HOMEMADE PROJECTS

☐ When we construct a radio/electronics device and put it in a box, its front panel often ends up looking shabby, with handwritten names for control labels. A nice-looking front panel reflects the quality of the project inside the box. Here is a simple way of making an attractive front panel that has a matte-finish silver hairline design. If your project box already has an aluminum front panel, great. If not, cut an aluminum plate the same size as the box's front panel and attach it to the box. Before beginning, make all necessary holes and cuts in the front panel(s).

Step 1. Wrap fine sandpaper around a piece of wood and sand the aluminum panel in one direction until fine hairlines begin to appear. If the panel is coated with paint, be patient and do this *until the paint comes off* and the hairlines appear.

Step 2. Thoroughly clean the panel surface. Now, spray the panel with clear *lacquer* paint. The purpose of this is to make the surface of the panel smooth for applying dry rub-on lettering. Wait until the lacquer dries completely, then apply the lettering.

Step 3. Spray the panel with clear *enamel* paint. (*Important:* Use a different type of paint than you used in Step 2. Otherwise, this coat may mix with the Step 2 paint, causing the lettering to float around in a sea of clear paint!) Spray a few coats until the paint completely covers the lettering.

Step 4. Heat the front panel from *behind* the painted side until it is almost too hot to touch. You can do this over a gas stove, but be careful to keep the painted side from making direct contact with the flames. Remove the panel from the heat source and *immediately* spray on another coat of clear enamel from some distance away (1 foot or more), so that the paint particles land on the panel spread widely apart. As the panel cools, the paint particles will shrink, giving a matte finish on the panel.

This is not an original idea, but something I learned back in Tokyo many years ago when I was a kid, making a lot of projects and looking for neat ways of making a good-looking front panel. I hope this technique gives you a handsome front panel that the device inside the box truly deserves!—*Kunio Mitsuma, KA3RRF, Calder Sq, PO Box 10407, State College, PA 16805*

SOLDERING TO STAINLESS STEEL—ALMOST

☐ Stainless steel doesn't take solder, but the equivalent of a soldered connection *can* be made to stainless steel by means of a welding technique. Using an oxyacetylene or Mapp® gas torch, braze a patch of brass to the steel. Solder your connection to the brass instead of the steel. If you use this technique for connection to a stainless steel clamp on an aluminum antenna element, be careful not to allow contact between the brass and the aluminum: corrosion can result where these metals touch.—*Edson B. Snow, W2UN, Pompano Beach, Florida*

H & K INTERACTION: SOLDERING TO STAINLESS STEEL

In "Soldering to Stainless Steel—Almost," Edson B. Snow, W2UN, described a method of welding a brass patch (eminently solderable) to stainless steel (difficult to solder). In response to this, readers write:

☐ I've been soldering to stainless steel for over 20 years, achieving structurally sound joints that compare favorably with joints in iron or brass. There's no trick to it. At one time, I used a special paste flux, but now I use ordinary zinc chloride/hydrochloric acid liquid flux, available at hardware stores. Bar solder (40% tin, 60% lead) or rosin-core wire solder works well.

The metals to be soldered to *must* be clean. Tin each piece separately, then clamp or otherwise hold the pieces together. Next, heat the work and flow solder into the joint.

For joining thick pieces of stainless-steel at right angles, I clamp them securely into position (*after* tinning), *carefully* preheat the parts with a propane torch (taking care not to discolor the metal) and finish the job with a large soldering iron. This method allows me to pile up enough solder to form fillets that greatly strengthen the joint. —*Ed Nickerson, K4EBF, 610 N Yachtsman Dr, Sanibel, FL 33957*

☐ Ed Snow's H & K note on soldering stainless steel prompted me to look up the solders I've been using. *Stay-bright*™ (manufactured by the J. W. Harris Co, Inc) or Kester® "Sil-Strong" (4% silver, 96% tin) solder will do an excellent job on stainless steel and many other metals. "Sil-Strong" melts at 430 °F and can be applied with a regular soldering iron; it's also claimed to be five times stronger than regular tin-lead solder—a statement that, according to my experience, seems to be true.

I found both products at my local hardware store. They're more expensive than regular soft solders, but since they do the job, they're worth the price.—*Bill Corse, K3YSL, PO Box 125, New Freedom, PA 17349*

☐ Fabricators of kitchen equipment find stainless steel to be one of the easiest metals to solder. The secret is to use the proper flux. A number of such fluxes are available on the market, and these can be obtained at sheet-metal supply houses. I use Lloyd's stainless-steel flux, which is manufactured by the Johnson Mfg Co, Princeton, IA 52768. (Although my name is Lloyd, I have no connection with this company.) I've had no problems with corrosion of the soldered joints; just be sure to rinse or wipe the work clean with a damp rag when finished. —*Lloyd Franklin, W9WUR, 8006 S Kirkland Ave, Chicago, IL 60652*

SOLDERING TO STAINLESS STEEL—AGAIN

☐ Concerning "Soldering to Stainless Steel—Almost": I've successfully soldered stainless steel to stainless steel—and to iron, cast iron, brass, copper and other metals—by using homemade acidic soldering flux made of the following ingredients: 37 g of zinc chloride, 23 g of glacial acetic acid and 40 g of hydrochloric acid. (This formula produces a considerable quantity of flux; you can scale down the quantities *in proportion* to suit your needs.) To make the zinc chloride, I dissolve zinc in hydrochloric acid until the solution is saturated; then I carefully add the rest of the ingredients.—*Roger Del Nero, WA2HNQ, RFD #6, Box 291, Rome, NY 13440*

AK7M: This formula calls for chemicals that are hazardous to touch and breathe. Hints and Kinks recommends that readers unsure of their ability to handle dangerous chemicals purchase ready-to-use zinc-chloride flux instead of trying to blend their own. Preformulated acidic fluxes are hazardous, too; use them carefully.

RE-CEMENTING TUBE GRID AND PLATE CAPS

☐ When the ceramic adhesive that holds a plate or grid cap to a tube breaks away from the tube envelope, making a connection to the loose cap can strain the terminal's metal-to-glass seal and wire. I successfully reattached a loose cap to an 811A with high-temperature stove-gasket cement. (I use a cement manufactured by Rutland; I bought it at a hardware store.)

If the cap is still properly soldered to the terminal wire, skip to the next paragraph. If the cap has come loose from the tube and terminal wire, carefully clean the wire, sanding it (if necessary) so solder can adhere. Resolder the cap to the wire.

Following the manufacturer's instructions for handling and applying the cement, push the cement under the cap edge to fill the tube-to-cap gap as fully as possible. Prop up the tube while the cement sets.

Tube heat apparently helps the cement cure, so using the tube may further strengthen the cement-to-glass bond. So far, the cap I reattached this way has stayed put.—*Jay Bryant, KM4IM, 4736 Dauphine Blvd, Tallahassee, FL 32803*

WHEN FUSES SHATTER

☐ In the course of performing their function, tubular glass fuses may shatter if subjected to a severe overload. This causes two problems: (1) glass shards in the holder and (2) the detached fuse end cup inside the holder base. These remnants can usually be ejected by inserting a small rod through the back end of the holder *if* that end of the holder is accessible.

These problems can be minimized by wrapping the glass body of the fuse with vinyl tape. One or two turns are enough; ¾-in-wide tape is a perfect fit on standard size fuses (3AG, and so on). Use transparent tape to allow visual inspection of the fuse element.

If the back cup of a disintegrated fuse can't be pushed or pulled from the holder by other means, here's an adhesive solution: Put a dab of mixed five-minute epoxy glue on the passive end of a wooden match. Carefully insert the matchstick into the fuse holder, glued end first. When it bottoms, twist it gently, but firmly, to seat it in the fuse end cup. Allow the epoxy cement to cure for 10-15 minutes and pull out the matchstick. If you recover only glass fragments, repeat the procedure until the errant cup is extracted. —*Marty, W6BDN, and Dan, N6BZA, Levin, Menlo Park, California*

USING HEAT AND COLD TO MOUNT PARTS

☐ A remembered high-school physics demonstration helped me replace the tip on my collapsible 5/8-wave hand-held transceiver antenna. I'd pulled the original tip loose and lost it. The replacement tip sent to me by the factory apparently had been made for a different antenna: The socket for the antenna was too small.

I enlarged the socket with a drill one size smaller than the antenna tip. Then I put the antenna in our food freezer for a couple of hours. Next, I heated the tip in a 400° F oven for 15 minutes. Taking proper care not to be burned by heat *or* cold, I tried to assemble the parts again. Voilà! Shrunk by cold, the antenna slipped into the heat-enlarged hole of the tip. As the parts reached the same temperature, the antenna swelled slightly and the tip shrank, resulting in a press fit as strong and tight as a weld.—*Richard Ellers, K8JLK, Warren, Ohio*

REPLACEMENT PA TRANSISTORS

☐ With winter here, I would like to pass some practical advice along to owners of the Kenwood TS-130. On a winter day in January 1983, I had left my mobile rig out in the cold for several hours at about 0 °F. When I switched the rig on, the collector current rose to a very high value, and one of the PA transistors developed an emitter/collector short. I checked with an RF engineer and found that this is common failure mode for RF power transistors that are several years old. He suggested that I avoid this problem in the future by warming the rig to about 20° before applying power.

I replaced the original Toshiba 2SC2290s[18] with a pair of matched Motorola MRF-421s, which are listed as direct replacements in the Motorola manual. The replacement procedure is very straightforward: Simply install the new transistors and adjust the bias current as described in the shop manual. The results are excellent, and the new transistors produce slightly more power than the originals on 10 and 15 meters. These transistors have been in service for about three years now, with no signs of instability or other problems.—*George Hovorka, WA1PDY, Milton, Massachusetts*

[18][These same PA transistors are used in many contemporary radios as well, such as the TS-430S.—Ed.]

TRANSISTOR HEAT SINKS FROM ALUMINUM TUBING

☐ Here are two alternatives to forming small heat sinks on a vise. Each makes use of open-seam, 3/8-inch-OD aluminum tubing. See Fig 25A. Cut the tubing to length, and clean the cut with reamer and file. Pry open the seam with a screwdriver and slip the sink over the transistor. The sink shown in Fig 25B uses the same technique, but is more open to the air. The 3/8-inch tubing is just right for transistors in TO-5 and TO-39 cases.—*Daniel G. Mackintosh, W6SPC, San Francisco, California*

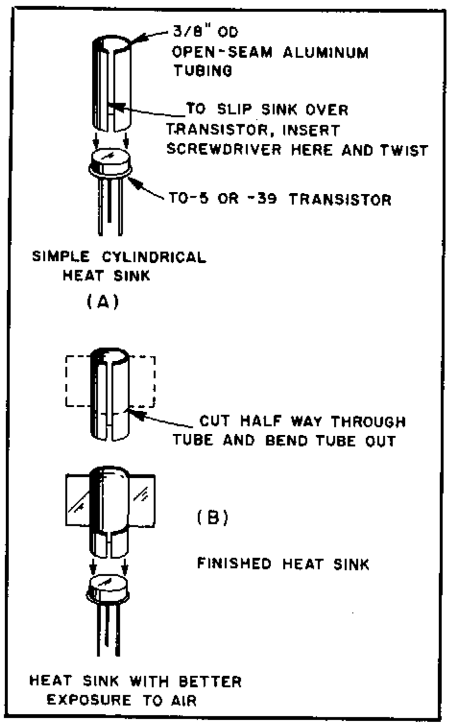


Fig 25—W6SPC's quick TO-5/TO-39 heat sinks from open-seam, 3/8-inch-OD aluminum tubing.

REDUCTION-DRIVE TUNING CAPACITORS FROM UHF TV TUNERS

☐ **Surplus UHF TV tuners, and those in discarded TV sets, may serve as a source of reduction-drive tuning capacitors. The geared reduction drives on these variable capacitors have practically no backlash. After you have located such a tuner, carefully open it. You should see a tiny three-section variable capacitor with an integral reduction drive. Depending on when the tuner was manufactured, it may have a detent system for channel selection. If such a system is present, remove or otherwise disable it.**

Now, let your creativity be your guide. In one project, I disconnected the capacitor stators from the tuner circuitry, wired them together and brought a lead from the parallelled stators out through a hole in the tuner box. I kept the tuner knobs and used them to adjust the capacitor.—*James Smith, KD4YD, Ellenton, Florida*

REPAIR VARIABLE CAPACITORS WITH PLASTIC SHEET

☐ I bought a homemade L-network Transmatch at a recent hamfest only to discover later that the ceramic insulation of its variable capacitor was badly cracked. After I overcame my disappointment, I noticed that the capacitor could be disassembled; it was held together with screws rather than rivets. I measured the thickness of the broken insulator (¼ inch), and headed to a hardware store to find replacement material.

Fifty cents' worth of scrap 1/8-inch Plexiglas™ provided the solution. Using the ceramic pieces from the capacitor as a template, I marked and drilled two identical Plexiglas pieces to bring the thickness of the replacement assembly to ¼ inch. Even though I had to make several tries at sizing the pieces because of my inexperience with tools, the rebuilt capacitor works! This hint may help others save damaged variable capacitors that cannot be replaced easily or cheaply.—*Oscar Martinson, N0DKB, Minneapolis, Minnesota*

IMPROVED PERFORMANCE IN OLDER VARIABLE CAPACITORS

☐ I read with interest N0DKB's capacitor-repair hint and decided that replacing with acrylic plastic the bakelite insulation in some of my older capacitors (those used in situations where appearance and authenticity do not matter) might improve their efficiency. I tried this idea with my antenna tuner's variable capacitors (Fig 26 shows two views of one) and was pleasantly surprised at the improvement.—*Rodney K. Schrock, KD3OR, 402 Lincoln St, Somerset, PA 15501*

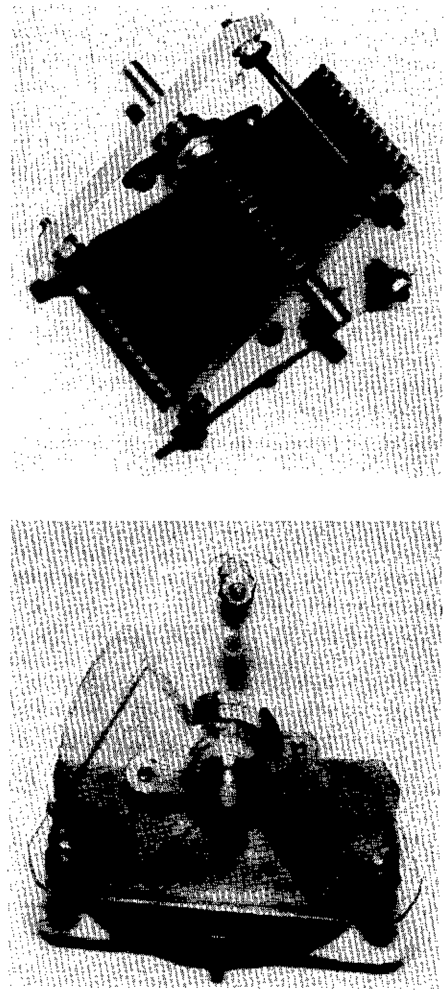


Fig 26—Rodney Schrock improved the efficiency of his MF/HF antenna tuner by replacing the bakelite insulation in its variable capacitors with Plexiglas. (Acrylic plastic is also manufactured under the trade names Acrylite and Lucite.) This capacitor is a General Radio 247. *(photos by KD3OR)*

QUICK FORMS FOR SMALL, ADJUSTABLE COILS

☐ Cut a short piece of heat-shrink tubing that is just large enough in diameter to pass a no. 4-40 or 6-32 screw. Coat the screw with silicone lubricant, slip the tubing over the screw and shrink the tubing. After the tubing has cooled and hardened, wind the coil on the tubing without removing the screw. Use quick-setting epoxy glue to secure the wire to the form.

Once the glue has set, you can adjust the inductance by varying the core material and the depth to which it is turned into the coil.

Assuming the coil's inductance with an air core as standard, a brass screw *reduces* the inductance and a ferrous screw *increases* the inductance. Steel (a very poor core material at RF) and brass lower the coil Q in addition to changing its inductance. Ferrous cores suitable for RF are available with threads of standard pitches.—*Edwin B. Walker, DDS, WA4DFS, Mountain City, Tennessee*

A SOURCE OF FERROUS CORE MATERIAL FOR FILAMENT CHOKES

☐ Ferrite cores from TV flyback transformers can serve well as core material for filament chokes. Here are my experiences in fabricating and testing a filament choke wound on such a core in a home-built two-813 amplifier. The core I used is rectangular, with inside dimensions of about 1¾ × 1½ inches.

After removing the transformer windings, I wound several layers of electrical tape on the core to protect the choke winding from the core's sharp edges. Next, I wound 34 bifilar turns of no. 12 enameled wire—as many as would fit—on the core. (I obtained the wire from an electric-motor repair shop.)

My next concern was whether the core would saturate with the choke windings supplying filament power (10 V ac at 10 A) to the 813s. To test this, I wound a few turns of wire on the core and shunted this winding with a capacitor. Then, I determined the resonant frequency of this parallel tuned circuit with a dip meter. Next, I checked the tuned circuit's resonant frequency with 10 A flowing through the choke windings. No change had occurred in the circuit's resonant frequency; hence, I concluded that the core could handle 10 A without saturating.[19] The core's ac voltage drop tested as 0.2 V at 10 A. (I needed this information because I planned to heat the 813s' filaments with a rewound power transformer. That I did; my rewound transformer puts out 10.2 V under load.)

With the flyback-core filament choke in place, my amplifier works well from 1.8 to 30 MHz. The choke also works well in a single-3-500Z amplifier that covers the same frequency range.

I thank Larry Stark, K9ARZ, for encouraging me to test this idea, and Arne Sjomeling Jr, KØAS, for providing me with technical material on choke design. (Arne tested some flyback cores and determined their permeability to be about 1000.) —*Mark Meyer, WAØNSY, Rt 2, Box 28, Watertown, SD 57201*

[19]Core saturation would reduce the core's permeability, and, assuming that the core material is operative at the test frequency, the inductance of the test winding. An increase in the test tuned circuit's resonant frequency would indicate that such an inductance shift has occurred.—*AK7M*

MORE ON USING TV-FLYBACK-TRANSFORMER CORES FOR FILAMENT CHOKES

☐ WAØNSY's idea (M. Meyer, "A Source of Ferrous Core Material for Filament Chokes," Hints and Kinks, *QST*, Aug 1989, p 39), is a good one. Old TV flyback cores should make excellent filament chokes and his construction technique looks sound. Some cautions are called for, however.

Assuming that Mark's 10-A test filament current flows through both windings in just the way it would flow in practice, no magnetic flux is produced in the core because the fields from the two windings have opposite "sense" as seen by the core, causing them to cancel. Thus, filament current is not the core-saturation problem it appears to be, and the test, as described, is invalid.

In an amplifier tube with a directly heated cathode, however, the cathode current also flows in the choke windings. Because this current—dc—has the same sense in both windings and produces flux in the core, it's the one we need to worry about.

Any given core can withstand a certain number of dc ampere-turns, the product of the net winding direct current and the number of turns. In a typical flyback core—say, a Ferroxcube 1F19-3C6A—about 18 ampere-turns causes a 50% reduction in inductance. WAØNSY's design used 34 turns, giving 18 ampere-turns ÷ 34 turns = 530 mA—about the maximum dc cathode current in his single-3-500Z amplifier.

Mark's core has an A_L value of about 2500 mH per 1000 turns (better expressed as 2.5 µH/turn^2). On such a core, 34 turns gives 2.9 mH—a reactance of almost 33 kΩ at 1.8 MHz. That much reactance seems ridiculously high for a choke in a low-impedance cathode circuit. Why not reduce the number of turns dramatically? The answer is core loss. The core material is designed to exhibit low loss at 20 kHz, not 2 MHz. At medium and high frequencies, the core loss causes an equivalent parallel resistance, which also varies with turns squared. The power dissipated in this resistance limits how *few* turns may be used.

An experiment using a 100-W CW transmitter at 1.8 MHz, driving a 50-Ω dummy antenna in parallel with a single winding on the prospective core material, will reveal the minimum turns requirement. Just reduce the number of turns until you detect core heating (with your finger, after you've turned the RF off). The test must be repeated on all other bands, because the lowest frequency doesn't necessarily need the highest number of turns. Once you've determined the proper number of turns, wind the practical choke with the same number of bifilar turns.

Parasitic series resonance occurs at some frequency in every choke. The more turns the choke contains, the lower the frequency of series self-resonance. If series resonance occurs in an Amateur Radio band, you may have a very hot choke indeed when you transmit on that band! (Because the choke exhibits a very low impedance at series resonance, it sinks the drive power that would otherwise be fed to the amplifier circuit of which it is part.) Because filament-choke service requires a relatively low-impedance choke to begin with—one requiring considerably fewer turns than a high-impedance choke—it should be possible to construct a filament choke that is series resonant above 30 MHz—the best place for the series self-resonance in an MF/HF-amplifier filament choke. That's another incentive to minimize turns. —*David M. Barton, AF6S, 14842 Nelson Way, San Jose, CA 95124*

☐ The test Mark describes should be done with dc equal to the total expected cathode current, rather than with filament ac. The test current can be applied through one wire of the choke's bifilar winding or through both of them in parallel; the result is the same. I believe that the choke voltage drop Mark measured (0.2 V at 10 A filament current) is due essentially to wire resistance and not core loss.

For a tube with an indirecly heated cathode, use a trifilar choke: one wire for each heater lead and one for the cathode lead. As in the case of a bifilar choke carrying filament current for a directly-heated cathode, the trifilar-choke core sees only the tube's cathode current and not the heater current while keeping the cathode heater leads isolated at 60 Hz and at the same potential at MF/HF. Select the choke core for its RF characteristics—while operating at the expected dc cathode current, but neglecting the filament/heater current—at the frequency of interest. —*Harold C. Myers, K4JHM, 555 Hembree Rd, Roswell, GA 30076*

A SOURCE OF RING MAGNETS

☐ Some of the ring magnets used in speakers are quite large and powerful. The magnets are discarded with faulty speakers, but they are useful around the shop, or for a home-built magnetic antenna mount.

But have you ever tried to salvage one of these magnets? The magnet material is often ceramic—very hard and brittle. Any attempt to separate the magnet and speaker usually results in a broken magnet. Careful application of heat from a propane torch, however, softens the cement that holds the magnet and allows it to be removed in one piece.

Slowly apply heat to the metal speaker case (heat can damage the magnet) until the cement starts to soften, then gently pry the magnet free. I have not found a speaker magnet that could not be removed with this method.—*J. M. Simms, N7BBC, Tucson, Arizona*

HOME-MADE COIL DOPE

☐ Tuffak® and Lexan® plastics can be used to make a superior coil dope. To do this, dissolve a quantity of one of these plastics in a polycarbonate solvent capable of bonding them chemically. (One such solvent is Weldon-35, made by Industrial Polychemical Service, 17109 S Main St, Gardena, CA 90247 and usually available at plastic sign shops.) The result is a fine, workable paste that dries quickly to a clear coating. Caution: Don't breathe the fumes of this solvent and the coil dope, use them in a well-ventilated area and don't get them into contact with your skin.—*Jack Sobel, WØSVM, 64 Burning Tree Dr, Chesterfield, MO 63017*

CRYSTAL SOCKETS FROM SPEAKER TERMINALS

☐ Radio Shack® "Button Terminals" are intended for use as spring-loaded terminals for speaker wiring, but they also work well as sockets for popular crystals with 0.486-inch pin spacing. These devices, RS nos. 274-622 (four terminals) and 274-623 (eight terminals), can be used to hold two and four crystals, respectively. Crystals in FT-243 and HC-6/U holders fit perfectly, as shown in Fig 27.—*WJ1Z*

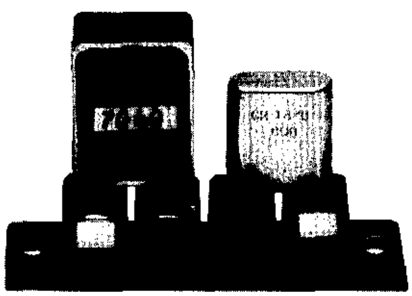


Fig 27—Yes, Radio Shack *does* carry crystal sockets—disguised as push-button speaker terminals! Here, a four-terminal RS 274-622 holds FT-243 and HC-6/U rocks. These crystals have 0.486-inch pin spacing; crystals with wire leads work fine, too. Terminals capable of holding four crystals are also available—see text.

HOMEMADE CONDUCTIVE GLUE

☐ I needed an electrically conductive paste, much like the "Aquadag" coating on CRTs, in order to repair a circuit board on a calculator that used graphite instead of copper. I found that by mixing about six parts of graphite powder to one part of model-airplane cement, I ended up with a very good conductive material when the mixture dried. Don't use an epoxy or white glue; these adhesives produce a nonconductive coating when they cure or dry.—*Fred L. Redburn, KX5F, 13005 Heinemann Dr #710, Austin, TX 78728*

PAPER-CLIP METER SHUNTS

☐ Needing a meter shunt for monitoring current flow with a microammeter, I determined that I needed about 30 inches of copper wire of a gauge sufficient to handle the current. Looking for something more compact, I discovered that a steel paper clip works perfectly!

Straightened, the clip exhibited a resistance of about 0.025 Ω from end to end. (Since very few ohmmeters measure resistances this low, I simply hooked a 12-V battery to an old auto headlamp [with the paper clip in series] and measured the circuit's current drain [about 3 A]. Then I measured the voltage drop across the paper clip [0.075]. Solving the basic Ohm's Law equation [resistance = voltage divided by current] for resistance [$R = 0.075 \div 3$] gave the clip's resistance: about 0.025 Ω. A conductor's resistance varies linearly with length, so if you need less than the clip's entire resistance, tap proportionally along its length. I generally use an alligator clip to determine the exact position I need before soldering the attaching wires.

Paper-clip resistors have other uses. I needed a low-value resistor to divide the current between the pass transistors and regulator chip in a regulated power supply. The paper clip worked perfectly.

Unless you are an avid builder, one box of clips may provide a lifetime supply of shunts: at about a half cent apiece!—*Colin Lamb, K7FM, 29830 NE Mt Top Rd, Newberg, OR 97132*

WJ1Z: And why stop at paper clips? I've seen the helix from a spiral-bound notebook used as the resistance element in a low-voltage, high-current rheostat—and as coil stock for low-inductance, low-Q, low-power parasitic-oscillation suppressors à la Richard L. Measures, "Improved Anode Parasitic Suppression for Modern Amplifier Tubes," *QST*, Oct 1988, pp 36-38, 66, 89.

A SHUNT FOR REMOTE LOAD SENSING IN HIGH-CURRENT POWER SUPPLIES

☐ I needed an adjustable low-value, high-current resistor to provide the small voltage drop necessary for remote load sensing in a high-current-power-supply project. Fig 28 shows my solution. I clamp a small loop of a stainless-steel rigging-cable strand between two metal blocks. Grooves lightly filed in the blocks hold the loop in place. Machine screws hold the blocks together and take solder lugs for shunt connections. Tap the lower clamping blocks' holes to take the machine screws; drill the upper blocks to pass the screws. This arrangement keeps base-insulator flexing from loosening the shunt connections—an important consideration in high-current, low-resistance applications.

Discarded baseboard room heaters can serve as a source for narrow strips of thin stainless-steel sheet and several sizes of nichrome wire.—*Louis Smithmeyer, WB7DWE, 12009 30th Ave SW, Seattle, WA 98146*

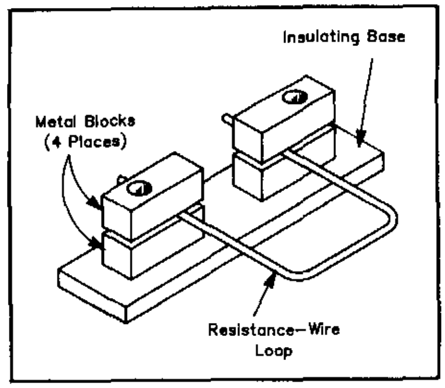


Fig 28—Louis Smithmeyer mounts a small loop of resistance wire in metal blocks for use as a resistive shunt in a high-current, remote-load-sensing application. The holes pass machine screws that hold the assembly together. Grooves filed in the clamp blocks help keep the wires in place.

WJ1Z: The length of the wire loop depends on the wire's diameter and material, and the resistance you need. If you know your wire's length, diameter and material, and that material's resistance relative to pure copper, you can roughly calculate the wire's resistance with the help of arithmetic and the resistance-versus-feet listings in the *ARRL Handbook*'s copper-wire table (Chapter 35). For a given length and diameter, nichrome wire is roughly 65 times more resistive than copper; aluminum wire, 1.6 to 3.3; iron wire, 5.6; stainless-steel rigging wire, 39.3. These figures derive from Louis Smithmeyer's observations; I've rendered his data in terms of pure copper's resistance to help you use the *Handbook*'s copper-wire table. A properties-of-metals listing in a reference-data text can provide resistance values for other metals.

A SUBSTITUTE FOR SPADE BOLTS

☐ Unable to find a source of spade bolts, I devised the fastener shown at Fig 29. It works well, but I'm still on the lookout for a small-quantity source of spade bolts!—*William L. Fleming, WA9VPU, 5315 Wiley Ave, Indianapolis, IN 46226*

AN EMERGENCY REPLACEMENT FOR NUTS WITH ODD-SIZED THREADS

☐ I recently required the use of an old milliammeter, which had the mounting screws permanently embedded in the case flange. The nuts for the no. 2 mounting screws were missing, and there were no replacements in any of my accumulated hardware. By using the plastic sleeve that insulates hook-up wire as a replacement nut, I quickly secured the meter on the new panel (see Fig 30).

Find a short piece of insulated wire with a conductor diameter slightly smaller than the threads you wish to fit. Slide enough insulation off one end of the wire to cover the exposed screw threads. Form a handle at the other end of the wire by making a

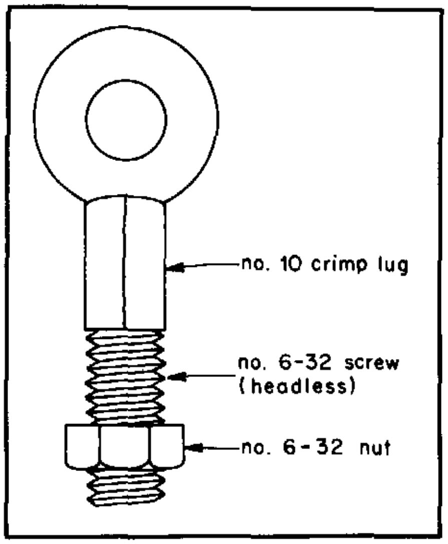


Fig 29—Bill Fleming uses a no. 10 crimp lug and a headless no. 6-32 screw in place of a spade lug. The nut secures the lug to the mounted surface; not shown is the hardware necessary to secure the crimp lug to the mounted object.

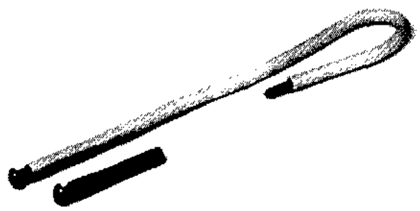


Fig 30—Samples of W1HHF's nut-from-insulation technique.

bend. Expand the empty insulation with some needle-nose pliers, and apply a small amount of lubricant to the screw. Turn the screw into the open end of the insulation. Once the joint is tight, cut off the excess wire and insulation.—*Antonio G. O. Gelineau, W1HHF, Burlington, Vermont*

VCR BELTS DRIVE CAPACITORS

☐ We of the Beaumont Amateur Radio Club own two Heathkit HW-101 transceivers to loan out to members (especially new Novices). The last time we checked out the transceivers, we noticed that their variable-capacitor drive belts were dry-rotted and needed replacement. We wanted to replace the belts soon, so instead of checking to see if they are still available from Heathkit, we found excellent replacements locally. We used VCR drive belts! They are of good quality, widely available and reasonably priced.—*Beaumont Amateur Radio Club, W5RIN, PO Box 7073, Beaumont, TX 77706*

USE *QST* MAILING BAGS AS HEAT-SHRINK MATERIAL

☐ *QST*'s plastic mailing cover can be used as heat-shrink material! Cut a ribbon of the plastic and wrap it around whatever you wish to seal. If necessary, secure the winding with a temporary tie of thread or small wire. A match provides enough heat, but tends to darken the plastic; a propane torch is too hot.—*W. Burt Butts, KK4TN, Douglasville, Georgia*

Editor's Note: KK4TN's hint really works! *QST* mailing-bag plastic is colorless, so it absorbs heat more slowly than black heat-shrink material: Be careful that you don't ignite the plastic or associated wire insulation as you cure the winding. In the ARRL lab, a disposable lighter and a heat-shrink gun both produced good results. The lighter worked faster.

A SOURCE OF SHIELDING MATERIAL FOR RF PROJECTS

☐ I discovered a source of sheet-brass scrap on a recent visit to a local automobile radiator repair/rebuild shop. The sheet brass used at such shops is semisoft and is an excellent material—and very cheap at scrap prices of less than a dollar per pound—for use in building RF-tight boxes. A $5 selection allowed the fabrication of several small boxes for VHF converters and preamplifiers with hand tools and a soldering iron. This material is vastly cheaper than the copper tooling material I've previously used for this purpose. —*Larry Kayser, WA3ZIA, PO Box 6, Alplaus, NY 12008*

ALUMINUM GUTTER SCREENING FOR SHIELDING

☐ Aluminum Gutter Guard screening (available in hardware stores) is useful for shielding ventilation openings in radio gear. Because it's manufactured by expanding one piece of aluminum sheet, Gutter Guard screening avoids the corrosion problems common to screening made of individual wires. Also, its open "weave"—holes about ¼ inch square with less than 1/16 inch of aluminum between them—obstructs air flow minimally.—*Dan, N6BZA, and Marty, W6BDN, Levin, Menlo Park, California*

USES FOR EMPTY STICK-DEODORANT CONTAINERS

☐ For some time, I have been using empty stick-deodorant containers for coil forms and component modules. [Two to three minutes in the microwave oven gives a good idea how lossy the plastic is. See KZ9Y's hint on p 6-6.—Ed.] I mount two banana plugs (spaced ¾-inch apart) in the cap and install components inside it. The container body is screwed onto the cap to protect the circuitry. (Fine sandpaper quickly removes the product name from the outside of the container.)

The 1-7/8-inch-diameter English Leather™ container gets barely warm, but the 1¾-inch-diameter Old Spice Stick™ gets quite hot—the cool one is less lossy.

I also use the containers to store small nuts and bolts. The push-up feature makes it possible to push up the last remaining bolt and remove it easily from the container.

The cap and part of a container body covers the loading coil on my mobile antenna. It is nice to get something besides a vanishing aroma for your $2.—*Philip DeJarlais, WØJHS, Champlin, Minnesota*

A NEAT PANEL MOUNT FOR LEDS

☐ Finishing washers, commonly available in hardware stores, make professional-looking LED mounts (see Fig 31). Two dabs of hot glue between the back of the LED and the panel hold the assembly in place.—*H. L. Van Ness, W7MPW, 8005 Sand Point Wy NE, Apt A34, Seattle, WA 98105*

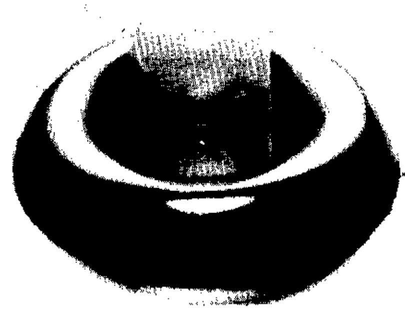


Fig 31—W7MPW's finishing-washer LED mount looks just fine.

REWELD BROKEN TUBE FILAMENTS

☐ Here is a procedure that can sometimes repair broken vacuum-tube filaments. This technique requires some luck, and not all attempts at repair will be successful. This is the story of one successful repair and one failure.

I had a pair of unused 100TH triodes, which would cost about $200, each, to replace. These tubes, and the larger 250TH, have notoriously fragile filaments. Rough handling or extreme temperatures can fracture or shatter the tube filament. In the latter case, repair is possible only by opening the glass envelope, which is impractical without a laboratory. When the filament is only broken in one place, it may be repairable.

In my case, the two 100THs had been stored all winter in an unheated shack on top of a mountain. When first stored, both tubes were in excellent shape. Spring found both filaments broken at the top, where they are normally welded to the filament support stem.

The vacuum in both tubes appeared good. (A crude check of vacuum in a glass tube is to gently tap it: A tube with good vacuum will ring crisply.) I connected an ohmmeter, set for its highest sensitivity range, across the filament pins of one tube. Next, I tapped the tube envelope at various points with the plastic handle of a light

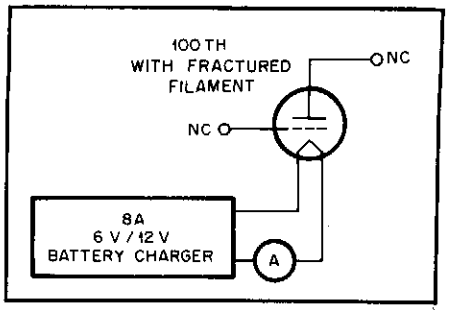


Fig 32—KI3U's setup for repair of broken vacuum-tube filaments.

screwdriver. There were several places where tapping on the envelope caused the ohmmeter needle to flick momentarily, indicating that the filament and stem were vibrating into contact. I marked the place where the tapping was most effective with a felt marker.

The actual repair was made by connecting an 8-A, 6/12-V battery charger (set for 12 V) and a dc ammeter to the filament pins (see Fig 32). As I began tapping the tube envelope with the screwdriver handle, bluish-white sparks appeared at the top of the filament. With increased tapping frequency, the filament suddenly lit brightly, drawing more than 8 A. I immediately switched the battery charger to the 6-V position and the current dropped to a steady 5.75 A. After a few seconds, 12 V was again applied for about 1 second, then 6 V with 5.75 A drawn. After 35 minutes, I reversed the charger polarity. (The current had stabilized at 5.6 A.) In reversing the polarity the filament experienced the first shutdown since becoming rewelded. Power was removed after five minutes at reverse polarity. Using a variable ac transformer, I applied power until the filament drew its published current of 6.3 A. At this current, the RMS ac voltage across the filament was 4.0 V. The published voltage is 5.0-V ac (RMS). Nine minutes after applying power, I raised the voltage to 5.0 V. The current read 7.0 A. Three and one-half hours later, I cut all power to the filament for the day.

For the next 30 days, I ran the filament at 6.3 A for 1.5 hours daily to stress relieve the weld. Each time, the filament drew 6.3 A at 4.0 V and 7.0 A at 5.0 V. At the end of the 30-day period, I measured the interelectrode capacitances. The input capacitance was approximately 0.5 pF higher than the published value of 2.9 pF. The other two capacitances were equal to the published ratings. The emission of the filament was also good. (All instruments used had an accuracy of ±2%.)

An attempt to repair a second tube ended in failure. As before, I began tapping the tube while 12 V was connected to the filament pins. Once again, following considerable internal sparking, the filament suddenly lit brightly. I immediately shut off the battery charger and switched to 6 V. By the time I turned the battery charger back on, the filament had cooled. Now, it did not light; the weld had broken. Repeated repair attempts resulted only in a lot of sparking. Eventually, the glass tube cracked.

The critical difference between the successful weld and the failed attempt was that I did not cut power to the filament, but simply reduced the voltage: The filament was not shut off for at least 35 minutes after the initial lighting in the successful repair. In the second case, I immediately cut the power and allowed the filament to cool. I believe this error caused the failure.

Several questions come to mind about this procedure: Since dc welding requires the correct polarity to be applied between the materials to be joined, it is possible that the polarity was wrong in the second case. (I had not written down the polarities.) Perhaps the rewelding would work better with an ac power source. In any case, I believe it is critical to maintain power after the initial relighting. The new weld must be given sufficient heat to become strong.

Tubes such as the 100TH are still manufactured, although primarily as replacements for older equipment. They are antiques, and one might ask, "Is it worth attempting to repair them?" There are probably many antique tubes sitting on shelves with broken filaments that have lots of emission left in them. Some of these tube types have not been manufactured in decades, and may only be put into service through this kind of repair. Furthermore, the amateur may use similar techniques to repair broken filaments in modern transmitting tubes under emergency conditions. Perhaps a suitable transducer (coupled to a variable-frequency audio oscillator) can be used instead of a screwdriver handle to vibrate the tube shell in a controlled manner. High-power transmitting tubes are very expensive, and their filaments do sometimes break prematurely. The type of equipment necessary to attempt repair is certainly present in the average amateur station.—*Berj N. Ensanian, KI3U, Eldred, Pennsylvania*

FIXES FOR 3-400Z AND 3-500Z TUBES

☐ In investigating a filament failure in my home-brew push-pull 3-500Z 40-meter amplifier, I found something that I had never seen before. All wiring, the filament transformer and tube sockets were working correctly, but the series connected filaments of the tube would not light. I pulled the amplifier out of the relay rack and examined the circuitry. It was easy to find which tube was at fault: Twisting one tube lightly in its socket caused both tubes to light. Examination of the tube base showed slight signs of heating on pin 1. (I just couldn't believe that a 3-500Z's filaments might burn out after only 3½ years of use!) Using a soldering iron, I melted the solder on pin 1 of this tube and an air bubble appeared—an indication that the pin had been improperly soldered to begin with. I resoldered the pin and everything worked fine. The other filament pin of the faulty tube was soldered properly, as were those of the other 3-500Z.

REMOVING GRID-TO-FILAMENT SHORTS IN 3-400Zs AND 3-500Zs

Since they were introduced in the 1960s, 3-400Z and 3-500Z vacuum tubes—particularly early versions—have been plagued with grid-to-filament shorts. In my opinion, this usually results from inadequate ventilation of the tubes, or from the improper operating conditions that can occur when 3-400Zs are replaced with 3-500Zs without adjusting the bias on the newer tubes.[20] (I did the latter myself on an early version of the original Henry 2K amplifier and experienced nothing but grid-to-filament shorts—until I rebuilt the transmitter and changed the bias, that is!)

If the tubes are not severely damaged, grid-to-filament shorts can be removed by connecting 120 V ac (in series with a 120-V, 500-W incandescent lamp for current limiting) between pin 1 or 5 (filament) and pin 2, 3 or 4 (grid) of the tube base. Gently tap the tube with a soft piece of wood or similar material. This should clear the grid-to-filament short and restore the tube to useful service. *Wear eye protection* and take care not to contact the ac mains while doing this—and be careful not to break the tube!

Experience has shown me that removing grid-to-filament shorts with this technique eventually deteriorates the grid, the result of which is the flow of plate current even with the associated amplifier in standby. I don't consider this current to be a problem as long as it remains below 50 mA—I've been operating a pair of original carbon-plate 3-500Zs (purchased in the mid 1960s) in this way for over ten years! In standby, they draw about 45 mA. "Zapping" the grid-to-filament short circuits out of these tubes did not affect their output-power capability.

If your tubes are still under warranty and seem to harbor grid-to-filament shorts, contact the tube manufacturer instead of trying my zapping technique. If the tubes' warranty has expired, though, give my idea a try; you may be pleased with the results. —*John O. Norback, W6KFV, ARRL Assistant Technical Coordinator, 133 Pino Solo Ct, Nipomo, CA 93444*

[20]A recent *QST* article suggests another possibility: that grid-to-filament shorts in these tubes can occur as a result of strong VHF parasitic oscillations. See R. Measures, "Improved Anode Parasitic Suppression for Modern Amplifier Tubes," *QST*, Oct 1988, pp 36-38, 66 and 89. —*Ed.*

MORE ON 3-500Z FILAMENT PINS

The 3-500Z triode, a vacuum tube rated for up to 500 watts of anode dissipation, remains popular in commercial and amateur-built RF power amplifiers; the 400-watt 3-400Z preceded it. John C. Norback, W6KFV, described "Fixes for 3-400Z and 3-500Z Tubes"—hints on how to clear filament-to-grid short circuits and cure intermittent filament operation in these tubes. Our next three correspondents have more to say about the 3-500Z's filament. Hints and Kinks prefaces their remarks with this caution: If your tube fails under warranty, *use* that warranty and *contact the tube manufacturer for advice* before attempting to modify or repair your tube.—*Ed.*

☐ The output power of my home-made 3-500Z linear amplifier suddenly dropped. Inspection revealed that one of its 3-500Zs was unlit. Further checks showed correct filament voltage at the tube sockets. I replaced the tube but wondered why a fairly new tube would develop an open filament. A close inspection of the tube pins uncovered the problem. During manufacture, the tube pins are force-fitted over tube-base wires. Apparently, in areas with high humidity like ours, the contact between the pins can become lossy. One of the filament pins was so loose I could turn it on its underlying wire! After much experimentation, I have found a way to restore the reliability of the tube-pin connections.

Wrap the 3-500Z in a towel or other soft cloth. Lay the tube on a rug or towel placed on your workbench. With a high-wattage soldering gun or iron, unsolder the bottom of the pins on the filament wires. (Attach a large heat sink to the wire between the pin and the tube base to avoid overheating the wire-to-glass seal.) Using a drill bit that just fits inside the tube pins, ream the inside of the pins until they're clean and bright. Resolder the pins carefully and wipe the newly soldered pins with solvent to remove remaining rosin. I have used this method on several intermittent-filament tubes with good success.—*Jim Brenner, NT4B, 5690 SW 36 Ave, Ocala, FL 32674*

☐ Having had considerable experience with 3-500Z failure related to apparent filament-pin-soldering failure, I am beginning to wonder if the real problem is how the wires are soldered into the pins. Because I had very carefully cleaned and resoldered the intermittent filament pins with each repair, I looked more carefully at the problem the last time it occurred.

The first thing I noticed was that the affected filament pin was very hot. (I had removed the tube immediately after it failed.) In fact, it was so hot that solder had melted and run out of the pin! Although it is possible that a poor solder connection in the pin could have caused resistance heating, I am quite sure that the pin was well soldered because I had carefully resoldered it myself.

I suspect that the real culprit is *poor spring tension in the socket contact,* which leads to poor contact between the socket contact and pin, and hence to resistance heating of the contact and pin. Putting this thinking into practice, I replaced the socket involved (it had been somewhat damaged by the heat anyway) and tightened the spring part of the contacts on my amplifier's other 3-500Z socket.

To date (about six months later), I have had no further problems. The amplifier, by the way, is a Heathkit SB-220.—*Wayne Mills, N7NG, Box 1945, Jackson, WY 83001*

☐ I don't believe that manufacturers build these tubes with bad filament-pin solder connections. The problem is created by loose tube sockets. Loose pins in the socket cause high-resistance filament-pin-to-socket connections, further causing the pins to heat up and the solder to drop down in the pin and cause an open circuit.

Cure: On my Drake L75 amplifier, I installed a new tube socket and, using a jeweler's torch, resoldered the pins with EZ Flow silver solder. End of problem. Before replacing the socket, I had the same 3-500Z fail twice.—*Paul "Van" Van Bolhuis, W4ZBD, R 4-Box 17D Pumphouse Rd, Westminster, SC 29693*

2C39 HEATER CONNECTIONS FROM SO-239 CENTER PINS

☐ Searching for a means of making a connection to the female heater terminal on a 2C39/7289 tube, I found that the center collet of an SO-239 coaxial jack fit the bill nicely. (Secure the SO-239 in a vise, solder cup up. Several sharp hammer blows to the solder cup will drive the collet out of the SO-239 center insulator.) If better contact is needed between the SO-239's female heater terminal, the slit end of the collet can be flared slightly by careful bending. —*Harry Conowal, WA4OFS, 2007 Peachtree Blvd, St Cloud, FL 32769*

PLATE-CAP CONNECTORS

☐ Heat-sink plate caps are nice to have, but some of us that build amplifiers don't run 3 kW. If you have gone into an electronics supply house lately and asked for a plate cap, you probably got puzzled looks and a profusion of dusty boxes flying out of a back room.

A suitable cap can be made from a block-style fuse holder. Do so by drilling out the rivet that holds the fuse clip to the plastic block, then use a hammer to form the clip completely around a metal rod having the same diameter as the plate cap. The rivet hole fits a no. 4-40 screw for connections.—*Karl Kauffman, NI6H, Morgan Hill, California*

KNIFE-SWITCH RESISTANCE FIX

☐ If you're using a knife switch in your station—I use one at RF—check the resistance between the blade and its pivot. Erratic switch performance puzzled me until I checked the resistance of my switch: *4 ohms!* A flexible jumper (braid is suitable) from blade to pivot solved this problem.—*Jack Nelson, W2FW, Schenectady, NY*

QUICK REPLACEMENT FOR MULTIPIN CONNECTORS

☐ After I bought a Collins R-392 receiver at a summer swap meet, I discovered that I couldn't test it because I didn't have a mate for its power connector. Here's one solution to this problem. Obtain a package of solderless butt-splice connectors (wire size no. 22-18 in this example). Count out one for each of the pins you wish to access on the equipment plug. Crimp one end of each of the solderless connectors just enough for a snug, sliding fit on the equipment-plug pins. "Hard crimp" connecting wires to the other ends of the solderless connectors, and slide the connectors onto the appropriate pins of the equipment plug. (If you use uninsulated butt splices, slip a short piece of insulating tubing over each splice to avoid short circuits between the equipment pins.) I have successfully used this method to furnish speaker, mic and power connections to several pieces of equipment.—*Ken Kolthoff, K8AXH/6, Vandenberg AFB, California*

CHAPTER 6
Test Gear

INTERFACING THE WB2OSZ TALKING FREQUENCY DISPLAY WITH THE DIGIMAX D-500 FREQUENCY COUNTER

☐ On behalf of a blind ham acquaintance, I built WB2OSZ's talking frequency display[1] from the semi-kit available from A & A Engineering.[2] After I got the talking display working, I discovered that the transceiver at hand (an ICOM IC-701) did not have the multiplexed display necessary for proper operation of the talking display circuit. An interface could be built to solve this problem, but the necessary interconnections would require significant disassembly of the transceiver.

As an alternative solution, I decided to apply the talking frequency display to the DigiMax D-500 frequency counter. After a number of unsuccessful trials, I arrived at the configuration shown in Fig 1.[3] Briefly, I attached the appropriate leads from the "talker" to the outputs of the D-500's 4511 BCD-to-7-segment-display driver IC, and the appropriate talker strobe lines to the *inputs* of the D-500's digit driver (a 75492). (Do not use the outputs of the 75492. I spent considerable time trying to get this to work before I gained access to a scope and found that the 75492's output waveforms are unusable.) I used inverting hex buffers (4049s) at U9 and U10 on the talker board; no input level shifting is required (see the talking frequency display article). Loading on the counter circuitry is minimal.

A transceiver's frequency display is available continuously, but the D-500 displays only *0* until an incoming signal is detected. Thus, the talker, when used with a frequency counter, must be triggered at the beginning of a display period. This is accomplished by C1, R1 and R2 in Fig 1. These components generate a pulse when the D-500's embedded decimal point lights. This pulse is fed to inverter U9F (unused in the talker circuit) on the talker board. The output of U9F is connected to pin 12 of P1 (RESET) on the talker board. S1 enables the talker circuitry.

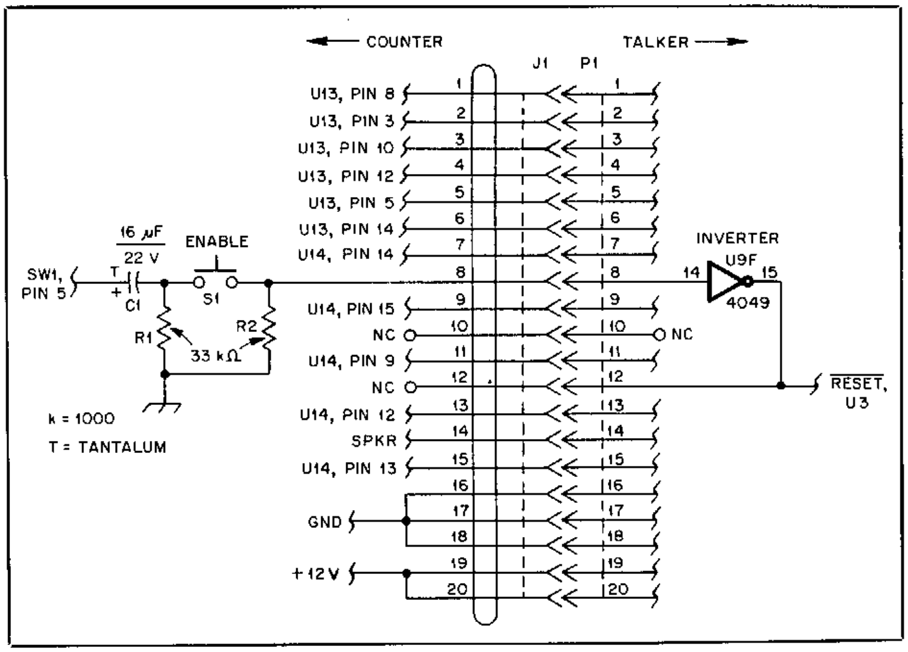


Fig 1—These interconnections and modifications allow the WB2OSZ talking frequency display to be used with the DigiMax D-500 counter. Resistors are ¼ W, carbon film; S1 is a normally open push button. P1 is mounted on the talking display board; J1 terminates the ribbon cable that connects to P1. U9F, on the talking display board, was unused in the original display circuit; here, it serves as an inverter. U3 is the Z80® microprocessor on the talking display board. Part designators U13, U14 and SW1 are DigiMax nomenclature for components in the D-500 counter. See text.

The values of C1, R1 and R2 were determined more by parts I had on hand than through optimization; other values may work better. With the values shown in Fig 1, useful talking frequency measurements can be made in the D-500's higher resolution setting in direct *and* prescaled modes. Thus, the talker/D-500 combination is useful for all frequencies up through the 70-cm ham band.

When the D-500's prescaler is in use, some mental translation of the talker output is required. This is necessary because the talker was designed with emphasis on HF readout, and because its chip set can speak numbers only up to "fifty nine." As a result, the D-500/talker combination speaks "Fourteen seven eight one oh" when the counter displays 147.810 MHz.

The values I chose for C1, R1 and R2 provide a characteristic I hadn't sought: Two display cycles must occur before the talker is triggered. This useful accident assures an accurate count before talking commences. After activating the transmitter, press S1, ENABLE, and hold talker *and* transmitter on until speech readout ends.

I connected the 20-conductor counter-to-talker ribbon cable to the D-500 counter board by means of careful tack soldering. The stiffness of the cable makes this task tedious, but I was able to stabilize the wires sufficiently by fanning the end of the cable. I repackaged the talker, counter and speaker in a metal cabinet. The D-500's 8-digit display is visible through a slot cut in the cabinet; this makes the D-500's full precision available to a sighted helper if necessary. For routine frequency checks, I suggest feeding the transmitter into a dummy load and routing RF to the counter via an M-358 coaxial tee. To avoid overdriving the counter, couple the transmitter signal to the counter input by means of a 5-pF capacitor.

I thank Dan Burton of DigiMax, and John Langner, WB2OSZ, for their encouragement and support in this project.—*John E. Runninger, WB2LCP, Rome, New York*

[1]John Langner, "A Talking Frequency Display," *QST*, Apr 1985, pp 14-17.
[2]A & A Engineering.
[3]The similarity between the circuits of the DigiMax D-500 and -1200 counters suggests that the Fig 1 circuit should also function with the D-1200, and may fit inside the D-1200 case. This has not yet been tried, however.—Ed.

HOW TO MEASURE FREQUENCIES WITH YOUR RIG'S 10-Hz-RESOLUTION FREQUENCY DISPLAY

☐ Maximally accurate use of the frequency display on a modern transceiver is not always as easy as just tuning in a signal and reading the frequency display. All of the modern, microprocessor-controlled transceivers I've seen indicate the *suppressed-carrier frequency* on SSB. Because it's rare that any two people will tune a given SSB signal for identical recovery of the baseband audio, it's hard to suggest a practical technique for getting better accuracy out of a rig's 10-Hz-resolution display during SSB reception.

Improving the accuracy of such a display during CW reception is a different story. The display on a modern, microprocessor-controlled transceiver correctly indicates the frequency of an incoming CW signal *only when the rig is tuned to place the signal at a particular point in the IF passband.* In practice, placement of the signal at this point is achieved with the help of the transceiver's CW sidetone oscillator. The sidetone-oscillator frequency is set such that the sidetone pitch is more or less identical to the pitch of an incoming signal correctly situated in the passband. To measure a frequency (or to set the transmitter on the frequency of the incoming signal), you just key the sidetone, zero-beat the incoming signal with the sidetone, and read the correct frequency from the rig's frequency display.

As Brice Wightman reminds us in "Use Your Transceiver's Notch Filter as a Zero-Beat Indicator," (p 8-2) the drawback to this tuning procedure is that the sidetone oscillator may not really be where the rig's frequency-control and -display circuitry "expects" it to be. Brice suggests one way of getting around this: Use the rig's notch filter as a tunable audio marker.

But what if you don't want to tie up your rig's notch filter, or if the rig doesn't have a notch filter or sidetone oscillator? Several equipment manufacturers now offer excellent general-coverage *receivers* as adjuncts to their ham-transceiver lines. Generally, these receivers are more operationally flexible than the general-coverage-receiver portions of the transceivers that complement them; like transceivers, these receivers tend more and more to include frequency displays capable of 10-Hz resolution. There's only one rub: What do you use for a reference tone in determining the frequency of an incoming signal? Receivers don't have sidetone oscillators as transceivers do. Brice Wightman's notch-filter technique works with receivers *and* transceivers, but it ties up the notch filter—*if* the receiver has one. You can use an outboard audio oscillator, of course, but mixing its output with the receiver audio presents a problem, especially if you're wearing headphones. An outboard phase-locked-loop (PLL) tone decoder is another possibility,[4] but PLL decoders tend to be too drifty and unselective to allow accurate resolution of tone frequencies to 10 Hz.

Here's a technique for measuring CW or carrier frequencies with any receiver or transceiver that:

- Has a frequency display capable of resolving frequencies to 10 Hz;
- Has "two VFOs" or at least two memories; and
- Receives a WWV or CHU frequency within a few megahertz of the signal you wish to measure.

Neither a notch filter nor a sidetone oscillator is necessary for measurements with this method, and you don't need to build or buy outboard gizmos. The following instructions refer to a receiver with "two VFOs" and a VFO A/B switch; use any adjacent pair of your receiver's memory channels if you can't toggle between "VFOs."

1) Set the receiver to CW (same mode on both VFOs).

2) Using VFO A, tune in the signal you wish to measure.

3) Using VFO B, tune to the active WWV or CHU frequency nearest to the frequency you wish to measure. Adjust the receiver tuning so that the frequency display indicates the carrier frequency of the standard station *exactly* (7.33500 MHz, for example). Make a mental note of the carrier pitch.

4) Switch back to VFO A. Retune the signal you wish to measure so that its pitch matches that of the standard-station carrier (VFO B). Toggle back and forth between VFOs A and B and adjust VFO A until the pitches match as closely as possible. (There will likely be *some* error because of the limited resolution afforded by the receiver's tuning steps.)

5) Once you've matched the pitches, the receiver's display indicates the frequency of the incoming signal to within 30 Hz or so.

I like this technique because it sets frequency-display error (if any) to *zero* at the standard frequency. What measurement errors you *do* encounter depends on your ability to match pitches, the error (in parts per million [ppm]) of your frequency display and *the frequency separation between the standard and measured signals.* If you don't know your receiver's display accuracy, assume that it's "on the edge of spec." Example: For a display with a maximum error of ±10 ppm (10 Hz per megahertz), a 17.1-MHz measurement based on the 15-MHz WWV signal would be off by 21 Hz (2.1 × 10), assuming a perfect match between the pitches of the standard and measured signals. (For this application, we can safely assume that any frequency error in the WWV and CHU carrier frequencies is so small as to be insignificant.) Note, however, that this measurement technique does not determine the *sign* of the measurement error (whether the error is positive or negative) because we don't know the sign of the display error. Another caution: Although this frequency-measurement technique works with transceivers as well as it works with receivers, it is not a substitute for a given manufacturer's instructions on how to set the transmitter in a transceiver to zero beat with an incoming signal.

A closing comment on "zero beating": Two signals are said to be "at zero beat" when they are perceived as being at exactly the same frequency. The only way to assure true zero beat is to compare the signal frequencies *directly.* This is most often done aurally (with a receiver) or by means of a frequency counter. A zero-beat technique that makes use of an intermediate ("transfer") oscillator—such as a transceiver sidetone—is an indirect technique. Show me a zero-beating technique that lets me hear *my signal in relation to the other signal,* and I'll show you a separate receiver and transmitter!—*WJ1Z*

[4]Rich Erhardt, "A Precise Tuning Indicator for General-Coverage Receivers," *QST*, Sep 1987, pp 22-24.

USING A RECEIVER TO FIND TUNED-CIRCUIT RESONANCE

☐ You can find the resonant frequency of an inductor/capacitor combination if it falls within the tuning range of your receiver. Connect the components as a parallel tuned circuit in series with the antenna lead as shown in Fig 2. With the receiver tuned for minimum signal or noise response, the receiver frequency display shows the approximate resonant frequency of this tuned circuit.

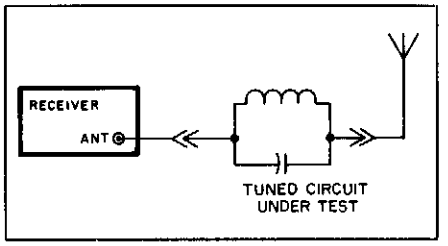


Fig 2—If the resonant frequency of an inductor/capacitor combination falls within the tuning range of your receiver, you can find resonance with this circuit.

This technique can be used in situations where a dip meter is impractical, such as when the tuned circuit under test is inside a shield can or inaccessible because of its position. There is often no need to remove or otherwise isolate the tuned circuit from the associated circuitry.—*Gordon Crayford, VE6EI, Lacombe, Alberta, Canada*

USING A RECEIVER AS A NEUTRALIZATION INDICATOR

☐ Ham lore has it that grounded-grid amplifiers need not be neutralized, but this is true only at frequencies at which reactances in the tube(s) and amplifier circuitry do not encourage positive feedback. I was reminded of this when I built a grounded-grid amplifier using parts I already had on hand. The tubes I used—805s—work well as class-B audio amplifiers but were not designed for grounded-grid RF service. *This* grounded-grid amplifier required neutralization! My neutralizing technique requires only a receiver (or transceiver in receive mode) and an antenna.

First, remove all power from the amplifier and be sure its high-voltage filter capacitors are safely discharged. Next, hardwire the RF contacts of the amplifier TR relay into the transmit mode. Connect the receiver to the amplifier input and the antenna to the amplifier output. Tune in a steady signal and peak the amplifier tank circuit for a maximum S-meter reading. Adjust the amplifier neutralizing capacitor for a signal null. Finally, return the TR relay wiring to normal. The amplifier is neutralized.

I like this technique because it can be done when nothing in the amplifier is hot, thermally *and* electrically.—*Scott Reaser, K6TAR, Pacific Palisades, California*

Editor's Note: Although neutralization of the amplifier went well, K6TAR later reported that the rig didn't pan out. Showing true ham spirit, Scott penned this note on the back of his publication release form: "Please note that although I think the idea I submitted has merit, that particular application was a disaster. Case in point: 805 triodes made a lousy linear, even if the tubes were free! Subsequent to my original communication, I started over with the amplifier. Rebuilt with a single 3-500Z and a Hypersil® transformer supply, the amplifier works nicely. The lesson is to use parts designed for the application."

EXTEND THE RESISTANCE-MEASUREMENT RANGE OF A DMM

☐ My digital multimeter (DMM) measures resistance up to 2 megohms, and this is adequate in most cases. When I need to measure resistances higher than 2 MΩ, I use the circuit shown in Fig 3. When two resistors are connected in parallel, the resultant resistance is always lower than the value of the lower resistor. The unknown resistance can be found from the formula:

$$R_X = \frac{R_S \times R_T}{R_S - R_T} \qquad \text{(Eq 1)}$$

where R_X is the unknown resistance, R_S is the standard resistance (2 MΩ in this case) and R_T is the value indicated by the DMM.

As Fig 3 shows, my R_S consists of a 1.2-MΩ fixed resistor in series with a 1-MΩ potentiometer (wired as a rheostat); I adjust the pot so that R_S = 2 MΩ. Next, I connect R_X to the circuit and read R_T on the DMM. Then I solve for R_X with Eq 1. Table 1 shows the DMM (R_T) readings that correspond to selected values of R_X for R_S = 2 MΩ. (Any reasonable value can be used for R_S; I settled on 2 MΩ because that value fit the components I had on hand.) Using a pocket calculator, resistance values up to 50 MΩ can be determined with reasonable accuracy.—*Cornelio Nouel, KG5B, 4966 Paseo del Rey Dr, Brownsville, TX 78521*

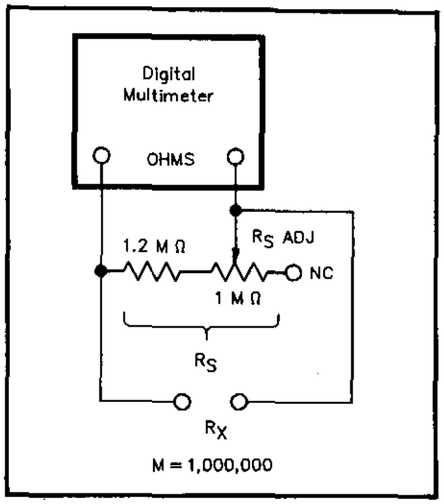


Fig 3—Cornelio Nouel measures resistances above the highest range on his DMM with the help of this circuit and Table 1.

Table 1

DMM Readings for R_X Values with R_S = 2 MΩ

Reading, MΩ	*R_X, MΩ*	*Reading, MΩ*	*R_X, MΩ*
1.111	2.5	1.636	9.0
1.200	3.0	1.666	10.0
1.273	3.5	1.765	15.0
1.333	4.0	1.818	20.0
1.428	5.0	1.875	30.0
1.500	6.0	1.905	40.0
1.555	7.0	1.923	50.0
1.600	8.0		

MEASURING THE INDUCTANCE OF LOW-L INDUCTORS

☐ In "Calculating Power Dissipation in Parasitic-Suppressor Resistors" (*QST*, Mar 1989, pp 25-28), I stated that the amount of inductance used in a parasitic suppressor has a large effect on the HF power dissipated in the resistor. Because the suppressor-resistor power dissipation cannot be calculated without knowing the inductance of the suppressor inductor, a method of accurately measuring values of small inductance is useful. Here's how I do this without exotic test equipment.

The items required are a dip meter, a disc-ceramic fixed capacitor (with 1½- to 2-inch-long leads) of a known value between 30 and 62 pF, and two miniature copper test clips. Construct a test fixture by soldering the miniature test clips to the capacitor leads (don't cut the leads short).

The measurement procedure is as follows: Find the total inductance of the test clips, the capacitor leads and the capacitor itself. Do this by shorting the test clips together and measuring the text fixture's self-resonant frequency (always somewhere at VHF) with the dip meter. (Couple the dip meter to the loop comprising the capacitor, leads and test clips for this test.) Because you know the value of the capacitor, you can find the total L by using the formula

$$L = 1 \div 4\pi^2 f^2 C \qquad \text{(Eq 2)}$$

where
L = inductance in henrys
f = frequency in hertz
C = capacitance in farads

With the 47-pF capacitor I used in my test fixture, the total L worked out to be 0.086 µH. I wrote this inductance on a paper label and fastened it to the test fixture for future reference.

To measure the inductance of a low-L inductor, clip the test fixture across the ends of the inductor and measure the new, lower resonant frequency with a dip meter. Then, find the total inductance of the unknown inductor and the test fixture with Eq 2. Since you already know the inductance contributed by the test fixture (0.086 µH in my case), you can find the unknown L by subtraction.—*Richard L. Measures, AG6K, 6455 La Cumbre Rd, Somis, CA 93066*

STRAY CAPACITANCE AFFECTS INDUCTANCE MEASUREMENTS

☐ As I calibrated my version of the L-Meter,[5] measurement errors confused me until I realized what was happening. Although a coil of wire exhibits inductance, there is also *distributed capacitance* between the turns of the coil. Because the L-Meter (an oscillator) depends on tuned-circuit resonance to measure inductance, the inductance *and distributed capacitance* of the inductor under test are factors in its inductance measurements.

When an inductor is measured on a reactance bridge or Doyle Strandlund's gadget,[6] the inductor's capacitive reactance cancels part of its inductive reactance. This results in an inductance reading less than the actual inductance of the inductance under test. Distributed capacitance has the opposite effect in measurements made with the oscillating L-meter: The measured inductance of the component under test appears to be greater than the actual inductance of the part.—*Herbert T. Bates, KA0CAG, 1622 Fairview Ave, Manhattan, KS 66502*

[5]Alf Reinertsen, "The L-Meter," *QST*, Jan 1981, pp 28-29.
[6]Doyle Strandlund, "Amateur Measurement of R+jX," *QST*, Jun 1965, pp 24-27.

IMPROVISING A CALIBRATED AUDIO GENERATOR

☐ Have you ever wished you had an audio signal generator? You may already have one that's accurate and stable, and whose output is smoothly controllable, in *your MF/HF transceiver*! If your transceiver contains a marker generator and a digital frequency display, you can probably use it to generate audio signals at known pitches. Here's how.

Tune the transceiver to exact frequency of one of its marker signals—such as 28,300.00 kHz (28.30000 MHz).[7] Turn on its marker generator and set its **MODE** switch to lower sideband (**LSB**). If the transceiver allows adjustment of its IF bandwidth during LSB reception, set its IF bandwidth to maximum. Tune upward in frequency—slowly. When the frequency display reads **28.300.05** or so, you may start to hear a low-pitched audio tone; at 28.300.05, this is an audio pitch of 50 Hz.[8] You can use the radio's RIT control for fine tuning, if desired.

By reading the digital readout and mentally subtracting the starting frequency (28.300.00 in this case) from it, you can determine the frequency of the marker-signal pitch. If your starting frequency was 28.300.00 MHz and your display now indicates **28.301.20**, the pitch you're hearing—assuming that the frequency display is accurate, and that the marker signal is actually at 28.30000 MHz—is 1.2 kHz. If your transceiver includes IF-shift and/or IF-slope-tuning controls that operate in LSB, adjust these controls to maximize the marker-signal level (as indicated on the transceiver S meter) as you tune.

The maximum audio frequency you may be able to develop may be 2.7 to 3.0 kHz, depending on your transceiver's IF bandwidth, the frequency differential between the transceiver's BFO and IF center, and the range of its IF-shift and IF-slope-tuning controls. Because the audio frequencies used for routine Amateur Radio voice and digital communications are quite a bit lower than those necessary for hi-fi, this frequency-generation limit is not a disadvantage because it allows us to generate the highest audio frequencies we can use in our rigs on SSB.—*Martin L. Cardwell, NB3T, 4600 White Ave, Baltimore, MD 21206*

[7]Most current transceivers display medium frequencies (300 kHz to 3 MHz) and high frequencies (3 to 30 MHz) with two decimal points—one between the 1-MHz and 100-kHz places, and another between the 1-kHz and 0.1-kHz places. For the frequency given, such a display reads **28.300.00** for 28.30000 MHz (28,300,00 kHz). —*AK7M*

[8]Adjusting the radio's **IF SHIFT** control to produce lower-pitched background noise may help somewhat; on the other hand, 50 Hz may be a bit too low for some transceiver audio systems to reproduce anyway. If so, keep tuning; you'll probably hear the signal between 28.300.10 and 28.300.20.—*AK7M*

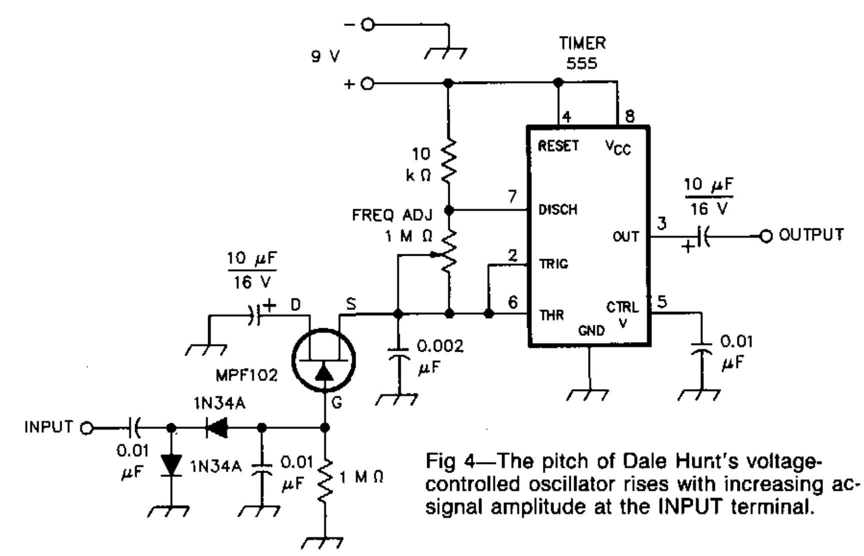


Fig 4—The pitch of Dale Hunt's voltage-controlled oscillator rises with increasing ac-signal amplitude at the INPUT terminal.

A VOLTAGE-VARIABLE AUDIO OSCILLATOR

☐ Fig 4 shows the circuit for a simple voltage-variable oscillator based on the ubiquitous 555 timer. Its oscillation frequency can be varied over several octaves.

I designed the circuit as an audio detector for an impedance bridge, so I could watch what I was adjusting instead of a meter. The oscillator pitch is lowest with no ac voltage applied to **INPUT**, and rises as the input-signal level increases. The opposite characteristic—highest pitch with no input signal—can be obtained by eliminating the 10-µF capacitor at the MPF102 drain and connecting the drain lead to pin 7 of the 555, although I haven't tried this.—*Dale Hunt, WB6BYU, 1612 W Cherry Ave, Lompoc, CA 93436*

A BUFFER FOR THE *HANDBOOK* BRIDGED-T OSCILLATOR

☐ The one-transistor audio oscillator pictured on page 25-20 of the 1991 *ARRL Handbook for Radio Amateurs* requires a

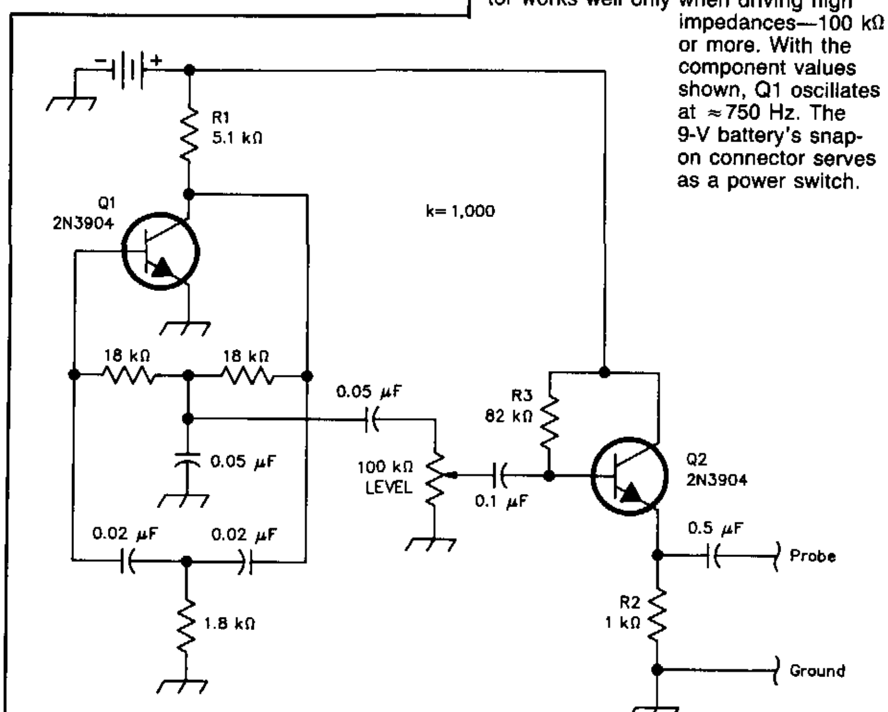


Fig 5—Daniel Swenson and Robert Jensen add an emitter-follower buffer (Q2) to *The ARRL Handbook*'s bridged-T audio oscillator (Q1) to provide audio output at a low impedance (≈65 Ω). By itself, the *Handbook* oscillator works well only when driving high impedances—100 kΩ or more. With the component values shown, Q1 oscillates at ≈750 Hz. The 9-V battery's snap-on connector serves as a power switch.

high-impedance load. Because we sometimes need to inject audio into low-impedance circuits, we sought to adapt this circuit to drive a wide range of load impedances. Our solution: a one-transistor buffer amplifier with a low output impedance.

Fig 5 shows the circuit as applied to the *Handbook* audio oscillator. Both stages can be built on a small piece of perf board. Our version isn't housed in a case. Mounting the battery on the board with a small clip makes the entire unit hand-holdable. The injection probe consists of an insulated piece of stiff hookup wire. A clip lead connects the commons of the probe and the circuit under test.

Set up the circuit as follows: Experiment with the values of R1 (the oscillator collector resistor, starting with 3.3 kΩ as the *Handbook* suggests) to find a resistance that's high enough to prevent appreciable distortion, yet small enough to still give a strong output signal. (We settled on 5.1 kΩ for our application.) Next, disconnect the oscillator from the 9-V supply by unsoldering one of R1's leads. Measure and note the dc voltage across the buffer-stage emitter resistor (R2). Experiment with different values for the buffer-stage base-resistor (R3) until you find a resistance that causes about one-half of the power supply voltage (4.0-4.5 V for a 9-V supply) to appear across R2. Reconnect R1. This completes adjustment.

Our injector's audio output is adjustable from 0 to 150 mV. The buffer's output impedance is about 65 Ω. The circuit draws 6 mA at 9 V, so battery life should be sufficient for many hours of testing.—*Daniel C. Swenson and Robert Jensen, WAØASV, Waseca, Minnesota*

A SIMPLE CURRENT LIMITER FOR EQUIPMENT TESTING

☐ Many years ago, when I was installing and servicing electron microscopes as a field representative for RCA, one of the most important items in my tool kit was a rubber pigtail socket equipped with alligator clips and a 100-W, 120-V lamp. This gadget was really useful for locating fuse-blowing faults in power supplies and associated equipment. Since then, I've gone a step further and added switches and a fuse as shown in Fig 6. The result is a compact current-limiting unit that can be used to check transformers and other equipment for short circuits.

The 100-W lamp, DS, serves as a current limiting resistor. The device under test is plugged into J, and P is connected to a 120 V ac source. S2, LIMIT, is a SPDT (on, center-off, momentary-on) toggle switch. With S2 set to LIMIT ON, DS is in series with the device under test across the ac line. Full line voltage appears at J only if the device under test draws no current. The more current drawn by the device under test, the lower the voltage at J when S2 is set to LIMIT ON.

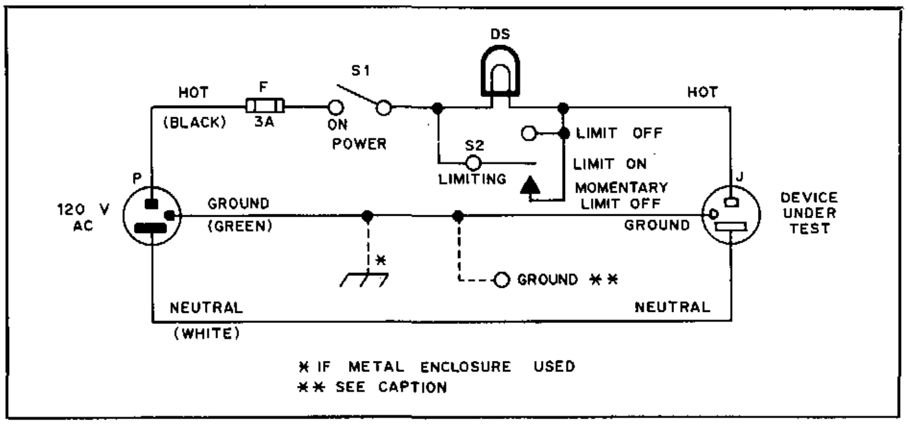


Fig 6—Lew Howard's current limiter uses an incandescent lamp to prevent serious equipment damage should a short circuit occur in the device under test. If you build the current limiter into a metal enclosure, be sure to connect the mains ground wire (green) to the enclosure. It's also a good idea to add a GROUND binding post (connected to the mains ground wire) to the current limiter for use with equipment having two-wire ac cords. This allows the chassis of the device under test to be connected to the ac mains ground for safety. Speaking of safety: Contact with the ac mains can kill you. *Be careful* when constructing and using this circuit.

DS—100-W, 120-V incandescent lamp in ceramic socket. Other wattages may be useful; see text.
F—3-A, 250-V fuse in panel-mounted holder.
J—120 V ac jack.
P—120 V ac cord set with plug.
S1—SPST toggle rated 3 A (or more) at 120 V ac.
S2—SPDT on, center-off, momentary-on toggle rated 3 A (or more) at 120 V ac.

When S1 is turned on, the brightness of DS indicates the absence or presence of a short-circuit fault in the device under test. If the lamp burns at full brilliance, a short circuit exists. If the lamp burns at partial brilliance, the device under test is probably sound. S2 can be set to LIMIT OFF to apply 120 V ac to the device under test if all appears well; pushing S2 to MOMENTARY LIMIT OFF does likewise as long as the switch is kept in this position. Should the device under test fail with full mains voltage applied, the fuse, F, provides much better protection than the 15-A fuses or breakers that are standard in house wiring.

Of course, this device is nothing new and is certainly not an invention of mine. After listening to many woebegone on-the-air discussions related to troubleshooting, though, I felt compelled to share this bit of knowledge—it may help save a lot of fuses and expensive gear!—*Lewis N. Howard, W4LHH, 4132 Creek Stone Ct, Stone Mountain, GA 30083*

Properly applied, this circuit can also be used as an aid to restoring vintage or long-unused equipment—especially transformer-operated equipment that has been stored under humid conditions. ("Firing up" such gear cold may *literally* result in fire because of moisture-induced short circuits in transformer windings.) Page 26-28 of the 1988 *ARRL Handbook* discusses safe procedures for burning in vintage gear with the help of a variable-voltage autotransformer. Lew Howard's current limiter can serve as a cheap-and-dirty substitute for a variable-voltage transformer in this application if a suitable selection of incandescent lamps is available. (The lower a lamp's wattage, the higher its resistance. Use the lamp current limiter to power up vintage equipment in steps by starting with a low-wattage lamp—say, 40 W or less—and working up in lamp wattage until even a high-wattage lamp—200 W or so—is not lit to full brilliance by the current drain of the device under test.)

You can also use a light-bulb current limiter to reduce the heat of a soldering iron. Plug the iron into J and try lamps of different wattages until the iron's temperature is where you want it.—*AK7M*

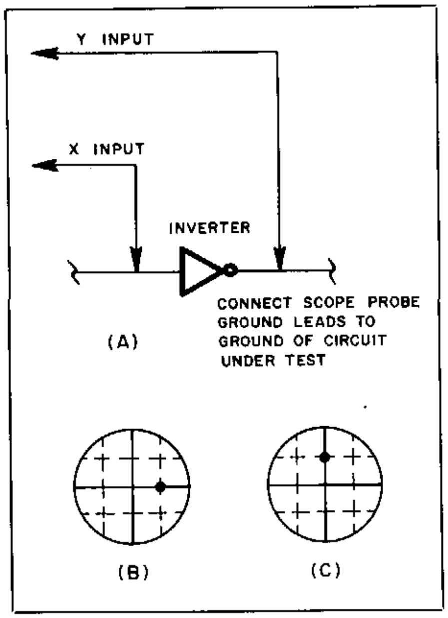


Fig 7—Using the horizontal (X-axis) and vertical (Y-axis) inputs of a single-trace oscilloscope as a dual-channel logic probe. Connect the X and Y inputs as shown at A. B shows the display when the inverter input is high, and C shows the display when the inverter input is low. Scope sensitivity is 5 V/div in these examples.

USE A SINGLE-TRACE OSCILLOSCOPE AS A DUAL-CHANNEL LOGIC PROBE

☐ A dual-beam or dual-trace oscilloscope is nearly a necessity in serious digital troubleshooting, but what if you have only a single-trace scope on hand? For some applications, a single-trace scope can simulate dual-trace performance without using adapters or modifications.

Fig 7 shows how you can simultaneously use the X and Y inputs of a single-trace scope to monitor the input and output of a TTL inverter. First, shut off the scope's sweep. (Reduce the display intensity so that the resultant stationary dot does not damage the CRT's phosphor coating.) Connect the scope's X input to the inverter input, and the Y input to the inverter output as shown in A. Set the X and Y amplifiers for equal sensitivity. Insets B and C of Fig 7 show the scope display for a functional inverter with input high (B) and low (C). If the input to the inverter is clocked, the displayed spot shifts rapidly between these two positions, resulting in a diagonal line. Need a trigger or third channel? Use your scope's beam intensity modulation (Z-axis) input. An inexpensive, single-trace oscilloscope can be surprisingly useful in digital troubleshooting when it is applied with imagination. *—B. N. Ensanian, KI3U, Williamsport, Pennsylvania*

TEST RF INSULATORS IN A MICROWAVE OVEN

☐ From time to time, situations arise where a piece of scrap plastic would make a convenient RF insulator. Some plastics, however, are very lossy at RF. Unless the application is critical, a simple test can provide reasonable assurance that the material is suitable for the job.

To perform the test, irradiate an ounce or two of the material in a microwave oven. (Protect the oven by including a cup of water with the sample as an RF load.) Operate the oven at high power for two to three minutes, then remove the sample. If the plastic has become warm, it is probably too lossy for use as an RF insulator. (The warmth is more apparent if you cool the sample in a freezer for about 15 minutes just before the test.) Insulators tested in this fashion have given me no problems at power levels up to 1000 W at 50-100 MHz.*—E. R. Berg, KZ9Y, Rockford, Illinois*

A SIMPLE FIELD-STRENGTH METER

☐ Fig 8 illustrates a field-strength meter that can be used for antenna or matching-network tuning. It consists of a short dipole antenna, a detector and a digital multimeter (DMM). With A and A′ equal to about 2 feet, the field-strength meter provides adequate near-field sensitivity from 80 through 2 meters. (This is the range over which I've tried the circuit; the meter's actual range may be wider.)

I built my version of the detector on a small piece of copper-clad board and coated it with epoxy resin for permanent outdoor use. To minimize the pickup of feed-line radiation, I mount the meter antenna horizontally when sampling energy from my horizontal HF dipoles and vertically for use with my 2-meter groundplane antenna.*—Albert E. Weller, WD8KBW, 1325 Cambridge Blvd, Columbus, OH 43212*

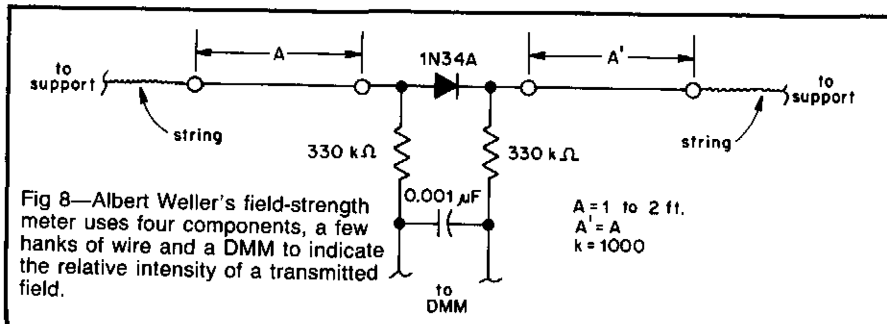


Fig 8—Albert Weller's field-strength meter uses four components, a few hanks of wire and a DMM to indicate the relative intensity of a transmitted field.

BEWARE OF ERRONEOUS METER READINGS IN RF FIELDS

☐ Checking the voltage on the dc line to my 2-meter mobile transceiver, I saw the reading (nominally 12 V) drop by nearly a volt when I keyed the transmitter. Convinced that this wasn't an accurate representation of the supply voltage, I bypassed my multimeter for RF—and the meter indicated the proper 12 V. Then I remembered building a regulated power supply that showed an amazing amount of ac voltage at its dc output—a fictitious indication caused by a parasitic oscillation in the supply's pass-transistor-regulator circuitry.

A multimeter can give strangely erroneous readings in the presence of an RF field, or when ultrasonic audio energy is present in the dc or low-audio circuit under test. This effect can be especially severe when the meter test leads pick up RF energy. For instance, when you measure the voltage on a 60-Hz line, RF pickup may cause an absurdly high reading that has nothing to do with the actual line voltage. (If you experience this, try selecting another, higher, voltage range. You may discover that the meter reading is independent of the range selected—a sure sign that RF is the culprit.) The RF may be from your transmitter, if you're testing audio or ac power circuits while it's operating.

Modern multimeters include protective diodes across the terminals of their meter movements. This arrangement can allow rectification even when the meter rectifier is disabled (as is the case when the meter selector switch is set to a dc voltage or current range). Indication of an abnormal voltage change, such as (false) evidence of poor voltage regulation in a well-regulated supply, is one possible result of this. If the multimeter includes a protective solid-state circuit breaker, "RF in the meter" may cause the breaker to false.

A bypass capacitor—a component that allows RF to pass while blocking dc—across the multimeter's test-lead terminals is an almost certain cure for these problems. Try 0.01 µF at HF, 0.001 µF at VHF.[9] (Be sure that the working voltage of the capacitor you use is greater than the voltage expected in the circuit under test.) Repositioning the multimeter test leads may also help where direct RF pickup is a problem.*—Charles P. Baker, W2KTF, 2715 Wilson Ave, Bellmore, NY 11710*

The high-gain sensing circuitry in electronically regulated power supplies may also be RF sensitive, so if you measure unexpectedly weird shifts in regulated-supply output with transmitter keying, your voltmeter may not be at fault. Trying a meter of different design (or a passive voltage/current indicator, such as a lamp or LED, capable of indicating relative level shifts) can help you determine whether the fault lies in the instrument or the circuit under test.*—Ed.*

[9]The value you use is not critical in most cases, but accurate audio measurements may require that you minimize the bypass capacitance, perhaps augmenting it with an RF choke or chokes between the bypass capacitor and the multimeter terminals, to avoid rolloff toward the high end of the audio range.

NOISE BRIDGE AUDIO LINKS

☐ Last year, while contemplating a move to a new house with a new antenna system, I decided to build my own 20- and 15-meter Yagis. After running computer design programs for the antennas and the gamma matching stubs, I sought a similarly accurate method of adjusting the matching devices—a method that would not require multiple trips up and down the tower to check the system SWR in the shack.

Part of my solution to this problem was to use a noise bridge at the antenna. Using a noise bridge at any other location—separated from the unknown impedance by a length of feed line—requires that the length of the feed line be known. (Feed-line lengths that are multiples of electrical ½ λ allow R and X to be read directly from the bridge dials with no additional calculations; other lengths require correction of the bridge readings according to the electrical length of the line.)

The difficulty with locating the noise bridge at the antenna is that the station receiver has to be left in the shack. I solved this problem by having a helper transmit the receiver audio from the shack to me on the tower by means of hand-held VHF transceivers. This is now standard practice at my station, and it makes antenna adjustment bearable, even in the winter months.—*David Rodman, MD, KN2M, 368 Hedstrom Dr, Buffalo, NY 14226*

☐ Lugging the station receiver outside for noise bridge measurements can be avoided by using a "wireless" intercom at the end of an extension power cord. (Actually, *wireless* is a misnomer in this case because such intercoms use the ac power lines for interconnection!) Tune the station receiver to the desired frequency and place the speaker or headphones near the shack intercom unit. Press the intercom HOLD button and take the companion intercom unit—plugged into the extension cord—to the antenna site. Connect the noise bridge to the antenna, and connect the feed line to the noise bridge RECEIVER terminals. Now, you can adjust, cut and try to your heart's content! If you're using an impedance bridge and a dip meter instead of a noise bridge, the intercom can be used to keep track of the dip meter frequency as it varies with tuning and loading. —*Arthur C. Erdman, W8VWX, 224 Chaucer Ct, Worthington, OH 43085*

AK7M: Depending on the distance between the shack and the antenna site, a long speaker cord might suffice as a wire "noise bridge remoter." If a radio link is what you need, though, and hand-held ham transceivers aren't available, 49-MHz transceivers may provide the solution. Speaking of solutions and their problems, let's not leave the subject of noise and impedance bridges until Arthur Erdman clues us in on an effect worth watching for:

"If a smooth bridge null (down to almost zero) cannot be obtained and all calculated [matching network] values appear to be correct, don't overlook the possibility that a local AM or FM broadcaster is inducing an unwanted voltage in the system. In my case, when I tune even a short vertical to the broadcast band and listen in with a pair of headphones connected in series with the impedance bridge indicator, I can receive several stations—just like a crystal set! The strongest station produces an indication of over 100 μA in an RF ammeter connected between the antenna base and ground; the nearest station is 7 miles away!

"Traps aren't the solution in this case; they add reactances that throw measurements and adjustments off. Adjusting for the best SWR at a transmitter power sufficient to mask the effects of the unwanted signals is the way to go—but remember that increasing power means increasing QRM!"

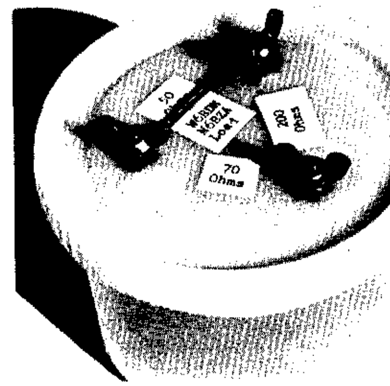


Fig 9—This dummy load can be used to provide a balanced resistive termination of 52, 70 or 200 ohms. For a 52-ohm load, connect a jumper as shown; no jumper is required for a 70- or 200-ohm termination. The unit can be used as an unbalanced load by grounding one of its terminals.

A BALANCED 52, 70 OR 200-OHM DUMMY LOAD

☐ If you want to check SWR with a balun in your antenna system, it's handy to have a balanced resistive termination of the correct impedance. Fig 9 shows an inexpensive, easy-to-build balanced dummy load that exhibits commonly needed resistances of 52, 70 and 200 ohms. It will dissipate about 40 W for short periods; this rating is usually adequate for SWR checks.

The load consists of two resistor branches, each of which is made of 2-W, 5%-tolerance carbon-composition resistors (see Fig 10). These are soldered to no. 8-32 threaded brass rods in a V configuration and immersed in mineral oil in a one-pint plastic freezer container. The rods pass through, and are fastened to, the container lid. Connections to the resistor posts are made by means of wing nuts. The load branches are used singly for a 70- or 200-ohm load, or in parallel for a 52-ohm load.

To build the dummy load, drill three holes in a triangular pattern near the rim of the container lid. Soldering the resistors to the brass rod comes next. To avoid melting the container top during soldering, use the drilled container top as a template to locate three matching holes in a piece of scrap lumber. Drill the holes and insert the brass rods into them; if necessary, use nuts to set their height to what it will be when they're mounted in the freezer-container top. Working up from the base of the rods, wrap the resistor leads around the rods and solder. Keep the leads short, but leave ample clearance (1/8 to 1/4 inch) between the resistors to allow free oil circulation. Position the lowest resistors well above the wood to ensure that they'll be covered with oil when the assembly is inverted after completion (see Fig 11).

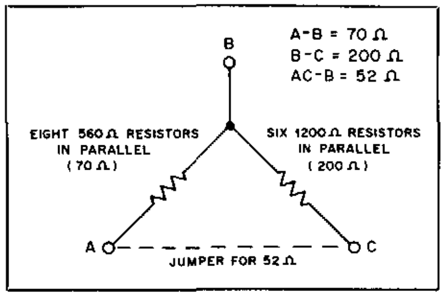


Fig 10—Schematic of the balanced dummy load. Resistors are 2-W, 5%-tolerance, carbon-composition units.

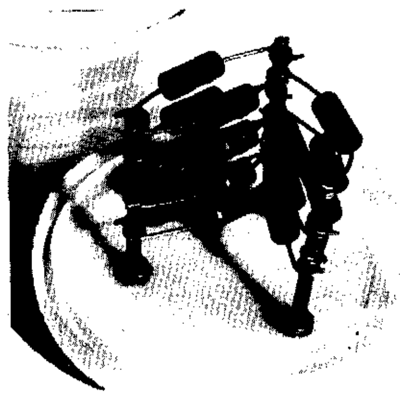


Fig 11—Construction of the balanced dummy load. The resistors, spaced to aid cooling, are immersed in mineral or transformer oil to increase their power-handling capability.

When the resistors and rods have cooled, brush off any excess rosin, remove the assembly from the lumber scrap and install it on the container lid. Use nuts and washers on both sides of the lid. Fill the container about ¾ full of mineral or transformer oil and put on the lid. Adjust the oil level, if necessary, but don't overfill the container—oil is messy!

To use the dummy load, place it on a cardboard box to isolate it from grounded objects. Connect the balun under test to the appropriate terminals; use a jumper (as in Fig 9) to connect the load branches in parallel if you need a 52-ohm load. Apply power (we use about 20 W—*briefly*) and check the SWR at the frequencies of interest. Don't let the load overheat. The load also works well to check unbalanced transformers (for example, 52 to 70 ohms) as well.—*Dan, N6BZA, and Marty, W6BDN, Levin, Menlo Park, California*

CHAPTER 7

Antenna Systems

FEED LINES

PL-259 INSTALLATION HINTS

□ When installing a PL-259 connector on RG-8 cable, many amateurs find it impossible to tin the braid and solder it to the connector without melting the cable dielectric. Here's an alternate method of joining RG-8 cable to a PL-259 connector. This method has all the integrity of a soldered connection, but none of the usual headaches. The possibility of heat damage to the cable dielectric is minimized because the only soldering involved is at the tip of the PL-259 center pin.

Refer to Fig 1. First, remove 15/16 inch of the jacket using a sharp knife. (Do not cut or nick the braid.) Next, cut through both

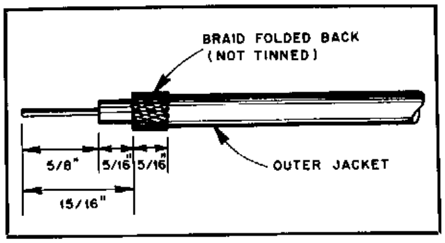


Fig 1—Cable prepared for connector mounting per KG6QY's suggestion.

braid and dielectric 5/8 inch from the end of the cable and remove the cut braid and dielectric. Slip the connector outer shell onto the cable. Unravel the remaining 5/16 inch of braid and fold it back over the cable jacket. Forcibly thread the body of the PL-259 onto the cable by hand. Lightly clamp the knurled portion of the PL-259 body with pliers, and screw the body tightly onto the outer jacket until the end of the inner conductor shows at the end of the connector tip. Use pliers to grip the cable while screwing it into the connector, but be careful not to damage the cable.[1] Lastly, solder the tip of the center pin to the inner conductor and make the usual checks for continuity and short circuits.—*Bruce M. Haldeman, KG6QY, Sun City, California*

[1] I tried Bruce's suggestion with a PL-259 and RG-213 in the ARRL lab. Pliers were needed to screw the connector onto the cable, and some distortion of the cable jacket resulted. This unwanted effect should be reduced by trimming some of the braid flush with the end of the cable jacket or by trimming the shield to about 3/16 inch after folding.—*Bob Schetgen, KU7G, ARRL HQ*

VARIATIONS ON THE PL-259 THEME

Editor's Note: It's safe to say that most radio amateurs install, or will have installed, at least one UHF-series coaxial plug (a solder-on PL-259 or its crimp-on equivalent) during their ham careers. It's also a pretty sure thing that most hams will have read and followed the standard PL-259 installation procedure (described in *The ARRL Handbook* for umpteen years)—at least once. As if all those niggling insulation-measuring and -stripping instructions aren't bad enough, though, soldering the cable braid to the connector requires considerable heat—and the connector doesn't always take solder before the cable dielectric (insulation between braid and center conductor) is destroyed! Result: Frustrated hams look for solderless (or, at least, reduced-heat) means of installing solder-on UHF plugs to coaxial cables.

Hints and Kinks' most recent example of this phenomenon came to us from Bruce M. Haldeman, KG6QY. As soon as Bruce's hint made print, additional H & K readers responded with *their* variations on this popular subject. This month, Hints and Kinks presents these stories, and several related items already on file, in a group. Afterward, we'll review the pros and cons of nonstandard PL-259-installation techniques in general.

An Expansion on the KG6QY Method

□ Re Bruce Haldeman's connector-installation technique, I have always installed PL-259s to 0.405-inch coax (such as RG-8) this way. I've found a method that increases the ease of threading the plug onto the cable jacket. Simply cut four small V-shaped pieces, 90° apart, out of the cable jacket before folding the braid over the jacket (see Fig 2). This allows the jacket to

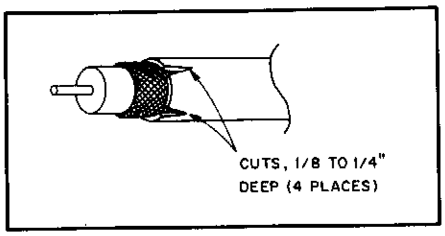


Fig 2—James Viele reports that removing four small sections of the cable jacket makes Bruce Haldeman's PL-259-installation suggestion even easier to implement. See text.

compress into a sort of taper that makes threading the connector onto the coax much easier. Also, I've found that it's not necessary to unravel the shield if this is done: You need only push the shield back over the cable jacket. A razor blade or utility knife works fine for making the cuts. —*James Viele, N8IRL, 161 Fox St, Hubbard, OH 44425-2122*

"Solderless Solder-On" Connectors: Iffy

□ The solderless PL-259 application technique shown by KG6QY may appear to work at first, exhibiting low resistance and a low SWR, but long-term results will probably be disappointing. On all too many service calls, I've found such connections on CB, amateur and even commercial installations. The complaints included erratic SWR, noisy reception and reduced communication range. These problems became noticeable more quickly at VHF/UHF than at MF/HF. (In my opinion, use of such "solderless solder-on" connectors may also compromise lightning protection and open the door to TVI.)

The standard PL-259 installation procedure results in electrical and mechanical integrity, but it subjects the cable dielectric to high heat. I get around this by sliding a small piece of chewing-gum foil between the dielectric and braid after exposing the braid. The foil deflects heat from the dielectric during soldering. Use a high-wattage soldering iron (100 W or more) and good-quality solder to tin the braid. Slide or screw the connector onto the cable. Next, heat the connector body (with that high-wattage soldering iron) and apply solder sparingly. (A high-wattage soldering *gun* with its tip removed works well at this step: Press the tip-support tubes against the connector and press the trigger. Result: Current from the gun passes through the connector, heating the connector directly. Be sure you apply sufficient pressure to the gun before pressing the trigger or sparks may fly!) Connectors installed in this manner have outlived the cable on which they were installed.—*Burton W. Armbrust, WB8EBS, ARRL Assistant Technical Coordinator, 628 Woodward Ave, Iron Mountain, MI 49801*

Another Way of Installing PL-259 Coaxial Connectors

□ I have always considered it a challenge to insure a positive braid connection to coaxial connectors until I developed this technique: Notch the back edge of the connector or reducer with a file. Then, solder the twisted shield braid to the notch.

For RG-58, RG-59 or "Mini 8" cables, file a single notch in the reducer (UG-175 [RG-58], UG-176 [RG-59, Mini 8] or equivalent). When using larger cables, file two diametrically opposed notches in the rear of the connector barrel, comb out the braid wires, separate them into two bundles and solder one bundle to each notch. Cut off the excess braid with side cutters and file the joint(s) flush. Sample assemblies are shown in Fig 3.—*Art Zavarella, W1KK, 1702 Main St, Agawam, MA 01001*

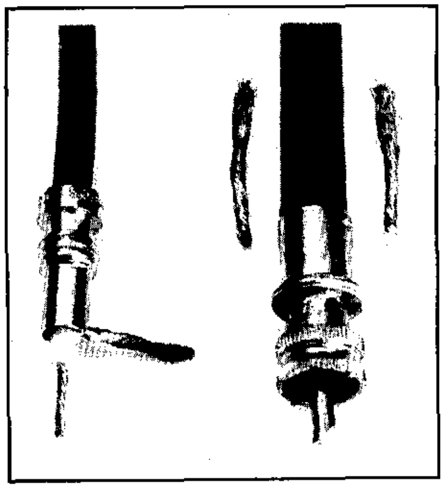
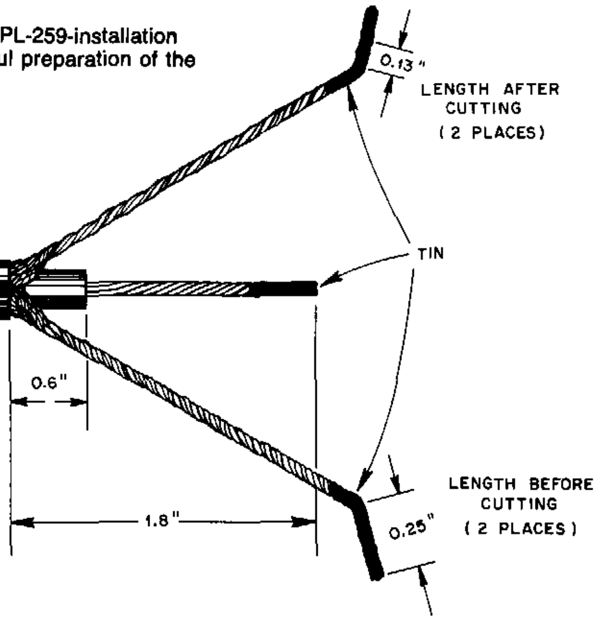


Fig 3—Art Zavarella's PL-259-installation hint. Left: Mini-8 foam-dielectric cable installed in a UG-176 reducer. This assembly is ready for removal of the extra braid wire (one bundle) that protrudes from the bottom edge of the reducer. At right: a PL-259 installed on RG-8 cable. The extra braid wire (two bundles) has already been cut off and the solder joints have been filed flush. For outdoor use, be sure to seal the cable jacket to the connector with epoxy or RTV sealant. See text.

Fig 4—John Parnell's PL-259-installation hint depends on careful preparation of the cable braid. See text.



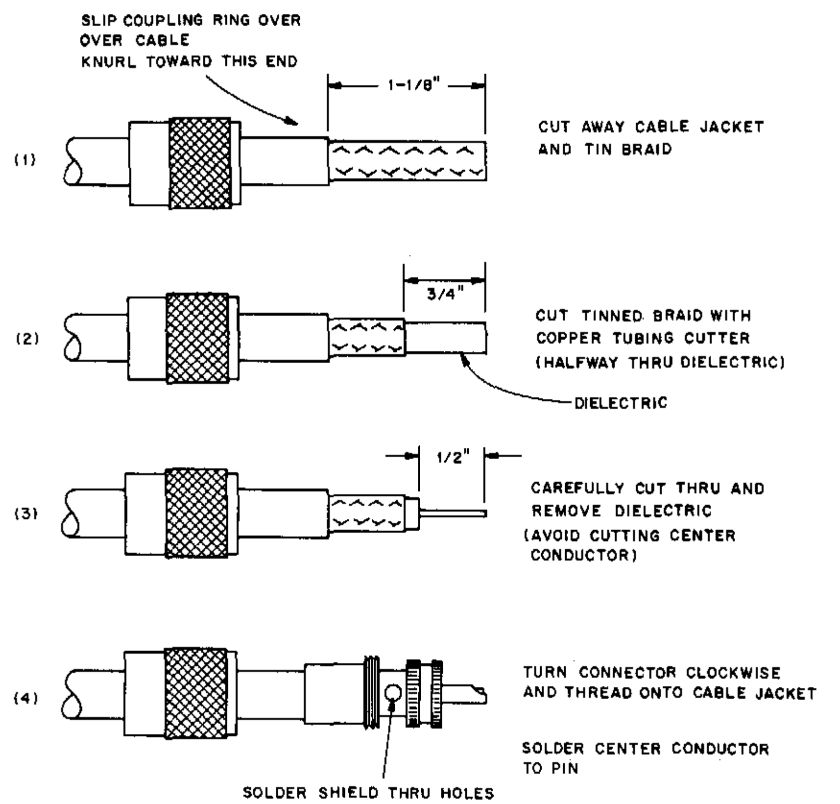


Fig 5—Ralph Hirsch's technique for installing a PL-259 on RG-8 coaxial cable. See text.

Assembling PL-259 Connectors to RG-8 Cable

☐ Here's *my* technique for assembling a PL-259 to cable:

1) Remove 1.8 inches of the cable sheath as shown in Fig 4, and unravel the braid back to the sheath.

2) Separate the braid strands into two equal bundles and twist each bundle tightly. The bundles should be diametrically opposite. Tin the ends of the bundles. Next, bend and cut the bundle ends as shown.

3) Remove all but 0.6 inch of the exposed cable dielectric. Tin the end of the center conductor, retwisting the center-conductor strands first, if necessary.

4) Slip the connector coupling ring on the cable—with the ring facing in the correct direction! Next, insert the end of the cable into the connector body, feeding each of the two shield bundles through its own (diametrically opposite) holes in the connector body. As always, slip the tinned cable center conductor into the PL-259 pin. Put the cable into the connector until the cable sheath butts against the connector body.

5) Heat the connector body with a high-wattage soldering iron and continue to push the cable into the connector until the dielectric passes the soldering holes in the connector body. (Continue to pull the braid bundles through the soldering holes as the cable moves further into the connector. Use pliers to avoid being burned.)

6) Wrap the shield bundles around the connector body (in the soldering-hole well). Cut them off after about 1/6 turn.

7) Solder the shield bundles in the soldering-hole well. Solder the center conductor to the connector pin.

8) When the connector has cooled, retrieve the coupling ring and assemble it to the connector body.—*John Parnell, KQ3E, 15 Del Rio Dr, Yardley, PA 19067*

Installing PL-259s at K1RH

☐ Assembling these connectors can be quite a problem for hams of all ages and experiences, especially when a UG-175 or -176 reducer must also be used. Many alternatives have been proposed to the standard procedure. The loose braid strands involved with some of these alternatives can cause problems. Here're two PL-259-installation techniques (one for

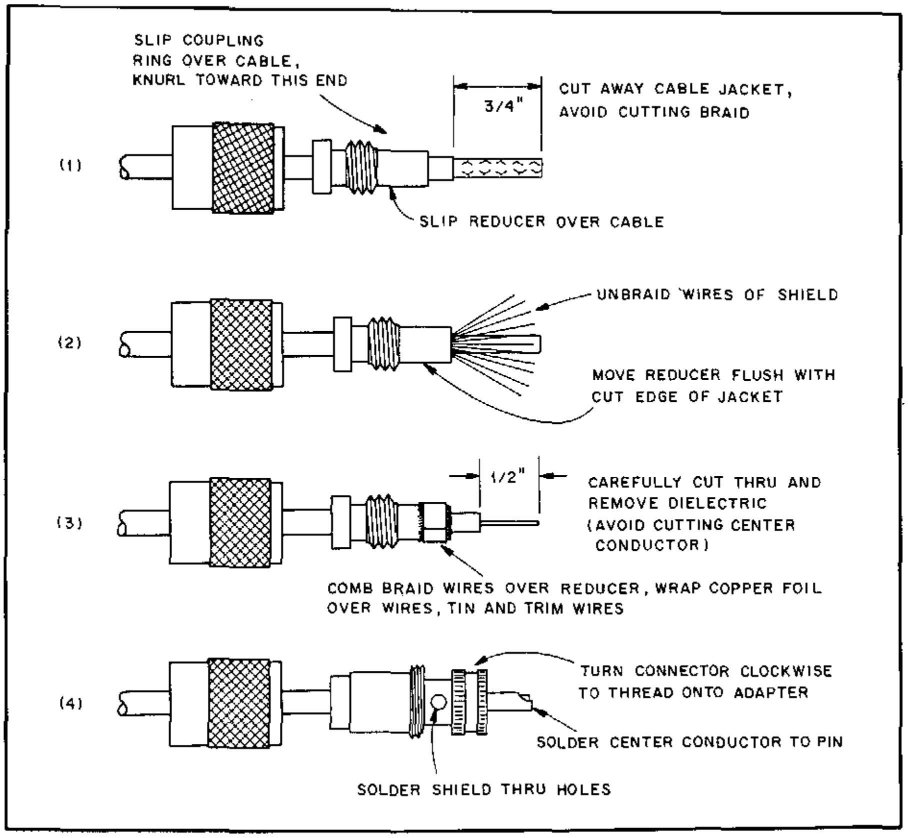


Fig 6—The Hirsch method as applied to RG-58 and a UG-175 reducer. The secret of this procedure is the copper foil used in step 3. See text and Fig 7.

each size of cable) that eliminate loose braid strands and provide excellent electrical contact and physical strength, in addition to good cosmetic appearance with no braid showing.

For RG-8 cable: Disassemble the PL-259 connector and slip the coupling ring over the cable. Be sure the ring is facing in the right direction!

See Fig 5. Remove 1-1/8 inches of the cable jacket, being careful not to cut into the braid. Make certain that the shield is *not unbraided*, then tin the entire exposed portion of the braid. Using a copper-tubing cutter, cut through the tinned braid and about halfway through the cable dielectric at a point ¾ inch from the free end of the cable. Using a utility knife, carefully cut through the remainder of the cable dielectric, being careful not to cut or nick the center conductor. Remove the excess braid and dielectric. Tin the exposed center conductor.

Slip the connector assembly over the center conductor and, *holding the cable steady*, turn the connector clockwise so that it is threaded onto the cable jacket. (Assistance from a pair of slip-joint pliers may be necessary at this point. If so, grasp the connector between its solder holes and tip on the knurled portion of the connector.) As you do this, you'll see the tinned braid creep into sight through the solder holes. Once the shield has moved just beyond the holes, you're ready to solder it to the connector. (Note: Depending on the diameters of the particular cable and fittings you use, it may be difficult to turn the connector onto the cable. If this is the case, apply a *very small* amount of petroleum jelly to the cable jacket. Be careful not to get any lubricant on the cable braid, because it will interfere with the soldering necessary to complete the installation. After you screw the connector onto the cable, wipe off any remaining lubricant. Caution: Lubricants other than petroleum jelly may eventually soften the cable jacket.)

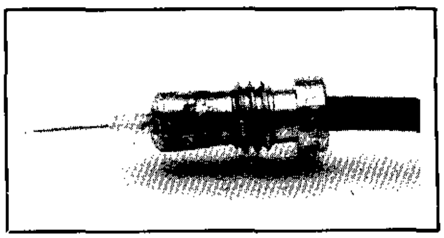


Fig 7—This reducer/cable assembly is ready to be turned into the connector body. Note the soldered copper foil cap at the narrow end of the reducer.

There are two methods of soldering the shield to the connector. One is to use a small, pointed soldering iron and let the solder flow through the solder holes onto the tinned braid. If your iron will not work for this, use your high-wattage gun or iron to melt a small pool of solder in the holes, making sure that the surrounding metal is thoroughly heated. (Usually, the solder will not flow *through* the holes; instead, it pools in the holes. While the solder is still molten, use a wooden match stick to push the solder through the hole and into contact with the tinned cable shield. Next, reheat the solder so that it flows onto the tinned shield.) Further application of heat to the connector body should also cause some of the solder on the cable braid to melt, providing more braid-to-connector contact than just afforded by the solder at the holes.

Next, solder the cable's inner conductor to the connector pin, being careful not to get solder on the outside of the tip. Using an ohmmeter, check the cable/connector assembly for center-conductor continuity and shield-to-conductor shorts. If all checks out, assemble the coupling ring to the connector and your cable is ready for use.

For RG-58 cable: Because RG-58 is smaller in diameter than the PL-259, a UG-175 reducer must be used. This means further that a different connector-installation procedure must be followed than that appropriate for RG-8.

See Fig 6. Slip the coupling ring over the cable. Be sure the ring is facing in the right direction! Next, slip the UG-175 reducer over the cable with the thin portion of its barrel toward the free end of the cable.

Remove ¾ inch of the cable jacket, being careful not to cut the braid. Using an awl or ice pick, *completely unravel* the exposed braid. Move the reducer up the cable to where the thin end of the reducer barrel is even with the point where the jacket was removed. Carefully comb the shield strands back over the reducer barrel, spacing them as evenly as possible. Wrap a 1½-inch length of 3/16-inch-wide self-adhesive copper foil (stained-glass foil is suitable)[2] around the end of the reducer barrel so that the foil adhesive holds the strands firmly in place where they are folded over the end of the barrel.

Being careful not to melt the cable dielectric, solder the shield strands to the foil. Start as close to the dielectric as possible and continue over the foil to the other edge of the foil so that the shield strands are soldered to both edges of the foil. Keep the solder coat as thin as possible. The result is a small solder cap (the foil) with unsoldered wires underneath. Using a utility knife or razor blade, trim off any excess shield strands. (Do not attempt to lift these strands; cut through them against the barrel. You'll probably cut through

[2]A kit containing enough copper foil for several cables is available from the author for $1.50 and a large SASE. The ARRL and *QST* in no way warrant this offer.

some excess solder, but you should have no trouble with this step because solder and wire cut easily.)

Strip ½ inch of dielectric from the cable center conductor. (Fig 7 shows the assembly at this point.) Grasping the thick end of the reducer, and keeping the soldered cap firmly against the end of the cable jacket, screw the connector body onto the cable (clockwise), making certain that the cable center conductor moves into the connector pin. As with the RG-8 installation procedure, don't twist the cable or the reducer—hold them steady while you screw on the connector body. When the soldered cap just clears the conductor holes, solder the cap to the connector body using the technique described for RG-8 cable.

Solder the cable center conductor to the connector pin and trim off any excess wire. Check for continuity and short circuits, screw on the coupling ring, and the job is complete.—*Ralph M. Hirsch, K1RH, 172 Newton Rd, Woodbridge, CT 06525*

PL-259 Installation

☐ The time-honored method of terminating a PL-259 coax connector when using a UG-175 or UG-176 reducer has always bothered me, particularly with regard to the amount of heat necessary to melt the solder for a reliable connection. The method in question involves folding the braid back over the sleeve of the reducer, then turning the reducer into the body of the PL-259 and applying solder through the holes in the PL-259. The PL-259 has to get mighty hot before solder will flow into it properly!

I discussed this method, and my doubts as to the wisdom of applying so much heat to the assembly, on the air with a friend of mine, Ken Guge, Sr, K9KPM. Ken told me of *his* method, which is much simpler and safer. I've since used his idea myself and found it to be everything that he indicated.

To use Ken's method, tin the very end of the UG-175 or -176 reducer (the threadless end) and slip the reducer onto the cable. Strip the cable back as in the standard method [see page 37-13 of the *1988 ARRL Handbook*—Ed.]. Next, *don't* fold the shield braid back over the reducer as in the standard method. Instead, unbraid the shield with a pointed tool so that it fans out radially from the center conductor. Tin the fanned braid from the center outward for about ¼ inch. Using diagonal cutters, trim the tinned braid to within about 1/8 inch of the cable jacket. Slide the reducer up to the tinned braid. Using moderate heat, solder braid to the tinned end of the reducer.

Strip and tin the cable center conductor as called for in the standard PL-259 assembly method. Using two pairs of pliers—one on the reducer collar and the other on the PL-259 body—turn the reducer/cable assembly into the PL-259 as tightly as possible. Solder the cable center conductor to the PL-259 pin, and the job is finished—in half the time necessary to do it using the standard method, I'll bet! (If you feel that a soldered bond between the reducer and the PL-259 is necessary, solder the joint at which the reducer and connector body meet. This step should not be needed, though, if you turn the reducer into the PL-259 tightly enough.)

There's a further advantage to using the K9KPM method: The PL-259 and reducer can be disassembled and reused with a minimum of bother. If you give Ken's method a try, I think you'll like it as much as *I* do. In fact, it almost makes PL-259 installation fun! (Well, I did say *almost*.)—*Dave Miller, K9POX, 7462 Lawler Ave, Niles, IL 60648*

Pros and Cons of "Solderless Solder-On" Connectors

☐ What's the purpose of seeking alternative methods of installing PL-259s? Bruce Haldeman put it succinctly: The goal is an installed connector having "all the integrity of a soldered connection, but with none of the usual headaches." It's safe to say that thousands of PL-259 users will use, are using, or have used, some form of "solderless solder-on" PL-259 in their radio installations. What are the pros and cons of using such connectors?

Pros: Relative ease of installation; greatly reduced chance of damage to cable dielectric by soldering heat; greater likelihood that the connector can be reused.

Cons: Unsoldered joints can deteriorate rapidly with age, especially when subjected to the elements and/or cable movement. The resultant poorly conducting joints can cause increased line loss, SWR anomalies, harmonic generation during transmission, and noise and intermodulation distortion during reception. "Solderless solder-on" techniques that do not preserve the cable shield *around the entire circumference of the cable* can allow signals to leak out of the cable and flow on the *outside* of the shield—a highly undesirable condition.

Discussion: One reason for the increased popularity of nonstandard PL-259-installation techniques may be that the UHF-series hardware commonly available nowadays is nickel plated. When UHF connectors were first introduced—and when the standard PL-259-installation technique was developed—silver-plated PL-259s were standard. (Foam-dielectric cable—which melts much more readily than standard RG-8, and which is another reason why nonstandard PL-259 installations are widespread—*didn't* exist then.) Silver takes solder readily; nickel does not.

Once out of their protective wrapping, silver-plated connectors, especially old ones, are easy to spot: They're usually tarnished. *Resist the urge to clean them.* Silver oxide is an excellent conductor; removing the tarnish just prepares another layer of silver for oxidation—and later removal by you, if you're of the "gotta get the tarnish off" persuasion. Chapter 24 of *The 1988 ARRL Handbook* (page 24-6) suggests that silver solder may give best results with silver-plated PL-259s; standard tin-lead "electronics" solders work well, however.

The best way to install PL-259s is the standard way. Well-soldered joints avoid the semiconductor effects common in poor mechanical joints because *alloying* occurs where solder meets the base metal. The best way to solder to a nickel-plated brass connector is to file, sand or steel-wool it down to brass before soldering.

Yes, soldering the cable shield to the PL-259 body takes considerable heat—and *practice* if you intend to do it well every time. But connector installation is a job *worth* doing well. Use a soldering iron or gun rated at 100 W or more—more is better. (Burton Armbrust's chewing-gum-foil hint may be of help in preserving foam cable dielectric during soldering.) Note: As far as I know, *PL-259s were never intended to be reusable.* The best medicine for a suspect, botched, or short-circuited PL-259 is a one-way trip to the trash barrel. Recovering an installed PL-259, especially if a UG-175 or -176 reducer is involved, can require enough heat, acrobatics and dangerous fumes that you'll probably wish you'd thrown out the bum connector in first place!

The best crimp-on coaxial connector is one designed for the purpose. Crimp-on connectors *are* available, at least for RG-58, RG-59 and Mini-8 cables; consider using one of these instead of a "solderless solder-on" PL-259. (Incidentally, if it's "solderless" or "crimp-on," it's not *really* a PL-259—no matter what the package says!) In my opinion, though, even designed-for-application crimp-on connectors are a second-rate alternative to *soldered-on PL-259s.*

Whatever connectors you use, seal them against the elements if you use them outdoors: Water can rapidly degrade and destroy coax if it gets inside the cable. If your station includes any crimp-on or "solderless solder-on" RF connectors, though, look to them first if you notice any of the symptoms listed above.—Ed.

VARIATIONS ON THE PL-259 THEME—REVISITED

☐ I agree with those who report that solderless PL-259s invite trouble: Coax fittings *must* be soldered to give long and reliable service! Another comment concerns the PL-259's center pin: Unless it is correctly aligned, and its outer surface is free of solder and flux, the pin may deform any contact into which it is inserted.

Maybe there would be fewer variations in PL-259 assembly techniques if the PL-259 were better designed! The official method entails soldering temperatures that melt the cable insulation, and this frustrates achieving electrical integrity *and* satisfying appearance of the assembly. Also, it's hard for me to cut insulation without nicking the underlying metal.

My method of attaching PL-259s includes: (1) using wet tissue paper to absorb heat; (2) using a hot wire instead of a blade to cut cable insulation; and (3) soldering the braid to the *outside* of the plug (see Fig 8).—*Marvin J. McGarity, W4WU, 1416 Sutherland Pl, Birmingham, AL 35209*

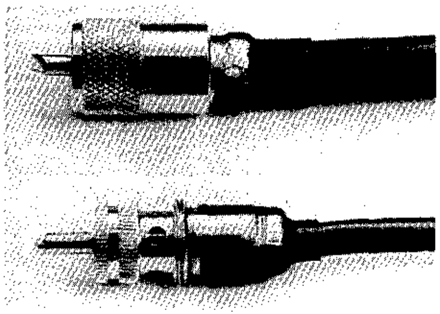


Fig 8—Two coaxial plugs attached using the McGarity method. The heat-shrink tubing is shrunk after the braid has been soldered to the connector and the coupling ring has been moved to its proper position.

☐ The method advocated by John Parnell, KQ3E, is a method I have used for nearly 50 years with satisfactory results. I have another method—one that has become my "standard." It is very similar to the method advocated by Ralph Hirsch, K1RH, except that I wrap the braid with tinned copper wire and solder the wire to the braid before screwing the cable into the connector body. This, in itself, makes a very tight joint, but I add another step by soldering a fillet of solder to the connector. This ensures electrical integrity as well as preserving the shield. I have had absolutely no problems with properly sealed joints made in this fashion.—*I. L. "Mac" McNally, K6WX, 26119 Fairlane Dr, Sun City, CA 92381*

☐ My approach to the problem of assembling PL-259s is simple and direct: I don't use them! Instead, I use N connectors (they're designed for 50-Ω operation, and their shield-to-connector connection is clamped, not soldered). In a similar manner, BNC connectors, when used with RG-58 cable, work very well for the numerous short interconnects common in many Amateur Radio stations. N connectors are inherently weatherproof; the bayonet construction of BNC connectors makes them a good choice for situations in which quick connections and disconnections must be made. Unlike UHF connectors, N and BNC connectors can be easily reused and have constant-impedance characteristics.

A complete changeover from UHF connectors to N/BNC connectors would be quite a headache; I recommend a phaseover instead. In my station, I use N or BNC connectors on all new equipment, and use UG-83 UHF-to-N adapters for older gear. (UHF-to-N adapters are available in a number of styles; flea markets are a good place to pick these up.) N connectors may be more expensive than their UHF counterparts, but the added cost is worth it: N connectors are better.—*Peter H. Bliss, W8DTD, 8701 Kings Mill Pl, Raleigh, NC 27614-9150*

☐ I found no mention in your column as to why many of us probably don't solder our PL-259s: We don't have a hot enough soldering iron, and we can't justify buying one for the number of times we'll use it. Several years ago, while living in Mountain Village, Alaska, I needed to solder a plug. I had some low-temperature solder (probably Wood's metal or a similar bismuth alloy) that's meant to be melted with a match or cigarette lighter, so I just heated the plug on my stove and ran the solder in.

My new soldering iron (75 W) doesn't do much better at soldering PL-259s than my older 30-W iron. So, I found my low-temperature solder, used it with the new iron—and it worked just fine. The lower soldering heat probably didn't damage the cable dielectric much, either.—*David M. Chamberlin, WL7BLV, PO Box 75071, Fairbanks, AK 99707*

AK7M: Yes, 30 W, and even 75 W, is insufficient heating power for proper assembly of a PL-259. I use a trigger-selectable 100/140-W soldering gun—at 140 W—with reasonable success. Our next PL-259-problem-solver improves on the soldering-gun technique...

☐ Here's my quick, easy and painless soldering-gun method of soldering the cable braid to the connector body during PL-259 assembly. Shape a soldering-gun tip as shown in Fig 9. Prepared in this way,

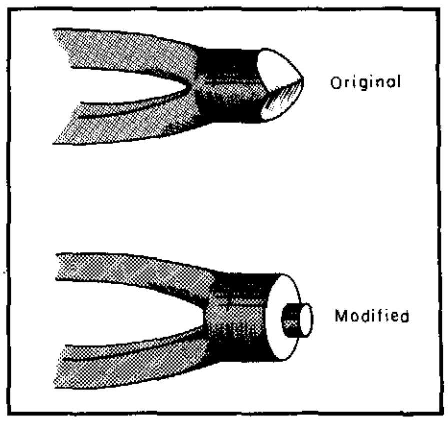


Fig 9—Bob McKay assembles PL-259 connectors with a soldering-gun tip filed to this shape. Be prepared to reshape or replace such a tip every few soldering jobs, though: Soldering-gun tips erode with use, contributing a fraction of their copper to every joint they solder.

the tip fits into the connector-barrel solder holes to heat the braid and the connector barrel. This reduces the time necessary to solder the braid to the connector, minimizing the likelihood of damage to the cable dielectric.

Several additional precautions can speed connector assembly and assure a good braid-connector solder joint:

- Always tin the braid before assembling the connector.
- Use liquid rosin flux (such as General Cement Liquid Solder Flux, usually available at TV-parts supply houses).
- Never try to solder nickel-plated connectors without first filing the edges of each connector-barrel solder hole to expose the brass connector material.
- Use a soldering iron or gun of sufficient power; 100 W is marginal in still air and insufficient in moving air.
- Solder *all* of the connector-barrel solder holes. They are there to allow complete soldering of the braid (or braid and reducer) to the connector body.

Assembling a PL-259 according to these guidelines takes only a few minutes and produces a dependable connector assembled as its manufacturer intended.—*Bob McKay, N8ADA, 317 Ernst Ave, Dayton, OH 45405*

☐ I've been employed by the engineering department of a major-network TV broadcasting company for over 28 years, and over the course of time, we've used a great many PL-259 connectors for video distribution. (Now, we mainly use BNCs.) Our biggest UHF-plug headache has not been with connections within the assembled connectors; rather, we were kept busy by PL-259 coupling rings that loosened over time.

To prevent this problem, use "gas" (slip-joint) pliers to tighten UHF-plug coupling rings during their last quarter-turn or so of travel. Of course, pliers are necessary to loosen a connector installed in this way—but that's a small price to pay for the peace of mind pliers-tightened connectors afford!

Another PL-259-assembly point: Don't let solder flow over the outside of the plug center pin during assembly. The center-pin collet in UHF-series jacks is not intended to accept diameters larger than that of the center pin.—*David Miller, NZ9E, 7462 W Lawler Ave, Niles, IL 60648*

AK7M: Oversoldered PL-259 pins can be filed or scraped clean of excess solder, but this procedure may also remove the pin's plating. Go easy.

☐ A bit more trouble soldering cable braid to PL-259s? I just drill the connector-barrel solder holes slightly larger—no problem! —*Richard Mollentine, WA0KKC, 7139 Hardy, Overland Park, KS 66204*

TUBING REDUCER REPLACES COAXIAL HOOD

☐ The UG-106 hood is the preferred method of preserving the shielding of RG-8, RG-213 and similar cable behind an SO-239 coaxial jack, but I couldn't find a local source of these parts. I discovered, though, that hardware and plumbing shops carry a substitute: A 1/2-to-3/8-inch copper tubing reducer that does the job nicely! (See Fig 10.) A 140-W soldering iron.

provides sufficient heat to install the reducer.

Prepare the cable as shown in Fig 10A by removing 7/8 inch of the cable jacket and folding back the braid. Strip 3/16 inch of insulation from the center conductor. Tin the outside of the narrow end of the tubing reducer. After the reducer cools, slide it over the cable, narrow end first.

Tin the back of the SO-239 base plate as shown in Fig 10A and allow it to cool. Solder the cable center conductor to the SO-239 pin (Fig 10B). Slide the reducer flush with the SO-239 base plate and solder it to the plate as shown in Fig 10C. Like tinning the back of the plate, this operation requires thorough heating of the work, so be sure to let the soldered assembly cool before you move to the next step.

See Fig 10D. Pull the cable braid over the reducer. Wrap several turns of solid hookup wire around the braid and twist the wire ends tightly to hold the braid in place. Trim the braid close to the wire with diagonal cutters, then solder the wire-wrapped braid to the tubing reducer. —*John J. LoRe, W4LGD, White Stone, Virginia*

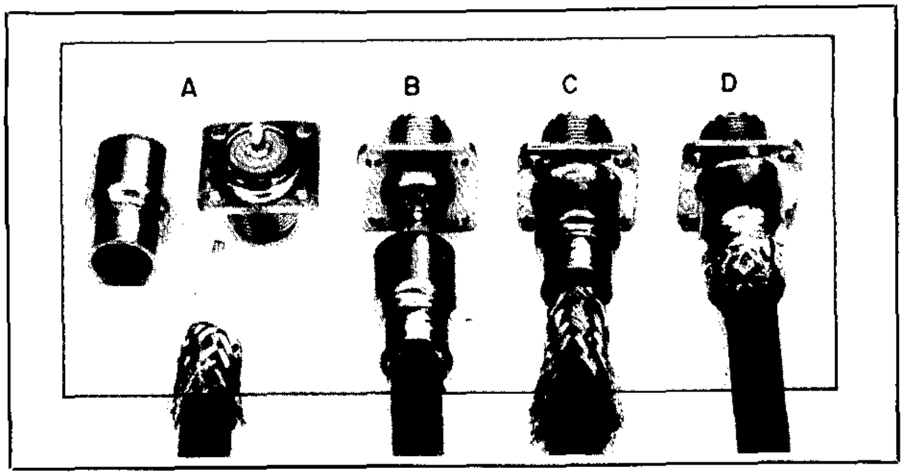


Fig 10—W4LGD uses a 1/2-to-3/8-inch copper tubing reducer as a substitute for the UG-106 coaxial hood. Like the UG-106, the tubing reducer provides shielding between panel and cable braid for RG-8, RG-213 and similar transmission lines. See the text for instructions.

EASIER BNC- AND N-CONNECTOR INSTALLATION

☐ Getting all the cable-shield wires through the clamp can be difficult during installation of BNC and N connectors; usually, a few braid wires end up getting squashed under the clamp. Solution: Hold the wires down by wrapping them with electrical tape. Don't tape beyond the braid wires onto the coax outer jacket; just tape the braid itself.—*Zack Lau, KH6CP, ARRL Laboratory Engineer*

CONNECTIONS FOR ½-INCH HARDLINE

☐ Many hams would use rigid coaxial cable (Hardline) in their stations if not for the hard-to-get and often expensive connectors that it requires.[3] Here is a way to fit ½-inch Hardline with a PL-259 for about $3. Refer to Fig 11 while reading these instructions.

A) Remove the shield and dielectric to expose approximately 3/8 inch of the center conductor. Slip a 3/8- × 5/32-inch brass tube over the center conductor and solder it in place. (This ensures a tight fit for the PL-258 barrel connector.)[4] Place a barrel connector on the prepared end of the Hardline.

B) Cut a 1½-inch-long piece of 5/8-inch (inside diameter) aluminum tube and slit the ends with a hacksaw to allow easy compression when the clamps are tightened. [The end that clamps to the Hardline needs at least four large, V-shaped slots for the 5/8- to ½-inch transition.—Ed.] Clean the outside of the Hardline and the inside of the fitting. Coat the mating surfaces with conductive grease, such as Dow Corning Molykote™ 41, and center the fitting over the Hardline/barrel-connector joint.[5]

C) Place hose clamps at each end of the aluminum fitting and tighten the clamps snugly. Weatherproof the connector assembly with epoxy or another sealant.

This arrangement should last many years if done correctly. Good DXing!—*Dennis Stice, WB5GDB, Oklahoma City, Oklahoma*

[3]For more homebuilt Hardline connectors see "Hardline Coaxial Connectors You Can Make," in Apr 1987 *QST*, p 32.

[4][I tried WB5GDB's suggestion with some Hardline in the ARRL Lab. The line has a 0.162-inch center conductor that fits a PL-258 snugly. The Times Microwave Systems (an LPL company) catalog lists ½-inch Hardline with center conductors ranging from 0.098 (75 Ω) to 0.162 (50 Ω) inches, while the pin of a PL-259 measures 0.155 inches. Some lines require the brass tube, while others do not.—Ed.]

[5]Molykote 41 is available from Eastern Bearings.

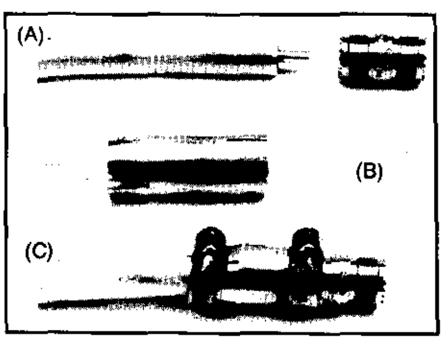


Fig 11—WB5GDB's Hardline connector (see text for explanation.)

FILE COMB STRAIGHTENS BRAID

☐ Need to straighten the braid on bare lengths of coaxial cable and shielded wire? Use a file comb to brush the braid along its length.—*Guy Black, W4PSJ, Fairfax, Virginia*

STRIPPING COAX WITHOUT NICKING ITS BRAID

☐ Here's a reliable way of making sure you don't nick coaxial cable's braid or center conductor. Use a fresh, single-edge razor blade. Connect one test lead of an audible continuity tester (a DVM or DMM equipped with one, or a piezoelectric buzzer and battery, will suffice) to the blade. Connect the other test lead to the conductor you don't want to nick. Begin cutting. If the tester sounds, lighten up on your cutting force until the noise stops.—*Thomas Cott, KB2GZS, 8 Gables Rd, Hicksville, NY 11801-3218*

☐ "Don't nick braid or center conductor!" This warning is common in RF-connector-installation instructions—and heeding it is almost impossible to do using common hand tools. My solution: Instead of a knife or razor blade, draw ***a nylon thread*** back and forth over the insulation to cut it without scoring the conductor beneath.

I use Coats & Clark transparent nylon thread; it cuts very cleanly. It tends to break under moderate loads, though, so you may need to experiment with heavier thread for larger cables.—*Phillip D. Dolan, KØCGB, 7415 Portland Ave S, Richfield, MN 55423*

INEXPENSIVE CONNECTOR PROTECTION

☐ I travel to some nasty environments when out on DXpeditions, Field Day and VHF/UHF mountaintopping trips, and my idea of fun *isn't* cleaning out the N connector on a cable end I've inadvertently dropped in the mud! With luck, designed-for-application protective caps can be

Table 1
Furniture Leg Caps for RF Connectors

Cap ID, inches	*Connector*
3/8	female BNC
1/2	male BNC
5/8	female N and UHF
3/4	male N and UHF

located at fleamarkets. As a substitute, I protect connectors with plastic caps intended for use on metal furniture legs. These caps are available at many hardware stores in packages of four for under a dollar per package. Table 1 lists the caps I use for various connector types. Because of connector manufacturing tolerances, the caps listed as suitable for male N and UHF connectors may have to be held in place by means of tape—but protecting connectors against dirt, snow and insects is well worth the extra effort.—*Roger Wagner, K6LMN, Los Angeles, California*

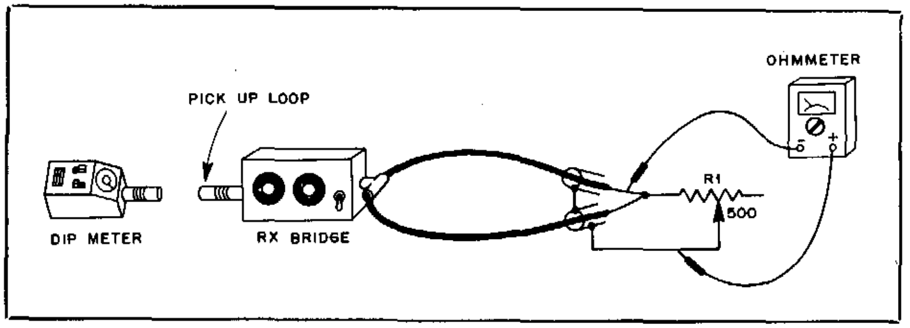


Fig 12—The test circuit for parallel-connected coaxial cables. When the potentiometer is set for 30 Ω, the RX bridge reads 30 Ω at any frequency. When the potentiometer is set for 18 Ω, the RX bridge reads 50 Ω when the frequency is such that the cables are an electrical λ/4.

MORE ON USING COAXIAL FEED LINES IN PARALLEL

☐ Coaxial cables of different impedances can be operated in parallel to obtain special impedance characteristics. Cables apparently follow the same impedance and power-distribution laws as resistors. For example, if 50-Ω and 75-Ω cables are used in parallel, the resulting impedance is 30 Ω. This 30-Ω impedance may be useful for matching mobile or vertical antennas. It could also be used as a λ/4 matching section between a 50-Ω line and a Yagi antenna. Depending on the exact impedance of the cables, a wire beam that presents an impedance of 18 to 20 Ω can be nearly matched. Fig 12 shows a test arrangement for experimenting with parallel connected cables.

When connecting coaxial cables in parallel, the electrical lengths of the lines must be equal. Different physical line lengths will result if the velocity factors of the cables differ.—*Bob Perthel, W9MWD, Elm Grove, Wisconsin*

AMATEUR RADIO PLUMBING

☐ Most operators try to locate their antennas outdoors and their transceivers indoors for rather conspicuous reasons. One common obstacle to that goal is transmission-line routing. The old standby, an open window, permits the intrusion of insects in summer and cold air in winter. Hams have dreamed up some ingenious methods of getting the signal out of the house: A fitted sash plug can be used to seal open windows; that idea is especially attractive if you rent your home. My club newsletter even explained how to drill holes through window panes (yes, glass)! [Lad's idea first appeared in the Chicago Suburban Radio Association newsletter, *TXT*, for Apr 1983.—Ed.] Major publications have also shown soffit connectors and wall conduits.

One of my favorite feed-throughs is a roof conduit. I have installed two at my station, each with excellent results. Fig 13 shows the details. Many ½-inch cables fit through the conduit without binding. Also, plastic pipe edges are much less likely to damage the cable jacket than are metal pipe edges. Since the pipe is not under hydraulic pressure the special fitting solvent should not be used. The two elbows can be glued to each other with silicone rubber. Since access is desirable, use no glue on the elbow-to-pipe joint. The weight of the cable will prevent the elbow assembly from separating.—*Lad Kucera, N9AEG, Clarendon Hills, Illinois*

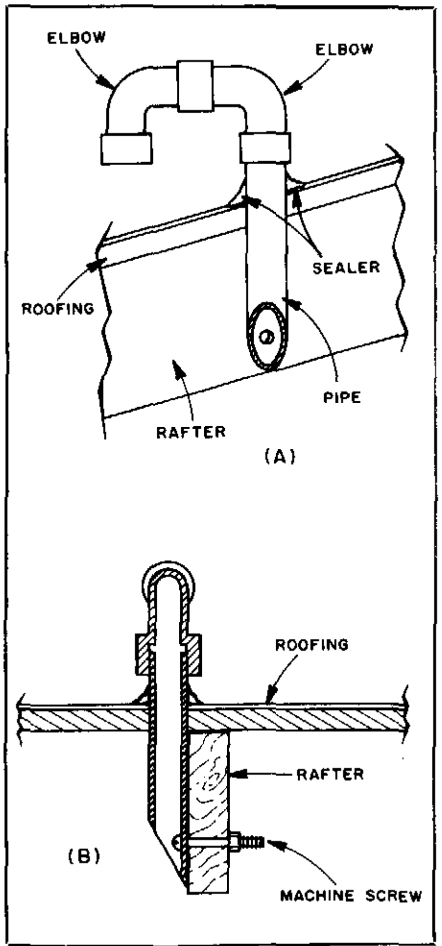


Fig 13—A side view (A) and cross section (B) of N9AEG's roof conduit for flexible coaxial feed lines.

☐ Experimenters often attempt to use the 1- to 2-inch vent pipes on buildings as antenna supports. Fortunately, plastic plumbing parts are a prolific source of adapters and masting. The inner and outer dimensions of most pipes and fittings are similar regardless of the material, so slip-joint fittings are usually sufficient for short, light-duty supports.

Most existing metallic vents are fairly well grounded and can provide a reasonable ground for a vertical antenna when the cable shield is connected to the vent. [In this arrangement, the pipe may serve either as a ground conductor or a counterpoise depending on the length of the vent pipe. Any electrical discontinuities in the pipe may cause problems.—Ed.]

Inexpensive "trap adapters" are exceptionally useful. They hold tubing of any material without threading (and at any length).

Most vents are pressure-relief devices—as long as the installed mast is left open, no plumbing problems should result. —*C. Buttschardt, W6HDO, Los Osos, California*

FLEXING DAMAGES COAXIAL CABLE

☐ If you've ever had trouble with fluctuating SWR and similar erratic behavior in a coax-fed RF system, my experience with three pieces of coax removed from 75-MHz IF amplifier modules may be of interest to you. The bandwidth, differential gain and phase response of the amplifiers would not stay put; the coax was the culprit.

Flexing of the coaxial cables had resulted in damage to the cable shield at several plugs. The IF-amplifier manufacturer had not provided access holes large enough for 90° coaxial adapters, necessitating that the coax be pulled away from chassis connectors at a 90° angle at several places. In this wideband application, the integrity of the coax was critical in maintaining proper tuning of amplifier stages. Cable-shield damage resulted in signal leakage, circuit detuning and uncertain RF grounding. This was caused by 150 to 200 flexing cycles over a period of about 15 years. These cables were used indoors, by the way; wind flexing was not a problem.

Coaxial cable is particularly vulnerable to flexing damage at connectors and bulkheads. Protect it well, flex it minimally, keep bending radii as large as possible and take the action of weather into consideration.—*Kurt U. Grey, VE2UG, Sept Iles, Quebec, Canada*

A FIX FOR CABLE BREAKAGE AT CONNECTORS

☐ Most amateurs have experienced connector failure at points where wire or cable connects to plugs, as maximum flexure occurs as these points. Treatment with hot-melt glue is a simple and reliable means of reducing such problems. The glue, available from hardware stores, comes as a stick of plastic that's melted for application in a heated gun, and acts as a glue after cooling. The glue is moderately flexible and soft when cool.

Using the glue is easy. After assembling and electrically testing a connector (a phone plug, for instance) but before screwing on the shell, squirt hot glue into the connector cavity to envelop the wires in plastic. Don't apply too much; you'll need to get the shell over the connector afterwards. (If you apply too much glue, remove the excess with a knife after the glue sets.) Remember that hot-melt glue gets *hot*, and stays hot for 5 to 10 minutes after application. Treat the glue and its gun with the same caution as you would a hot soldering iron.

After the glue cools, screw on the connector shell. Squirt more glue into the connector around the hole where the cable enters the shell. Let the glue cool and clean up any excess. Cooled, the glue acts as a strain relief at the connector cable entrance, significantly strengthening the connector wire(s) against accidental pulls and lengthening the connector's service life. (Disassembling a glued connector is more difficult than disassembling a "dry" one, but it can be done.)—*Bob Locher, W9KNI, 1445 Northwood Cir, Deerfield, IL 60015*

STRAIN RELIEF FOR COAXIAL CABLES

☐ For some time now, I've been using long-wire antennas in the inverted-vee configuration. I feed the antennas $\lambda/4$ from one of the leg ends so that I can use coax transmission lines. (Each leg is an odd multiple of $\lambda/4$ in length.) Thus, the feed point is not at the apex, but along one of the sloping legs. This arrangement frequently creates a sharp bend at the coaxial connector (see Fig 14).

To remedy this problem, I slip a short length of ¾-inch garden hose or automotive heater hose over the outside of the PL-259 connector. (A little petroleum jelly on the connector makes the job easier.) The hose is relatively stiff in comparison to the coaxial cable and it nicely evens out the sharp bend. In addition it serves as a weather shield for the connector. I secure the hose with vinyl electrical tape, but a hose clamp (or both) would probably make a more durable assembly. Photos of my installation appear in Fig 15. —*J. A. Ciciarelli, WB3DDM, Beaver Falls, Pennsylvania*

ON BURYING COAXIAL CABLE

☐ Buried feed line is aesthetically pleasing because it's invisible! If you're like me, however, the possibility of coax contamination or damage by soil, water ingress and frost is sobering. What to do?

In my installation, I first buried PVC tubing to act as a conduit for my feed line and rotator-control cable. I used black, 1½-inch-OD tubing purchased from a local plumbing supply shop; it comes in 25-ft rolls and is very flexible, but not flexible enough to collapse during burial.

Once the tubing was in place in the ground, I fed a length of Copperweld™ copper-clad-steel wire through it as a "fish" wire. Next, I secured one end of my rotator-control and feed lines to the fish wire and pulled them through the plastic tubing.

This simple and relatively inexpensive procedure has enabled me to enjoy years of worry-free service from my cable assemblies. —*Edward Peter Swynar, VE3CUI, 48 Evergreen Dr, Whitby, ON L1N 6N6*

COAX-SEAL WARNING

☐ After my experience during a hot California August weekend, I feel that potential users of Coax Seal™ should be warned that the product is temperature sensitive. Although there is no information in the directions, an inquiry to Universal Electronics, Inc resulted in a new roll of Coax Seal and a product-specification sheet. The specifications state that the material should be applied when ambient temperature is between 50°F and 90°F. I found it impossible to remove the "plastic mastic" from its container at 95°F. What a mess! [I think this problem can be avoided by refrigerating the Coax Seal for a short time before use. —Ed.]—*Don Johnson, KD6DT, Livermore, California*

TO SEAL OR NOT TO SEAL

☐ When Larry Wolfgang, WA3VIL, reviewed the Cushcraft R3 vertical antenna

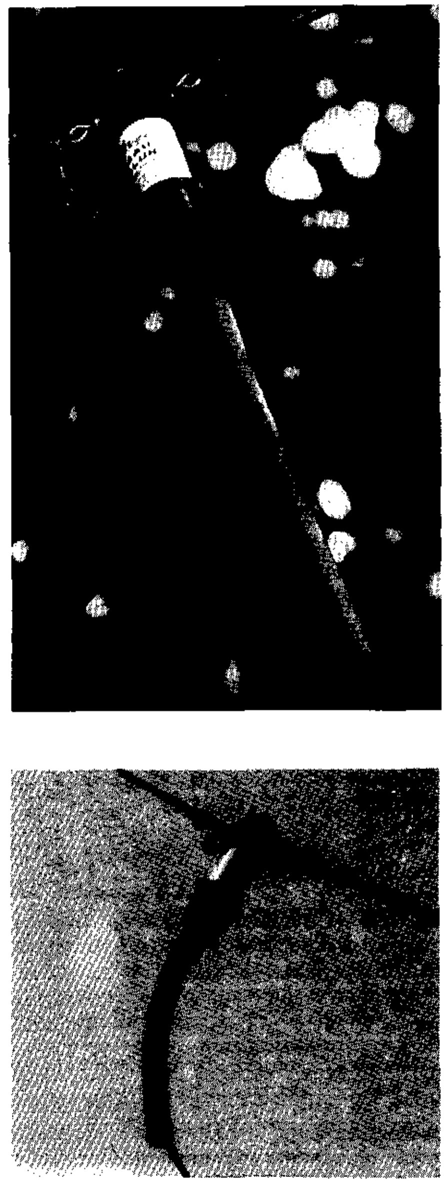


Fig 15—Photos of WB3DDM's strain relief in place on his antenna.

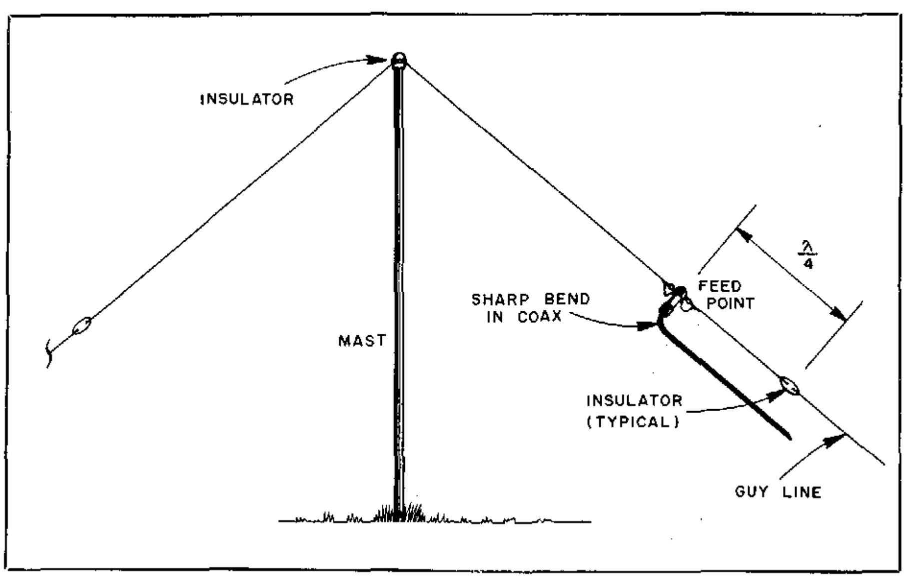


Fig 14—WB3DDM's long-wire antenna with a low-impedance feed at one end.

in March 1983 *QST*,[6] he noted that the cover of the mast-mounted capacitor tuning assembly "should not have come off as easily as it did." I had the same impression when *my* R3 arrived. The cover was secure enough, but there were rather wide gaps between the cover and base plate.

My R3 was to be mounted on top of a 35-foot tower. I didn't want to take the antenna down once it was in place. I knew that the antenna was going to be exposed to the rigors of a Maine winter, and the thought of rain driving into the capacitor tuning assembly bothered me. So, with the intention of keeping out the elements, I ran a generous bead of silicone sealant along every joint and seam of the tuning assembly. I must have done a good job—*too* good. Shortly after the antenna was installed atop the tower, the SWR rose to an unacceptable level, and no amount of tuning from inside the shack would bring it below 3:1.

Eventually, I took the antenna down and opened up the box I had so carefully sealed. Inside, I found a considerable amount of water—enough to leave a puddle on my work bench—and some corrosion of the capacitor itself. Condensation was obviously the culprit. I removed all the sealant, drilled a couple of drain holes in the tuning-assembly base for good measure, and erected the antenna again. The SWR problem disappeared completely. The antenna tuned to a 1:1 SWR on all three bands—10, 15 and 20 meters—with no difficulty. The moral of this story may be that sometimes the manufacturer knows best.—*Hugh Aitken, W1PN/1, South Gouldsboro, Maine*

Editor's Note: Sealing an assembly with room-temperature vulcanizing (RTV) substances can cause corrosion problems even if condensation doesn't occur within the sealed enclosure, depending on the RTV product used. Some RTV sealants emit corrosive vapor (commonly, acetic acid) as they cure. Noncorrosive sealants are a must for electrical and electronics work.

Unscreened drain holes can provide a means for small insects and spiders to enter a compartment, as Paul Pagel, N1FB, relates in "Tune Up Your Tribander" (*QST*, April 1986, pp 27-28 and 31). Note 2 of the article suggests using RTV sealant to secure screening over drain holes against the entry of these intruders.

[6]L. Wolfgang, "Cushcraft R3 Three-Band Vertical Antenna," Product Review, *QST*, Mar 1983, pp 45-46.

SHIELD CHOKES FOR COAXIAL CABLE

☐ When a coaxial (unbalanced) transmission line is used to feed a balanced antenna directly, RF current can flow on the *outside* of the cable shield. Even when a balun transformer is used to correct the imbalance, near-field antenna radiation can induce current flow on the outside of the cable shield if the coax does not leave the antenna perpendicularly. RF current flow on the outside of the shield is undesirable because it can distort the radiation pattern of the antenna, and may lead to inaccurate SWR measurements and stray RF in the shack.

You can use two *shield chokes* to reduce the effects of external shield current at the ends of a feed line. Form each choke by winding ten turns of feed line at the minimum bending radius (usually ten times the line diameter) recommended for the line. Use electrician's tape to hold the turns in place after you wind each coil. Place one choke within ¼ wavelength (at the highest operating frequency) of the antenna; place the other at the same distance from the transmitter. Caution: Don't form shield chokes in foam-dielectric transmission line. Tightly coiling such cable can cause the center conductor to move out of concentricity because of foam "cold flow." This changes the line impedance at affected points and reduces the power-handling capability of the cable.

If you're thinking of using a 1:1 balun transformer with your coax-fed dipole or at the driven element of a beam antenna, consider using a shield choke instead. Shield chokes are easy to construct using readily available materials. Properly built, they can handle as much power as the coax that composes them. In balun applications where impedance transformation is not required, a shield choke may be the better alternative.—*Bob Schetgen, KU7G, ARRL HQ Staff*

CONSTRUCTING LADDER (OPEN-WIRE) TRANSMISSION LINE

☐ Most commercial, open-wire transmission lines available for amateur use consist of spreaders and no. 18 copper wire. No. 18 is satisfactory for 1500 W at low to moderate SWRs, but it is inadequate for the very high SWR that can occur when a multiband antenna system is used at 1500 W. No. 14 solid-copper wire is better suited for this application. I've never seen commercially available, high-quality, no. 14, two-wire transmission line, however, so I made my own as described here.

Solid wire is better than stranded wire for constructing open-wire-transmission line because solid wire does not twist and short as easily as stranded wire. (Exception: Use finely stranded wire for the top few inches of the transmission line, near the feed point, where flexibility is important.) All-copper solid wire is best. (The springiness of copper-clad steel wire—Copperweld™ wire, for example—makes it not only very dangerous to eyes when it is handled and cut, but also makes it too unruly for use in transmission lines. Copper-clad steel wire also becomes prematurely brittle in normal use because of wind movement.)

No. 14, single-conductor, solid-copper, thermal wire ("TW"), used for wiring houses, is commonly available in 500-foot rolls where building materials are sold. This wire affords a good compromise between strength and stiffness. Its insulation can be removed by fastening one end of the wire to a stationary object and carefully pulling a sharp knife between the copper and the insulation of the stretched-out wire. (No. 14 TW can also be used for antenna wires if the feed-point insulator and transmission line are supported by means other than the antenna itself.)

Insulators

High-RF-quality, lightweight, long-lived, inexpensive and easy-to-fasten feed-line insulators can be made from acrylonitrile-butadiene-styrene (ABS) thermoplastic. If you can find it, 3/8-inch, round ABS rod stock or, as a second choice, 3/8-inch ABS square rod stock, works well. (Round stock affords less wind resistance.) These materials can be found at some of the larger plastic-supply houses. If you have a color choice, black is usually the most UV-resistant color.

If you can't find ABS rod stock, you can make your insulators from ABS plumbing pipe, which is commonly available. For use as open-wire-line insulation, ABS pipe must first be heated and flattened into sheets. Cut the ABS pipe lengthwise into halves or thirds with a table saw. Make the lengths about the same as the width of a Teflon®-coated cookie sheet that will fit into your oven. Since ABS is a thermoplastic that melts at about 150 °C, set the oven temperature to about 180 °C (350 °F). Bake the ½ or ⅓ round sections of the pipe, concave side down, on the cookie sheet until they begin to soften. When the pipe sections are soft, open the oven and place a sheet of plywood, weighted with a brick, on top of the pipe sections. When the ABS is flat, set it aside to cool.

If you're using ABS rod, cut it into pieces of uniform length (3 to 6 inches). If you're using ABS pipe, use a table saw to cut the heat-flattened pipe into strips about 3/8 inch wide and 3 to 6 inches long.[7] Notch the ends of the insulators to a depth of about ¼ inch with a hacksaw or band saw that makes a cut *narrower* than the width of no. 14 wire.

How many insulators you need depends on the line's length and wire spacing. It's best to space the insulators at a distance equal to five to ten times their length. Six-inch-long insulators, for instance, are usually spaced 30 to 60 inches apart. Assuming 6-inch spacers spaced 60 inches apart, a 50-foot feed line requires nine

[7]The line impedance, which can be calculated from the equation $Z_0 = 276 \log (2S \div d)$, where Z_0 is the characteristic impedance of the line, S is the center-to-center distance between the line conductors, and d is the conductor diameter (in the same units as S), is generally not critical in situations where the feed line is intentionally operated at a high SWR—that is, when its impedance considerably mismatches that of the antenna it feeds. This can occur when, for instance, an open-wire-fed doublet is operated on several bands. What counts is the feed line's ability to handle, with minimum loss, the high voltages and currents that can occur under high-SWR conditions. The main mechanical consideration is that the feed-line wires be far enough apart, and equipped with enough spacers, not to short-circuit with wind movement.

insulators—assuming that the distance between each line end and its adjacent insulator is equal to the insulator-to-insulator spacing. Use no more insulators than are necessary to keep the feed line from twisting and shorting.

Fastening ABS Insulators to the Wire

Clamp both parallel wires, spaced appropriately, into a vise. Stretch the wires out straight and fasten their free ends to a stationary object. With the flame from a propane torch, heat one wire where you want a given insulator to be fastened. When the wire is hot enough to melt the ABS, press the wire into the insulator notch. The heated wire will melt its way to the bottom of the notch in the ABS. Hold the wire in this position for about 15 seconds to allow the thermoplastic to cool and reharden, trapping the wire. You can lessen the cooling time by pressing a damp rag to the insulator and wire. Repeat this operation until the line is completed. (Notes: This operation can be done with two hands, but it is much easier and faster with four hands. Don't overheat the wire; doing so may cause the thermoplastic to decompose and/or ignite.)

Lengthening the Feed Line's Service Life

The useful life of ladder line in windy areas can be extended by fastening a Dacron cord or braided-Dacron fishing-line tether (or tethers) to an insulator about halfway up the feed line. Pull the tether sideways to form an angle of about 45° and fasten it to a stationary object. The tether will keep the feed line from whipping around in the wind and avoid flexing that could eventually cause the wires to break. Two or three tethers, fastened to the same feed-line insulator and spread about 120° apart, work better than one.—*Richard L. Measures, AG6K, 6455 La Cumbre Rd, Somis, CA 93066*

THE BABY-BOTTLE BALUN

□ The merits of feeding a balanced antenna such as a Yagi, quad or dipole through some balancing device and coaxial cable have been convincingly demonstrated to me by Eggers in "Analysis of the Balun" (*QST*, Apr 1980, p 19). Ferrite-balun information in the *Radio Amateur's Handbook* (Newington: ARRL, 1982, p 19-7) and DeMaw's article on air-core baluns, "Simple Coreless Baluns" (*QST*, Oct 1980, p 47) led me to construct an air-core balun for my new triband quad antenna. [See also, "How to Build and Use Balun Transformers" (*QST*, Mar 1987, p 34).—Ed.]

The problem of protecting my homebuilt balun from adverse weather was troublesome (plastic food-storage boxes notwithstanding) until I discovered the answer at hand during a 3 AM feeding of my newborn son—his plastic baby bottle!

A 6-inch-long bottle holds a 10-trifilar-turn 1:1 balun on a 1-inch (outside diameter) form. A 4:1 balun of 10 bifilar turns neatly slips into a 4-inch bottle.

Construct the balun housing (see Fig 16) by drilling the bottle bottom for the SO-239 connector and its mounting bolts. Drill 1/8-inch holes on opposite sides of the bottle 1½ inches from the top, and mount binding posts in them with solder lugs on the inside of the bottle. Fit the screw-on collar with a 1½-inch-diameter plastic disk to which a small eyebolt is attached. Seal the bottle threads and seams at the binding posts and SO-239 with a liberal coating of silicone rubber to complete the project. Don't discard the nipple—it may prove useful as a pacifier sometime when you fail to bust a DX pileup!—*John P. King, KA2F, Little Silver, New Jersey*

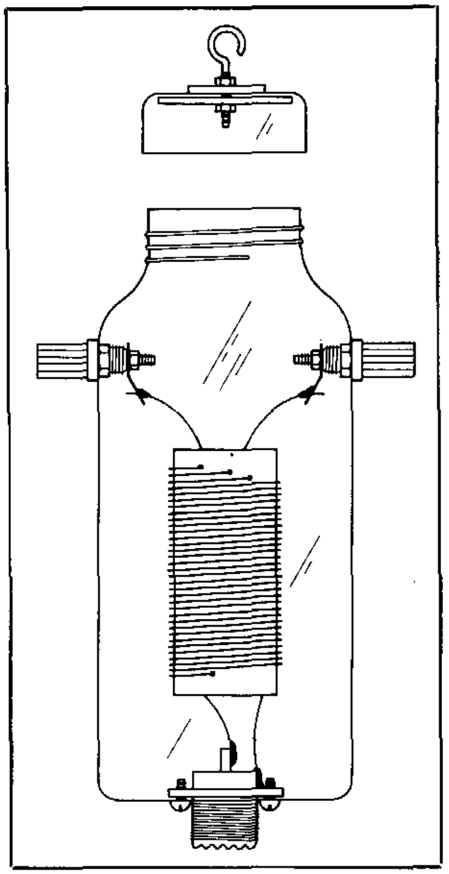


Fig 16—KA2F's baby-bottle balun housing.

ANTENNA PRUNING BY NUMBERS

☐ Because they are approximations, the well-known formulas for antenna length in feet (1005/f for a full wavelength, 468/f for a half wavelength, 234/f for a quarter wavelength, and so on, where f = frequency in megahertz) don't always provide on-the-nose results: Often, the lengths they provide end up a little on the long side. (Irregularities in installation, proximity of nearby objects and other factors account for some of the difference.) A coax-fed, 7.2-MHz, half-wave dipole cut to length per 468/f may show minimum SWR at, say, 7.1 MHz instead of the design frequency. This is where "cut and try" comes in: To lower the SWR at 7.2 MHz, you cut a few inches off each leg of the dipole (the same amount off each leg!) and measure the SWR again. Usually, several tries are needed to shorten the antenna enough to minimize SWR at the design frequency.

Here's the technique I use to minimize cut-and-try antenna pruning in cases where the antenna is too long to start with:

1) Install the antenna per the appropriate formula and determine the frequency at which it exhibits an SWR dip. (If the antenna is indeed too long, the minimum-SWR frequency will be somewhat lower than the design frequency.)

2) Substitute the minimum-SWR frequency for the design frequency in the antenna-length formula you used, and solve the equation. The difference between the answer and your antenna's installed length equals how much wire you must remove from the antenna to move its minimum-SWR point to the design frequency.

Example: Based on the equation 1005/f, a full-wave loop for 1.9 MHz should be 528.9 ft long, but measurements show that a loop of this length exhibits an SWR dip at, say, 1815 kHz. Per step 2 above, substituting 1815 kHz for the design frequency in the full-wave length formula (1005 ÷ 1.815) results in a length of 553.7 ft. Shortening the antenna by 24.8 ft (553.7 − 528.9) should move the SWR dip to 1.9 MHz.

Using this procedure to adjust several antennas, I have come very close, if not right on, to moving the SWR minimum to my design frequency with only one antenna-length adjustment.—*Wayne M. Sutherland, NQ7Q, PO Box 1721, Laramie, WY 82070*

AN A-FRAME MAST FOR HOME AND FIELD DAY

☐ Figs 17 through 20 detail an A-frame mast that has stood the Ozaukee Radio Club (ORC) in good stead for the past several years. It can be disassembled into short, lightweight pieces 10 feet or less in length, and is light enough for rooftop mounting. Including nylon guy ropes and hardware, it can be built for about $50—not bad for a 30- to 40-foot skyhook. This item first appeared in *The ORC Newsletter.*

Purchase 16 furring strips (8-foot 1 × 2s) from your favorite lumber store. Construction-grade lumber is fine, but make sure each piece is straight and has no major defects. A knot or two is okay, provided the knots are secure; no knot*holes* please!

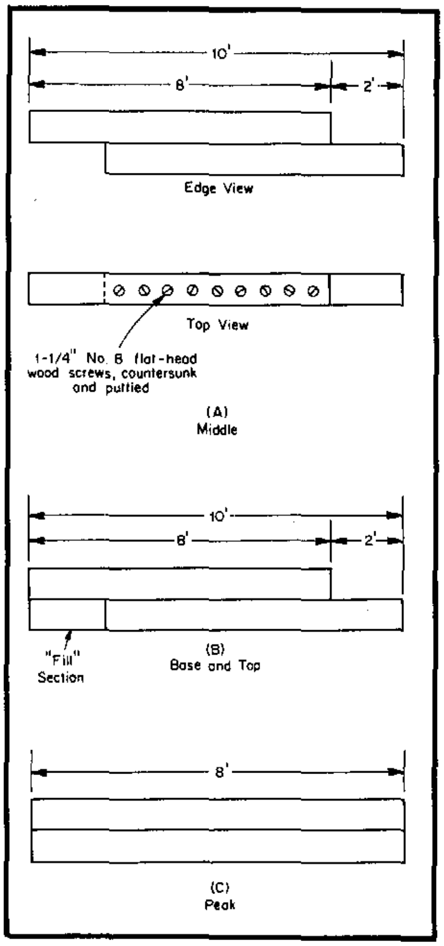


Fig 17—Stan Kaplan's A-frame mast consists of 1 × 2 furring strips, glue, wood screws and eyebolts. This drawing details the mast middle (A); base and top (B); and peak (C) sections.

Make the middle section (Fig 17A) as follows. Measure 2 feet from one end of two 8-foot furring strips and draw a line—perpendicular to the boards—across them. Run a bead of waterproof glue or construction adhesive (such as "Liquid Nails") along the 6-foot length of one of the marked boards, and overlap the 6-foot section of the second board as shown in Fig 17A. Two feet of each board should extend beyond the overlapped section. C-clamp the pieces together before proceeding.

Further fasten the two pieces together (while the glue is still wet) with countersunk no. 8 × 1¼-inch flat-head wood screws. (I prefer to drill a countersunk pilot hole in one board only, and then run in a screw. Splitting of the non-drilled board doesn't seem to be a problem, and this makes for a tight, permanent joint.) Put in a screw 1 inch from the end of the overlap, and every 6 inches thereafter. For maximum strength, alternate the sides that the screw enters; this is not critical to the integrity of the mast, however. Make sure the screw head is below the surface of the wood, and *putty the hole.* This will prevent rusting of the screw heads, which can ultimately lead to rotting of the adjacent wood.

To make the base and top sections (Fig 17B), follow a similar procedure, but "fill" one end of both of these assemblies with an additional 2-foot-long piece of 1 × 2, as shown. The base and top sections are identical; one end of each of these sections is a 2 × 2 square.

The peak section (Fig 17C) consists of two 8-foot lengths of 1 × 2 held together with glue and screws.

Next, drill ¼-inch-diameter holes, as shown in Fig 18, in both ends of all middle

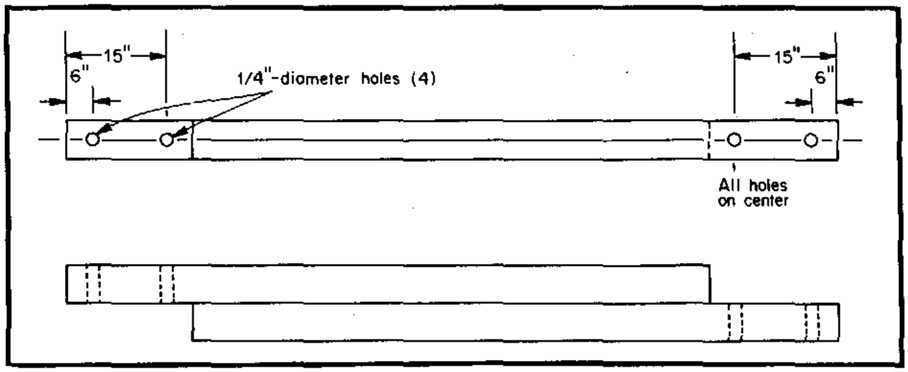


Fig 18—The mast-leg-section-fastener holes must be precisely located if the corresponding sections of both mast legs are to be interchangeable. Locate the fastener holes as shown here and described in the text.

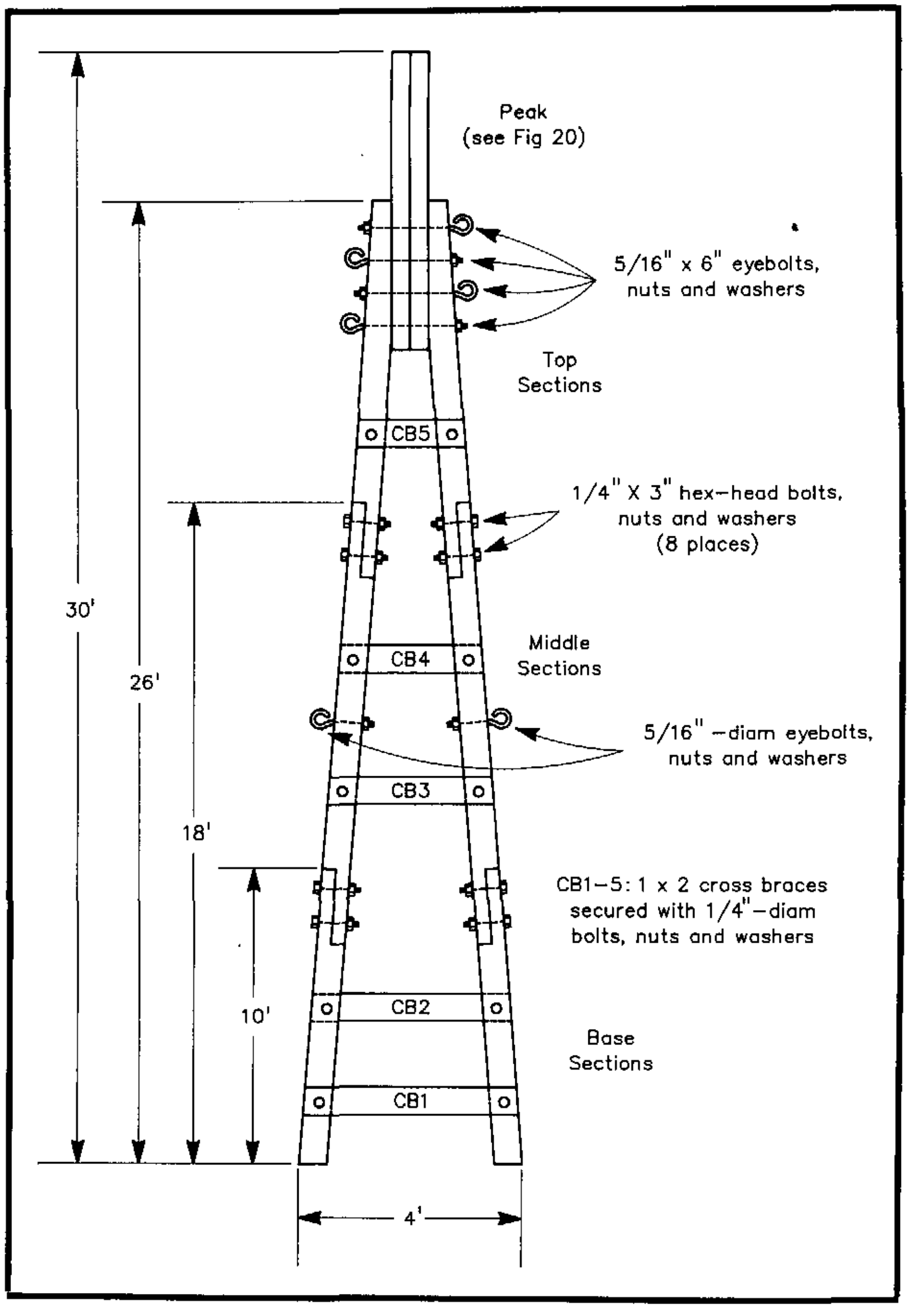


Fig 19—Plan view of the A-frame mast. Cross braces CB1 through CB5 consist of 1 × 2 stock cut to the appropriate length; install CB5 first as described in the text. This mast must be guyed at the top and middle.

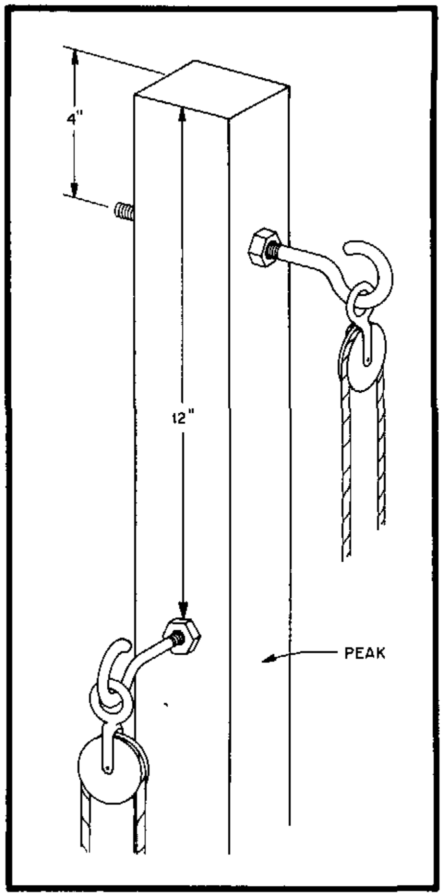


Fig 20—Pulley placement on the A-frame mast.

sections, and in the non-square ends of the top and bottom sections. Make sure these holes are placed *exactly* 6 and 15 inches from the section ends, *centered* in the board. If you locate and drill these holes carefully, corresponding mast-leg sections will be interchangeable. See Fig 19. Drill the top sections to pass, and then install, the four 6-inch-long, 5/16-inch-diameter eyebolts used to anchor the mast's four top guy lines. Install another pair of eyebolts in the center of the mast's middle sections. These anchor the mast's four middle guy lines.

Fig 19 also shows how the sections go together. The cross braces (CB1-CB5) are simply 1 × 2s cut to an appropriate length. Cut the bottommost one to 4 feet and install it first. This provides ample separation of the legs at the mast base.

Fig 20 shows two eyebolts that have been pried open to allow a pulley to be slipped in, and then closed again. Mount these pulley/eyebolt combinations at 90° angles to each other as shown, at least 8 inches apart vertically. You can use both eyebolts to anchor antennas, or an antenna on one and a Field Day flag on the other. (We hoist our ARRL flag with the second pulley when the wind isn't too high.)

The procedure I've described yields a 30-foot mast. You can add one more pair of middle sections to form a 38-foot mast. Don't go higher than this, however: This furring-strip construction method is not substantial enough for heights above 40 feet.

A word about guy lines. For safety's sake, don't skimp on guying. You can purchase a 50-foot length of top-quality nylon "sash cord," which has a breaking strength of about 600 pounds, for about $5. Nylon is good because it doesn't rot, stretch or lose strength when wet. Moreover, in my experience, nylon cord can last for two to three years of constant outdoor exposure, which is more than can be said for hemp and other types of natural-fiber ropes. You'll need at least 50 feet for each of the top four guys, and it's probably a good idea to use that length for the four middle guys.

Don't forget a halyard for each pulley—to hoist whatever you need to hoist. (Remember, for a 30-foot mast, each halyard must be over *60* feet long: The halyard must go up to the pulley and return so you can tie stuff on!) To prevent tangles, snake one end of each halyard between the mast cross braces. The other end of each halyard—to which you tie your dipole, random wire or whatever, must swing free of the mast. Don't forget to tie on all guy lines *and* string the halyards *before* you erect the mast.—*Stan Kaplan, WB9RQR, 11541 N Laguna Dr, Mequon, WI 53092-3119*

AK7M: When installing this (or any) mast, be certain that it and its associated antennas cannot fall across or otherwise touch power lines.

SPEED ANTENNA REPAIR WITH AN APEX TEMPLATE

☐ I have two inverted-V (drooping-dipole) antennas: one for 80 and one for 40 meters. They must be taken down periodically for maintenance. Before I took them down the first time, however, I decided to develop a means of ensuring that I could reinstall them at their original apex angles. Here's the technique I use. For clarity, I'll discuss the installation of *one* drooping-dipole antenna.

After the antenna is initially installed and pruned, and has proven to be satisfactory, stand about 50 feet away from the antenna and determine its apex angle by means of a clear-plastic protractor held at arm's length. Then, transfer that angle to a 5- × 8-inch file card. The apex of the trace should just touch the top border of the card. Cut off the card sections *above* the trace. On the remainder of the card, record details of the antenna's construction for future reference, such as installation date, height at apex, apex angle, length of each dipole leg, frequency of adjustment and so on.

If the antenna must be taken down later for maintenance, you can reinstall it, or build a new one, by referring to the information recorded on the card. Obtain the original apex angle by standing at the same spot as before and holding the cut card at arm's length. Even if you need to build the antenna again from scratch, the apex template can help you to duplicate the original antenna closely.—*Anthony De Vito, K2OV, Medford, NY*

MOUNT AN INVERTED V ABOVE YOUR BEAM ANTENNA

☐ Our lot is small and nearly filled with house, patio, walkways, driveway and so on. Thus, there is little choice in the selection of a low-band antenna—we put up a trapped, inverted V for the 40- and 80-meter bands. It was placed in the usual way, below our triband beam with the apex at about 45 ft. Lackluster performance prompted us to strive for improvement.

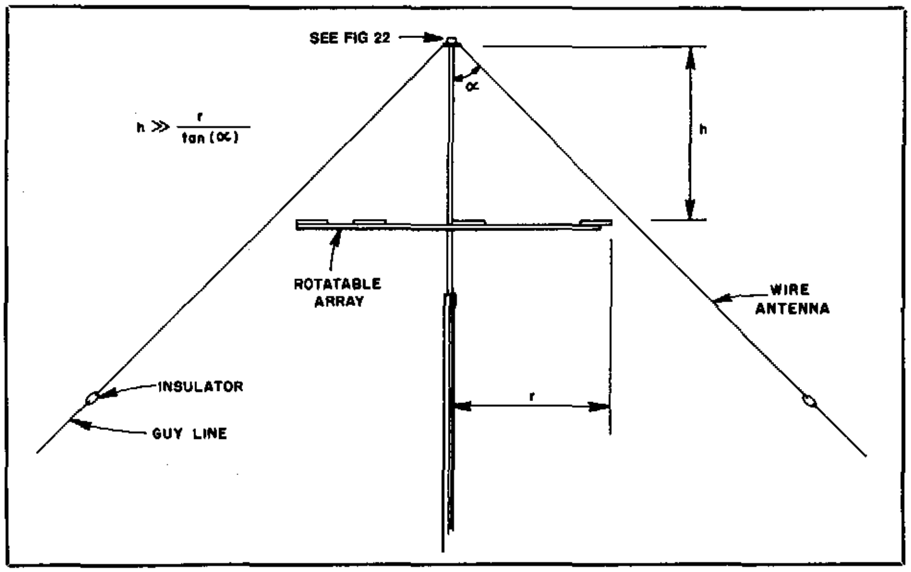
Why not mount the V above the beam? Any additional antenna height should help. A little trigonometry provided the following information: If the angle, α, between the antenna wires and the mast is at least 45°, and if the apex of the V is mounted above the center of the beam by at least the turning radius (plus a little extra height and/or angle to allow for wire droop and wind sway) there should always be clearance between the two antennas (see Fig 21).[8] The V-mast mount must allow the beam to rotate while the V antenna stands still.

A pair of Vs, oriented perpendicular to each other (see *QST*, Aug 1982, p 45; Nov 1970, p 17), would guy the extension mast quite nicely. Unfortunately for us, that setup would place one of the V legs right over our neighbor's house. We didn't even ask; instead, we angled the two legs somewhat, in the horizontal plane, and used a third guy (broken up into non-resonant lengths with insulators) to support the mast. Since we wanted to lift the 1¼ × 18-ft extension mast to the top of the beam mast manually, we chose lightweight aluminum tubing as the best material for the extension. Our feed point and the guy line is mounted on a PVC assembly that rotates freely inside the top of the extension mast (see Fig 22).

The end-support ropes are tied to convenient trees. The V apex is about 70 ft high (over $\lambda/4$ on 80 meters!), and the ends are about 30 ft high. The entire antenna is now above the house and the high-voltage ends are safely elevated. The rotatable array seems more stable in high winds because of the guyed extension mast, and beam performance is unaffected by the V antenna.

With this improvement, the 'BDN DX tally has soared from 16 to 37 countries on

Fig 21—Proper choice of the critical dimensions, h and α, allows one to successfully place a wire antenna above a rotatable array. (The turning radius of the rotatable array is the variable, r.) Allow some extra height for wire sag.



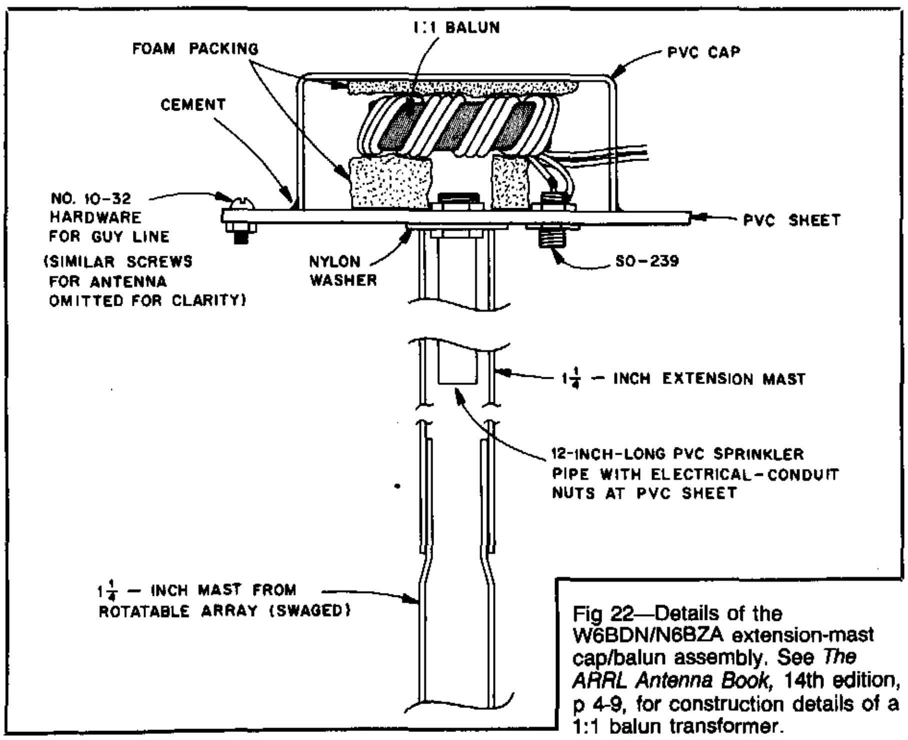


Fig 22—Details of the W6BDN/N6BZA extension-mast cap/balun assembly. See *The ARRL Antenna Book,* 14th edition, p 4-9, for construction details of a 1:1 balun transformer.

[8][Keep in mind that an apex angle of 90° is suggested as a minimum. The optimum apex angle for an inverted-V antenna is about 120°. If possible, make the extension mast shorter, and elevate the dipole ends more.—Ed.]

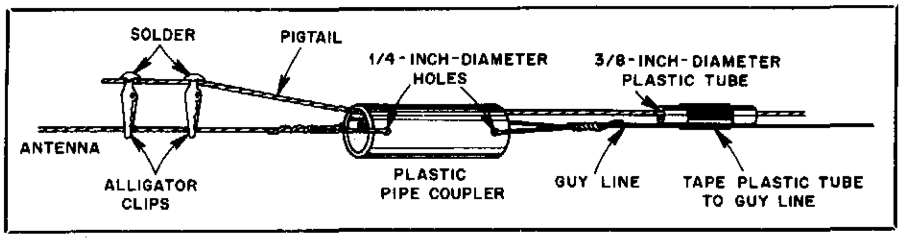


Fig 23—KA6UXR's movable wire-antenna extensions make antenna adjustment convenient.

75 meters! So try giving your inverted V a lift!—*Martin, W6BDN, and Daniel, N6BZA, Levin, Menlo Park, California*

"PIGTAILS" MAKE ANTENNA ADJUSTMENT EASY

□ Wire-dipole and inverted-V antennas often need trimming in place, even when carefully cut to calculated measurements. They are easy to shorten, but one may trim off too much, or the calculated length may be too short in the first place. Aside from the initial setup, resonance may drift over time for electrically obscure reasons. Antenna stretching is difficult!

After patching wire onto the ends of several antennas, I developed a versatile adjustment system. First, use only bare wire for the antenna, and cut it somewhat shorter than the calculated length. [Try 2-3%.—Ed.] Next, attach the antenna ends to the guy lines with an insulator made by drilling a plastic pipe coupler with ¼-inch holes for the antenna wire and guy (Fig 23). Make a pigtail (extension) from the same wire as the antenna and long enough to well exceed the calculated antenna length. [Again, 2-3%.—Ed.] (The antenna should be slightly too short without the pigtails, but slightly too long with them fully extended.) Solder a couple of alligator clips at 90° to each pigtail as shown in the figure. Insert the pigtails through the insulators and attach the alligator clips to the antenna ends.

The antenna resonant frequency is now easily adjusted by moving the pigtails along the antenna ends. The pigtails appear weather resistant, and they make antenna adjustment easy.—*Alex Comfort, MD, KA6UXR, Ventura, California*

ALTERNATIVE ANTENNA INSULATORS

□ I never seem to have any antenna insulators handy when I need them. Plexiglas is good, but cutting and drilling it is not always practical (on Field Day, for example).

If great strength is not required and the installation is temporary, I use Wiffle practice golf balls. They work well and are far less expensive than porcelain insulators. —*Bob Raffaele, W2XM, Albany, New York*

ELECTRIC-FENCE INSULATORS ALSO WORK FOR ANTENNAS

□ A good substitute for "egg" strain insulators can be found at almost any feed store that carries electric cattle fence supplies. Known as corner post insulators, they cost about $2 for a package of 10. I've used several for over a year, and weather does not seem to bother them.—*Frank A. Reed, Jr, W6PWQ, Langlois, Oregon*

MODIFIED WORK GLOVES

□ Did you ever suffer from frosty fingers during tower climbing and antenna work in cold weather? Not only is cold metal uncomfortable, but numb fingers make it easy to drop small parts. Gloves just seem to get in the way.

Try cutting the fingertips from a pair of inexpensive work gloves. (Cheap cotton gloves are fine.) Cut off the glove fingers midway between the first and second joints. Gloves modified in this way will protect your hands for grasping and holding while keeping your fingertips free for delicate work.—*Ray Lustig, KD3A, Washington, DC*

Editor's Note: Rus Healy, NJ2L, of the ARRL HQ staff, adds that cycling gloves can also serve this purpose. These gloves have padded leather palms and no fingers, and usually cost from $10 to $20. They are available from most bicycle shops and mail-order suppliers of cycling equipment.

MORE ON MODIFYING GLOVES FOR INCREASED DEXTERITY AND BETTER FEEL

□ When I read the suggestion about cutting the fingertips from work gloves it reminded me of something that may be of further value to your readers. As a police officer, I've learned a trick passed down from the old timers on the force: Cut a slit into the palm side of the glove's trigger finger to allow your trigger finger to slip out when you hold a pistol. Of course, this modification also allows the finger to be returned to the glove!

For doing antenna work in cold weather, a pair of gloves modified this way (perhaps the thumb and first finger of each glove, or at least these fingers on the glove for the dominant hand) would allow these fingers to be kept warm between instances of handling small parts.—*Harry Blesy, N9CQX, 7810 Central, River Forest, IL 60305*

MAKE A SNUG FIT FOR TELESCOPING TUBING

□ In many antenna projects, it is desirable to have two pieces of metal tubing with a snug telescoping fit. Quite often, I find that the tubing "just right" for such a job *isn't* just right because the slip joint is too loose. Here is a solution I developed while constructing a two-section, push-up antenna mast from 1½- and 1¼-inch thin-wall electrical conduit.

First, remove the cutting blade from a pipe cutter that is large enough to cut the tube you wish to form. Purchase or fabricate a new steel roller (Fig 24). The new

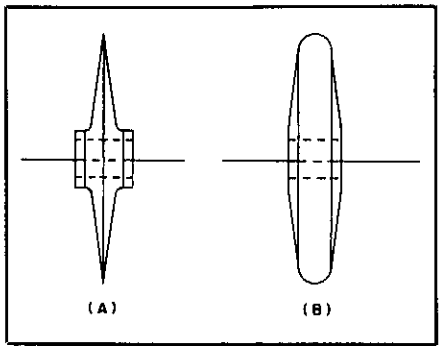


Fig 24—The original cutting roller (A) and a new forming roller (B) used to work tubing for a snug fit. (The exact shape of the new roller is not important. It should be ground from solid steel and have the same hub width and outer diameter as the cutting roller it replaces.)

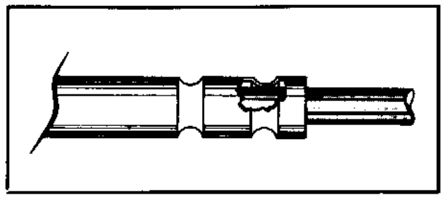


Fig 25—Use the new roller to groove the larger tube of a slip joint. This reduces the tube's inner diameter slightly to provide a snug fit with a smaller tube.

blade rolls a groove (Fig 25) in the pipe or tubing instead of cutting it. Install the new roller in the pipe cutter.

Use your new forming tool to tighten loose slip joints in this way: Place one tube inside the other and use the modified pipe cutter to roll two or more grooves in the larger tube. Continuously turn and slide the smaller tube to test the fit. Stop when there is a noticeable increase in the friction between the two tubes. (If you roll the groove too deeply, the two tubes will be permanently bonded together! This method is useful, however, for locking two pieces of tubing together.)

Application of this method is not limited to large tubes or thin-wall tubes. A similarly modified small tube cutter works with diameters as small as ¼ inch. I have used the larger tool to groove standard 1½-inch water pipe. No doubt it would work just as well with heavier (schedule 80) pipe. My own problem I encountered using this method has been an occasional split seam while I was experimenting to see how deeply I could groove welded tubing. —*J. M. Simms, N7BBC, Tucson, Arizona*

AN INEXPENSIVE CONCRETE CUTTER

☐ My problem wasn't a difficult one. All I needed was a 22-inch-square cut in concrete so my tower would fit along one side of my driveway. I checked into having someone cut the hole for me. Wow! Prices ranged from $80 to $105—so much for *that!* Renting a cutting machine looked a bit better: $55 plus the cost of the cutting blade. But jump up cow—that's more than half of what a rotator, or enough bags of concrete for the tower base, would cost!

The solution—simple *and* cheaper than the first two options—came to me one night as I lay in bed waiting for that sandman character. I realized that a concrete-cutting machine looks like a heavy-duty grass edger. Would a grass edger *work?* I tried it! I changed the oil on my edger (cost, $1.25) and installed a new belt ($4.17, and the edger needed it anyway). With the help of a 10-inch-diameter masonry-cutting blade ($3.88), water from the garden hose, two or three hours' worth of patience, sun, breaks and beer, the job was all but done. Then, with the help of a 16-pound sledge, I finally hit, er, pay dirt!—*Steve Grimminger, KG6KL, 6107 Whitewood, Lakewood, CA 90712*

WARNING ON USING A GRASS EDGER TO CUT CONCRETE

☐ After reading Steve Grimminger's "An Inexpensive Concrete Cutter," I feel obliged to sound a cautionary note concerning the use of a grass edger as a makeshift concrete saw. While most of us have at one time or another been guilty of misusing a tool, this is a misuse with potentially deadly consequences!

All nonmetallic cutting and grinding wheels and blades consist of an abrasive/bonding-agent composition. Used as intended, they are relatively safe and effective tools. Used improperly, they have a nasty habit of disintegrating and sending shrapnel in all directions, sometimes maiming, disfiguring or killing the saw operator. Having worked in the industrial maintenance field for many years, take my word for it that you don't want to become the target of an exploding abrasive saw blade!

While I know nothing of the construction (guards, rotational speed, and so on) of the edger used by KG6KL, one thing is sure: It wasn't designed to be used as a masonry saw. So, even though the cost of renting or buying a concrete saw for a small job may seem prohibitive, you can't put a price on your safety, or that of those around you. In the long run, it pays to use tools only for their intended purpose. —*Roger Burch, WF4N, Rt 3 Box 235, Central City, KY 42330*

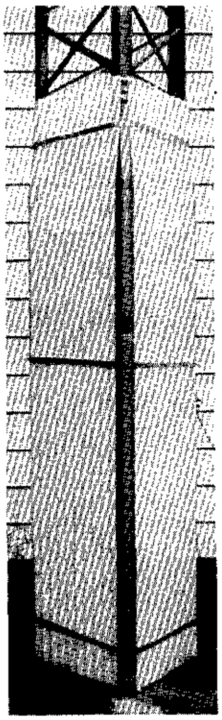
TOWER ANTI-CLIMBING SHIELDS

☐ Fig 26 shows a practical safety solution to discourage unwanted climbers on a tower: an anti-climbing shield. In this case, the shield is installed on a Rohn HDBX48 tower, but should be readily adaptable to other towers as well.

The shield consists of three 2 × 8-foot sheets of corrugated fiberglass roofing, metal plumbing straps and three bolts with wing nuts. The nuts and bolts hold the straps in place; the wing nuts face outward to allow removal when necessary.

This safety solution is inexpensive, uses readily available materials, and is pleasing to the eye. Most importantly, it removes the temptation for unwanted (usually young) visitors to climb the tower.—*Betty Oakberg, N4LZL, 105 Ulena Ln, Oak Ridge, TN 37830*

☐ Radio antennas fall under the category *attractive nuisance* because they form irresistible temptations to neighborhood adventurers. Virtually every tower, in town or not, needs some means of foiling unauthorized climbers. A simple and fairly inexpensive guard can be made from 1 × 10 or 1 × 12 rough-sawn spruce, as shown in Fig 27. This material is smooth-finished on one side and rough-finished on the other. Mount the lumber with its smooth side facing the inside of the tower; the rough sides of the boards should face outward to afford splintery discouragement to would-be steeplejacks. Attach each board to the tower with a pair of U bolts, one bolt on each end of each board.



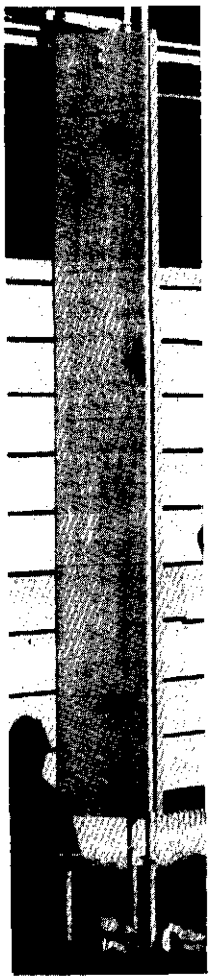


Fig 26—(left) Betty Oakberg uses this fiberglass-roofing guard to keep unwanted climbers off her tower. Betty's son Frank installed this guard in just a few minutes.

Fig 27—(above right) Robert Brown's anti-climbing tower guard consists of 1 × 10 spruce lumber, paint, nuts and U bolts. See text.

The guard shown in Fig 27 cost me around $25 to build. Such a guard can be constructed in one afternoon, and, if painted to match its background, is unobtrusive to neighbors (most of whom probably tend to regard antennas less as things of beauty than radio amateurs generally do). Incidentally, spruce must be painted for weather resistance; protected in this way, it can last for decades.—*Robert E. Brown, WA9MRU, 309 S Minnesota Ave, Morton, IL 61550*

UNIVERSAL JOINTS PREVENT ANTENNA-MAST BINDING

☐ Aligning a rotator with a mast so that no binding occurs when the mast turns can be frustrating and time-consuming. Even a slight misalignment can cause the mast to bind in the tower thrust bearing, possibly causing damage to the rotator motor.

I solved this alignment problem by using two universal joints (U joints) to couple the rotator to the mast (Fig 28). The universal joints are installed so that their pivot directions are offset by 90°. The U joints permit the mast to remain vertical in the tower while accommodating considerable misalignment between the rotator and mast.

The U joints shown in Fig 28 are from a NATCO multiple boring machine and are

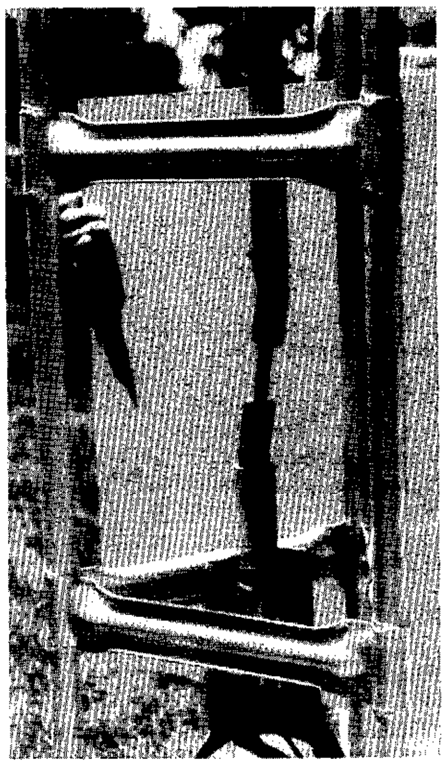


Fig 28—Jay Lowe uses two universal joints to correct misalignment between his rotator and antenna mast. *(photo by Jack McCann, KDØSV)*

approximately 7/8 inch in diameter. Similar U joints, used in farm machinery and power take-off units, are available at farm-implement or hardware stores for $2 or less. A short length of 1-inch-diameter pipe, drilled to pass the rotator-to-joint bolt, couples the rotator to the lower U joint; the antenna mast is coupled to the upper U joint in this way. The U joints are coupled by a metal rod of suitable diameter and length.—*Jay Lowe, KA0RKR, 3901 Missouri, Joplin, MO 64801*

ITS' A STANDOFF

☐ Here's a versatile, low-cost tower side mount for UHF and VHF vertical antennas (Fig 29). You can find all of the material necessary to build it—a 10-foot length of ¾-inch-diameter, thin-walled steel electrical conduit and two stainless-steel hose clamps—at any well-stocked hardware store. My standoff cost me a total of $5.50.

Make the standoff's two included angles (Θ in Fig 29) 90° or more to keep the horizontal part of the conduit from trapping water. (If you ask nicely, the hardware-store staff may even bend the conduit for you.) Put a plastic cap on the upper pipe end to keep water out. Also, be sure to make the standoff's lower vertical portion at least 36 inches long so you can clamp it inside your tower. Other than offering these two suggestions, I leave the standoff's construction particulars up to you.

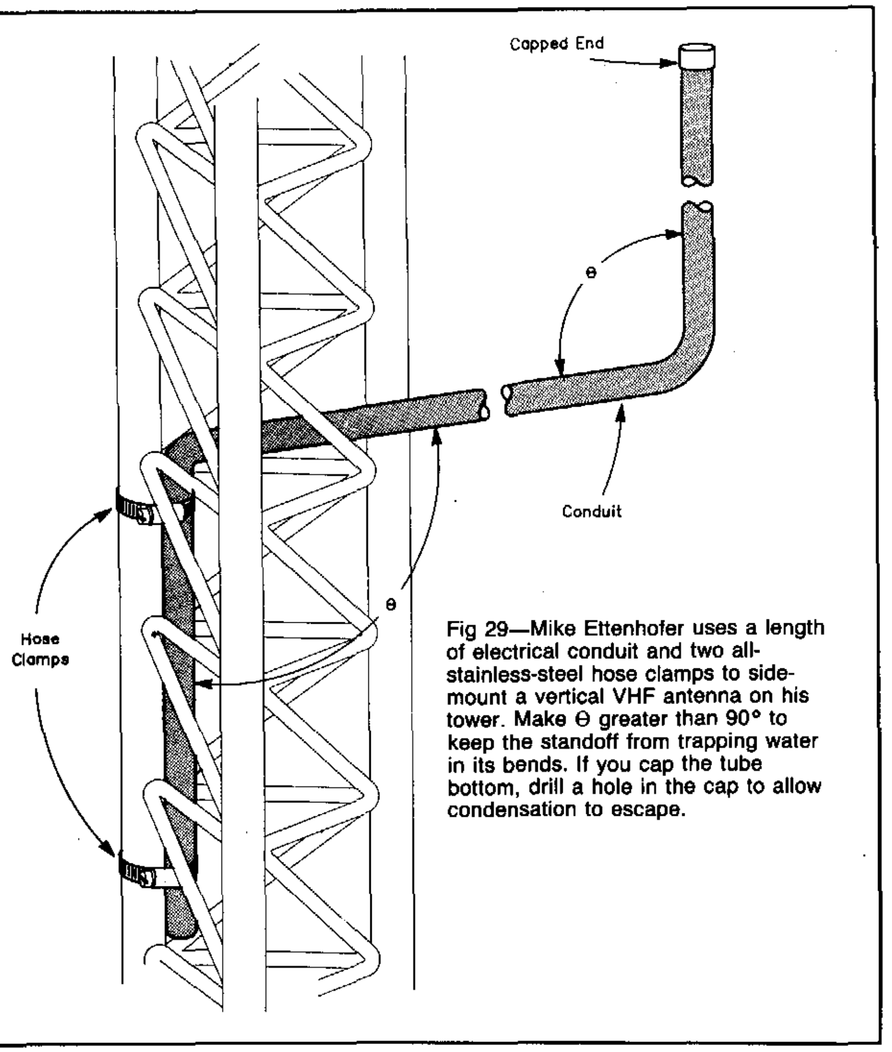


Fig 29—Mike Ettenhofer uses a length of electrical conduit and two all-stainless-steel hose clamps to side-mount a vertical VHF antenna on his tower. Make Θ greater than 90° to keep the standoff from trapping water in its bends. If you cap the tube bottom, drill a hole in the cap to allow condensation to escape.

Experiment with the standoff at ground level to find a mechanically sound mounting method. On my Rohn 25 tower, passing the conduit through a rung opening and nesting the horizontal portion in the lower crotch of a diagonal brace gave the most stability.

Once you've determined how to mount your standoff, use the hose clamps to fasten the standoff's 36-inch vertical position to the inside of the back tower leg. (Be sure to position the clamp's tightening screw and clamp-band tail *inside* the tower leg: Metal protruding outside the leg could be dangerous to someone climbing the tower.)

Next, mount your antenna and feed line to the standoff. Once you've done this, adjust the standoff's bends so that everything is square with the world (unless you're not bothered by a nonvertical vertical antenna!). If everything passes inspection, mount the standoff/antenna combination in its final position on the tower.—*Mike Ettenhofer, WB8VDC, Ann Arbor, Michigan*

PVC-PIPE GUY PROTECTORS

☐ I agree with Earl Anderson ("Wrap Your Guy Lines," Hints and Kinks, *QST*, Oct 1986, p 48) that guy cables should be visible. I prefer not to use pipe-insulating sleeves for guy protectors, though: The sleeves' foam material absorbs water and keeps a wet surface in contact with each protected guy for prolonged periods, speeding guy rusting.

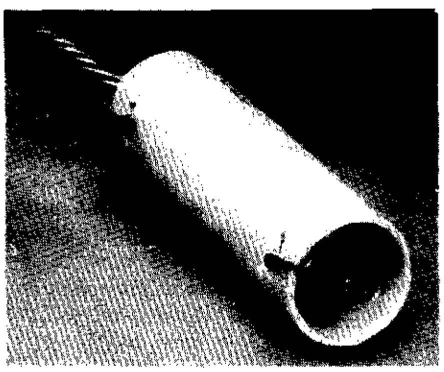


Fig 30—Elliott Hood holds his PVC-pipe protectors in place with steel wire.

Here are two alternative solutions. K-Mart and other stores carry slip-over shower-curtain rod covers that can easily be slipped over existing guys; these covers are available in a number of highly visible colors. They are made of a plastic that brittles after four or five years of exposure to sunlight.

A better solution that's most easily added to yet-to-be installed guys, or to guys that can be temporarily detached at ground level, is ¾-inch-ID, white-PVC pipe. Purchase a 20-foot section of pipe—mine cost about $4—at your local plumbing supply house and cut it to size (5-foot lengths are suitable). Fig 30 shows how steel cross wires can be used to attach the pipe to the guys. I used 0.041-inch, stainless-steel, safety-lock wire for this purpose; a single guy-wire strand may also work. (You may be able to install PVC-pipe guy sleeves over undetachable guys by slitting the pipe lengthwise with a table saw. Properly placed, the cross wires can serve to close the resultant slits.)

After you've twisted the cross wires enough to give the protector a sufficiently tight grip on the guy cable, position the protector on the guy as appropriate. (Leave the twisted cross-wire ends long enough so that they can be bent back inside the PVC tube.)

If you intend to paint your protectors, I suggest roughening the pipe's outer surface slightly with PVC-pipe solvent or sandpaper prior to painting.—*Elliott Hood, NE9I, 5627 Danbury Dr, South Bend, IN 46614*

BEWARE YOUR CRANK-UP, TILT-OVER TOWER!

☐ We've all heard stories of crank-up towers. Here's one that demonstrates potential danger standing in thousands of backyards.

Hurricane Gloria blew through Connecticut in 1985. After coming home from the office just before the storm, I disconnected and walked my 48-ft vertical antenna down in a minute or less. Then I cranked my 60-ft tower down to 40 ft—a level at which the Yagi mounted atop the tower was just above the big maple that has grown up under it. (The tower had not been lowered for six years; now that the tree was much larger than it had been when the tower was installed, lowering the antenna would have to involve alternately tilting the tower and lowering its top section in steps to keep the Yagi clear of the maple while minimizing the overhung load on the tower pivot.)

Initially, I cranked down the top tower section. When the time came to tilt the tower, I called my wife, Shirley, to manage the winch as a check against my pulling the tower bottom away from the post too quickly. Frustratingly, the tower would not pivot! Getting down closer to the ground, I got a grip on the tower base and pulled hard. Although the tower swung out into position, I did not see what had resisted the pivoting.

I then assumed the cranking-over task, with Shirley guiding cables and latch-lock pull ropes, and the 160-m antenna wire, away from tree branches on either side of the tower. As I cranked, I could not believe my eyes as the bottom of the tower moved slowly *sideways*—perhaps as much as a foot! I locked the winch and grabbed the bottom of the tower to halt its motion. The tower seemed to be *barely* attached to the top of the ground post at the hinge. I secured the bottom end of the tower with a line and decided to investigate this strange behavior.

The tower has a 10 × 10-inch steel plate welded into it; this plate is bolted flat against the hinge plate on the ground post. The hinge consists partly of a 4-inch-long heavy steel tube welded horizontally to the top of the 8-inch-diam ground post. Similar tubes on either side of, and aligned with, this tube are welded to the hinge plate that bolts to the tower. I remembered that four 1-inch bolts had secured the tower to the hinge plate. Could these have come loose in six years of windstorms? No—inspection showed that they were unchanged.

As I continued to inspect, I was shocked and literally terrified to see *daylight* through one of the two joints in the hinge through which the hinge pin should have been visible. *The heavy steel tower, canted 40° from horizontal, half extended, with Yagi and rotator heavily stressing the pivot, was right over my head and held in place only by the remaining end of the hinge pin*—and *that* had started to twist off when the tower moved sideways!

I locked the winch and ran out from beneath the tower. There it stood. Which was safer: Bringing the tower down or putting it back up? I went indoors to think. The hinge pin was equipped with a dowel pin to keep the hinge pin from sliding out of the hinge tubes; that dowel forced the hinge pin to rotate with the tower. It was between the dowel pin and the center hinge tube that the hinge pin had sheared—apparently when I pulled the tower bottom away from the ground post. The hinge pin had apparently been frozen by rust in the center hinge tube (stationary on the ground post). If the other end of the pin had also sheared, the tower—with rotator and beam—would have come loose from the ground post, lifting me into the sky before falling off the post, and likely onto both of us. (Shirley would have been under the tower at the tilt-over crank at the time.)

Because the other end of the hinge pin had not sheared, I reasoned that, contrary to what the tower manufacturer had intended, the pin had turned in the other end tube (welded to the tower) and was probably undamaged aside from being bent when the tower moved sideways. It seemed that cranking the tower back to vertical and leaving it extended to 40 ft (to allow it to clear the tree) rather than cranking it to horizontal with the top section and Yagi extended—a much greater load on the hinge—would be much safer.

When the rain let up, I chained the tower to the top of the ground post, drilled out the end of the broken hinge pin, put a jack under the bottom end of the tower to take the weight off the broken hinge pin, and drove the broken pin out. At the same time, I replaced the old hinge pin with a *stainless steel* pin—which the tower manufacturer should have used in the first place.

I would like to promulgate some words of experience to fellow hams who own tilt-over towers: Lubricate the hinge pin as best you can. Painting it to keep the rain out is inadequate in the long run. If you have an old tower, beware of rust freezing the hinge pin at points you cannot see. If the pin freezes, tilting the tower can easily shear off the pin and drop the whole tower *on you*. Rock the tower slightly before cranking it over, and be certain you understand which part of the hinge pin should rotate in relation to the tower. Don't be satisfied only with the fact that the pin appears to turn!

We all know that crank-ups are dangerous. (A local VHFer had both wrists broken when he reached to stop a flailing tower crank.) The hinge pin is an inobvious source of danger. Replacing it with a stainless-steel pin is mighty good insurance.—*Ned Raub, W1RAN, 12 Deerfield Rd, Waterford, CT 06385*

SIMPLE AND INEXPENSIVE MOTOR FOR CRANK-UP TOWERS

☐ Cranking up a tower by hand is a chore, and commercial motor drives are expensive. A cast-off power unit from a chain-driven garage-door opener can do the job inexpensively. In my case, I welded a bicycle sprocket to the winch assembly on my tower and coupled a Perma Power ® motor to the sprocket by means of a bicycle chain. With the 6-inch sprocket I installed, the motor raises the tower in seven minutes. A smaller sprocket would raise the tower faster, and might be a better choice.—*John R. Kersten, WØNY, Brainerd, Minnesota*

A TOWER THRUST-BEARING COVER

☐ Fig 31 is a drawing of a Volkswagen transaxle boot. The part is available at local Volkswagen dealers and it serves well to protect rotator thrust bearings from the weather. On a vehicle, the boot is installed by wrapping it around the transaxle and fastening it closed with screws. Thus, it can be easily installed on an existing tower assembly with a minimum effort.—*Robert Powell, KB6FNP, Lakewood, California*

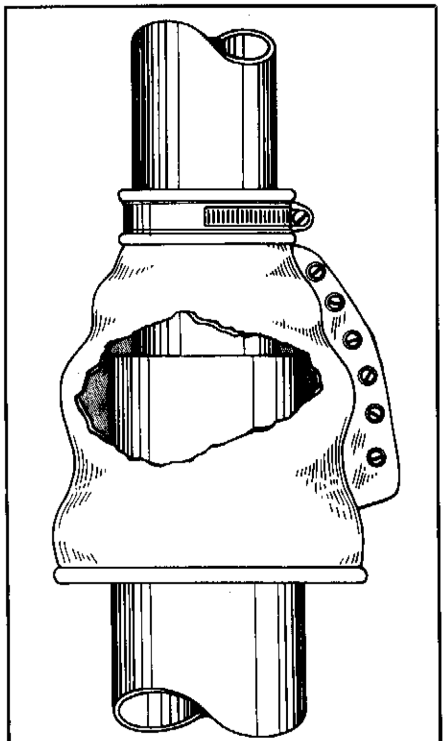


Fig 31—KB6FNP suggests a Volkswagen transaxle boot to cover and protect a rotator thrust bearing.

Editor's Note: No doubt similar fittings are readily available at junk yards as well. Use your ingenuity when fitting the boot to the mast. If the mast is smaller than the boot opening, wrap the mast with sheet rubber to increase its diameter. If the mast is too large, use sheet rubber to pad between the mating boot surfaces. Sheet rubber can be salvaged from tire shops that service commercial trucks. Heavy trucks still use tires with inner tubes—the discarded tubes are a good source of rubber (about 3/32-inch thick).

Frugal readers may wish to fabricate a custom thrust-bearing boot by wrapping the mast/bearing with sheet rubber. Cut a section of rubber large enough to cover the bearing and wrap it around the mast. Secure the seam(s) with no. 6 or no. 8 hardware. Use a hose clamp to fasten the assembly in place on the mast and seal the assembly with RTV.

NOISE-SUPPRESSION AND BRAKE-CONTROL MODIFICATIONS FOR THE HY-GAIN HDR 300 ANTENNA ROTATOR

☐ After installing my Hy-Gain® HDR 300 rotator, I observed that a new noise source had appeared on 6 meters. I traced the noise to the HDR 300: The noise emanated from the ribbon cable associated with the rotator's multiplexed LED display! I solved this problem by wrapping aluminum foil around the ribbon cable and wrapping bare wire around the foil. After taping the foil-wire sleeve in place and dressing it to keep it out of contact with other HDR 300 wiring, I grounded the sleeve wire to common on both of the HDR 300's PC boards. RFI problem solved!

The second HDR 300 problem I solved was one of my own doing: Sometimes, I left the brake off with the rotator turned on. Because my antenna stack is large enough to windmill in a strong wind, I worried that damage might occur if I left it unbraked. This problem can be solved as follows:

Replace the HDR 300's stock SPDT RIGHT/LEFT switch with a 3PDT, center-off unit. Wire this switch as shown in Fig 32. One of the additional two poles goes between the HDR 300's POWER and BRAKE switches; the third pole serves as part of added brake-control circuitry (also shown in Fig 32).

Whenever S1 (RIGHT/LEFT) is thrown and the rotator BRAKE switch is on, the voltage at the secondary of T1 is rectified, charging the 100-µF capacitor and turning on Q1. Q1 actuates K1. When S1 is released, the rotating motor stops and the path between U1 and Q1's base circuitry is cut by S1C. Q1, K1 and the rotator brake solenoid stay on, however, because of the charge remaining on the 100-µF capacitor. When the capacitor discharges sufficiently through the 100-kΩ resistor to turn off Q1, K1A opens, cutting ac mains current to the brake solenoid and engaging the brake.

With the RC values shown in Fig 32, the delay between opening the RIGHT/LEFT or BRAKE switch and engagement of the brake is about 7 seconds. This allows the rotating antenna stack to coast to a stop before the brake engages.—*Paul D'Anneo, K6UZK, 6126 Ocean View Dr, Oakland, CA 94618*

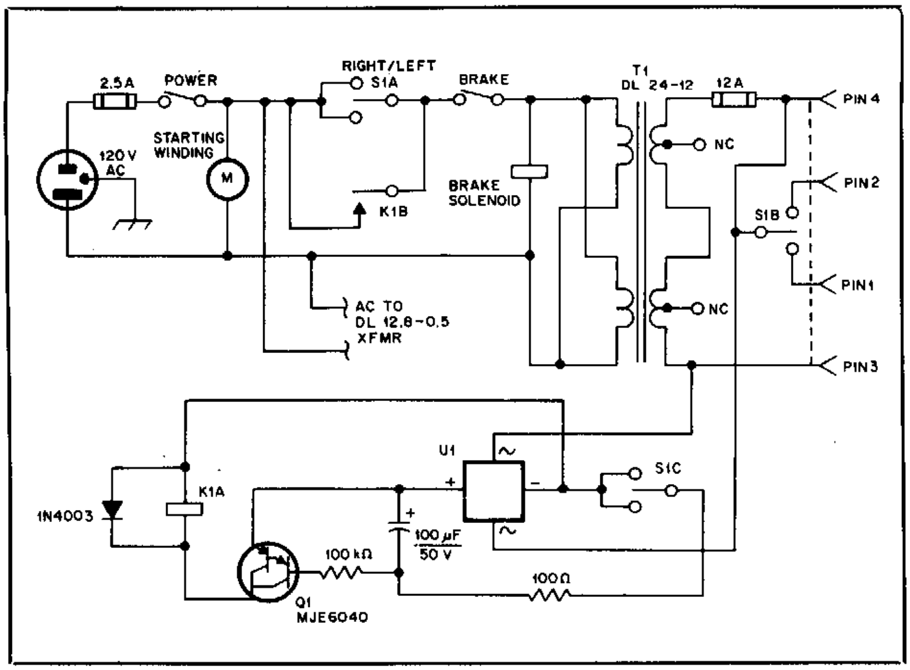


Fig 32—Delayed automatic braking for the Hy-Gain HDR 300 rotator. T1 is shown wired for 120 V ac. K1 is a 28-V dc relay; S1 is a 3PDT, center-off toggle rated for 120 V ac service; U1 is a 4 A, 100-PIV bridge rectifier. Resistors are ½-W carbon film.

SMOOTHER CONTROL WITH THE U-100 ROTATOR

☐ The Alliance U-100 rotator, popular among satellite enthusiasts as an elevation rotator, can be positioned by its stock controller in 10° steps—acceptable resolution for wide-beamwidth antennas, but somewhat coarser than optimum for most 70- and 24-cm antenna arrays. Many satellite-active U-100 users modify their controllers for finer resolution by installing a double-pole, normally open push button in the control wires connected to the controller's terminals 1 and 2. Using this feature requires that the push button be held until the desired elevation is achieved—an inconvenience to U-100 users because it's a comedown from the controller's standard operation, which automatically moves the rotator to the heading you preset.

Fig 33 shows how to add an additional switch that allows you to toggle between position-vernier and set-and-seek operation with the U-100. Set to **NORMAL**, S2 (**MODE**) selects the U-100's standard set-and-seek operation. Setting S2 to **VERNIER** selects rotator control by means of push button S1, **VERNIER DRIVE**. Use the normal mode to position your U-100 to the 10° increment nearest the heading (elevation) you need. Then select the vernier mode and use S1 to fine-position the rotator to where you want it.

When S2 is set to **VERNIER** and the indicator is between clicks, the controller's pilot lamp lights more brightly than normal. I considered adding a switch to prevent lamp burnout, but after using the modified controller for over a year I still haven't had to replace the bulb.—*Dave Guimont, WB6LLO, 5030 July St, San Diego, CA 92110*

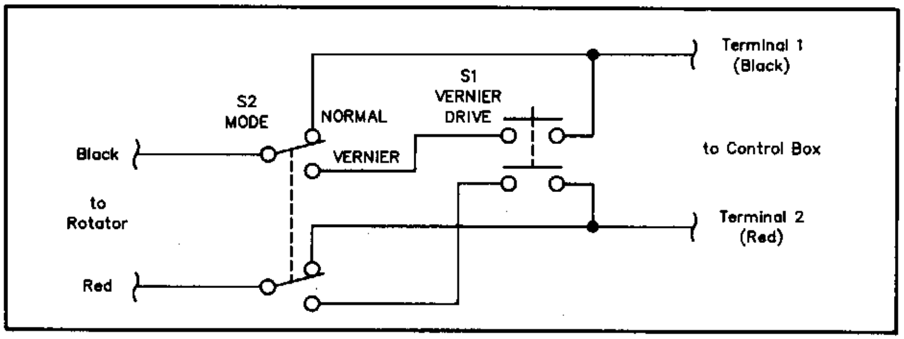


Fig 33—Dave Guimont adds switch-selectable position-vernier operation to his Alliance U-100 rotator by installing two switches—a double-pole push button (S1) and a DPDT toggle (S2).

VACUUM TUGS LEADER ROPE THROUGH CONDUIT

☐ I run the wires to my tower underground through a conduit. Because the conduit is over 100 feet long, pulling the first of several wires or ropes through the conduit was hard—until I discovered an easier way. I tape my shop vacuum's hose to one end of the conduit and drop a lightweight rope, with a sock tied to it, in the other end. The vacuum pulls the sock and rope through the conduit. When the sock plugs the vacuum hose, the vacuum motor strains and runs at a different pitch, signaling me to turn off the vacuum.

This has worked for me for many years and has saved hours of frustration. I hope that it will help others.—*William Jacobs, WA8YCG, Route 1, Box 212, Independence, WV 26374*

EASY BEAM-ANTENNA CALIBRATION

□ Now that the winter storms have passed us by, and the spring thundershowers are on the move, do you ever wonder if your beam antennas are still pointing in the right direction? Many articles have been written on this subject, but there is a very easy way to check antenna heading.

Aim the beam north or south and check your daily newspaper or weather bureau for the exact time of local sunrise and sunset. Using simple arithmetic, figure the time that is exactly halfway between sunrise and sunset. This will be "high" noon, local time (the time when the sun is directly overhead). Any shadow cast at this time will point to either the North or South Pole, depending on your latitude and the position of the sun.

While the indication can be off slightly, most of us are using 3- or 4-element Yagi antennas with a 30° to 40° beamwidth. This method provides ample accuracy for such situations.—*Ed Karl, KØKL, Manchester, Missouri*

DRESS UP YOUR ANTENNA FARM FOR THE HOLIDAYS

□ For the past two years, I've used my 45-ft antenna tower to create a Christmas tree out of lights. It's a simple project that brings a lot of positive comments from the neighborhood.

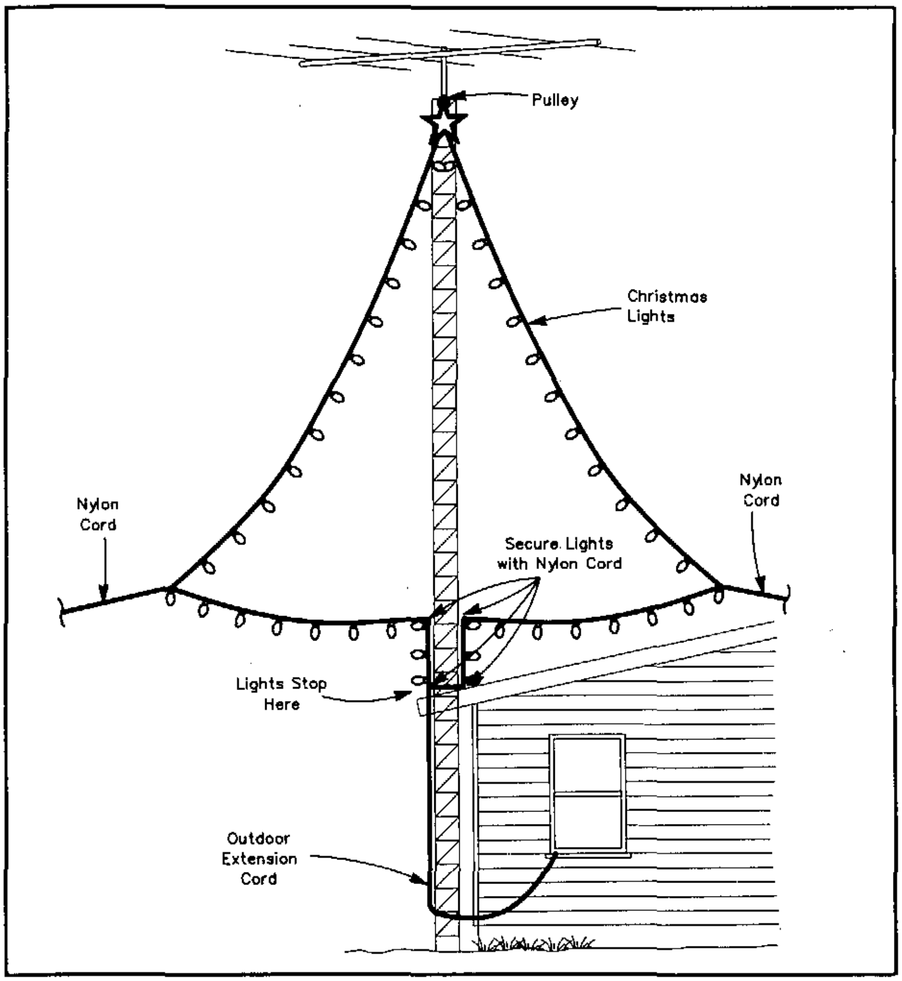


Fig 34—Bob Wertz uses his antenna tower and colored lights to transmit a warm holiday message to hams and nonhams alike.

See Fig 34. With one light string hanging down each side of the tower, I shape the tree by using nylon cord to tie back the strings above rooftop level.

At night, the light tree can be seen from a long way off. I have also thought of making the tower into a giant candy cane, or a big arrow pointing to the heavens.—*Bob Wertz, NF7E, Flagstaff, Arizona*

TRY A SIGMA BEAM ON YOUR SMALL LOT!

[Editor's Note: An article describing JG1UNE's Sigma beam appeared in the Feb 1980 issue (p 280) of Japan's *CQ Ham Radio* magazine.]

☐ A full-size beam antenna is great—if you have the space for one. Many of us, however, live in apartments and just don't have that space. Figs 35 through 38 describe the results of my experiments with a miniaturized beam antenna in a Σ (sigma) configuration. My antenna is mounted at the top of a tower, about 15 m above the building roof.

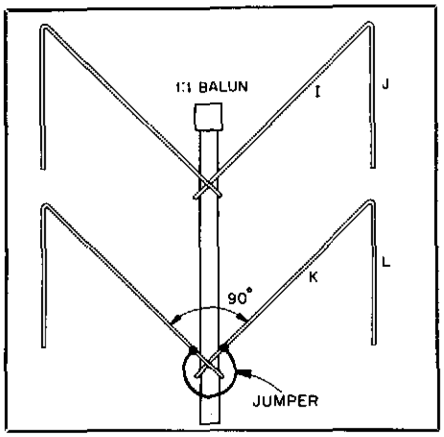


Fig 35—JG1UNE's Sigma beam. Tube sizes and lengths appear in Table 2.

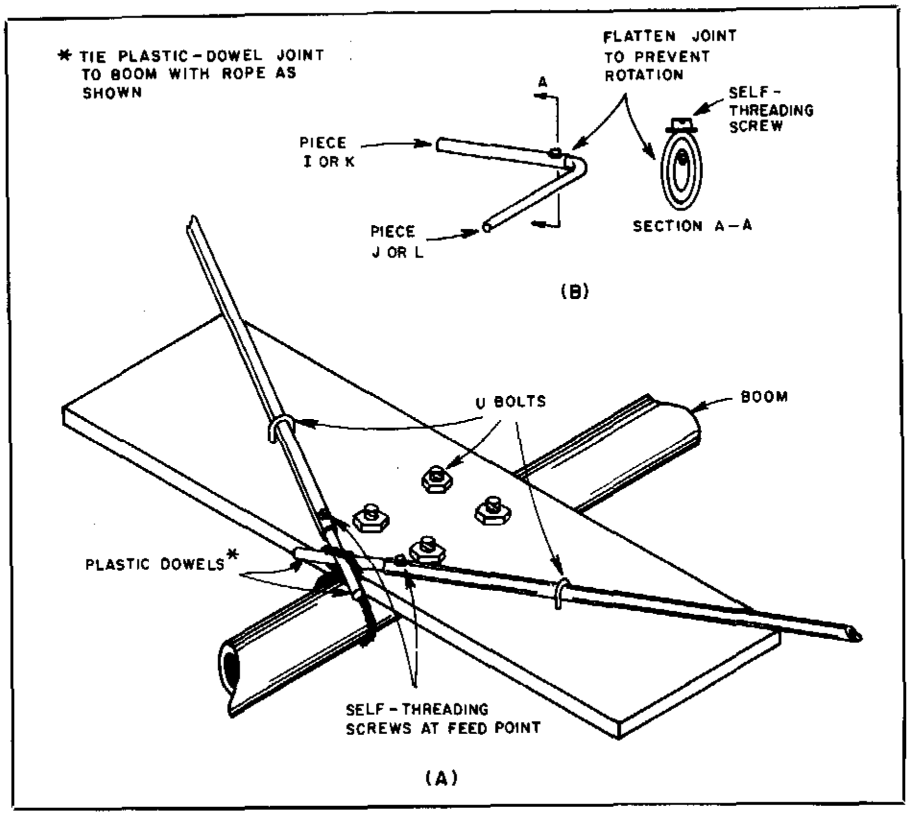


Fig 37—Details of the mounting-plate assembly (A) and element joint (B). Flatten the joint slightly after assembly to prevent rotation.

The Sigma beam is a compact antenna shaped like the Greek letter sigma; it is a V beam with the element ends bent to reduce its size. A list of materials for a 28-MHz antenna, constructed of aluminum tubing, appears in Table 2. Be sure to flatten the tube joints *(after assembly!)* to keep the element ends from rotating (see Fig 37B and Section A-A).

My beam was a little heavy when all elements were made of metal tubing. Also, the tube joints are weak points, which are threatened by strong winds. The antenna weight can be reduced, and construction simplified, if we use straight bamboo or fiberglass spreaders to support wire elements. Two such antennas are shown in Fig 38. [This also eliminates any overlap problems where the element centers cross at the boom. Use nylon twine or some other insulating material for the lines at the element ends.—Ed.]

An SWR plot of my Sigma beam compares well with that of a full-size, two-element V beam. The two curves are nearly identical, with the SWR less than 1.7:1 from 28 to 29 MHz. The folded element

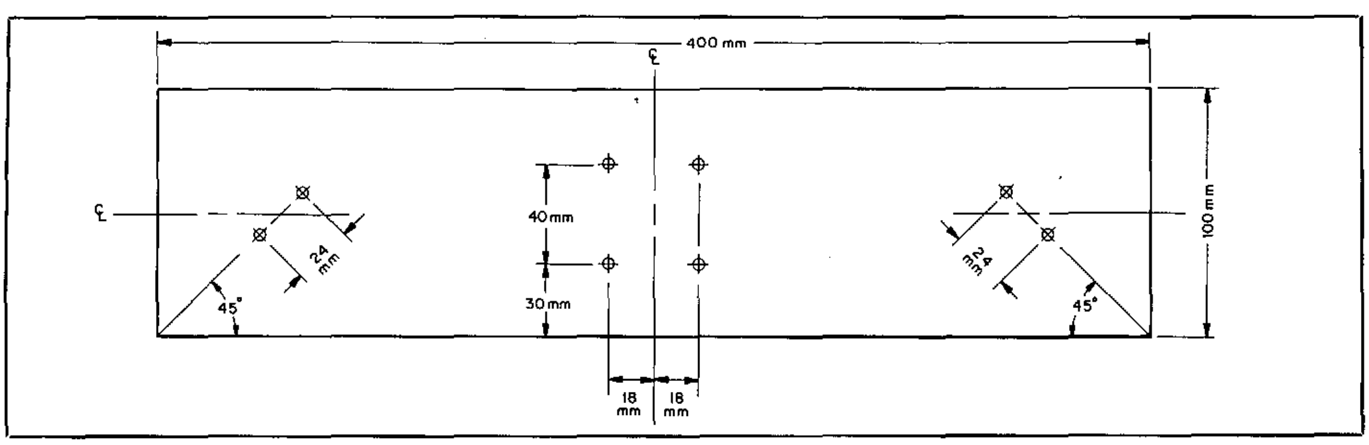


Fig 36—Drilling pattern for the mounting plate. [Dimensions are in mm; inches = mm × 0.0394. Size holes and adjust locations to fit locally available hardware. The mounting plate may be hardwood rather than plastic, or plastic sleeves may be used to insulate the elements from a metal plate if a plastic plate is not available.—Ed.]

Table 2

Construction Materials for the JG1UNE Sigma Beam

Aluminum tubing:
- 2 pcs (I) —12 mm × 1.6 m†
- 2 pcs (K) —12 mm × 1.7 m
- 2 pcs (J) — 9 mm × 0.83 m
- 2 pcs (L) — 9 mm × 0.88 m

Boom: 32 mm × 1.0 m
Plastic dowel: 6 mm × 1.0 m
Acrylic plates: 2 pcs—100 mm × 400 mm × 5 mm
U bolts:
- 4 pcs—12 mm diameter
- 4 pcs—32 mm diameter

Self-threading screws: 6 pcs
Rope: 1.5 m

†Letters in parentheses are part identifiers as shown in Figs 35 and 38.
Inches = mm × 0.0394; feet = m × 3.2808.

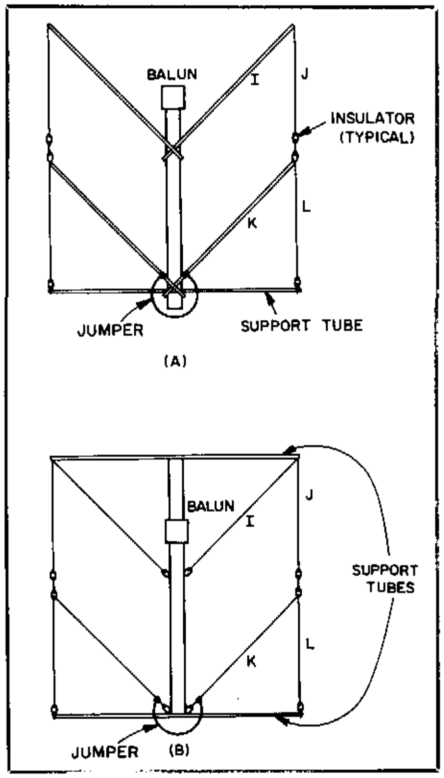


Fig 38—Variations on the Sigma beam that increase strength by reducing weight and mechanical complexity. Wire is used for the element end sections at A, while all conductors are wire at B. Wire lengths are the same as the tube lengths given in Table 2.

ends seem to have little effect on the antenna impedance. My Sigma beam is fed through a homebuilt 1:1 balun.

I have contacted many Americans and Europeans while using this antenna and 40 W of output power. The V antenna has slight gain over a dipole, and I feel that the Sigma beam provides the performance of a V beam in a very compact package. There's no need to give up DXing because you live in an apartment. Try a Sigma beam!—*Aki Kogure, JG1UNE, Tokyo, Japan*

A DOUBLE HALF-WAVE LOOP ANTENNA

[Here is some modern information on an interesting antenna that has been in *The ARRL Antenna Book* for years.—Ed.]

☐ Fig 39 shows an effective, easy to build and inexpensive HF antenna. The plans are from an old issue of *QST* that I bought at the Wheaton Community Radio Hamfest in 1984.[9] The more I read about the double half-wave loop, the more interested I became; so I decided to give it a try. This antenna can be built for any band (see Table 3), but I decided to try it for 15 meters, because of the convenient size. Table 4 is a materials list for the 15-meter antenna. Because the antenna is 85 inches wide, I suggest that it be assembled outdoors. The necessary materials can be found at most local hardware stores.

For 15-meter operation, the hoops should have a circumference of about 22.1 ft, with a 3-inch end gap. Each loop is made of ¼-inch (ID) copper tubing. Some snug fitting clear-plastic hose is forced over the hoop ends to maintain the gap (see Fig 40). The circles are mounted so that the hoop gaps line up with each other (see Table 3).

The two circles are mounted parallel to each other and separated 1.0 inch for each meter of wavelength at the operating frequency (1 × 15 = 15 inches). PVC tubing (½-inch ID), a few tee fittings and two electrical-junction-box covers form the hoop-support structure (see Fig 41). Steel pipe flanges are used at the center of the spoke assemblies, and also on the 1¼-inch mast pipe.

The hoop-support structure may appear weak, but it is not. Since I live in the windy Chicago area, I know how strong an antenna must be to survive adverse weather. The PVC structure is flexible, lightweight, durable and wind-resistant.

I wasn't sure how to construct a 72-Ω twisted-pair feed line, so I came up with a different feed method using 52-Ω coax. At the suggestion of my brother Tom, WB9EAW, there is a 1:1 balun between the antenna and the coax. I determined the correct feed-line attachment points while exciting the antenna with a dip meter. The

[9]J. Reinartz, W1QP, "Concentrated Direction Antennas for Transmission and Reception," *QST*, Oct 1937, pp 27-28.

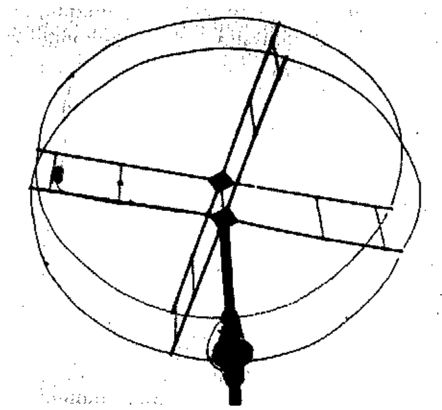


Fig 39—A photo of KA9LYR's completed loop antenna.

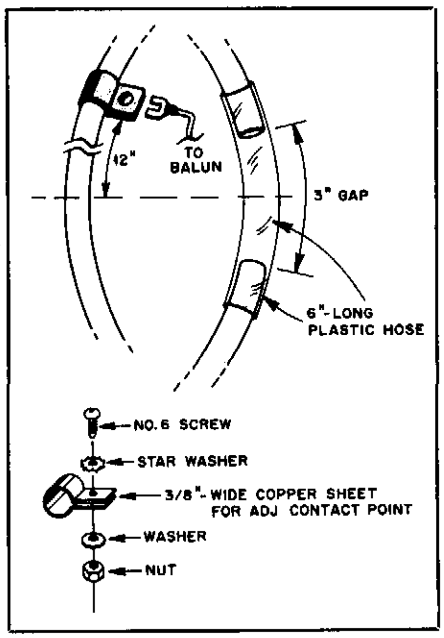
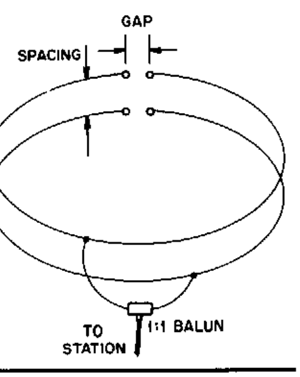


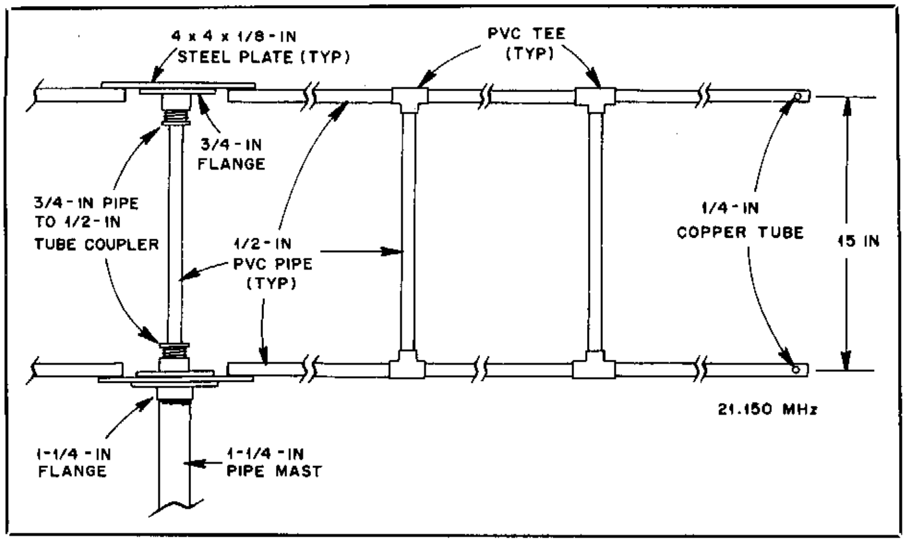
Fig 40—Construction details of the individual hoops. The plastic hose must fit tightly over the copper tubing in order to hold the ends in place (A). Make two sliding clamps to feed the antenna (B). [Use stainless steel hardware to prevent corrosion.—Ed.] Place one clamp on each hoop, and position them on opposite sides of the hoop center line (also see Table 3).

Table 3

Dimensions for the Dual Half-Wave-Loop Antenna

Frequency (MHz)	*Circumference (Ft)*	*Spacing (Inches)*	*Gap (Inches)*	*Diameter (Ft)*
1.80	260.00	160	33.33	82.76
3.75	124.80	80	16.00	39.73
7.15	65.45	40	8.39	20.83
10.07	46.45	30	5.96	14.79
14.18	33.02	20	4.23	10.51
21.23	22.05	15	2.83	7.02
24.94	18.77	12	2.41	5.97
28.85	16.22	10	2.08	5.16
52.00	9.00	6	1.15	2.86
146.00	3.21	2	0.41	1.02





← Fig 41—One spoke of the PVC-pipe hoop-support structure. Use two no. 6-32 screws, nuts and lockwashers to fasten each spreader arm to the appropriate steel plate. Four similar sets of no. 6-32 hardware fasten the ¾-inch flanges to the plates. Use no. 10 hardware to fasten the bottom plate to the 1¼-inch flange. All arms are similar except for balun and feed-point details. Mount the balun on the vertical PVC strut closest to the feed point.

Table 4

Parts List for KA9LYR's 15-Meter (21.150 MHz) Dual Half-Wave-Loop Antenna

Qty	*Description*
3	½-inch PVC pipe (10-ft sections)
16	½-inch PVC tees
2	¾-inch pipe to ½-inch PVC connectors
2	4 x 4 x 1/8-inch steel plate (cover from large electrical junction box)
2	¾-inch pipe flanges (steel)
1	1¼-inch pipe flange (steel)
2	Sliding copper clamps to fit around copper tubing (may be fabricated from 3/8- by 6-inch strip of copper flashing)
1 ft	Plastic tubing to fit snugly over ends of copper hoops
46 ft	¼-inch ID soft copper tubing
1	1:1 balun
1	Can of PVC-pipe cement
*	Assorted no. 6 hardware
4	No. 10 nuts and bolts (for 1¼-inch pipe flange)

best setting was about 12 inches on each side of the balun. The SWR is low, and the antenna seems to have good directivity.

The major radiation lobe occurs on that side of the antenna closest to the current loop (feed point). [Visualize the major lobe by imagining an arrow drawn from the open hoop ends, across the middle of the circle.—Ed.] Signal reduction appears in the opposite direction. The field-strength gain in the forward direction appears to be about 28%, compared to a dipole. The front-to-back ratio seems to be about 6 dB.

On-the-air performance is good. My rig is a Ten-Tec Century 21 that provides 60 W to the antenna, which is mounted at 20 ft. I used a "Green Mountain" vertical antenna for comparison. (It has four radials 65 ft long and 15 radials 30 ft long.) The loop works well on stateside contacts. My first DX contact on the new antenna was YS1JBL in Salvador, followed by ZF1CA in Cayman Islands; OE1LYA, Vienna; UA3AJ, USSR; VO1OS, Newfoundland; and JA5JTE, Japan. These contacts did not all occur in one day, but I can sure hear a difference between the performance of the vertical and the loop! *—Dick Kaitchuck, KA9LYR, Des Plaines, Illinois*

LONGER LIFE FOR YOUR QUAD ANTENNA

☐ Having kept a quad antenna up and working for approximately 25 years, I'm sometimes asked how it's done. Sad experience has been my teacher! My first quad was a W2AU design. It worked very well, but its 20-meter element, and sometimes its 15-meter element, required periodic patching because of ice- and wind-related flexing. Typically, element-wire breakage occurred at the element corners—where they're supported by the quad's spreaders. Adding a two-wire strengthener (see Fig 42A) at each element corner solved this problem.

Teflon®-insulated wire is a better choice than stranded bare wire. Oxidization of the quad's original stranded copper wire was the reason for this: Ten or so years ago, I noticed that the quad's elements had turned green, and I took this as a sign that weather was taking its toll. (The quad's electrical performance was not affected.) Discovering that Teflon-insulated wire was available in odd lots at flea markets, I bought some. (It helped that I wasn't fussy about insulation color!)

The stock quad's spreaders were tied together (Fig 42B) with 50-pound monofilament (nylon) fishing line, which deteriorates in sunlight because of ultraviolet bombardment. I replaced it with more-durable cord.[10]

[10]*Nylon* cord, especially that treated to improve its resistance to ultraviolet light, is much better than monofilament fishing line for outdoor use; *Dacron* cord is even better. Because it deteriorates rapidly in ultraviolet light, avoid using *polypropylene* lines in sunlit locations.—*Ed.*

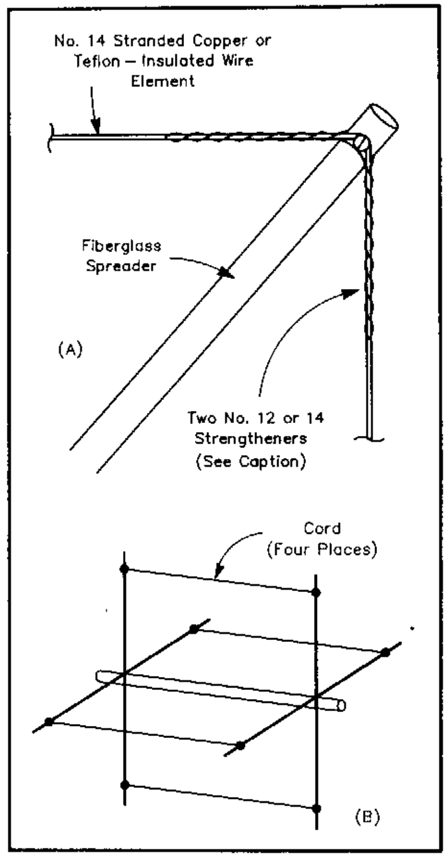


Fig 42—With its elements constructed as shown at A, Paul Atkins's quad has survived for over a decade without being kayoed by the weather. Although bare no. 14 stranded copper wire is shown for the elements, *Teflon-insulated* no. 14 stranded copper is better choice because of its greater strength and weatherproofing. (If you use insulated wire, take care not to nick the wire's strands when removing its insulation for soldering. If possible, use a thermal stripper to do this.)

Each corner strengthener consists of two pieces of no. 12 or 14 bus wire 14 to 16 inches long. After cleaning the element wire until it's bright and solderable, twist on one strengthener wire. Twist on the second strengthener wire *in the other direction.* Using rosin-core solder and a soldering iron hot enough to heat the work thoroughly, solder the three wires together. Complete the job by cleaning the joint to remove whatever rosin remains. The finished strengthener can be wrapped with tape as required.

B shows the spreader-to-spreader lines Paul replaced with cord. See text and note 10.

My quad uses tapped-coil inductive reflector tuning. I replaced its Miniductor coils with home-made, 1-inch-ID coils wound of no. 12 tinned bus wire. (I wound each coil on a 1-inch-diameter temporary form, removed it from the form and slipped it into position on its respective quad insulator.) Feeling that tapped coils—whether their unused turns are shorted or left open—introduce loss, I tuned the quad reflectors by adjusting the tuning coils' turn spacing as necessary.

I haven't had to repair my quad since I performed these modifications almost 15 years ago.—*Paul T. Atkins, K2OZ, 56 Ormsay St, Park Ridge, NJ 07656*

A SLIDING ELEMENT MOUNT FOR SMALL BEAM ANTENNAS

□ One of the more frustrating parts of experimental UHF and VHF Yagi antenna construction is getting optimum spacing and adjustments done without wasting materials or drilling unnecessary holes. My solution to this problem is shown in Fig 43.

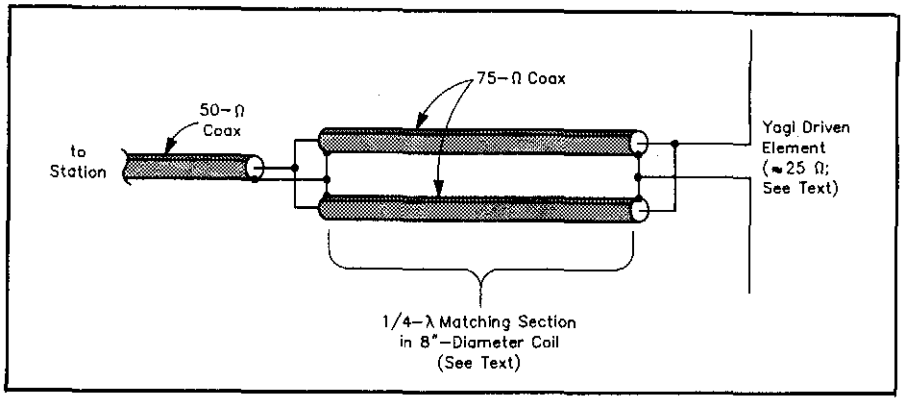


Fig 44—Bob Zavrel matches his monoband three-element Yagi antenna to 50-Ω coax with a ¼-λ, 35.3-Ω line section. Called a *Q-section* or quarter-wavelength transformer, such a matching section is a special case of the *series-section transformer*, a very useful device you can read all about in *The ARRL Antenna Book*, 16th edition (pages 26-15 and 26-16, and 28-12 through 28-14), and *The ARRL Handbook* (pages 16-5 and 16-6), both of which are available from The ARRL Bookshelf. Bob's 35.3-Ω line consists of two 75-Ω lines in parallel; coiled, they form a *choke balun* (Fig 15A, page 26-12 in *The ARRL Antenna Book* and Fig 16, page 16-9 in *The ARRL Handbook*) that keeps RF off the outside of the coax and helps preserve antenna balance. Be sure to use 75-Ω cable appropriate for your transmitting power.

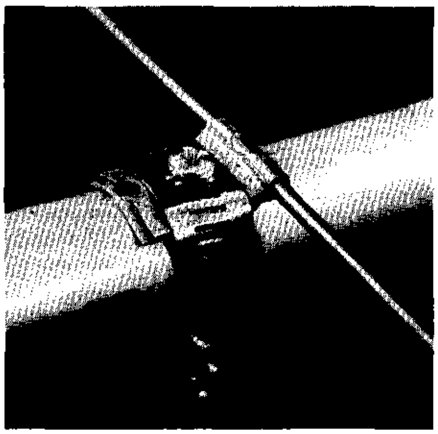


Fig 43—Kenneth Munford's adjustable element mount. The screw is added after final element placement has been determined. See text.

The materials needed are copper-plated steel welding rod, plumber's tape, acid-core solder and sheet-metal screws. First, cut the elements to length. Cut the plumber's tape into 2-1/8- to 3-1/8-inch strips, and form a *U* 2-1/2 inches from one end of each strip. Using a vise or locking pliers, crimp the tape securely around the center of each element. Solder the tape to each element using a propane torch or high-power soldering iron. To put the antenna together, use hose clamps to secure elements to the boom. The elements can be adjusted for proper spacing merely by loosening the clamps.

This element-mounting technique offers a bonus: By placing the antenna upside down on a flat surface and loosening the clamps, the elements can be moved into perfect alignment with each other. To finish the job, drill a hole through clamp, tape and boom at each element, and turn a sheet-metal screw into each hole.

An 11-element Yagi constructed in this way has survived at 60 ft above ground for the past six years. It has withstood rain, snow, ice and 75-mi/h winds that toppled a broadcast tower 1 mile away. When the antenna was taken down recently, it was found to be in perfect electrical and mechanical condition.—*Kenneth S. Munford, N7KM, 3791 W Linda Vista Ave, Cedar City, UT 84720*

SIMPLE 50-Ω FEED FOR THREE-ELEMENT MONOBAND BEAMS

□ Evaluating different means of feeding a three-element 15-m Yagi, I considered that the feed-point impedance of a three-element monoband beam is about 25 Ω for element spacings that result in maximum gain. Even at resonance, feeding such an antenna with 50-Ω line would result in an SWR of 2. Then I recalled my old friend, the ¼-λ matching transformer: Connecting the 25-Ω antenna to my 50-Ω line via an electrical-¼-λ piece of coax of the impedance

$$Z_0 = \sqrt{Z_i Z_L} \qquad \text{(Eq 1)}$$

where Z_0 = matching-section impedance, Z_i = input impedance and Z_L = load impedance, would do the job nicely. But where could I obtain 35.3-Ω line? Connecting two pieces of 75-Ω coax (RG-59) in parallel gives a 37.5-Ω transmission line—close enough to 35.3 Ω for the job.

A quarter wave in transmission line is shorter than ¼ λ in free space because radio waves travel more slowly in transmission line than in free space. You can find the length of ¼ λ in transmission line by multiplying the wave's free-space wavelength by the transmission line's *velocity factor* and dividing the result by 4. Example: A 21.225-MHz wave is 46.37 ft long in free space according to the formula

$$\lambda \text{ (feet)} = \frac{984.25}{\text{frequency in megahertz}} \qquad \text{(Eq 2)}$$

In a transmission line with a velocity factor of 0.66, a 21.225-MHz wave is 30.6 ft (46.37 × 0.66) long. My ¼-λ transformer would be ¼ of this length—7.65 ft (7 ft, 7¾ in).

Fig 44 shows the transformer configuration. Parallel the matching-section-coax braids and center conductors at both ends of the line. Weatherproof the cable ends with electrical tape and/or sealing compound to keep moisture from damaging the cable. Coil and tape the matching section to form a shield-choke balun. Result: an impedance transformer that helps preserve your antenna's balance while keeping RF current from flowing on the side of the coax shield.

Fed this way, my beam works very well. The system exhibits an SWR of 1.2 or less over the entire 15-m band, 1:1 at band center. In principle, this technique can be applied to any three-element monobander. It avoids the mechanical-stability problems inherent in gamma- and beta-matching arrangements. —*Robert Zavrel, W7SX, ARRL Technical Advisor, Scotts Valley, California*

FEEDING AN 80-METER Δ LOOP AT 160 METERS

☐ After reading "The Full-Wave Delta Loop at Low Height,"[11] I found a satisfactory method of feeding an 80-meter loop at 160 meters. See Fig 45. C1 tunes the antenna to act as a ¾-λ resonator and allows the SWR at the feed point to be no more than 1.1 to 1 across the 160-meter band.—*Roy C. Koeppe, K6XK, 314 E Sandra Ave, Tulare, CA 93274*

[11]D. DeMaw and L. Aurick, *QST*, (Oct 1984, pp 24-25).

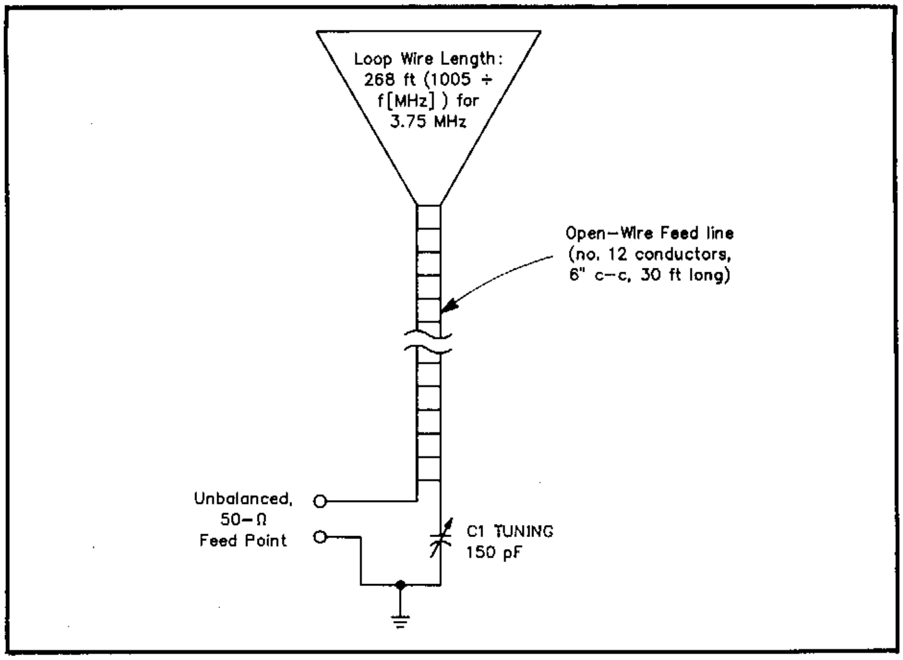


Fig 45—Roy Koeppe enjoys satisfactory 160-meter operation with an 80-meter Δ loop by feeding the loop as shown here. On 80 through 10 meters, Roy takes C1 out of the circuit and feeds the loop via its open-wire feed line and a balanced tuner.

SWITCHING AN 80/75-METER DIPOLE BETWEEN 80/75 AND 160 METERS

☐ A coax-fed 75/80-meter dipole can be used on the 160-meter band by connecting the dipole-feed-line inner conductor and shield together and feeding the coax and dipole as a random wire. Changing bands is inconvenient with this arrangement, however; moving from 75 or 80 meters to 160, for instance, involves disconnecting the antenna feed line, adding a shorting adapter to the feed-line connector, and connecting (or reconnecting) the shorted feed line to an antenna tuner.

Fig 46 shows my solution to this problem. When the BAND switch is thrown to 80/75, the coax line is connected to the transmitter, transceiver or antenna tuner as usual. When the BAND switch is thrown to 160, the inner conductor and shield of the coax feed line are connected together and to the center conductor of the TX OR TUNER connector. At the same time, the shell of the ANT jack is isolated from the TX OR TUNER connector shell.

Construct the switching adapter as shown in Fig 46. If you cannot locate a chassis-mount male connector for use as the TX OR TUNER connector, use a chassis-mount female connector in conjunction with a male-to-male adapter.

I have used this scheme at the 100-watt level without encountering arcing between the coax inner conductor and shield or between the BAND switch contacts. Nonetheless, be aware that RF voltage will be present *on the antenna feed-line shield* when a coax-fed 80/75-meter dipole is used as a 160-meter random wire—and don't touch the BAND switch when transmitting.—*Robert Stein, W6NBI, 1849 Middleton Ave, Los Altos, CA 94022*

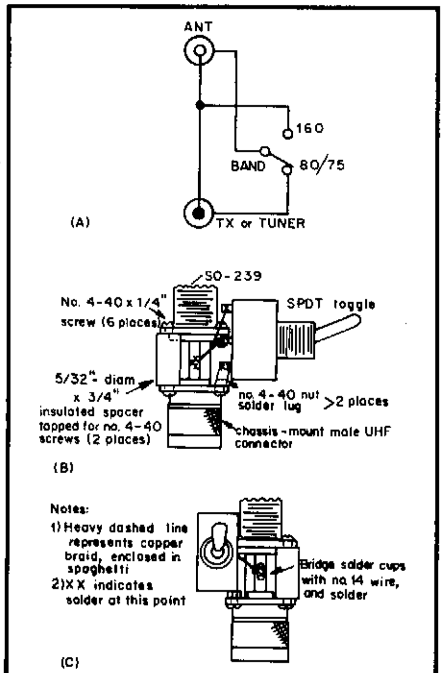


Fig 46—Robert Stein uses this arrangement to switch a coax-fed 75-meter dipole between dipole and random-wire modes. The BAND switch is a standard-sized toggle switch; don't use a miniature or subminiature switch in this application.

ADD 160 TO YOUR TRAP ANTENNA

☐ The popularity of the 160-meter band increases as we reach the bottom of the solar cycle. Therefore, I wanted to add coverage of the top band to my existing Hy-gain® 40/80-m trap dipole and developed an add-on trap to serve that purpose. Perhaps some other hams would be interested in adding that band coverage to their trap antennas.

Fig 47 shows the general layout of a newly constructed trap to accomplish the task. There are no expensive components, and a little labor can put you on 160 quickly.

Fig 48 shows how the trap portion of the coil is adjusted. First, set a dip meter at your favorite 80/75-meter frequency and

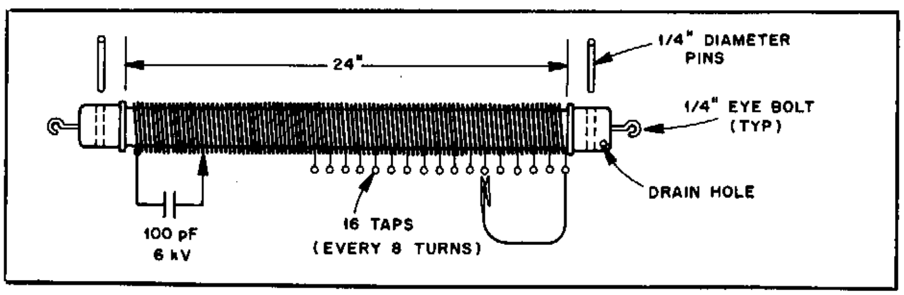


Fig 47—W9VYW's add-on trap for 160-meter operation. Close wind 84 ft (170 turns) of no. 14 AWG TW-insulated wire on the 1½-inch, schedule 40 plastic pipe (2-inch OD) form. Remove a small amount of insulation on every eighth turn and solder on 16 copper-wire tap points as shown. Plastic press fit (¼-inch diameter) pins hold the end caps in place.

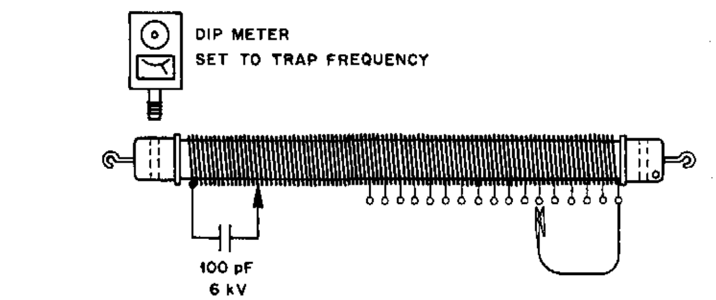


Fig 48—Locate the capacitor tap point for trap resonance (see text). W9VYW connected the capacitor across 24 turns for 75-meter operation at 3900 kHz.

Fig 49—A photo of W9VYW's trap after the capacitor is mounted inside the trap and before final adjustment on the antenna.

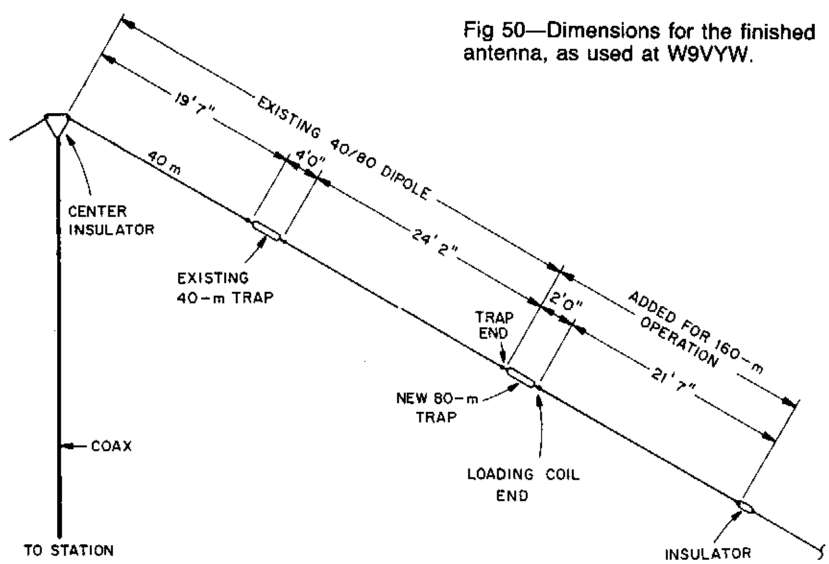


Fig 50—Dimensions for the finished antenna, as used at W9VYW.

couple it to the end of the trap. Connect one end of a 100-pF capacitor to the feed-point end of the coil, and use a needle to probe through the coil insulation with the other capacitor lead. Once resonance is found (indicated by a current dip on the meter), unwind part of the coil, drill the necessary holes, rewind the coil and permanently mount the capacitor inside the pipe.

Fig 49 shows the trap before it was mounted on the antenna. Notice that 16 tap points are shown for use in adjusting the loading inductance.

Fig 50 shows how the trap looks on the end of the antenna. In my case, there was room for 21 ft 7 in of wire at each end. The 1890-kHz tap is 91 turns from the end of the trap on my antenna. (Four turns, about two feet, on the coil seems equal to about one foot of antenna length.) Using this information as a starting point, determine the correct tap point for your antenna. (Make sure that you pull the antenna up to its operating height for each SWR measurement—the resonant frequency varies with height above ground.) Remove the extra tap points once the correct one is found, and solder a shorting wire between the correct tap point and the end of the coil. Weatherproof the new trap with a liberal coat of spar varnish.

My antenna has a physical length of 143 ft and an electrical length of 0.5 λ. *—Harvey Johnson, W9VYW, Milton, Wisconsin*

BETTER 7- AND 21-MHz OPERATION WITH A 7-MHz DIPOLE

☐ Many of us have tried using a 7-MHz dipole at 21 MHz with less than satisfactory results. End effect[12] causes a 1/2-λ dipole resonant at 7.1 MHz to resonate as a 3/2-λ dipole at about 22 MHz, not 21.3. Also, the at-resonance feed-point impedance of a 3/2-λ dipole is generally higher than that of a 1/2-λ dipole.

I suggest minimizing a 7- and 21-MHz dipole's minimum in-ham-band SWRs by using a compromise antenna length of 67 feet (long for 1/2 λ at 7 MHz, short for 3/2 λ at 21 MHz) and feeding the antenna via a coaxial feeder that includes a 21-MHz, 1/4-λ coax matching section between the antenna and its 50-Ω feed line. A 21-MHz Q-section should have little effect at 7 MHz.

I've found that 7 feet, 7 inches of RG-59 cable serves well as this matching section. Install it between the antenna's feed point and the 50-Ω coaxial feed line to the shack. If you use another cable type, you may have to adjust the matching section's length or tolerate a higher SWR at 7 MHz. (This is so because the matching section is capacitive at 7 MHz, and because different cables of a common impedance vary in capacitance per unit length.)

Fed via 50-Ω cable, such an antenna exhibits its lowest in-ham-band SWRs at the low end of 40 meters and the high end of 15 meters. I've also found that my version of this antenna displays slightly lower SWRs at the low end of 40 m and the high end of 15 m when it's configured as an inverted **V** (as opposed to a flat-top dipole).*—Bob Raffaele, W2XM, Albany, New York*

[12]G. Hall, *The ARRL Antenna Book*, 16th ed (Newington: ARRL, 1991), p 2-4 and Glossary of Terms (Appendix, p 2).

WJ1Z: At a height of 25 feet (about 0.2 λ) above ground, a flat-top, ½-λ, 7.1-MHz dipole exhibits a radiation resistance of around 65 Ω. A 50-Ω feed line connected to such an antenna exhibits an SWR of about 1.3 (65 ÷ 50) at resonance.

Operated as a 3/2-λ dipole, the same antenna (0.6 λ high at 21 MHz) exhibits a radiation resistance of about 110 Ω at resonance, resulting in an SWR of about 2.2 if you feed the antenna with 50-Ω cable. "So," you say, "what's the big deal? My radio's power-foldback circuitry still allows full power output at a 2.2:1 SWR." Snag: As Bob Raffaele says, 7.1-MHz dipole's 3/2-λ resonance occurs not at 1.3 MHz (7.1 × 3) but (because of end effect) near *22 MHz*. Without the help of an antenna tuner, your solid-state radio may not be at all happy driving a 7-MHz dipole at 21 MHz.

Bob's solution is worth trying. (See *The ARRL Handbook* and *The ARRL Antenna Book* for more on Q-section matching transformers.) He has arrived at some of the knowledge conveyed in W. Wrigley, "Impedance Characteristics of Harmonic Antennas," *QST*, February 1954, pages 11-14. Fig 51, after Wrigley, clarifies the idea. Another no-antenna-tuner solution worth trying is the capacitance-hat loading scheme presented in

Fig 3 of J. Healy, "Antenna Here is a Dipole," *QST*, June 1991, pages 23-26. With it, "you can make your 40-meter dipole resonate anywhere you like in the 15-meter band."

Ham lore has long held that "a ½-λ, 40-m dipole works just fine without an antenna tuner on 40 and 15." A brief look at the Amateur Radio literature, on the other hand, reveals that hamdom has also known for almost as long that this statement isn't true on its face. True, the conjugate match theorem holds that SWR isn't the performance-killing monster that ham lore says it is; nowadays, however, hams long accustomed to fighting Old Bogeyman SWR find their beliefs justified by modern radios with SWR-driven power-foldback circuitry that gags on SWRs much over 2!

Whatever the transmitter technology, we've almost always used some species of tuning/matching—adjustable transmitter output networks, antenna tuners, capacitance hats, whatever—to correct for end effect when using 40-m, ½-λ dipoles on their third harmonic. The classic 40/15-meter dipole isn't as simple as it looks!

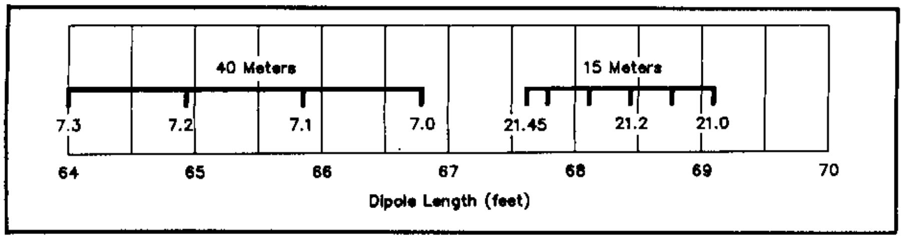


Fig 51—Resonant frequency of a harmonic antenna as a function of wire length in feet. Length = [492 (*n* − 0.05)] ÷ *f*, where *f* is frequency in megahertz and *n* is the order of the harmonic or the number of half-waves in the antenna. (After Wrigley, Fig 5; see text.) These plots explode the myth that a plain-vanilla 40-m dipole also resonates (as a 3/2-λ dipole) in the 15-m amateur band. A 40-m dipole can be made to work well at 15 m, of course; some form of antenna tuning/matching is necessary if the transmitter feeding such an antenna must see a low SWR on both bands.

A BROADBAND ANTENNA AT K6EHZ

□ "The thicker the elements, the broader the bandwidth," or so the antenna pundits say. I've built inverted-V dipoles in which each leg consisted of two wires in parallel at various spacings; these antennas exhibited useful broadbanding. My present 40-meter antenna consists of a pair of two-wire elements, each 32½ feet long, center fed with 52-Ω coax. Spacing between the wires in each element is 10½ inches. At an apex height of 45 feet, and with an apex angle of 107°, the antenna exhibits an SWR of unity across the entire 40-meter band. Performance is three to four S units better than a ground-plane vertical antenna at a distance of several hundred miles. *—P. Romiti, K6EHZ (SK)*

Editor's Note: Thicker conductors—and parallel conductors simulating a single thicker conductor—do make for broadened antenna bandwidth; more on this in Jerry Hall, "The Search for a Simple, Broadband 80-Meter Dipole," *QST*, Jul 1983, pp 22-27. See also Frank J. Witt, "Broadband Dipoles—Some New Insights," *QST*, Oct 1986, pp 27-37. For resonance at a given frequency, a thicker antenna will be somewhat shorter than a thinner one. The improvement in short-range coverage by K6EHZ's broadband dipole—a result of the greater high-angle radiation of the inverted V relative to the vertical—is unrelated to antenna bandwidth.

A TWO-BAND LOOP FOR 30 AND 40 METERS

□ After trying to find a way to place a 30-m delta loop inside an existing 40-m loop, I remembered an article in *All About Cubical Quad Antennas*[13] describing a 1½-λ, or "Mini X-Q," loop. The gain of this antenna was said to be about 1 dB more than a 1-λ loop. I installed a large, ceramic SPST knife switch in the center of the delta-loop's bottom leg (see Fig 52). With this switch open, the full-wave, 40-m loop becomes a 1½-λ, 30-m loop! The resonant frequency of this arrangement was 10.5 MHz. By adding 18-inch wires to the

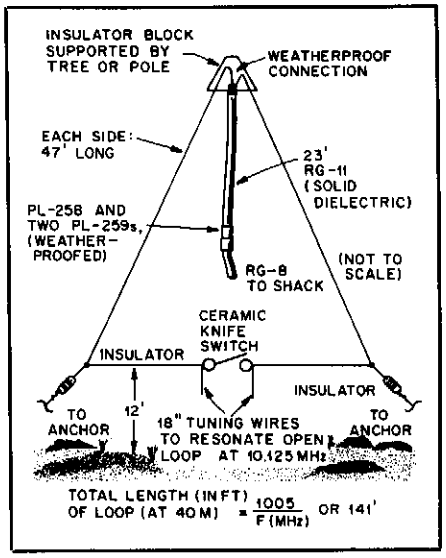


Fig 52—Jim Brenner's 30- and 40-meter loop. Note the 18-inch tuning wires used to lower the antenna's 30-m resonance from 10.5 to 10.125 MHz. The antenna is top-fed via a ¼-λ 40-m matching section. See text.

loop at both sides of the switch, I obtained resonance at 10.125 MHz.

Since the bottom of the loop is only 12 ft above ground, it's a simple matter to reach the band switch from ground level. (Caution: High RF voltage appears at the switch when the antenna is used for transmitting on 30 m.) Incidentally, the loop also works well on 15 m (SWR under 2:1 across the band) when set for 40 m, and I have used the 30-m configuration successfully on 80 m with the help of an antenna tuner.*—James Brenner, NT4B, 5690 SW 36th Ave, Ocala, FL 31674*

AN INDOOR DIPOLE ANTENNA

□ I live in an apartment. Because of this, I'm limited in the size and type of antenna I can install for use on HF. After trying end-fed random wires, loops, mobile verticals, rain gutters and so on, I designed a multiband dipole antenna that requires no tuning after installation. It's inconspicuous, non-hazardous and efficient. I used the following materials to construct it: one PL-259 connector; 12 feet of "Mini 8" coaxial cable; two nylon cable ties; approximately 45 feet of no. 22 insulated, solid copper wire; six test leads with alligator clips; 26 thumbtacks; and an SWR bridge. The antenna was installed in less than two hours.

After attaching the PL-259 to the coaxial cable, I wound 6 feet of the coax into a tight coil and held this winding together with two nylon cable ties. The result is a shield-choke balun at the point where the antenna elements attach to the cable.[14]

Using the formula ℓ (feet) = 234 ÷ f (MHz), I calculated the length of wire necessary for each leg of a half-wave dipole at 21.1 MHz. Next, I cut two wires to this length and attached them to the feed line, one to the shield braid and the other to the center conductor. Using my transmitter and SWR meter, I pruned the dipole ends equally until I obtained the lowest possible SWR at 21 MHz. (Caution: Trim the antenna wires only when the transmitter is *off*.)

At this point, the clip leads come into play. To get the antenna up and running on 14 MHz, follow this procedure: (1) Attach a clip lead to the end of the 15-meter dipole; (2) calculate the length of the legs of a 14-MHz dipole; (3) add enough wire to each clip lead/dipole leg to bring the total length of each 14-MHz dipole leg to the length calculated in step 2; and (4) prune the added wire for minimum SWR at the 14-MHz design frequency with the aid of the transmitter and SWR bridge. Continue this procedure to add additional clip leads and wire segments for 10 and 7 MHz. I used the thumbtacks to secure the wire pieces and test leads to the plasterboard ceiling of my apartment. Fig 53 shows the configuration of the entire antenna in linear form.

In my installation, the actual length of the dipole legs for a given band is about 14% shorter than the calculated length. This is probably due to the proximity of the antenna to the apartment ceiling—and the

[13]W. Orr and S. Cowan, *All About Cubical Quad Antennas* (Wilton, CT: Radio Publications, 1970).

[14]See Bob Schetgen, "Shield Chokes for Coaxial Cable," p 7-9.

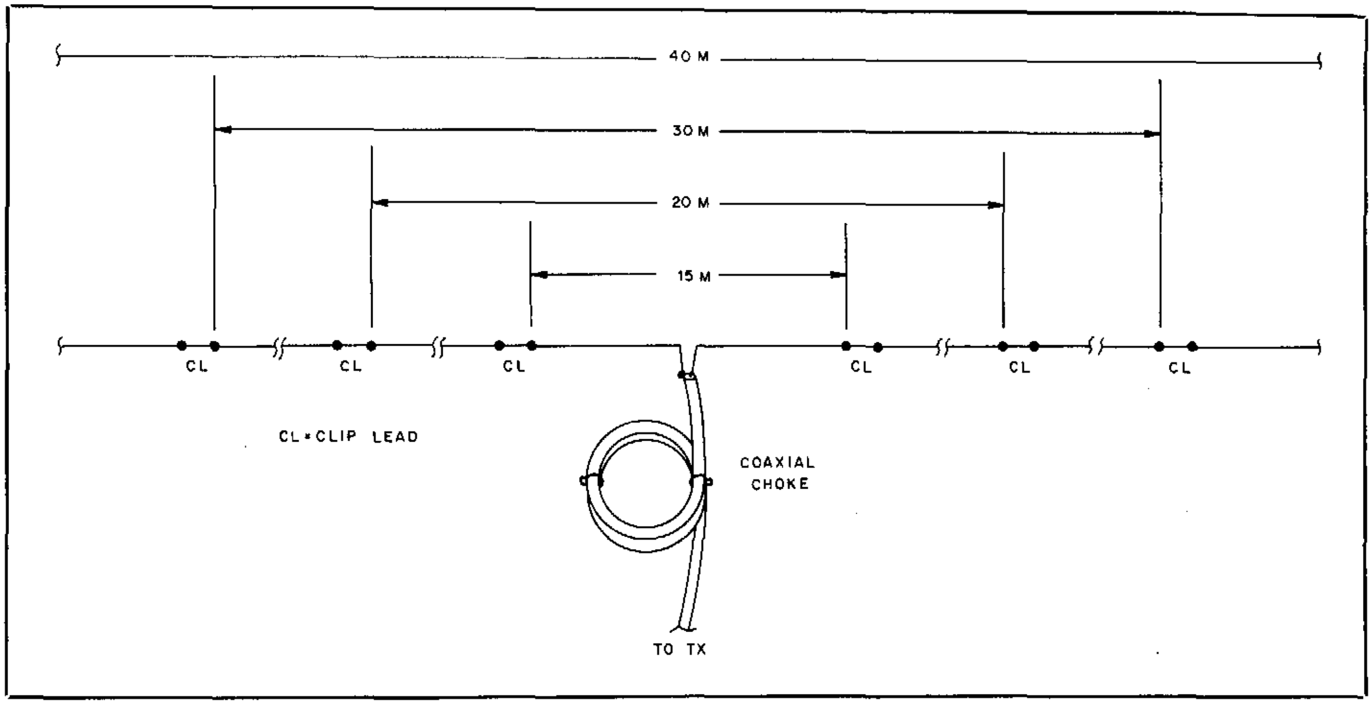


Fig 53—Larry Barry's multiband dipole makes crafty use of clip leads and thumbtacks to stuff half-wave dipoles for 15, 20, 30 and 40 meters into cramped apartment space. Changing bands entails only the connection or disconnection of clip leads. This drawing shows a straight dipole; Larry's antenna is bent into a square but works just fine. See text.

fact that I had to install the antenna around the perimeter of a square room, almost like a loop!

Careful pruning of the antenna for my favorite band segments paid off: An antenna tuner is unnecessary on all of the antenna's four bands. With the addition of Doug DeMaw's "AC Outlet Strip with Filtering" (December 1986 *QST*, pages 25-27), I eliminated TVI and RFI from my station.—*Larry A. Barry, NV5I, 4119 Medical Dr F-304, San Antonio, TX 78229*

An antenna similar to Larry's has been in use at AK7M for several years. I use alligator clips instead of test leads, and my antenna's wire sections are held away from the plasterboard by nylon cable ties and thumbtacks. I can't complain about its performance: I've worked plenty of DX on 30, 20 and 15 meters running just 20 W output. Moral: All's not lost if you live in an apartment: Just keep plugging away with That Old Ham Spirit!—*AK7M*

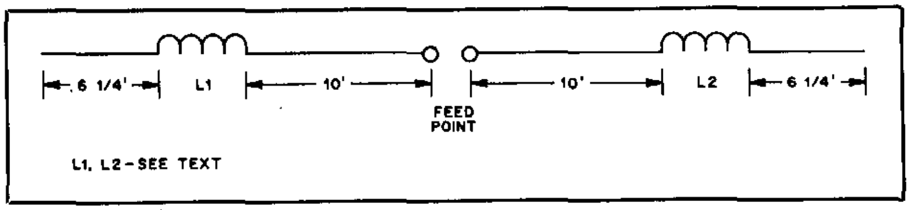


Fig 54—Stan Grimes suggests using this short, loaded 7-MHz half-way dipole where space is limited. The antenna and loading coils consist of no. 14 insulated wire; see text.

A SHORT 7-MHz DIPOLE

☐ Here are dimensions and construction information for a short, inductively loaded dipole for 40 meters. If installed over 50 ft above ground—outdoors or even in an apartment—it can provide plenty of DX.

See Fig 54. The antenna and loading coils consist of a total of 60 ft of no. 14 plastic-covered wire. Wind the loading coils first: Each consists of 30 close-wound turns on a 1½-inch-diam plastic form [pill bottles are suitable—*AK7M*]. Use the rest of the wire as shown in Fig 54. (If space prohibits an overall antenna length of 32½ ft, you can let the 6¼-ft end sections dangle for a total length of just over 20 ft. Feed the antenna as close to its center as you can; 50- or 72-ohm coax is suitable. Preferably, the feed line should leave the antenna at a right angle.

This system can handle up to 120 W. Installed as shown in Fig 54, it should exhibit better than a 2:1 SWR from 7050 to 7160 kHz.—*Stan Grimes, W7CQB, 13300 NW 14th Ave #A, Vancouver, WA 98685-1652*

AN INEXPENSIVE 6-METER LOOP ANTENNA

☐ When I received my Technician-class license, I wanted to work 6 meters, but I didn't have an antenna. My Elmer suggested the workable 6-meter starter antenna shown in Fig 55.[15]

The center block is a section of 4-×-4 post about 4 inches long. Eight dowel pieces (four 22½-inch-long pieces of ¾-inch-diameter stock and four 20½-inch pieces of ¼-inch-diameter stock) are required. (The ¼-inch-diameter pieces will be trimmed to length after installation, so make each of them at least 21½ inches long to start.)

Drill a hole in the center of the center block the same diameter as the antenna mast. Don't drill all the way through; the remaining wood will act as a weather cap for the mast. Next, drill holes for and install the dowels as shown in Fig 55, using carpenter's glue to hold the dowels in place. Set the assembly aside until the glue sets.

Measuring from the center of the center block, mark each ¼-inch-diameter dowel at 43½ inches out from the center and cut them at these marks. Next, mark each ¼-inch dowel 1 inch from its outer end. Measure from dowel to dowel between these marks; the distance should average 60 inches. (If necessary, remark the dowels to ensure 60-inch loop sides.) Now cut a slot into the end of the ¼-inch dowel to the marks. Round off the dowel ends with

[15]The loop's 60-inch (5-foot) side dimensions reflect the familiar full-wave-loop formula $\ell = 1005 \div f$, where ℓ equals the total length of the loop element in feet and f equals the loop's operating frequency in megahertz. The loop described here is dimensioned for 50.25 MHz.—*Ed.*

a file. Coat the whole assembly with outdoor varnish, and set it aside until the varnish dries.

Loop one end of the antenna wire through one end of the insulator. Off the end of the insulator, twist the free end tightly around the antenna wire (see Fig 55) and solder the twisted portion. (Remember, the total length of the element will be 20 feet, so be sure to leave enough wire to close the loop.) Position the insulator close to one of the ¼-inch dowels (see Fig 55). Run the wire through each of the dowel slots and through the other end of the insulator. Tighten the loop, twist the antenna wire around itself off the end of the insulator, and solder the twisted portion. Attach a 36-inch length of RG-59 (solid, not foam, dielectric) cable to the insulator, connecting the cable's center conductor to one end of the loop and the shield braid to the loop's other end (it doesn't matter which goes to which).[16] Tape (or otherwise seal) the antenna end of the coax against the weather. You can install any length of 50-ohm cable between the matching section and your station.[17]

Insert the mast into the block, install the mast to its support, and tie or tape the feed line to the mast.—*Eugene Hecker, WB5CCF, PO Box 940, Magdalena, NM 87825*

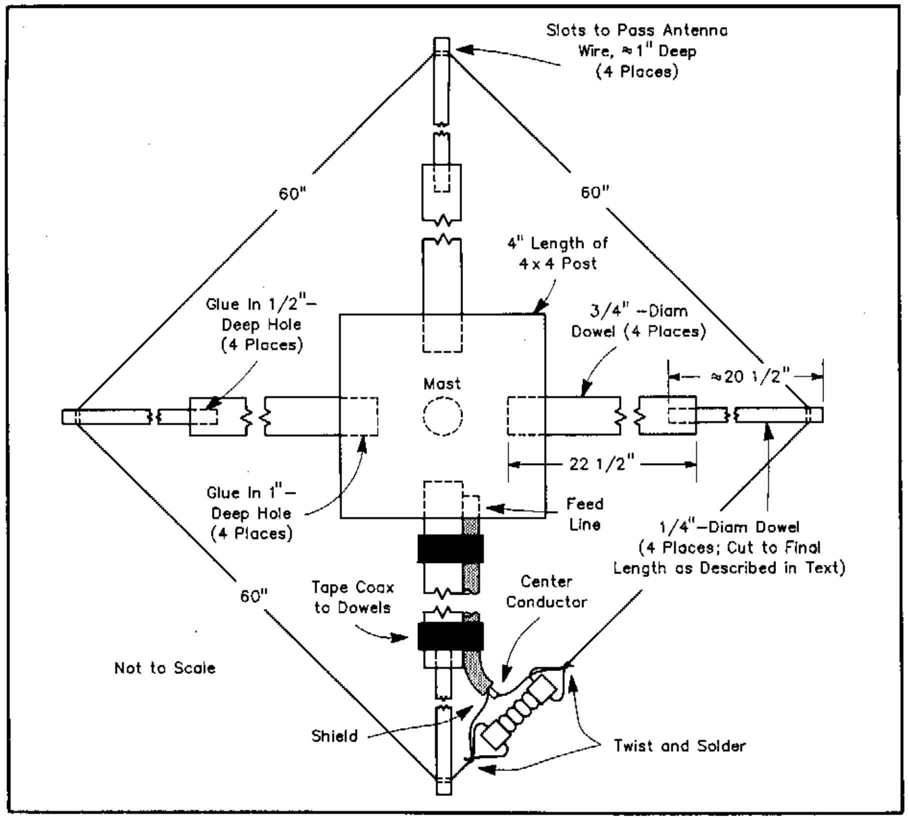


Fig 55—Eugene Hecker's 6-meter full-wave loop antenna, viewed here from the top, is easy to get up and running. The element consists of no. 12 or 14 copper wire. See text.

[16]Do not omit this cable section. It serves as a *quarter-wavelength transformer* to match the loop's radiation resistance (≈100 ohms) to 50-ohm cable. You must adjust its length if you dimension the antenna for a frequency other than 50.25 MHz, and/or if you construct the transformer of cable with a velocity factor different from that (66%) of solid-dielectric RG-59. To probe further, see *Transformers: ¼-wave section* in the 1991 *ARRL Handbook* or *Transformers: Quarter wave* in *The ARRL Antenna Book.—Ed.*

[17]For best results, you can preserve the loop's balance and minimize outside-of-shield RF currents by adding a ferrite-bead or coax-coil shield choke just below the matching transformer. See pages 16-9 and 16-10 in the 1991 *ARRL Handbook.—Ed.*

A BURGLAR-ALARM-TAPE ANTENNA FOR 2 METERS

☐ If you're a ham who is also a businessperson, you've probably discovered that being stuck in an office all day can mean doing without the use of VHF Amateur Radio. Privacy is one consideration; fortunately, I have an office all to myself. Aside from this, however, an office building is usually a prohibitively RF-noisy environment—and then there's the shielding effect of concrete and steel! Despite these difficulties, I wanted to install a 2-meter base-station transceiver in my office. An outdoor antenna seemed to be the only means of minimizing the building's RF noise and shielding effects until I discussed the problem with my friends Sam Payne, KB5VC, and Joe Matlock, N5ARY. They suggested using *burglar-alarm tape* for the elements of a 2-meter dipole antenna!

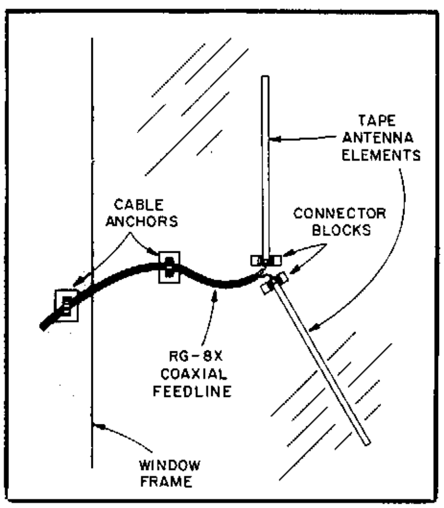


Fig 56—Van Flynn's burglar-alarm-tape antenna. See the text for element lengths and tuning information.

The idea works! I bought a small roll of self-adhesive alarm tape and two of the self-adhesive plastic blocks used for making electrical connections to the tape. I installed the tape on the inside of my office window in a "sideways inverted V" configuration (see Fig 56), beginning with two 19-inch-long elements (the length of both elements must be adjusted, as will be described shortly). One element is vertical. I positioned the second element slightly below the first element at about 135° from vertical.

The dipole is fed by means of RG-8X coax fastened to the connector blocks by means of the block terminal screws. The RG-8X center conductor is connected to the vertical antenna element; the lower antenna element is connected to the RG-8X shield. Nylon tie wraps and self-adhesive cable anchors hold the RG-8X to the window glass and keep most of the coax weight off the element connector blocks.

Tuning the antenna requires a transmitter and an SWR indicator. Use a razor blade to trim the antenna elements until you achieve the lowest possible SWR. (Make your cuts only when the transmitter is *off.*) Tuned in this way, my version of the burglar-alarm-tape antenna has a vertical element 16¾ inches long. The length of the "ground" element (connected to the coax shield) is 10¼ inches.

The antenna handles 20 W of RF from my transceiver without difficulty. Although I use my tape antenna at the office, this idea may come in handy for apartment or condominium dwellers who are stuck with sealed windows. I've even thought of using a tape antenna in high-rise hotels: It can easily be removed from a window with just a razor blade!—*Van Flynn, N5ARU, New Orleans, Louisiana*

Editor's Note: Hmm, such an antenna may also work well in the 222- to 225-MHz band. Novices, if you'd like to try a 222-MHz version of Van's tape antenna, start with 12½-inch elements and tune the antenna as he describes. I wonder if the self-adhesive copper tape used by workers in stained glass would be suitable for use as antenna-element material?

VERTICAL-ANTENNA TIPS: RADIAL MATERIALS, CONNECTIONS AND INSTALLATION

☐ Aluminum-mesh gutter covers make good radials for vertical antennas. They usually come in 25-ft lengths and seem to work well in my backyard. The strips are rolled up easily prior to lawn mowing, and they are convenient for portable operation. The strips are easily cut, and they may be bent and crimped together to make longer pieces.—*Vince Berkman, W9OES, South Jacksonville, Illinois*

☐ I have a suggestion for connecting a ground system to a tower or vertical antenna. Copper wire fasteners (such as Servit® connectors, by Burndy; see Fig 57) work well and require much less work than drilling, mounting and painting a circuit board or piece of copper flashing. The nuts are made in a U shape and screw down for a good mechanical and electrical connection. I have been able to put as many as 20 small-diameter wires in a single connector. A piece of flexible braid attaches the wires to the tower. This setup works well for me; it's easy to install and "dirt cheap."—*J. Craig Clark, Jr, N1ACH, Greenville, New Hampshire*

☐ Here's an "invisible" method of connecting radials at a hub. Begin with a large hoop made from 3/16-inch-diameter copper tubing, but do not immediately solder the ends together. Make the hoop large enough to clear the antenna or tower base by about 12 inches when in place.

Clear the area at the tower base by lifting the sod in sections and setting them aside in such a way that you can remember the location from which each section came. Next, place the copper hoop on the ground and center it around the antenna base. Use a small length of larger copper tubing as a coupling, and solder it in place to join the two ends of the copper hoop. Prepare copper-wire radials and install them with extra length at the antenna end for connecting to the hoop. Clean the radials where they contact the hoop and solder the connections.

My system is grounded through a 6-ft galvanized pipe driven into the ground a few inches from the hoop and in line with a tower leg. A copper ground strap is soldered to the hoop and clamped to the pipe. The strap is wrapped around the pipe and fastened to it with a stainless-steel draw-up bolt at ground level. I wrapped a 1-inch-wide aluminum strap around the top of the pipe (it protrudes 6 inches out of the ground) and secured it with another stainless-steel bolt. The other end of the aluminum strap is fastened to the tower leg with a third stainless-steel bolt.—*Floyd B. Gribben, VE7XN, Burnaby, British Columbia*

Fig 57—A Servit connector from Burndy Corp can be used to ground radials.

☐ Vertical antennas need radials to perform well. While it is work to install the plate which connects the radials to the antenna, that job is insignificant compared to the task of spacing and planting many radials of various lengths. With a little assistance from a fellow amateur, a gasoline-powered grass edger and a wheelbarrow with a large rubber tire, however, the entire bunch can be laid in one day. [WBØIJE refers here to the type of grass edger that cuts with a blade, rather than a flexible cord.—Ed.]

First, use the grass edger to cut a slot (about 2 inches deep and 1/8 inch wide) in the ground for each radial. You can start the blade into the ground very close to the antenna if you cut the slots as you pull the edger backwards. Then, place one or more radials in each slot.

Once the radials have been laid, use the wheelbarrow to close the slots: Fill the wheelbarrow with enough weight so that the ground closes, sealing over the wire, as the rubber tire rolls along the slot. I buried the coax to my antenna using the same procedure. This process works better if the ground is slightly damp. Because the grass is barely disturbed, it takes but a couple of weeks to regain a natural-looking lawn.—*Dale M. Ludwig, WBØIJE, Keokuk, Iowa*

INSULATION SUPPORTS AS RADIAL TIE-DOWNS

☐ Verticals are useful antennas for DX work on the low bands. For many hams, the tedious job of burying radials for a vertical-antenna ground system is a major drawback. Some studies have shown that radials laid *on* the ground, rather than buried in it, provide a more-efficient RF ground than buried radials. On-ground radials require special installation techniques, however: They must be securely fastened to the ground so that they do not trip people or foul lawn mowers.

For several years, I have successfully used insulation supports as on-ground-radial tie-downs. Insulation supports resemble very long, headless nails and are pointed at both ends. Designed to support thermal insulation between house floor joists, they are generally sold by building supply houses in 16- and 24-inch sizes at $12 to $15 per thousand.

Install the insulation supports on a given radial as follows: Lay the radial wire on the ground in its proper position. Prepare a dozen or so of the supports by bending them into a *U* shape. Drive these "staples" into the ground and over the radial every few feet along the radial. Space the staples closely enough along the length of each radial to secure the wire and keep flush with the ground.

The best time to install surface-mounted radials on a lawn is during colder months when grass is dormant: Turf will cover the radials as soon as warm weather arrives and the grass resumes growth. As a warm-weather alternative, mow the grass just before installing the radials.—*Drayton Cooper, N4LBJ, Bowling Green Presbyterian Church, PO Box 5, Bowling Green, SC 29703*

A SIMPLE, MULTIBAND VERTICAL ANTENNA

☐ The antenna in Fig 58 is based on a multiband vertical antenna described by Arthur S. Gillespie, Jr, W4VON, in the eighth edition of *Hints and Kinks for the Radio Amateur*. I have used some alternative construction techniques and greater length to provide better multiband operation than W4VON's original.[18]

Monopoles radiate in a toroid, or doughnut-shaped, pattern. The vertical radiation pattern of a λ/4 monopole is round; a large portion of the signal is radiated skywards at relatively high angles. A 5/8 λ, or λ/2 monopole has a flattened-toroid pattern, with corresponding gain over the λ/4 at low angles. This gain is about 3 dB for 5/8 λ and 1.5 dB for λ/2. A 3/8 λ monopole shows little gain over λ/4.

It may look wrong—feeding an asymmetrical, traditionally coax-fed antenna with parallel feed line, but radiator and radials are all the same length and the circuit is very similar to a vertical dipole or an extended double "Zepp" with center feed. Parallel lines have far less loss than coax, especially under high-SWR conditions.[19]

[18][Apparently, WB6AAM chose 20 ft as a convenient length from available materials. Antenna length, as shown in Table 5, is given with respect to a free-space wavelength. Since a Transmatch is necessary, the actual radiator and radial lengths are not critical.—Ed.]

[19][The line will not be balanced, however, so we can expect some feed-line radiation. Remember that parallel feeders should be kept away from the earth, and other objects, with standoffs. Also, the feed-line length in an unmatched system is significant: If you experience difficulty matching the system on a given band, change the feed-line length by λ/8 for that band. Continue experimenting until you find a line length that can be matched on all bands.—Ed.]

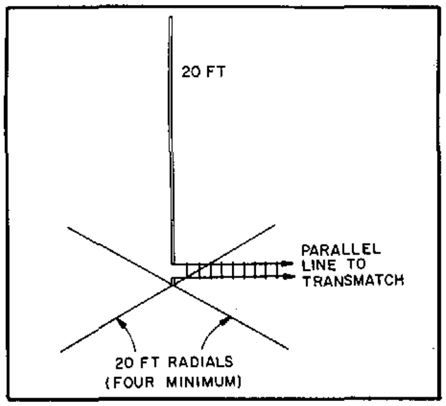


Fig 58—WB6AAM's multiband vertical-monopole antenna. Estimated gains for various amateur bands are shown in Table 5.

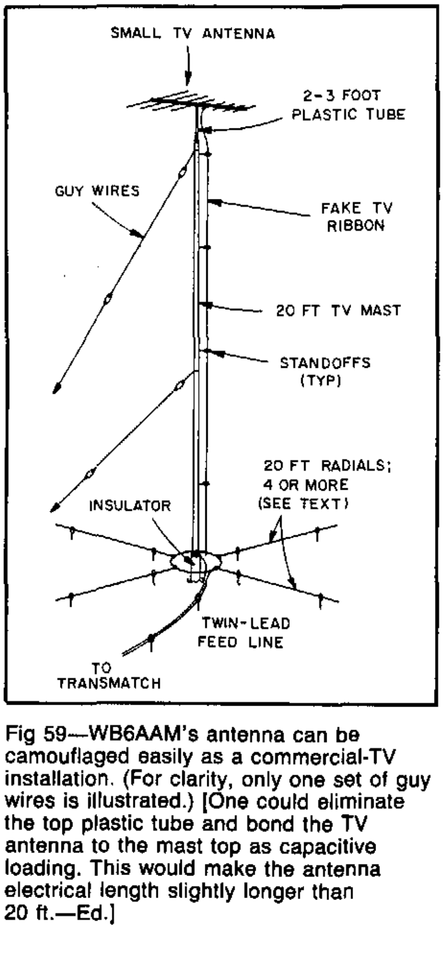


Fig 59—WB6AAM's antenna can be camouflaged easily as a commercial-TV installation. (For clarity, only one set of guy wires is illustrated.) [One could eliminate the top plastic tube and bond the TV antenna to the mast top as capacitive loading. This would make the antenna electrical length slightly longer than 20 ft.—Ed.]

The radiator can be any conductor: flagpole, round or square aluminum stock, wire and standoffs on a dry wooden pole, or TV-mast sections to name a few. A military set with mast sections, whip sections, insulator, base and guys would be a good field antenna.

Someone who lives where only TV antennas are allowed could try this idea: Use two 10-ft sections of TV mast and add a plastic insulating section (of a similar color) with a small TV antenna on the top.

Table 5
Estimated Performance of WB6AAM's Antenna†

Band	*Antenna Length*	*Estimated gain over λ/4*
10 m	0.58 λ	3 dB
12 m	0.51 λ	2 dB
15 m	0.43 λ	1.5 dB
17 m	0.36 λ	1 dB
20 m	0.28 λ	0.5 dB
30 m	0.20 λ	
40 m	0.15 λ	
80 m	0.08 λ	

†Gain shown is with respect to a λ/4 vertical monopole over a similar reflecting surface.

To add realism, add some TV standoff insulators and fake twinlead. (Remove the wire from the ribbon cable so that it does not interact with the antenna.) The radials can be thin wire or TV ribbon, close to the roof on standoffs. (Short each end of the TV ribbon—Fig 59.)

My version of W4VON's antenna is 5/8 λ on 10 meters as I prefer the 10, 12 and 15-meter bands. The design could be changed for 5/8 λ on some other band. Remember, however, that the take-off angle steepens quickly as antenna length exceeds 3/4 λ. As the length increases to λ, the vertical radiation pattern becomes more complex—resembling a cloverleaf, rather than a toroid. Multiple lobes of energy appear skywards as the length increases, with only minor lobes near the horizon. A 10-meter OSCAR user might take advantage of such a pattern, but terrestrial contacts won't be very strong.—*James G. Coote, WB6AAM, Los Angeles, California*

PUTTING THE BUTTERNUT VERTICAL ANTENNA ON 160 METERS

☐ My 160-meter antenna is a Butternut HF2V equipped with the optional 160-meter base coil. Considering that this antenna is only 32 feet long, it does a good job. Its bandwidth on 160 is 10 kHz or so without top loading. In fact, life on 160 with the HF2V is difficult for me only when I want to move around in the band: Readjusting the antenna is laborious.

My attempt to solve this problem was to put taps on the 160-meter base coil. I was satisfied with this until the weather turned bad. (Working at the antenna base in the freezing rain is unpleasant enough to get the old gray matter working on a better way!)

Butternut's optional 160-meter loading coil kit consists of a large inductor, two high-voltage 200-pF capacitors and mounting hardware. The two capacitors are used in parallel with the 160-meter coil to resonate the antenna in the 160-meter band. It occurred to me that easy remote tuning could be mine if I replaced one of the 200-pF fixed capacitors with a motor driven *variable* unit—to be controlled from the comfort of my shack, of course!

I calculated the inductance of the 160-meter coil as roughly 12.8 μH. Further calculations revealed that a coil of this value would require 550 pF to resonate at 1.9 MHz—more capacitance than that afforded by the paralleled 200-pF capacitors. Clearly, the antenna element adds enough inductance and capacitance to the circuit to bring the system down to its correct frequency. I decided to treat the antenna's effect as purely capacitive in calculating the value of my variable "QSY capacitor." I determined that placing a 150-to-250-pF variable in parallel with *one* of Butternut's 200-pF add-on capacitors would allow me to adjust the antenna's resonant frequency across the entire 160-meter band.

Finding a suitable variable capacitor was the next problem. I located a suitable capacitor in an electronics surplus store. Problem, though: Under test, the capacitor's 0.025-inch spacing could not withstand the voltage across the 160-meter tuned circuit. I increased its spacing to 0.05 inch by removing every other rotor plate and maintained the proper rotor-to-stator spacing by installing two rotor plates back-to-back wherever one was needed. To obtain the 150-pF minimum capacitance called for in my calculations, I rotated three of the rotor plates 180° relative to the others and paralleled the variable with a 50-pF, 3000-V mica capacitor. When three plates are fully meshed with the stator, this combination unit provides 150 pF; turning the shaft 180° meshes four plates with the stator and increases the total capacitance to 250 pF. I tested the QSY capacitor by substituting it for one of Butternut's 200-pF units. It worked great!

Next, I found a 120 V ac, 1 r/min timer motor to turn the capacitor shaft. To supply power to the motor, I decided to use two 120- to 12.6-V transformers back to back—one in the shack (step down) and the other at the antenna base (step up). The motor is coupled to the capacitor by means of a 1-inch piece of vinyl tubing cut from a fish tank suction cleaner. I mounted the QSY capacitor, motor and step-up transformer in a plastic lunch box and installed the box at the base of the antenna. To protect the components from the weather, I sealed the lunch box with caulking.

The QSY capacitor allows me to tune the antenna for a 1:1 SWR anywhere in the 160-meter band. Installation of the capacitor also had a positive effect on the SWR bandwidth at 40 and 80 meters: I gained 56 kHz at 80 and 84 kHz at 40.

Operating with the modified Butternut vertical is a pleasure. QSY on 160 is accomplished as follows. First, I determine the approximate capacitor setting by applying less than 1 W to the antenna and watching the SWR meter as the capacitor is tuned. As the capacitor approaches the correct value, the SWR drops rapidly. At this point, I turn off the capacitor motor and increase power to a watt or two. (The higher power level allows finer adjustment.) Then, I start the motor again and turn it off when the SWR reaches minimum. There you have it: 160-meter QSY in less than a minute with a few flips of a switch—from the cozy comfort of the shack!—*Robert G. Pierlott, III, WE4J, 8824 Nightingale Ln, Pineville, NC 28134*

WEATHER PROTECTION FOR VERTICAL-ANTENNA FEED POINTS

☐ I have found that in very wet and rainy climates, where the rain is usually wind driven, a weather boot sealed with silicone caulk does not work well. Coax Seal™ and especially electrician's tape do not adhere well to silicone caulk. The driving rain can be blown or wick into the bottom of the boot, then down the cable braid. Here, however, is an excellent procedure for weatherproofing antenna connections (refer to Fig 60):

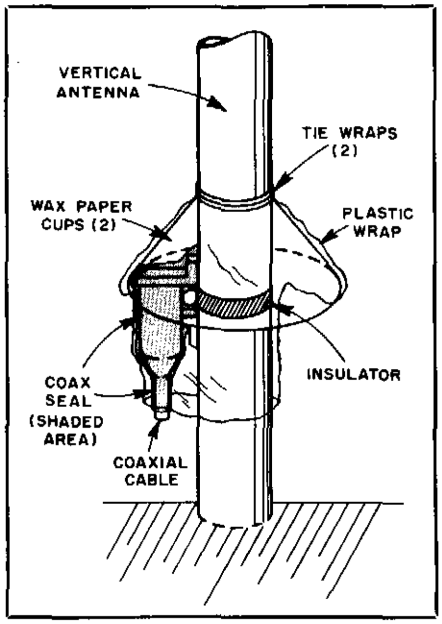


Fig 60—N7ENI's sealed connection on the feed point of a vertical antenna.

- Start with clean, dry connectors (as little skin oil as possible).
- Wrap the connection with several layers of electrical tape.
- Apply Coax Seal to the entire connection and down along the coaxial cable.
- Use two heavy-duty wax-coated paper cups, one inside the other, to make a "tent" around the antenna feed point and coax connector. (The cups deflect rain, so that water doesn't sit on top of the connector joint.)
- Lay a sheet of clear plastic wrap over the cups, push it up inside the cups and then pull it down over the sealed connections.
- Press the plastic wrap into the Coax Seal. (Coax Seal and clear-plastic food wrap stick together, thus forming an airtight joint.)

Wind, freezing rain and other severe weather cannot damage the joint. The great bond that Coax Seal makes with plastic wrap doesn't allow any moist air or wind-driven rain to enter the joint along the cable surfaces. I've had no leakage problems since using this system.—*James Fox, N7ENI, ARRL Technical Coordinator, Portland, Oregon*

THE WHIPPY WHIP

☐ The 2-meter band bustles with repeater activity in the Denver area: Even with 15-kHz channel spacing, almost all the possible repeater frequencies are filled. Having many repeaters to choose from is great, but two aspects of repeater use give constant trouble: Inadequate antennas and battery packs on hand-held rigs. I've found a way to attack both of these problems at once: the Whippy Whip.

A hand-held rig works surprisingly well if used with a decent antenna; the "rubber duck" commonly used with hand-held rigs might better be called a "rubber dummy load"! The Whippy Whip is a move toward a decent antenna. It consists of a BNC connector and a length of 0.025-inch music wire (available at hardware stores; my wire cost 15 cents). Disassemble the BNC connector so that no insulation is left in contact with the center pin. Sandpaper the end of the wire and tin it lightly. Then, solder the end of the wire to the connector's hollow center pin. Assemble the BNC and cut the overall length of the antenna to ¼ wavelength at the center of the 2-meter repeater band (19 to 19½ inches). (Make the wire a half inch or so longer than necessary to allow the wire end to be bent into a small loop with needle-nose pliers. Don't use the Whippy Whip without adding this loop because the end of the wire is dangerously sharp.)

With the Whippy Whip in place, you can make many contacts impossible with a rubber duck. Because the Whip is a significantly better antenna than the duck, you may often find that you can use your hand-held at its low-power setting and get more QSOs per charge out of the rig's battery pack. Not bad for a buck's worth of parts! By the way, I find the Whippy Whip to be every bit as convenient as a rubber duck because it can be looped into a circle or put into a pocket. It literally springs into action when released!—*Nate Bushnell, KDØUE, 7175 S Grant, Littleton, CO 80122*

AN UMBRELLA ANTENNA

☐ While I was going to work one rainy day in the Pacific Northwest, a strong gust of wind turned my umbrella inside out and made my friends laugh. When I got to work, I fixed my umbrella and let it dry in an open area with my coworkers' umbrellas. Looking at them gathered in the corner of the room reminded me of dish antennas with handle-shaped feed horns! *This* thought, combined with the memory of my inside-out-umbrella experience of earlier in the day, gave me the idea of basing a ¼-wave, 2-meter ground plane antenna on an umbrella frame. As soon as I got home that day, I started work on the project.

I found an old collapsible umbrella that looked just right for the job. (The right umbrella for the job should [1] be expendable; [2] have a straight, and not curved, grip; [3] have a telescoping metal handle; and [4] have a spoke assembly that is insulated from the handle.) I attached a coaxial feed line to the umbrella by soldering the coax braid to the spoke assembly and the coax center conductor to the metal umbrella handle (just above the plastic spoke bushing, with the umbrella handle up). To improve the performance of the spokes as a ground plane, I soldered connecting wires between the spokes close to the hub. Using an SWR meter and hand-held transceiver, I adjusted the length of the telescoping handle for minimum SWR (between 1.3:1 and 1:1 in this case). I soldered the handle sections together to preserve this adjustment. To help preserve the shape of the inside-out spoke assembly, I threaded nylon fishing line through the holes at the end of the spokes, pulled the line taut and tied it. Finally, I threaded a long machine screw into the plastic umbrella handle—at the top of the vertical antenna element—to allow the umbrella antenna to be hung from an antenna mast.

The antenna works! I can bring up a lot more repeaters with my hand-held transceiver now than I could before.—*Oscar Naimi, N7FXY, 24012 7th Ave W, Bothell, WA 98011*

LOOP COUPLING FOR J ANTENNAS

☐ Coax can be matched to a **J** antenna's quarter-wave section by means other than clamping, clipping, bolting or soldering. Using an idea by Lawrence Showalter, W6KIW, and Robert Hopkins, K6MUP, I tried coupling to a **J** with a loop (Fig 61). Loop coupling systems are nothing new for some antennas, but for the **J**, loop coupling is a new idea that works fine. I find that loop coupling allows me to obtain a lower SWR on the **J**'s feed line more quickly than tapping the line on the **J** element.

My **J** antennas consist of ½-inch-diameter copper tubing, elbows, **T**s and caps. The center-to-center spacing of the ¾- and ¼-λ portions of a **J** constructed of these materials is 1¾ inches. The coupling loop I use is 5½ × 1¾ inches in size and consists of plastic-coated no. 14 copper

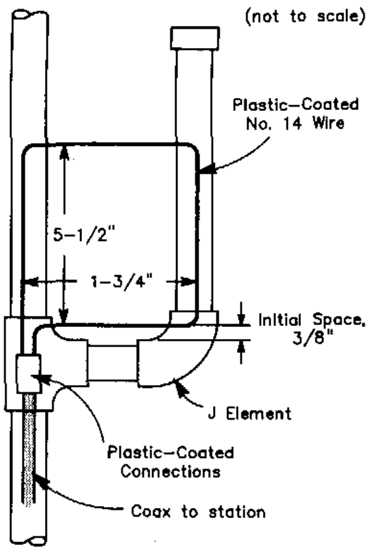


Fig 61—Henry Davis feeds his VHF J antennas with the loop coupling system shown here. See the text for how to position and mount the loop for minimum SWR.

wire. Connect one end of the loop to the coax center conductor and the other end of the loop to the coax shield. Be sure the loop ends don't touch where they connect to the coax, and coat the connections well with liquid plastic. (Plastic compounds intended for dip-coating tool handles work fine.) Position the loop flat against the **J**'s piping, with the loop bottom about 3/8 inch from the inside bottom of the crook of the **J**. Temporarily tape the loop to the **J** element.

Adjusting the loop for minimum SWR is simple: Move the loop up or down from its initial position until you find the point of minimum feed-line SWR. Once you've found this point, tape the loop as closely to the **J**'s copper pipe as possible. Space between the coupling loop and the **J** element raises the SWR.—*Henry Davis, W6DTV, 7822 Washington Ave, Sebastopol, CA 95472*

CHAPTER 8
Operating Techniques

A STEADY TONE FOR MAKING MIC-GAIN ADJUSTMENTS

☐ I use a recording of a steady, long (30-seconds) CW note to adjust the microphone gain on my SSB transceiver. [A code practice oscillator, or sidetone from a keyer, should also work well.—Ed.] To make the adjustment, play back the tone at moderate volume with the tape recorder speaker about two or three inches from the radio microphone, increase the microphone gain until the radio output power stops increasing, then reduce the gain a little. The CW note makes a much steadier signal than the common voice "Haaaaa Loooo" I often hear on the air.

I make frequent checks, and reports indicate that my signal is no wider than 3 kHz even when using my amplifier. Also, do use a dummy load while making transmitter adjustments.—*A. F. "Pete" Peters, KF7R, Livingston, Montana*

FAST OFF-THE-AIR TUNE UP

☐ In our crowded bands, it is nearly impossible to tune up on the air without creating QRM for someone. Fortunately, tune up off the air is possible and practical. K4KI described one approach using a simple, home-built bridge in the Dec 1979 *QST*. Another approach is to use an antenna noise bridge (such as those available from Palomar Engineers and MFJ Enterprises) with a Transmatch. Here is how:

1) Insert the bridge in the line between the transceiver and Transmatch.

2) Set the bridge for R = 52 Ω and X_{LC} = 0 Ω, and switch on the noise amplifier.

3) Adjust the Transmatch for a sharp null in receiver noise. (You may need to lower the RF gain.)

4) If you have a radio of broadband design, remove the bridge and you are ready to go. Narrow-band rigs should be tuned into a dummy load, then switched to the antenna. There is no need to check the Transmatch settings with an SWR meter (or repeak your narrow-band final amplifier) on the air. Tuning is perfect every time.

It is not convenient to insert and remove the bridge from the line for each tune up, but you can switch it in and out with a DPDT switch, as shown in Fig 1. You can buy such switches from Barker & Williamson (Model 551A), or build one yourself with a DPDT ceramic-wafer switch mounted in a Minibox (as shown in Fig 2). If you have a narrow-band amplifier, add a standard antenna switch to select either the dummy load or your Transmatch.—*Dick Lamb, KØKK, Iowa City, Iowa*

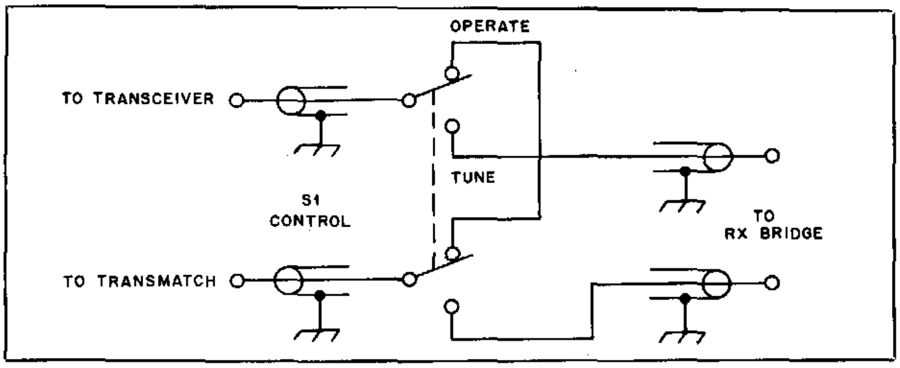


Fig 1—A schematic of the switching arrangement to place a noise bridge in the transmission line for Transmatch adjustment. Do not transmit with the noise bridge in the line!

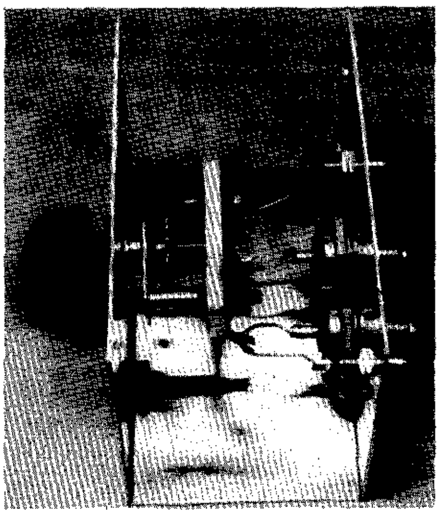


Fig 2—A photo of KØKK's home-built switching arrangement.

NOISE BRIDGE AIDS TRANSMITTER OUTPUT NETWORK ADJUSTMENT

☐ The anode matching network in a grounded-cathode or grounded-grid RF amplifier circuit must provide a proper load resistance to the amplifier tube(s) for maximum power transfer. Matching-network design formulas can provide the appropriate component values necessary for this condition, but adjustment of the network is often necessary after the amplifier is built—especially if the exact values of the components used are unknown. Here is the technique I use to make output-network adjustment quicker and easier. The method depends on the use of a resistance-reactance (RX) noise bridge.

Remove all voltages but filament or heater from the amplifier tube(s). Determine the proper load resistance for the tubes from the appropriate formulas and shunt a noninductive resistor of this value from the tube anode(s) to ground (across the input of the output matching network). Put the amplifier into its transmit mode, or temporarily rewire the amplifier's TR relay to connect the amplifier output to its load. Connect the noise bridge's UNKNOWN port to the amplifier's OUTPUT connector with a *short* piece of coaxial cable. Adjust the bridge to read zero reactance and a resistance equal to that for which the amplifier is designed (usually 50 ohms).

With a receiver connected to the appropriate noise-bridge port and tuned to the frequency at which the output network is to be adjusted, attempt to obtain a noise-bridge null by adjusting the amplifier output network. If you obtain a null, no further adjustments are necessary. If you cannot obtain a null, add or remove inductance in the amplifier output network until you achieve a null at zero reactance and 50 ohms resistance. (If you like, you can adjust the bridge for a null before changing network component values. The reactance and resistance values necessary for the noise-bridge null can help you decide whether to add or remove output-network inductance for a 50-ohm match.)

Once you've gotten your output network into proper adjustment, don't forget to remove the noninductive load resistor between anode(s) and ground!

This noise-bridge method sheds some light on what is otherwise often pure guesswork. Two amplifiers that I adjusted in this way both operate at near optimum efficiency. Although I've used this procedure only on pi networks, it should be equally applicable to other network configurations.—*I. Dean Elkins, K4ADJ, 212 Old Orchard Ln, Henderson, KY 42420*

USE YOUR TRANSCEIVER'S NOTCH FILTER AS A ZERO-BEAT INDICATOR

☐ In Hints and Hinks for August 1985,[1] Dr Gerald N. Johnson, PE, KØCQ, describes a method of setting the controls of a Kenwood TS-830S transceiver so that the rig's transmitted CW frequency is very close to that of incoming signals received at a particular pitch. The accuracy of his method depends on an operator's ability to recognize a pitch of 800 Hz, the difference ("offset") between the TS-830's transmit carrier and receiver BFO frequencies.

I prefer the method found in the instruction manual (for the TS-430S, in my case). This method zero-beats the pitch of a signal tuned at IF center with the 800-Hz transmitter sidetone. I prefer this method because the transmitter offset is almost exactly 800 Hz [assuming that the rig's CW receive and transmit carrier-oscillator frequencies are within tolerance—Ed.]—and because the ear can match two audio tones to less than the maximum tuning error possible with the '430's 10-Hz-step tuning (5 Hz).

This zero-beating technique has a drawback: It's more difficult to zero-beat the sidetone with a fading CW signal than a steady carrier, particularly when the audio from the received signal is considerably weaker than the sidetone. To avoid this, and to mark the IF passband center more permanently, I modify the TS-430S *Instruction Manual* zero-beat procedure (§5.6.1, p 13) as follows (this technique requires that the TS-430S frequency display has been modified for 10-Hz resolution):

1) Tune the transceiver as described in the *Manual* on a strong, steady carrier, such as a nearby beacon or WWV.

2) Switch on the transceiver's notch filter.

3) Adjust the notch filter for a null in the received signal. If the test signal is modulated with a continuous tone (often the case with WWV), be sure to null the carrier and not one of the tone sidebands.

4) Switch off the notch filter.

Leave the notch tuning control at this setting while operating. To zero-beat your transmitter with an incoming signal,

1) Tune the received signal close to IF-passband center by ear.

2) Switch on the notch filter.

3) Fine tune the transceiver to null the incoming signal.

4) Switch off the notch filter. Your transmitter and the incoming signal are now as close to zero beat as can be achieved with the rig's 10-Hz tuning steps.

For the most part, this method "dedicates" the notch to the zero-beating function. You can use the notch against signals very close to the desired signal, however, by adjusting the transceiver's RIT control to put the interfering signal in the notch. Remember: Don't adjust the notch-filter tuning control to reject interference; you're using the notch filter for zero-beating now. Use the transceiver's IF shift circuit for interference rejection.

Because the TS-430's AF sidetone oscillator operates independently of the '430's RF circuitry, the sidetone frequency may not be exactly 800 Hz. You can get around this error by measuring the actual sidetone frequency and allowing for the error when setting your transmit frequency. Here's how to use the TS-430's frequency display and sidetone oscillator to measure the sidetone frequency: Set the rig for CW reception at its "wide" IF bandwidth. Turn the IF SHIFT control all the way to the left. Tuning from well below the test signal, zero beat the test signal with the sidetone. Note this frequency. Next, tune in the test signal from *above,* zero beat it with the sidetone, and note *this* frequency. Subtract the lower frequency from the higher, and divide the result by two. The resulting number is your sidetone frequency. Measured with this technique, the sidetone frequency in my TS-430S turns out to be about 770 Hz. *—Brice Wightman, VE3EDR, Ottawa, Ontario*

BETTER OPERATING ON NOISY MF/HF BANDS

☐ Here in the Southwest, rainy-season thunderstorms bring almost intolerable early-morning static to my 75-meter Early Bird net. My outboard speaker, tailored to voice frequencies, actually accentuates static peaks—and my transceiver's noise blanker doesn't touch them. Through trial and error, I've found two things that help me work through all but the very strongest local storms (which would require me to shut down the rig anyway!).

1. Turn on your transceiver's RF attenuator and carefully reduce the radio's RF gain to the point where stations still come through with reasonable strength. This helps tremendously, but does not always let me pull through weaker signals in heavy static.

2. Use lightweight stereo headphones instead of a speaker. (They needn't be expensive—the ones I use cost $3 at a local discount drugstore.) Their transient response removes the sharp *crack* from static bursts and tremendously improves readability. Get phones with foam ear pads; they don't shut out outside conversation.

This combined approach—attenuation and RF-gain adjustment in conjunction with more effective headphones—reduces my static problem to the point where I can handle the net virtually all the time. *—George C. Whitney, W5VIJ, 1802 Debra St, Las Cruces, NM 88001*

WJ1Z: It also pays to select the narrowest IF filter that allows satisfactory copy; to experiment with your radio's passband tuning/IF shift/slope tuning; and to try your radio's different AGC choices (FAST, SLOW and maybe MEDIUM) for settings that let you hear the other stations best.

Ham lore, panel labeling and wishful thinking notwithstanding, the noise blankers in current MF/HF transceivers are generally not intended to act on static (and line noise). They're primarily designed to reduce internal-combustion-engine ignition noise and (in radios with a second or "wide" noise blanker) pulses from some types of HF over-the-horizon radars.

HOW'S THE WEATHER BEACON FOR VHF DX?

☐ VHF DXers are in constant need of beacon stations on 2 m to help them spot band openings. For years, TV- and FM-broadcast stations have served this purpose, but many do not transmit continuously.

NOAA weather stations, however, are handy, free VHF beacons. The stations operate, around the clock, on three frequencies near 162 MHz, and they don't cost you a dime (except in taxes).

Over the years, I have found NOAA stations near me, in the Carolinas, a good indicator of tropospheric ducting. Since the NOAA frequencies are fixed, a weather radio, scanner or one of the new 2-m rigs may be simply switched among the channels for a reliable propagation check. This morning, for example, the NOAA station at Conway, South Carolina (it identifies as Myrtle Beach), 110 miles from my QTH, is completely overriding the QRP repeater at Sumter, which is in my line of sight.

I have noted "tropo" openings on the NOAA frequencies for the past six years, and they almost always correlate with 2-m conditions. In the winter, I have heard the NOAA stations in Raleigh-Durham, Wilmington and Cape Hatteras, North Carolina, and some in Virginia, during tropo openings.

Since these signals are heard here with nothing more than a small, monopole antenna on the back of the scanner, I can well imagine that an outside antenna, especially a beam, would let me hear even more distant NOAA "beacons." *—Drayton Cooper, N4LBJ, Bishopville, South Carolina*

FINGERTIP BEAM HEADINGS

☐ I have a poor memory for beam headings. I once used the beam-heading references from the DX *Callbook,* but it took time to find the book and locate the country and heading. The DX station would

[1]Gerald N. Johnson, "Transceiver Tuning," Hints and Kinks, *QST*, Aug 1985, pp 41-42.

usually contact someone else or change frequency before I found the heading, and I would lose him. My solution is a Desk Top Automatic Directory (model 43-105; $24.95) from Radio Shack®. This device is intended for fast location of telephone numbers. I use it to find beam headings rather than phone numbers. If I hear a TI call sign, I simply push the button lettered "T" and see that TI is Costa Rica and the beam heading is 199°. It's both speedy and efficient.

The directory is powered by two C-size batteries. It has a keyboard consisting of 15 buttons labeled from A to Z. It contains about 40 index cards, which can be selected by pressing the appropriate button. I listed the countries alphabetically according to their call-sign prefixes and have over 340 on the index cards. Call signs with numbered prefixes are listed under "MN" and "QR."—*George R. Golodich, K2OEK, West Haverstraw, New York*

☐ Here is a way to have beam headings and international prefixes instantly available. With this simple gadget, you can have your antenna pointed at that rare DX station before he finishes his CQ call.

Next time you go grocery shopping, buy a large can of tomato juice. I found a 46-ounce can that is 7 inches tall and 4½ inches in diameter, with no dents—just right!

1) Remove the label, empty and rinse the can through two small holes in one end.

2) Drill a hole in the exact center of each end to snugly fit a pencil-size rod about four inches longer than the can. (A 2-inch extension at each end serves as an axle for the rotating drum.) Apply a little solder or epoxy to the axle and can ends to hold the rod in place.

3) Remove the page of International Radio Amateur Prefixes from the *Callbook*, and write the beam heading for each country next to the prefix. Trim the page margins to fit the drum, and secure the page to the drum with tape.

4) Make a rack of wood or metal to hold the drum, and place the assembly near your rotator controller.

With the completed beam-heading drum you can have your beam set "right on" and ready to answer when that DX station signs "over."—*Mal Tindall, KA8GOB, Sarasota, Florida*

PENCIL CONTROL FOR CONTESTERS

☐ In a CW contest, it is a terrible nuisance to keep track of your pencil, and you may have wished there was some simple way to eliminate that constant search. There is: *Wear* the pencil on your middle finger, cradled next to your forefinger. Attach the pencil to your middle finger with two rubber bands positioned between the knuckle and first joint, with the pencil point somewhat back of the middle finger tip. To write, curl your forefinger over the pencil and draw it down to be gripped between the forefinger and thumb on one side and the middle finger on the other side. (That's not how you were taught to hold a pencil, but penmanship is good enough for printing a log sheet.) After writing, curl your forefinger under the pencil and the rubber bands to lift it out of your way. Voila! Pencils that are over five inches long don't seem to balance well.—*W. A. "Spud" Monahan, K6KH, Manhattan Beach, California*

KEEPING TRACK OF AWARD ENDORSEMENTS

☐ Some operating awards can be endorsed for additional submissions beyond the basic qualification level. Keeping track of progress up the endorsement ladder requires good record keeping. You can use the same award-record sheets again and again if you use a *colored* pen (I use red) to enter QSO data on the record sheet. When you have accumulated enough entries to qualify for the basic award, make a black-and-white photocopy of the record sheets for yourself and send the *originals* to the award administrator.

Use the photocopied sheets to track your endorsement progress without confusion. The entries you made in color on the original record sheets appear in black on the photocopy. Record your endorsement data in color on the photocopy, and you'll have no trouble distinguishing records of endorsement QSOs (colored ink) from data pertaining to the basic award (black ink).

I devised this scheme to aid me in working toward Japan Amateur Radio League awards. JARL's Japan Century Cities (JCC) and JCG (Japan Century Guns)[2] awards, for example, have endorsement increments of 100, beginning at 200. With 641 Japanese Century Cities and 569 Japanese Century Guns, I'd go crazy without an easy means of distinguishing records of the first hundred QSOs from records of the second hundred, and so on. This technique helps me keep my records straight.—*Jack Wichels, W7YF, Edmonds, Washington*

[2]Japan has, as administrative districts, 47 prefectures. These are divided into cities, towns and villages. The *gun*, which is not an administrative district, is a regional congregation of towns and villages. See *The ARRL Operating Manual*, third edition, for details on JARL awards.—Ed.

CHAPTER 9

Around the Shack

VOICE AND OTHER MODES

IMPROVEMENTS TO A "REAL TURN-ON"

☐ I read George Murphy's "A Real Turn On" with great interest.[1] It was the first time I'd seen a ladder diagram in *QST*. One thing that bothers me about George's circuit is that if the first control circuit is de-energized, all of the following circuits are de-energized. Fig 1 shows a redesign that allows each circuit to be controlled independently after startup. This modified circuit requires that K2 (a DPDT relay in George's circuit) be changed to a 4PDT unit, three poles of which are used.

Modified as shown in Fig 1, the Turn-On works as follows: When power is applied, DS1 (OFF 1), DS3 (OFF 2) and DS5 (OFF 3) come on. Pressing momentary push-button S2, START 1, energizes solenoid K1A. The NO contacts of K1B close to shunt S2 and send 12 V dc to output 1 and DS2 (ON 1); the NC contacts of K1B open, turning off DS1. The closure of K1C's NO contacts arm the second control circuit.

Circuit 2 operates when S4, START 2, is pressed. Pressing S4 actuates K2A; the NO contacts of K2B shunt K1C; K2C shunts S4 and turns on DS4 (ON 2). At the same time, the NC contacts of K2B open, turning off DS3. Circuit 3 is identical to circuit 2.

As in George Murphy's circuit, the START switches are shunted by relay contacts once their respective circuits turn on. My circuit differs from George's in that the relay contacts that arm circuits 2 and 3 (K1C and K2D) respectively, are themselves shunted by relay contacts (K2B and K3B, respectively). K2B and K3B act as "arm-latch" contacts, allowing circuits higher on the ladder to be turned off without affecting circuits lower on the ladder. This preserves the 1-2-3 cold-start sequence. —*Eugene Hecker, WB5CCF, PO Box 940, Magdalena, NM 87825*

[1]G. Murphy, "A Real Turn-On," *QST*, Nov 1987, pp 23-27.

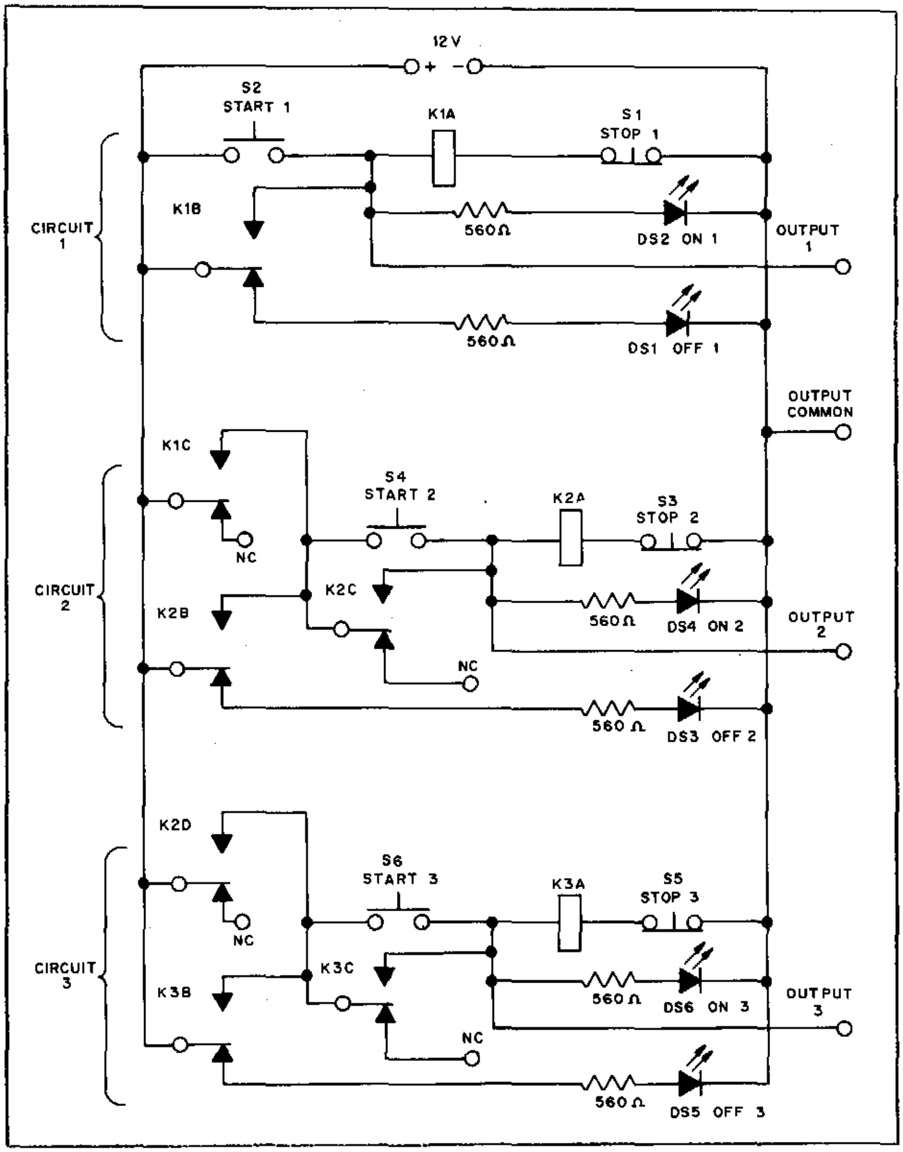


Fig 1—Eugene Hecker's modified Turn-On allows the various control circuits to be turned off independently once they've been powered up in 1-2-3 order. Note, however, that the ability to turn earlier circuits on and off independently can allow other than a 1-2-3 startup sequence if turned off circuits 1 and/or 2 are turned back on without restarting the entire ladder. (See text.) The remainder of George Murphy's circuit (see the article cited in note 1) is used without modification.

K1, K3—DPDT relay, 12 V dc solenoid (Radio Shack® 275-249 or equiv).
K2—4PDT relay, 12 V dc solenoid (three poles used; RS 275-214 or equiv).
DS1, DS3, DS5—Green LED.
DS2, DS4, DS6—Red LED.
Resistors are ¼-watt carbon film.

A 10-MINUTE ID TIMER

☐ Here's a 10-minute ID reminder that can be built in one evening for under ten dollars. All of its parts are available at Radio Shack. Accurate to within 1 second per timing cycle, it resets automatically at power-up, and at the end of each timing cycle.

Construction and adjustment. The timer (see Fig 2) can be built on a small piece of perfboard and housed in any convenient enclosure. Parts layout is not critical.

Adjustment. Adjust R1, COARSE TIME ADJ, to get you into the ball park, then adjust R2, FINE TIME ADJ, for precise 10-minute timing. The LED flashes for about 3 seconds at the end of each timing cycle. If a frequency counter or oscilloscope is available, you can save yourself much trial and error by adjusting R1 for 106 Hz (period, 9.5 ms) at pin 5 of U1.—*John Conklin, WD0O, 1704 Lower Silver Lake Rd, Topeka, KS 66608*

THE BEEP-OVER

☐ Many repeaters transmit a "courtesy beep" to signal the end of a transmission. The same practice can be used to advantage during MF/HF-simplex communication, particularly by net control stations. Fig 3 shows my circuit for providing an end-of-transmission beep. It should work with any transceiver with a positive PTT (push-to-talk) line that (1) must be grounded in transmit and (2) does not allow the PTT bus to rise above 15 V during receive. The Beep-Over can be built into the base of a microphone—I built one into my Kenwood MC-60—or placed in a metal box somewhere out of the way and connected by a short, shielded cable to the mike or your transceiver's phone-patch input.

U1, a 4047 low-power monostable/astable multivibrator IC, generates a pulse about 200 ms long as the PTT-bus voltage rises after PTT-button release. U2, another 4047 connected as an astable multivibrator, generates a 1-kHz signal when U1 keys it. The chips operate well on a 5- to 15-V supply; the PTT bus itself can supply the necessary current. D1 and C1 decouple and filter the PTT line for this purpose. (Alternatively, a 9-V transistor battery can power the device for several months.)

The ramping capacitor (C2) is important, as it keeps the transceiver keyed for a short time after PTT-button release to permit the

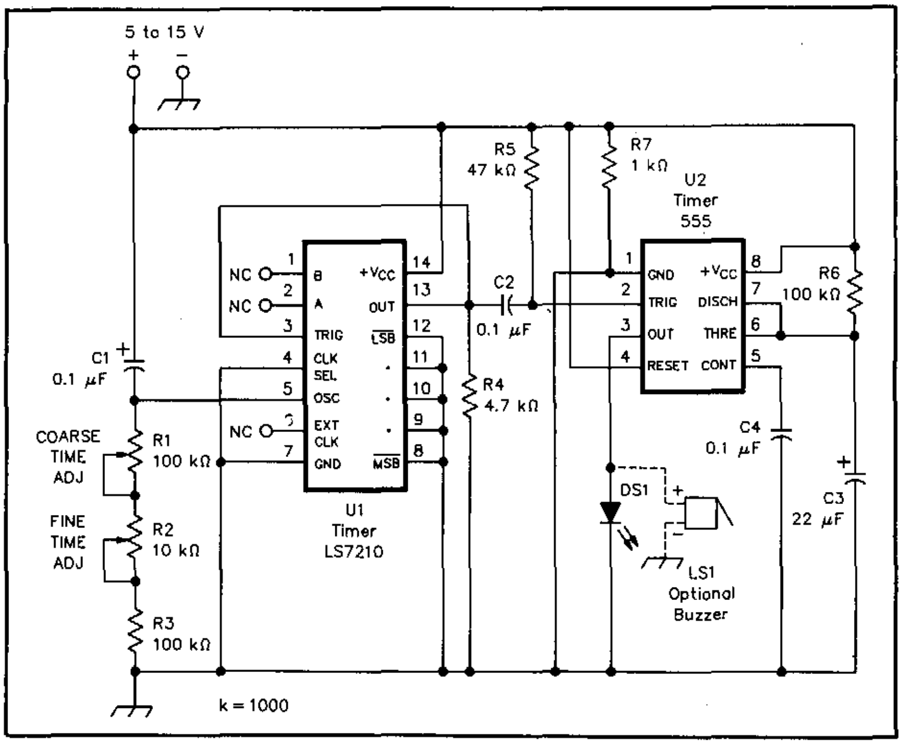


Fig 2—John Conklin's 10-minute ID timer is accurate to within 1 second per timing cycle. Use your TR relay to connect the circuit to its dc supply on transmit; the circuit resets automatically. All of the timer's resistors can be 5% or 10%-tolerance units. A standard (non-blinking) LED may be substituted for DS1; if you use a standard LED, wire a 220-ohm resistor in series with it for current limiting. If you use a buzzer, select one that draws less than 100 mA.

C1—Polyester, metallized film or tantalum (for low leakage), 16 V or more.
C2, C4—Ceramic disc, 16 V or more.
C3—Aluminum electrolytic, 16 V or more.
DS1—Blinking LED (Radio Shack 276-036 [red] or -030 [green]).
LS1—Buzzer, current drain 100 mA or less (optional).
R1—Trimmer potentiometer.
R2—Multiturn trimmer potentiometer.
U1—LS7210 timer IC (RS 276-1307).
U2—555 timer IC (RS 276-1723)

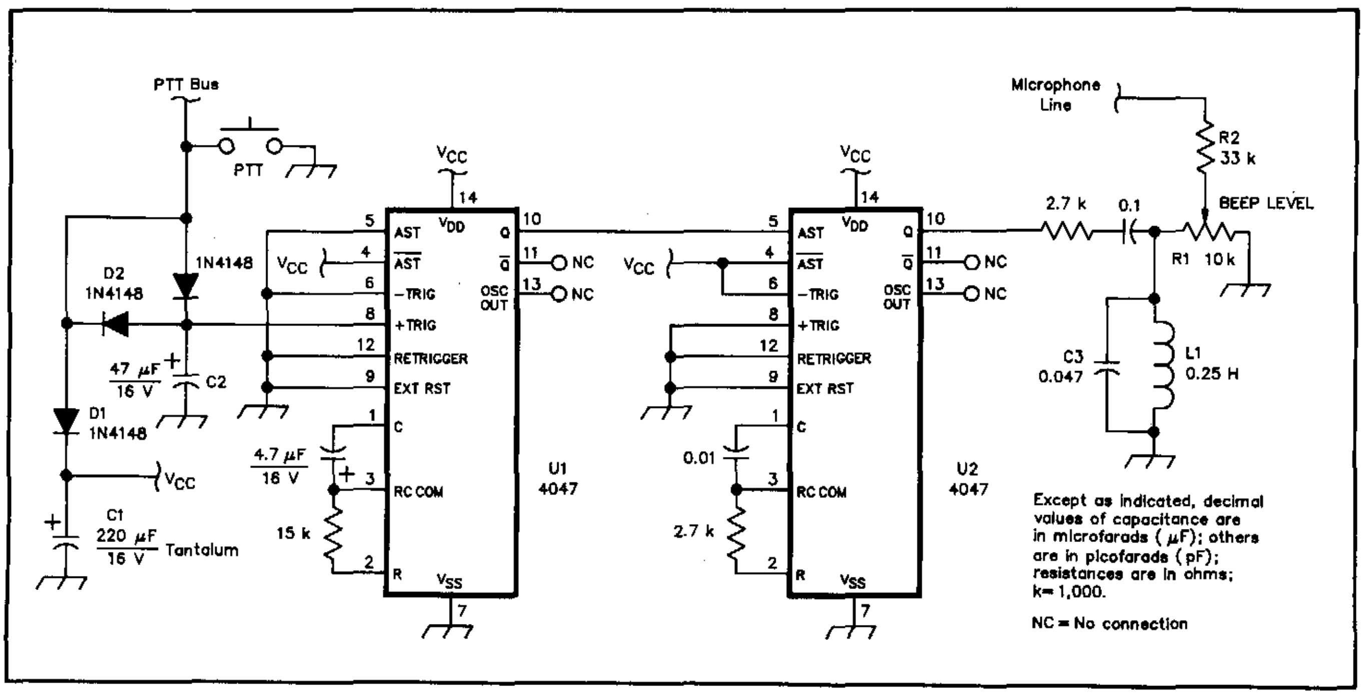


Fig 3—John Reinke's Beep-Over generates a courtesy beep on PTT-button release, before its associated transceiver switches to receive. (This schematic shows the preexisting mike PTT button merely to aid the text discussion; you don't need to install another one!) You may need to experiment with the values of C2 and R2 as described in the text. If you build this circuit, *connect your transceiver to a dummy antenna* when adjusting and testing it. All of the circuit's resistors are ¼-W, carbon-film units.

Beep-Over to insert its beep before the transmitter shuts down. You may need to experiment with C2's value for optimum results.

L1 and C3 turn the oscillator's square-wave output into a sine wave and eliminate most of the harmonic content of the beep. Any LC combination that resonates at the oscillator's output frequency and exhibits a reasonable Q should be satisfactory.

R2 keeps R1 from loading the transceiver mike line. You may need to experiment with R2's value in your application. With my MC-60 mike set to high impedance to drive my Kenwood TS-430S transceiver, 33 kΩ was about right.—*John Reinke, AB6I, 370 Kingsley Dr, Casselberry, FL 32707*

A DOORBELL ALERT ALARM

☐ Have you ever missed hearing your doorbell or chime when you were deeply engrossed in operating your station? The solution to this problem is simple: Run a length of thin, two-conductor speaker wire from the terminals of the existing bell or chime to an appropriate location in your shack and complete the circuit with an electromechanical buzzer. There's a much more pleasant-sounding and sophisticated method, however: Use a piezoelectric buzzer instead! (Radio Shack sells several suitable types.) The dc drive necessary to operate these devices can be obtained using the circuit shown in Fig 4.

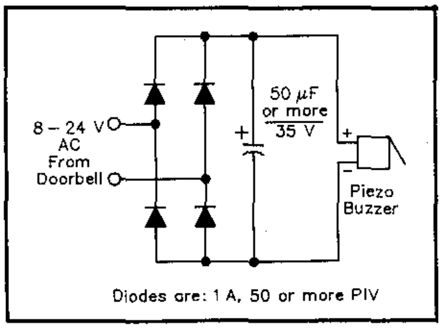


Fig 4—Maurice Sasson uses piezoelectric buzzers to extend the coverage of his doorbell. The filter capacitor, C, smooths the pulsating dc output of the bridge for purer buzzer tones. If the bell transformer voltage is too high for the alerter circuit, add a dropping resistor in series with one of the FROM TRANSFORMER lines.

Since installing these alerting devices in the shack, attic, basement and back porch, I haven't missed answering a ring—and my family is pleased with the alerter's melodious sound.—*Maurice Sasson, MD, W2JAJ, 3021 Middletown Rd, Bronx, NY 10461*

AN EASY FOOT SWITCH

☐ An inexpensive PTT switch can be built quickly from a plastic cassette case and a microswitch, as shown in Fig 5. Wire the switch first. Next, file a notch in the side of the case for wire egress, and file off the nib inside the case that resists the cover's movement. Fasten the wired microswitch to the inside front of the case with epoxy adhesive. Connect the wires to the device you wish to activate, and press the cover to close the switch.—*Harold Keenan, KB1US, 85 Topstone Dr, Danbury, CT 06810*

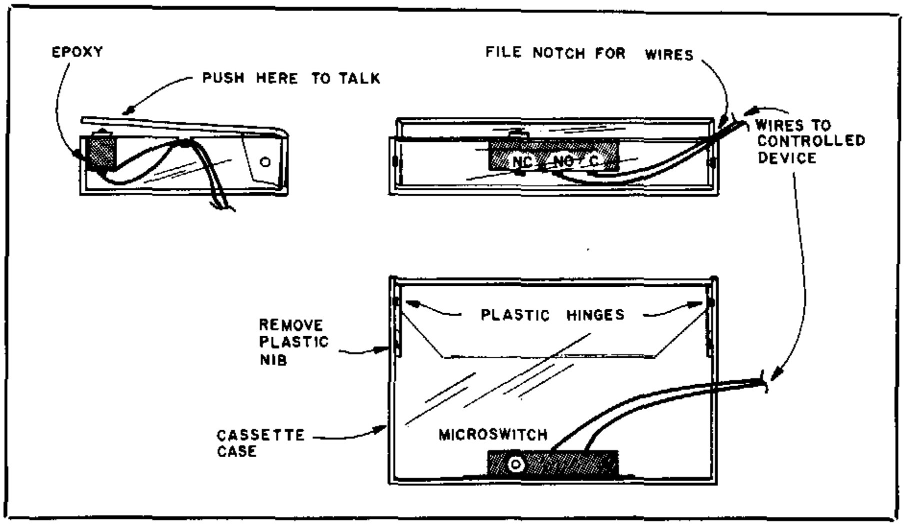


Fig 5—Harold Keenan's foot switch is based on a cassette-tape case and a microswitch.

SWITCH KEY MAKES RESETTING DIP SWITCHES EASY

☐ The printer I use in my ham shack computer system is a Commodore MPS-1000, which is capable of operating in two DIP-switch-selectable modes. Changing printer modes involves probing through a small back-panel window into the dark interior of the printer to reach the tiny DIP switch levers. After doing this several times with a pencil and a flashlight, I knew there had to be a better way!

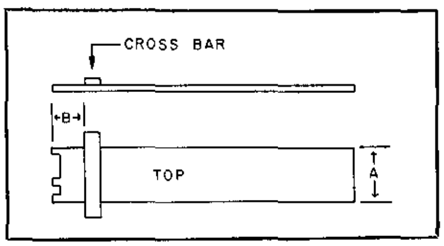


Fig 6—Ken May's switch key takes the frustration out of moving between two DIP switch configurations on his Commodore MPS-1000 printer. See the text for how to size dimensions A and B.

I solved this problem by fabricating a switch key as shown in Fig 6. The key can be constructed of any thin, stiff, nonconductive material that's handy; plastic sheet or perfboard is fine. (I used 0.1-inch-thick PVC stock.) Cut the key piece to any length suitable for your needs. Make dimension A equal to the width of the opening in the printer case. This keeps the switch key in lateral alignment with the DIP switch levers. To control the key's depth of penetration, cement a cross piece, B, to the appropriate point on the key body. Using a hacksaw and/or needle files, cut the appropriate DIP switch pattern into the end of the key.

Mark the appropriate key face TOP to avoid using the key upside down in future. Now, assuming that you've cut the right pattern into the end of the key, returning to the printer's proper DIP switch settings is a snap!—*Ken May, KA3LIM, 136 DeHaven Ave, Penndel, PA 19047*

ANOTHER WAY TO WEIGHT KNOBS

☐ Here is another way to weight hollow tuning knobs such as that on the TS-830S. First, purchase some lead "wool" at your local hardware or plumbing supply house. It takes two ounces (about 30 cents worth) to do one knob. Use a screwdriver with a small blade to pack the lead into the spaces on the inside of the knob. The wool can be packed very tightly with moderate hand pressure. (Lead wool packs more tightly than lead shot, so more weight can be added in less space.) If you feel the need for a sealant, cover the wool with some silicone caulk or epoxy.—*D. F. Christensen, W8WOJ, Midland, Michigan*

HEAD-OPERATED TUNING FOR FREQUENCY-SLEWABLE TRANSCEIVERS

☐ While renovating an old pair of boom-mic-equipped headphones, the idea occurred to me of controlling some of my new transceiver's functions at the headset. Many newer transceivers offer scan tuning that can be operated by UP and DOWN buttons on a microphone. I developed the scheme of using two mercury switches glued to each other at angles (Fig 7). By mounting this arrangement inside the headset, I reasoned, frequency control could be accomplished by simply tilting the head left for DOWN and right for UP. I tried the idea, and it works! With a little practice, I could fine-tune my transceiver with

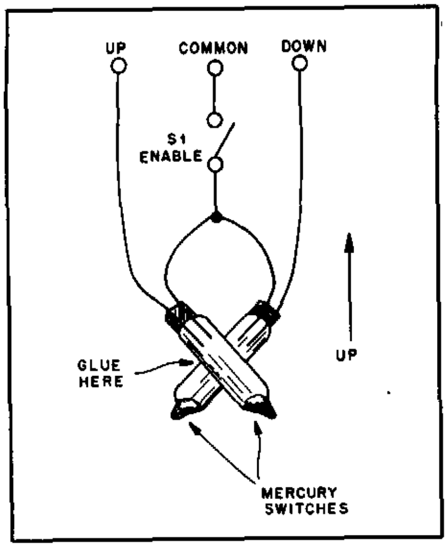


Fig 7—Bob Nagy's head-operated tuning scheme uses two mercury switches as UP and DOWN frequency-slewing controls. Mounted in a headset, they allow hands-off frequency excursions with rigs that include this feature. See text.

quick nods to either side.

This little modification has applications for handicapped hams, of course, but it's a neat idea for anybody's shack. Be sure to include a switch (S1) to turn the circuit on and off, though: If you forget that the head-operated tuning is operative, you may think other stations are drifting every time you scratch your head!—*Bob Nagy, WA2TMD, 3303 Larry Ln, Austin, TX 78722*

A GOOD, CHEAP HEADSET

☐ Several headsets on the market are useful for mobile and hand-held-transceiver operation. Most of these headsets cost $40 to $50, and others cost up to $80. Here is a cheaper way to get a good headset.

Radio Shack® catalog no. 432 includes "voice-actuated FM headset walkie-talkies" on page 70. Each of these units includes a headset consisting of a microphone, one earphone and a 17-inch earphone-mounted whip antenna. You can order a replacement headset (part no. Z-7868) through a Radio Shack store [and perhaps through Tandy National Parts—*Ed.*]. The price of the headset at the time I bought it was $10.18 plus tax!

The earphone cable consists of two coaxial cables (one with a clear-plastic-insulated center conductor and gray shield wire, and the other with a gray-plastic-insulated center conductor and black shield wire) and two single leads (one blue, one black). The clear-insulated-center-conductor coax carries RF; the black-insulated-center-conductor coax carries microphone audio. (The microphone uses an electret-capacitor element; in addition to audio, the mike cable carries voltage for the mike element.) The single blue and black wires carry earphone audio.

Through experimentation, I determined that the headset's mike element works well with the voltage and polarity present at my Kenwood TR-2600A's mike jack. (The '2600A's mike line sources 4 V dc [center conductor, positive] for use with capacitor mike elements.) The TR-2600A drives the headset earphone well.

Attempts to drive the headset's 17-inch whip failed until I discovered and removed the whip's inductive loading. To take the loading inductor out of the circuit, unscrew the earphone cover and lift the earphone element to one side. Solder a short piece of solid wire across the inductor terminals, and reassemble the headset. Modified in this way, the headset whip—somewhat shorter than ¼ λ, I admit—works on 2 meters at a reasonable SWR and provides communication over a greater range than a "rubber duckie."

For remote PTT switching, I mounted a SPST switch in a 35-mm-film can, and connected the switch to the mike-jack PTT terminals with two-wire cable. Clipped to my belt with a key-ring clip, this arrangement makes TR switching easy.

Of course, suitable connectors must be installed on the headset earphone wires, and antenna and microphone cables; because the connectors required vary with the application, I leave these details to you.—*Al Brogdon, K3KMO, Box 60, Damascus, MD 20872*

BETTER AUDIO QUALITY FROM AN OUTBOARD SPEAKER

☐ I have a hearing disability that requires bassier response and more audio output than my stock Kenwood SP-930 speaker could provide without objectionable distortion. I improved the power-handling capability and frequency response of the '930 by replacing its speaker with a 4-inch Radio Shack® automobile speaker (RS 40-1197). This replacement speaker exactly fits the mounting holes in the SP-930! Next, I lined the speaker cabinet with fiberglass insulation (RS 42-1082 or equivalent) to damp acoustic resonances.

Modified in this way, the SP-930 handles the full audio output from my TS-930 transceiver without noticeable distortion, and its frequency response is substantially improved. The outboard speakers used by many hams can probably be improved by similar modifications.—*Maurice Sasson, MD, W2JAJ, New Rochelle, New York*

ALC FOR RTTY OPERATION

☐ As a radioteletype (RTTY) enthusiast, I've been frustrated by incompatibility between transceivers and the automatic-level-control (ALC) output of various external power amplifiers. An external ALC circuit (Fig 8) suggested to me by Erwin Weber, W9DBM, has proven quite successful in solving this problem. With this circuit in place, I can adjust my amplifier for linear operation and, by adjusting R1, reduce the amplifier's output power—

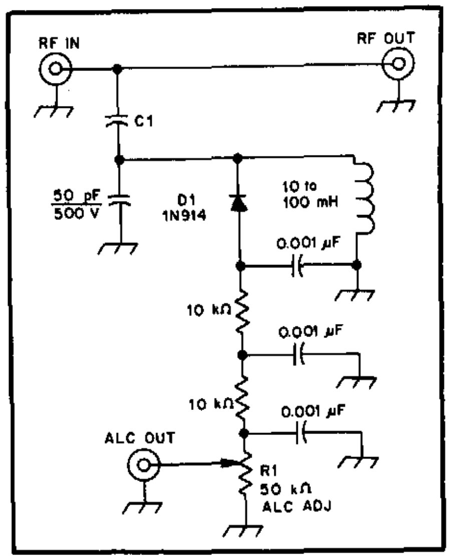


Fig 8—Hal Cupps uses this circuit to produce adjustable ALC voltage in his RTTY system. The polarity of D1 determines the polarity of the ALC signal produced. As shown here, the circuit produces a negative voltage with respect to ground. C1 consists of a ¾-inch-square piece of double-sided PC board (C1's leads go to opposite sides of the board). D1 may generate harmonics of the applied signal; because harmonics can cause interference to radio and TV reception, check reception of your local radio and TV signals after you've added the circuit to your station to be sure D1 isn't causing interference. If D1-generated interference occurs, low-pass filtering between C1 and the antenna can solve the problem.

without retuning the amplifier—to that suggested by the amplifier manufacturer for safe RTTY operation.—*Hal Cupps, W7LBD, 5833 E Onyx Ave, Scottsdale, AZ 85253*

USING DESK MIKES WITH THE KENWOOD TR-2500 AND OTHER TRANSCEIVERS

☐ The MC-60A and -50 microphones, and many other desk mikes intended for use with Amateur Radio transceivers having four- or eight-pin mike connectors, can be used with the TR-2500 and other hand-held transceivers by installing a simple adapter in the mike line. This is especially convenient for fixed-station operation because desk mikes generally allow "lock-to-talk" operation that hand-helds' PTT buttons don't.

The adapter (Fig 9) consists of a four- or eight-pin male mike jack, a suitable length of mike cable, a piece of insulated, stranded hookup wire the same length as the mike cable, a miniature phone plug (to match the hand-held's mike jack) and a small alligator clip.

Wire the adapter as shown in Fig 9 and wind the ground wire around the mike cable. Attach the alligator clip to the transceiver chassis ground at the rig's antenna jack or carrying-strap bracket. If your transceiver ground is common to that of your MF/HF station, you can connect the alligator clip to any station ground terminal. If you use an external speaker with your hand-held, you can connect the adapter ground wire to the speaker ground terminal.

Once you've installed the adapter, try setting the mike to its various output impedances (if it affords a choice) to discover which impedance produces the best transmitter audio with your hand-held transceiver. If the mike has a built-in preamplifier, try switching it on and off to see which configuration provides the best transmitter audio.—*Maurice I. Sasson, MD, W2JAJ, 75 Gail Dr, New Rochelle, NY 10805*

ILLUMINATE YOUR SWR BRIDGE!

☐ My Heath® SA-2060A Matching Network is very satisfactory in every respect, except that I missed the convenience of lighted panel meters. It is a simple task to add that feature, so I did not hesitate. A short search through my junk box yielded two "grain of wheat" lamps (for 12 V dc) left over from my model-railroading days. I attached one lamp to the top of each meter case with some cyanoacrylate adhesive and wired them to the accessory jack of my transceiver with some lightweight "zip" cord. The illuminated meters are now easy to read in the dim evening light.—*Gordon Lauder, W9PVD, Webster, Wisconsin*

ANTISTATIC TREATMENT FOR METERS AND LIQUID-CRYSTAL DISPLAYS

☐ Here's how to "destatic" a plastic meter window—a treatment called for when a static charge on the plastic deflects the meter pointer away from zero. Gently wipe the face of the meter with a little piece of antistatic or fabric-softener paper made for use in clothes dryers. Polish off the residue. Now the meter will behave as it should.

Buffing my hand-held's LCD window charged the window plastic and made the display's segment-connector traces visible. A dryer-paper treatment brought everything back to normal.—*Paul G. Koutnik, N9GTQ, Downers Grove, Illinois*

LIGHT UP YOUR ID BADGE

☐ The circuit shown in Fig 10A lights 10 LEDs sequentially in marquee fashion, and can be used to accent an ID badge as shown at Fig 10B. Build the circuit on a piece of perfboard, using ribbon cable to connect the FEDs to the 7017. (At least 11 conductors are needed: one for each LED anode, and one for the common LED cathodes). Because the 4017 is static sensitive, don't solder it directly into the circuit; use an IC socket instead. Use a socket for the 555 timer, too.

To provide best background contrast for the LEDs, I suggest mounting the ID badge into a suitable plastic box. In lieu of this, black cardboard strips can be glued around the badge. (If you use a box, cut a slit in the box to pass the LED ribbon cable.) Drill and mark the badge to take the LEDs, mount the LEDs on the badge, and wire the LEDs to the board. (I drilled *two* holes for each LED, one for each lead, in my badge.) Tape the 9-V battery across the center of the circuit board as shown in Fig 10B. Tape a piece of cardboard across the back of the perfboard to protect the wiring.

A snap-on battery connector serves as the on/off switch. To wear the illuminated badge, insert the circuit board into your breast pocket, leaving only the badge visible, or attach the badge to your shirt with its clip or pin.—*Al Greenstein, W4NFJ, 4138 NW 88th #107, Coral Springs, FL 33065*

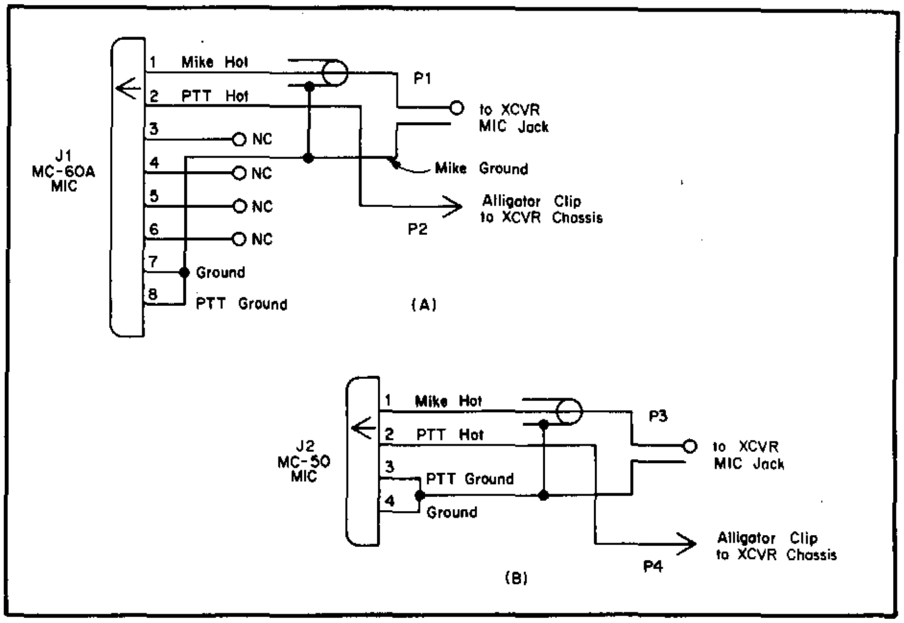


Fig 9—Maurice Sasson connects his desk mikes to his hand-held transceiver with the adapters shown here. These pinouts are correct for Kenwood MC-60A (A) and MC-50 (B) mikes; mikes of other manufacture may require different pin connections. Radio Shack carries the four-pin male jack (J2) called for at B (no. 274-002). The eight-pin mike jack (J1) required at A may be considerably harder to find, though; Amateur Electronic Supply, for one, carries such connectors under the part no. CBC-8P. P1 and P3 are 1/8-inch-diam phone plugs; P2 and P4 are alligator clips.

QUIETING EQUIPMENT FANS BY SERIES WIRING

☐ Muffin® and similar small 120-V ac fans are readily abundant at flea markets, surplus stores and so on. They are, however, quite noisy when run at their rated voltage. Although a series resistor may reduce the speed of a fan motor (and, hence, the noise it generates), wiring two fan motors in series yields considerable airflow, reduced power consumption and blissful quiet, with no power wasted in a resistor. The fans I've tried start without difficulty at 120 V ac when wired in series (60 V across each fan). Two fans, strapped together side by side with fiberglass tape, can serve as a handy fan for cooling final amplifier tubes, a heat sink or a person (I'm using such a fan to keep cool as I write this hint!). By connecting the fans in series with long leads and separating them physically, you can use a pair of fans in "push-pull"—one to blow cool air into a rig and the other to exhaust the hot air.

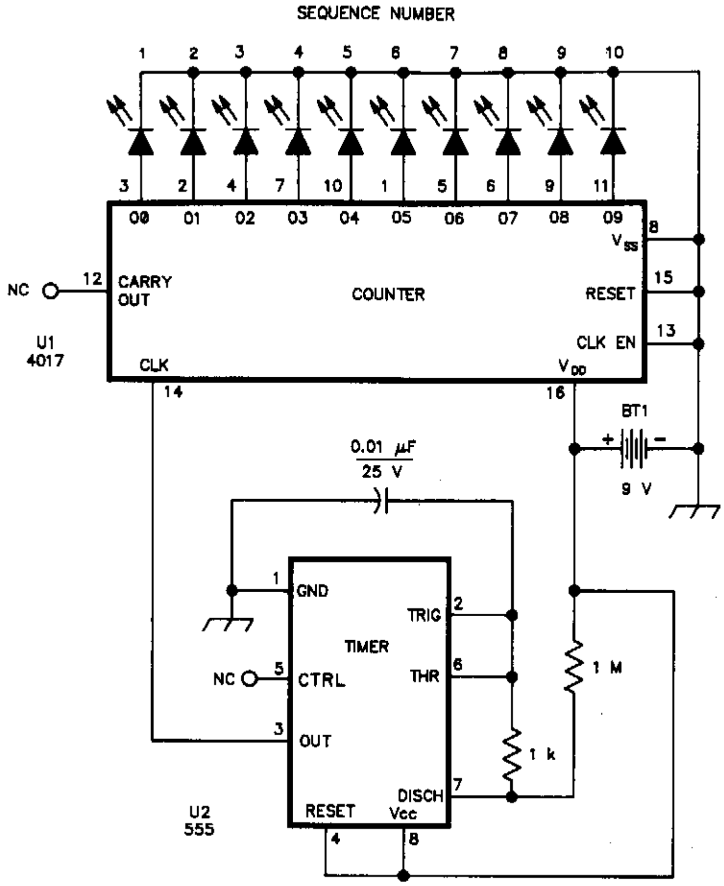
For safety, screen the fan blades with commercial fan guards or screening attached to the fan frames. Also, be sure that the fans' ac terminals cannot accidentally be touched under any conditions.

These fans are best connected to ac by means of slide-on power cords designed specifically for the purpose. If you decide not to use fan power cords, here's another word of caution: Be careful when soldering to the fan terminals. I had one terminal break loose from the motor lead and the surrounding plastic. I successfully excavated the lead, soldered on a piece of wire for use as a terminal, filled the cavity with epoxy glue, and voilà: the fan was as good as new! Use a heat sink or a low-power soldering iron to lessen your chances of damaging the fan terminals.

Considering the price (I've paid as little as $7.50 for two at a flea market) and the necessary work (only five minutes with a soldering iron), I find these fans to be the coolest deal in town!—*Mort Slavin, K3FGB, West Palm Beach, Florida*

QUIETING EQUIPMENT FANS—REVISITED

☐ Mort Slavin's "Quieting Equipment Fans by Series Wiring" touches on a sub-



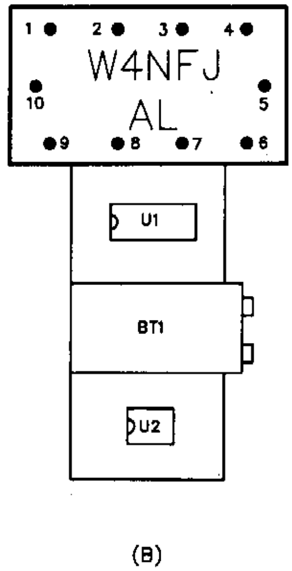


Fig 10—Al Greenstein's ID-badge-lighting circuit (A) uses a 4017 decade counter and a 555 timer to light 10 LEDs sequentially. Resistors are ¼ W; a snap-on battery connector serves as the on/off switch. Al's suggested badge/board configuration is shown at B.

ject of interest to many radio amateurs because "bargain" fans purchased by hams at flea markets may run too fast, or too loudly, to be useful. Mr. Slavin's method requires the presence of two fans; how can *one* fan be slowed effectively?

Fan noise is related to the physical design and integrity of the fan in addition to its rate of rotation. Vibration from worn-out bearings—quite common in used or surplus fans—can cause considerable noise if it is conducted to the enclosure (if any) in which the fan and associated equipment are housed. If the enclosure happens to resonate at the fan's vibration frequency, this noise can be severe. Slowing a fan makes the fan run quieter by reducing blade turbulence and lowering the frequency of the fan's vibration(s).

Continuous operation of a fan below its design speed may be harmful to the fan in the long run, however. This is so because the fan is designed to cool itself in addition to the equipment associated with it. Slowed, a fan may be undercooled by its own air flow and run hot, especially at high ambient air temperatures.

An appropriate compromise to the conflicting problems of fan noise and insufficient fan cooling is to link fan speed and air temperature. The simplest means of achieving this is a resistor in series with the fan, *with a thermostat in parallel with the resistor.* Choose a thermostat that (1) operates at the desired temperature; (2) closes with rising temperature; and (3) is capable of switching the fan power supply. Properly installed, such a thermostat will allow the fan to run at full speed to cool itself and its associated equipment above its trigger temperature; at air temperatures lower than this, the thermostat will open to allow the series resistor to slow (and quiet) the fan.

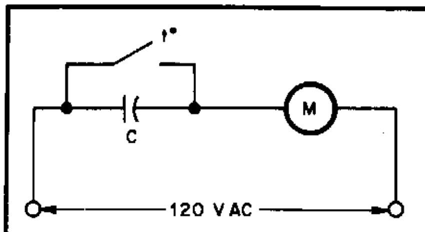


Fig 11—Joachim Wollweber suggests using a series capacitor, C, instead of a resistor to slow and quiet ac powered fans. A thermostatic switch can be added to achieve a workable compromise between fan noise, fan life and equipment cooling; see text.

A series resistor is an inefficient means of slowing a cooling fan, however, because it dissipates power as heat. An ac-rated *capacitor* of sufficient reactance to slow the fan to the desired speed—*and* capable of safely handling the fan current—is a better solution. Fig 11 shows how a fan-slowing capacitor can be applied in conjunction with a thermostat.

The capacitance required depends upon the characteristics and power consumption of the fan motor. Insufficient capacitance will keep the motor from starting; too much capacitance will allow the motor to reach its normal (noisy) speed. The proper value can be determined by installing insufficient capacitance to start the fan. Increase the value of this capacitance until the fan starts. [Safety first: Be sure to disconnect the fan circuit from the ac supply before adjusting the slowing capacitance.—*AK7M*]

Once you have determined the value of the fan-slowing capacitor, experiment to find the best location for the thermostat. Positioning the thermostat as closely as possible to the heat source should allow the thermostat to respond quickly to temperature variations at the heat source. A thermostat that actuates at a temperature somewhat lower than the target temperature may be of use in achieving this aim. *—Joachim Wollweber, DF5PY, Schillerplatz 18 A, 6500 Mainz, West Germany*

SAFETY SCREEN FOR COOLING FANS

☐ For added protection of transceiver fans in cylindrical cowlings: Cut a piece of plastic window screening and secure it over the fan cowling with a hose clamp or a strong rubber band. This keeps children's fingers and slim projecting objects out of the fan—especially important when the rig is used outside of the controlled environment of the home station.—*Clyde C. Blake, KA1BSZ, Ely, Vermont*

COAX-SHIELD CHOKE CURES TRANSCEIVER SELF-OSCILLATION

☐ The Yaesu FT-747GX transceiver is very sensitive to return currents on the outside of its coaxial feed line and sometimes goes into oscillation even at SWRs near 1:1. I cured this problem in my station by installing a coax-line RF choke between the transceiver and anything else it's connected to. The choke consists of a 6-inch-diameter, 10-turn coax coil like that shown in Chapter 26 of *The ARRL Antenna Book* and Chapter 16 of *The ARRL Handbook for Radio Amateurs*.[2] A friend of mine had a similar problem with a Kenwood TS-140S; a coax-shield choke solved that problem very effectively, too.—*Jay M. Jeffery, WV8R, 3819 Parkdale Rd, Cleveland Hts, OH 44121*

[2]A ferrite-bead choke, described in the *Antenna Book* and *Handbook* along with the coax-coil balun, will probably work, too.—*WJ1Z*

MORE ON SAFE AC-WIRING PRACTICES

☐ Larry Wolfgang's "Safe Ac-Power Wiring Practices"[3] reminds me that it's important for us to be aware of the proper way to connect fuses, power switches and ac receptacles. We hams can further add to the safety of our equipment by incorporating two safety features as specified in some European safety regulations:

Panel-mounted (axial, plug-in) fuse holders—Connect the end of the fuse holder that is farther from the panel to the line. Connect the end nearer the panel to the load. This ensures that the fuse touches only the holder's equipment-side terminal until you insert the fuse to a depth at which your fingertips can't touch the fuse cap's metal contact.

Power switches—Use a double-pole power switch or relay that interrupts both sides of the line (hot and neutral in 120-V systems, and both hot wires in 240-V systems). This ensures maximum safety in 240-V systems, and safe disconnection of 120-V devices under conditions where system-wiring polarity may be questionable (such as when nonpolarized plugs are present).—*Charles P. Baker, W2KTF, 2715 Wilson Ave, Bellmore, NY 11710*

[3]L. Wolfgang, ed, Hints and Kinks, *QST*, Apr 1984, pp 42-43, and reprinted in The ARRL Bookshelf's 12th edition of *Hints and Kinks for the Radio Amateur*.

QUICK POWER AND ANTENNA DISCONNECTS FOR EQUIPMENT LIGHTNING SAFETY

☐ Summer is almost upon us, and with it come unexpected, violent thunderstorms. Like every ham, I quickly dash to the shack to disconnect coax and pull power plugs at the first loud thunderclap to protect my investment in amateur gear. This behavior conditions other family members: My nonham husband awakens me out of a deep sleep to announce an impending storm with "Your radios!"

This is fine if the ham is home and can attend to the situation. When the ham *isn't* home, one of the family's nonhams may attempt to do this simple chore. Alas, he/she is confronted with a vast conglomeration of cables, patch cords, coax and what not. Having no idea where to begin, they may indiscriminately disconnect everything in sight, leaving your station in complete disarray. (I speak from experience!)

I solved this problem by simplifying and streamlining equipment disconnection. All my equipment plugs into heavy-duty ac outlet strips, making it simple to pull the plugs first. Then I identified the coaxial jumper that absolutely has to be pulled: the one that protects the most equipment. About 3 inches up the cable from its PL-259 connector, I wound a piece of masking tape around the coax and painted it *red*. (Marking one such jumper may not be enough: You may need to label an additional cable for VHF/UHF equipment.)

Now, even my kids know: If I'm not home, pull the plugs and disconnect the red coax!—*Claudia J. Lang, KC3GO, 3444 Bench Dr, Pittsburgh, PA 15236*

WJ1Z: The sensitive electronics common in modern Amateur Radio stations can be damaged by the current induced by lightning strokes miles away; in fact, weather-induced static damage can occur even if lightning is absent. So, protecting your gear against atmospheric electricity is a good idea. The best way to do this is to *keep your gear entirely disconnected from power, ground and antenna wiring when you're not using it.* This end-runs the questions of whether or not someone will disconnect the gear in time, and whether or not they'll be safe as they do so. Some background:

- This hint describes a precaution against indirect lightning strokes—a precaution that does not substitute for the protection afforded by the proper grounding and lightning suppression necessary in every outdoor antenna system. Indoor antennas can be struck, too.
- Disconnecting antenna and ac-power leads may not fully protect gear left connected to ground. The best way to protect station electronic equipment against lightning damage is to *disconnect all wires from the equipment and move the equipment away from station wires and cables.*
- If severe weather is already so close that you can see lightning flashes and/or hear thunderclaps, *you may be risking your life* by disconnecting antenna, ground and power leads: Keep a weather eye out and disconnect your gear *well before* severe weather moves into your area; better yet, keep it disconnected whenever you're not using it.

Also consider applying Claudia's big red switch idea to your station's ac supply. Install and identify a main ac-cutoff switch in your station. (Such a switch *does not* constitute lightning protection; lightning capable of leaping thousands of feet through the sky won't stop at a fraction-of-an-inch air gap!) Instruct family members on how to kill the power swiftly and safely if an electrical emergency—electrical shock, for instance—occurs in your station. Get everybody on the same wavelength about what to do and who to call if the unthinkable happens. *Every second counts.*

WATER MAKES DRIVING GROUND RODS EASIER

☐ Water from a garden hose can ease driving a tubular ground rod. All you need is a small hose clamp and a short piece of ½-inch-OD flexible plastic tubing connected to a ½-inch female hose fitting. Hose-clamp the free end of the plastic tubing to the ground tube. Turn on the water and push the open end of the ground tube into the ground. You'll feel a little resistance when the tube meets packed soil, but pulling the tube out an inch or so and trying again will usually clear the way. If you hit a rock, pull the tube out and try again a few inches away.

Using this technique, I installed two ground rods in 10 minutes. The parts for the hose adapter cost less than $2.—*Bob Hinshaw, WD6L, 5910 Vicente St, Chino, CA 91710*

INEXPENSIVE GROUND WIRE

☐ When installing an extensive ground system for a new tower, I needed about 20 ft of no. 8 copper wire. I was shocked to learn that it would cost me 65 cents per foot! After some research and a few calculations, I found that there was a cheaper equivalent.

I consulted the *ARRL Handbook*'s copper wire table and learned that the cross-sectional area of no. 8 wire is 16,510 circular mils (cmils). On a hunch—and having recently purchased 250 ft of no. 14 Romex cable (with ground wire, which made it a three-conductor bundle) for $25, or about 10 cents per foot—I also noted that the cross-sectional area of no. 14 wire is 4107 cmils. My hunch was confirmed: doubled three-wire Romex (6 × no. 14) would serve at least as well as a single no. 8 conductor—at less than 1/6 the cost of the no. 8 wire!

I cut 40 ft of the Romex and stripped all three wires in the bundle. Then I doubled each wire (folded each back on itself) and clamped the free ends (six) in a vise. Placing a screwdriver through the three *folded* wire ends, I twisted the wires until they were bundled so tightly that they looked like they'd been manufactured that way. Result: 20 ft of wire that was closer to no. 6 wire than no. 8 in cross-sectional area—at a cost of $4 versus $13 for 20 ft of no. 8!—*Stan Barczak, K8MJZ, 11220 Churchill Rd, Rives Jct, MI 49277*

MAYBE YOU NEED TO RESET THE MICROPROCESSOR

☐ Most late-model ham equipment is microprocessor-controlled. Occasionally, the microprocessor in such a radio may "lock up" for some reason, rendering the equipment useless. Working part-time at an Amateur Radio store, I've seen many rigs brought in for repair that required no repair other than resetting their microprocessors—a simple task that could have been done by their owners!

Reset procedures vary from radio to radio. In some cases, a panel button must be pressed as the equipment is powered up. Other gear requires that a toothpick or pencil be used to activate a switch through a small hole in the equipment case. Your transceiver's operating manual probably details the procedure necessary to reset the rig's microprocessor.

Certainly, *all* failures in state-of-the-art radios aren't caused by locked-up microprocessors. But it never hurts to give the reset procedure a try—you might save yourself a trip and a service charge. *—Michael A. Czuhajewski, WA8MCQ, Box 232, Jessup, MD 20794*

AK7M: Resetting a rig's microprocessor (also called a *micro* for short, or *CPU* [central processing unit]) may involve one undesirable side-effect: the erasure of frequency, mode, repeater split and other information in memory channels. Be sure to record such information before you try a reset!

BETTER TRANSMIT PROTECTION FOR GaAsFET PREAMPS

☐ My mast-mounted 2-meter GaAsFET preamp (an Advanced Receiver Research MM144VDG) was damaged on transmit despite the fact that I was using the manufacturer's TR sequencer.

Fig 12A shows a portion of the MM144VDG's sequencer output circuit; it's similar to the time-delay generator in recent *ARRL Handbooks*. Normally, when the mic PTT button is pressed, relay A opens immediately to take the preamp out of the line, and relay C closes after a set delay to key the transceiver. If relay A fails to operate or sticks for a period longer than C's delay (the apparent failure mode in my case), however, it's possible to transmit into the preamp.

A simple, albeit brute-force, solution to this problem is to add a DPDT relay (relay E) as shown in Fig 12B. Relay E is energized in receive and must release to allow its normally closed contacts to key the system transceiver. This ensures that power has been removed from the preamp before transmission begins. To guarantee that relay E is operational—preventing recurrence of the original failure mode—one set of relay E NO contacts is connected in series with the preamp power. If relay E fails, the preamp is turned off.

With relay E in place in the MM144VDG, transmit timing is unchanged, but return to receive is delayed by the relay E's pull-

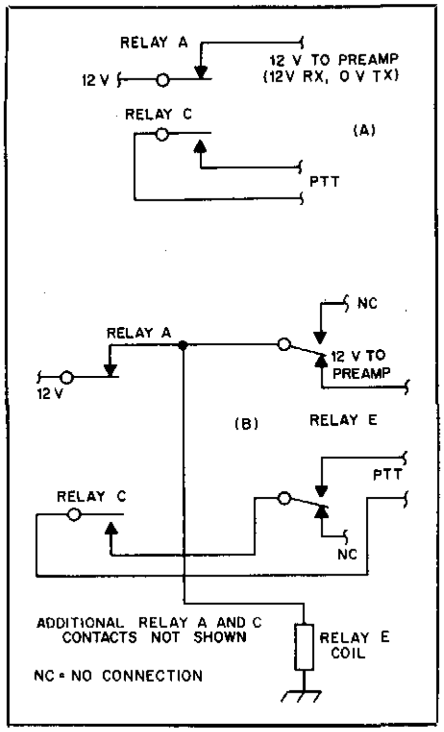


Fig 12—John Siegel modified the TR sequencing circuitry of his GaAsFET 2-meter preamp for fail-safe operation by adding a DPDT relay to the unit. The original preamp power and PTT switching circuit is shown at A; B shows the modified arrangement. Note that relay E is shown in the energized position. See text.

in time. If relay E sticks momentarily, the keying delay will be no shorter than the release time of relay E. Even if this happens, transmission into the preamp is impossible.

Although I haven't investigated this, a more elegant solution to this TR switching problem would modify the sequencer so that the timing for the MM144VDG's relays B, C and D is dependent upon the operation of relay A.*—John Siegel, K4BNC, 4 Quincy St, Marlboro, NJ 07446*

USING SOLID-STATE TRANSCEIVERS WITH UNTUNED-INPUT AMPLIFIERS

☐ The untuned input circuit of my Dentron Clipperton L amplifier caused my new transceiver's SWR-driven final-amplifier-protection circuitry to significantly reduce the transceiver's output on all bands. The problem was so bad that I couldn't use the amplifier *at all* on 10 meters. (The transceiver, a Kenwood TS-930S, contains an automatic antenna tuner, but the amplifier input impedance is evidently outside the tuner's matching range.)

To solve this problem, I installed a homemade pi matching network (two variable capacitors and a roller inductor) in the coax line between the transceiver and the amplifier as shown in Fig 13. (My station already included a matching network between the antenna and the amplifier [between the antenna and the transceiver with the amplifier off-line]. I'll refer to the antenna-to-amplifier matching network as Network 1 from now on. The transceiver-to-amplifier network will be referred to as Network 2.) Properly adjusted, this network allows the TS-930S to drive the Clipperton on all of my bands of interest, including 10 meters. (The TS-930's ability to meter output power and SWR is something new to me. If you use an amplifier, and you've never monitored the SWR between your exciter and amplifier with the amplifier operating, you may be in for a big surprise! From now on, I'll refer to SWR meter between the amplifier and antenna as SWR meter 1; the transceiver SWR meter is SWR meter 2.) I ran a series of tests to find the necessary settings for Networks 1 and 2, and recorded these settings for later reference. Now I can change bands quickly without on-air testings by presetting the matching networks to the recorded values.

Smooth amplifier in/out switching was my next concern. I couldn't just leave both networks in the line at all times; switching the amplifier off-line connects both networks in series and allows them to interact. To get around this, I modified the Clipperton L amplifier as shown in Fig 14 and connected Network 2 as indicated. Now, Network 2 is used only to match the transceiver to the amplifier. At other times—during receive when the amplifier is in line, and during transmit *and* receive when the transceiver is used on its own—only Network 1 is present between the antenna and the transceiver.

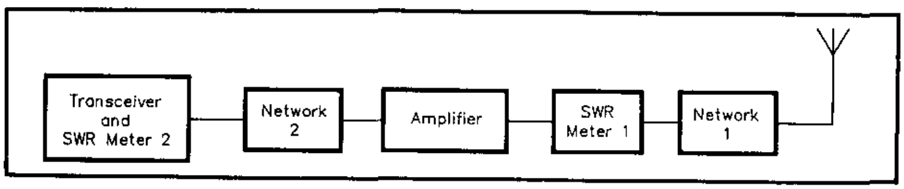


Fig 13—Martin Cardwell's addition of a transceiver-to-amplifier matching network (Network 2) to his station cured problems related to impedance mismatch between his transceiver and untuned-input amplifier. Network 1 matches the antenna to the amplifier output or the transceiver's antenna input. This arrangement is somewhat inconvenient because Network 2 must be switched out of the line when the antenna is to be connected directly to the transceiver. Martin solved this problem by modifying his amplifier and reconnecting Network 2 as shown in Fig 14.

I adjust the system for equal SWR in the "amplifier in" and "amplifier out" modes as follows: With the amplifier switched off and the transceiver producing about 30 W output, adjust Network 1 for minimum SWR as indicated by SWR meter 1. Turn on the amplifier and tune it up at reduced output power. Adjust Network 2 for minimum SWR as indicated by SWR meter 2.

A closing speculation: Some vacuum-tube power amplifiers include grid-current metering. Grid current can serve as an indication of drive, but I don't think it can reveal conditions of unacceptably high amplifier-input SWR. Reason: Even though the impedance of my Clipperton L's input circuit is not 50 Ω, I had no trouble driving the amplifier sufficiently—as indicated by grid current—with TS-520S and -820S transceivers.—*Martin L. Cardwell, NB3T, 4600 White Ave, Baltimore, MD 21206*

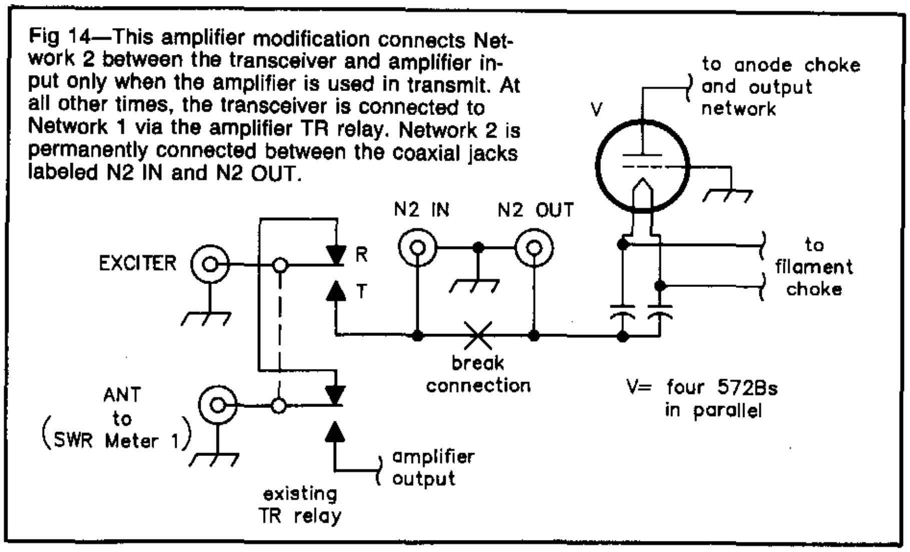


Fig 14—This amplifier modification connects Network 2 between the transceiver and amplifier input only when the amplifier is used in transmit. At all other times, the transceiver is connected to Network 1 via the amplifier TR relay. Network 2 is permanently connected between the coaxial jacks labeled N2 IN and N2 OUT.

AK7M: Martin is right. The presence of rated grid current in an amplifier tube indicates only that the tube is receiving enough drive to cause that grid current to flow. How well the tube is matched to its driver must be determined by other means.

DOES YOUR SOLID-STATE TRANSCEIVER REDUCE ITS OUTPUT POWER WITH RISING SWR BECAUSE IT'S SOLID-STATE?

□ You've probably heard that, in general, amplifiers, transmitters and transceivers that use vacuum-tube RF power amplifiers "don't care" what SWR they operate into. You've probably also heard that commercially manufactured, solid-state, Amateur Radio amplifiers, transmitters and transceivers reduce their output power as SWR rises. In print, at club meetings and on the air, the story seems to be that solid-state gear "has a problem with SWR" and vacuum-tube gear doesn't. What gives? How much of solid-state gear's famed inability to deal with rising SWR is myth, and how much of it is fact? What does tube gear have that solid-state gear doesn't?

Fact: *Whether or not a transceiver or transmitter reduces its output power in response to rising SWR is not* necessarily *related to the type of active device used in its final amplifier stage.* Many current, commercially manufactured Amateur Radio transceivers *do* reduce their output power in response to rising SWR. This feature is generally built into the RF power amplifier section of amplifiers, transmitters and transceivers that use *bipolar junction transistors (BJTs)* as RF power amplifiers. BJTs require such protection if they cannot tolerate the collector-voltage peaks that can occur in the presence of significant load mismatches. The BJTs used as final RF power amplifiers in today's commercially manufactured Amateur Radio gear generally require such protection.

SWR-driven output-power-reduction circuitry is not always *necessary when solid-state devices are used as final RF power amplifiers.* A bipolar junction transistor operated at a collector supply that is sufficiently low relative to its maximum-collector-voltage rating may not need load-mismatch protection. (And BJTs can be protected against load-mismatch-related overvoltage by means other than SWR-driven power reduction, such as power-supply current limiting or a Zener diode connected between the final-amplifier collector[s] and ground.) RF power MOSFETs are generally *immune* to load-mismatch-related damage if properly applied. *Solid-state transmitters that reduce their output power in response to rising SWR do so because of the presence of SWR-driven power-reduction circuitry, not because solid-state devices are used in their finals.*

Fact: *Many transmitters that use vacuum tubes as output amplifiers contain SWR-driven final-amplifier-protection circuitry.* Such circuitry is *common* in broadcast transmitters, for instance, regardless of whether solid-state or thermionic devices are used in the RF output stage. *Vacuum-tube transmitters that reduce their output power in response to rising SWR do so because of the presence of SWR-driven power-reduction circuitry, not because thermionic devices are used in their finals.*

If you're sufficiently convinced that the presence of SWR-driven "power foldback"—as it's sometimes known in telecommunications jargon—is not necessarily related to the type of device used in a transmitter's output stage, we're in a position to explode another myth: The belief that vacuum-tube-final transceivers and transceivers are generally able to work into a wider range of output impedances than modern solid-state gear *because they use vacuum-tube finals.* Yes, many recent, commercially manufactured, tube-final Amateur Radio amplifiers, transmitters and transceivers *are* capable of operating into load impedances somewhat above and below 50 Ω even in the absence of an external matching network, *but this is so only because the impedance-transformation ratio of the output network in such equipment is designed to be adjusted by the operator.* Most current, commercially manufactured Amateur Radio transceivers are designed to operate into a 50-Ω RF load *only;* some current transceivers include antenna tuners to get around this limitation. That such equipment tends to be solid-state is incidental. (Radio amateurs who remember the Heath® HW-16 CW transceiver, for instance, may recall that the HW-16 was designed to operate into an RF load impedance of 50 Ω *only;* the HW-16 had a vacuum-tube final.)

I can't resist blowing up a related myth: That only solid-state circuitry is capable of "broadbandedness," that transistors are the key to achieving a "no-tune" transmitter.[4] Several transmitters manufactured in the 1950s by Central Electronics, for instance, could be operated in a broadband mode—and some current commercially manufactured, vacuum-tube-based external power amplifiers feature broadband output-network tuning. *Vacuum-tube-final Amateur Radio transceivers, amplifiers and transmitters capable of working into a range of RF load impedances can do so only because they have been designed to do so, not because they use thermionic output devices.—AK7M*

[4]*No-tune* and *automatically tuned* are gradually coming to mean the same thing—probably because more and more "no-tune" gear includes automatic antenna tuners—but (in Amateur Radio parlance, at least) *no-tune* seems to have started out life as a synonym for *broadband* or *broadbanded.* I use *no-tune* as a synonym for *broadband* or *broadbanded,* not *automatically tuned.*

INCOMPATIBILITY BETWEEN VACUUM-TUBE AND SOLID-STATE EQUIPMENT

□ The growing popularity of modem-based digital communication (RTTY, packet radio, and so on) has led to the increased use of small, used oscilloscopes—often based on vacuum tubes instead of transistors—as tuning aids. Although tube-based scopes can be well suited to tuning-indicator applications, they should be thoroughly checked for compatibility before solid-state gear is connected to them.

The Heath® HO-10 monitor scope is an example of why such caution is necessary. This 3-inch-CRT oscilloscope was produced a number of years ago and is common at swap meets. Unmodified, the vacuum-tube-based HO-10 may damage solid-state equipment connected to it. Here's why—and how to modify the HO-10 for compatibility with solid-state gear.

The first fix involves the HO-10's MODE or FUNCTION switch. (This switch is marked MODE on the HO-10 schematic, but is labeled FUNCTION on the scope's front panel.) With age, this switch (see Fig 15A) may deteriorate to the point that it acts as a shorting switch (a switch containing moving contacts that connect to one circuit before breaking contact with another) instead of the *non-shorting* switch it was intended to be. When this happens, 170 V dc may appear at the HO-10's HORIZONTAL INPUT jack as the MODE switch is moved from SINE to AF TRAP. A voltage of this magnitude can instantly destroy low-voltage, solid-state circuitry. Cure: Replace the defective MODE switch with a switch that reliably breaks one circuit before making contact with another.

The second of the HO-10's problems is C16, the coupling capacitor between the HO-16's MODE switch and horizontal amplifier V3C. When the MODE switch is in the SINE position, C16 (2 μF at 200 WVDC) charges to about 170 V. If this happens, moving the MODE switch to AF TRAP (the position selected when the HO-10 is used as a RTTY tuning indicator) connects the charged capacitor across the HO-10's HORIZONTAL INPUT jack. A voltage of 170 can be fatal to a solid-state device connected to the HORIZONTAL INPUT jack. Cure: Add two 2-μF, 200-WVDC capacitors and relocate C16 as shown in Fig 15B.

Modified in this way, the Heath HO-10 makes a fine tuning aid for digital communications. It's likely that other monitor scopes—and, for that matter, other vacuum-tube-based equipment—may have similar problems. Because of this, it's

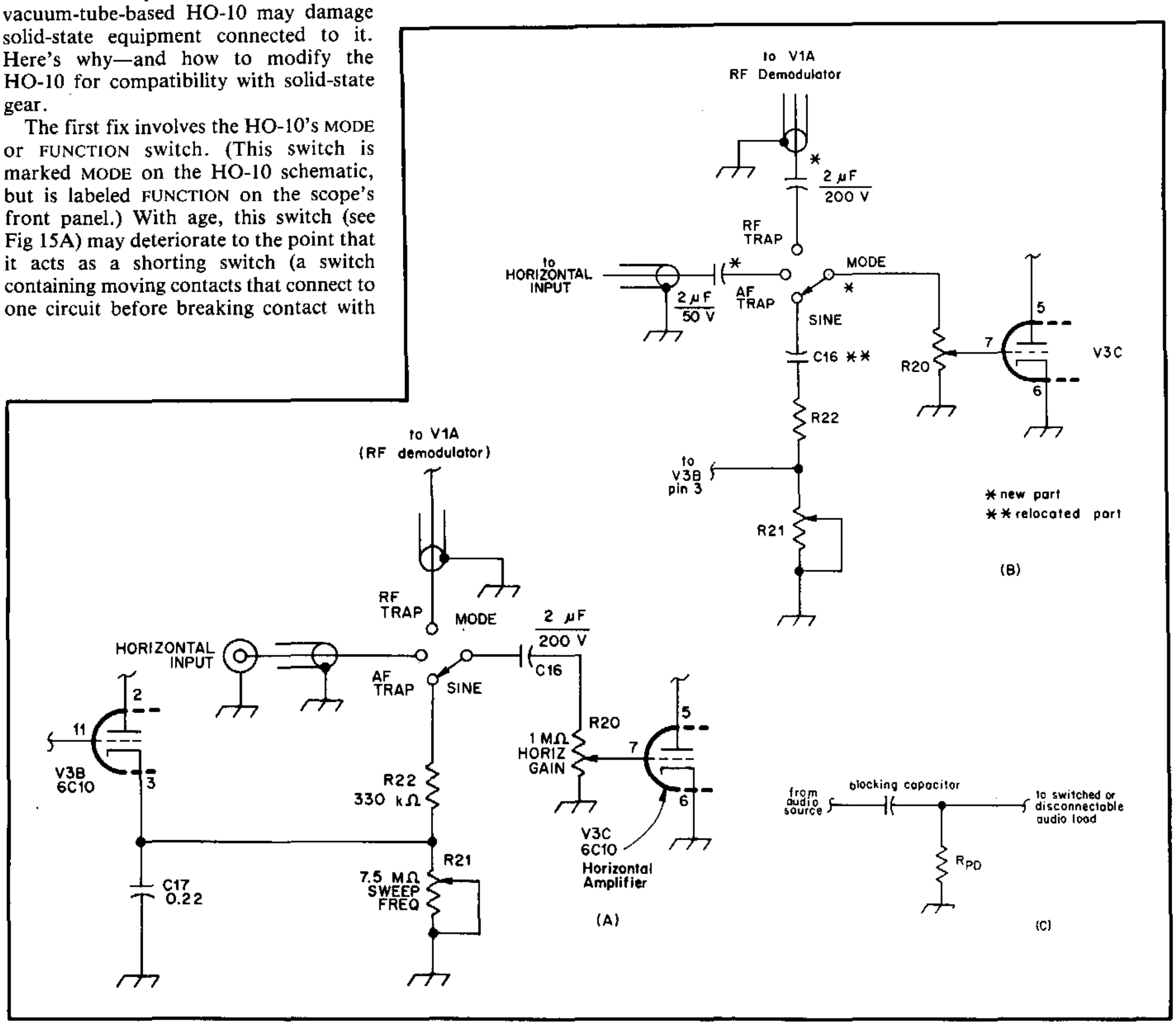


Fig 15—Deterioration of the Heath HO-10's MODE switch can cause momentary short circuits between the switch's AF TRAP and SINE terminals when the switch is cycled (A). When this occurs, V3B's cathode potential (as high as 170 V) appears at the HORIZONTAL INPUT jack, spelling almost certain doom for solid-state equipment connected to the jack. Dallas Williams suggests curing this with a new MODE switch. Even if the HO-10's MODE switch is in good shape, however, the high-voltage charge C16 acquires with the MODE switch in the SINE position is applied to the HORIZONTAL INPUT jack when the switch is moved from SINE to AF TRAP. Dallas's solution to this consists of moving C16 and adding two capacitors as shown at B. (The 2-μF capacitors are nonpolarized paper- or plastic-dielectric units.) C shows your editor's high-tech fix to thumps caused by sudden charging of blocking capacitors in audio circuits. To keep circuit loading negligible, make the resistance of pull-down resistor R_{PD} at least ten times the impedance at the point across which the resistor is connected.

a good idea to check vacuum-tube gear for safe operation before connecting it to solid-state equipment.—*Dallas Williams, WA0MRG, PO Box 1, Sedgwick, CO 80749-0001*

AK7M: Although Dallas's equipment-compatibility hint may seem to be equipment-specific, it isn't. One of the first facts we learn about capacitors is that they can "block dc while allowing ac to pass." This quoted statement is a bit simplistic: A capacitor can block dc *only after it has charged to the dc voltage it's expected to block.* If the simplistic view were true, you could connect one lead of a 0.01-µF, 1-kV capacitor to, say, 500 V and grab the capacitor's free lead with no ill effect. In fact—and depending on how close your body is to ground potential—you may receive a short, *dangerous* jolt as the capacitor charges to 500 V *through you.* This happens because an uncharged capacitor "looks like" a short circuit until it charges.

Unplanned-for capacitor-charging effects may be no more than annoying. Have you ever put a pair of headphones on *before* plugging them into an unloaded solid-state audio amplifier and heard a deafening *thump* as you plugged the headphones in? Such thumps occur when an amplifier's dc-blocking output capacitor charges through the output transducer (your headphones or speaker). This situation can be more than an annoyance: I once blew the headphone-circuit blocking capacitor in a 1930s-vintage ham receiver merely by plugging in headphones. The capacitor had been on the verge of failure; the sudden charging-current pulse finished it off and caused a headphone pop that made my ears ring for several minutes. What would have happened if I'd plugged in a solid-state amplifier instead of headphones?

If component failure causes voltage to appear where it doesn't belong, the cure is simple: Replace the failed component. If suboptimal circuit design is the cause, the circuit can be modified for safer (or less annoying) operation. Audio thumps or clicks that occur when a load is connected or switched can often be cured simply by the addition of pull-down resistors at the "floating" side of culprit capacitors (Fig 15C).

RADIOLESS RADIO FOR CLUB-NIGHT FUN[5]

☐ A contest inertia problem always nettled Bud Frohardt, W9DY, president of the Radio Amateur Megacycle Society. Take ARRL's Field Day, for example. The club's dozen or so operators each naturally required a half hour, more or less, to limber up and get contest exchanges rolling smoothly. This was especially true if any exchange specifications differed from the previous year's routine. Clearly, this warm-up hesitation subtracted from the overall results.

Bud mulled over remedial measures for a while, then had each member bring a pencil to a pre-FD RAMS meeting where prepared sample contest log sheets awaited. The pages carried sample exchange info for initial reference, as well as assigned call signs. For an added fillip, W9DY selected juicy calls—SY1MA, AC4YN, YK1AA, etc. A chance to be rare DX! When the gang had their pencils and paper ready, Bud hollered "Go!" and the fun began.

Slowly at first; the guys were a little self-conscious opening up, talking to themselves as it were. Then "SY1MA" and "AC4YN" called short CQs, and the fight was on. Bedlam! Cupped hands beamed audio all over the hall, QSOs began adding up and 20 never sounded so grand.

After a riotous twenty minutes, W9DY silenced the battle. By then, RAMs not only had the Field Day exchange down pat, but they had also established to the satisfactory enlightenment of everyone the minimum station identification tolerated by FCC in such activities. *This* is important. A later tape playback added to the fun. Member Jim Moss, WB9AJZ, it was ascertained, won this impromptu DX test by working every other "station" and a dupe besides.

Parker Brothers probably could do up a fancy package for this little gig, but all you really need are pencils, scratch paper and a little lung power. When the bands drop dead, folks, don't fidget, fret and fume. Call a club meeting and go all-audio, even oral telegraphy if you like. Instant pile-up, and any number can play.—*Rod Newkirk, W9BRD, 7862B W Lawrence Ave, Norridge, IL 60656*

[5]Reprinted from How's DX?, *QST*, Jul 1973, pp 106-110.

STORE YOUR *QST*s IN THEIR PLASTIC MAILING BAGS

☐ Don't throw away those plastic wrappers *QST* comes in. They're an excellent way to preserve your *QST*s. After each month's *QST* arrives, I carefully trim one end of the bag to remove the magazine. Reinserting *QST* in its bag is easy: Bend the magazine slightly in its middle and slip it back into the bag. Wonder if I can buy these bags by the dozen from ARRL? —*Bill Eppley, W2SDB, 434 Adams Ave, Cape Canaveral, FL 32920*

AK7M: QST Circulation Manager Debra Jahnke tells me that *QST* bags *aren't* available from HQ because they're custom cut and sealed as *QST* rolls off the presses each month at R. R. Donnelley & Sons, Glasgow, KY. Debbie adds that some members use zip-resealable food-storage bags for storing *QST*.

A LEG FOR C64 PROGRAM CARTRIDGES

☐ Many hams use Commodore 64™ personal computers. Coupled with the right software, the C64 provides an easy way to get on CW, AMTOR and RTTY. Many software packages come in the form of plug-in cartridges. You simply stick the card edge into the connector at the back of the C64 and away you go.

The AEASOFT cartridge that I use is rather long. I was concerned that the long cartridge put a bending moment on the C64 connector that might cause eventual connector failure. I felt what the cartridge needed was a "leg up"—or, at least, a "foot up"—to support its free end.

A search through my junk box uncovered a plastic equipment foot of just the right height. I used a few drops of glue to secure the foot to the bottom of the cartridge. Now, there's no evidence of movement once the cartridge is inserted into the connector, as the foot rests on the desk top and supports the cartridge. —*Paul K. Pagel, N1FB, ARRL HQ*

USING THE ROBOT 800C AS AN ELECTRONIC TYPEWRITER

☐ The Robot Model 800C SSTV terminal can be used as an electronic typewriter for typing letters and other data. Your system must include a Robot 800C with parallel or serial printer modification, and a dot-matrix or daisy-wheel line printer. (I recommend the use of a parallel printer, if you have one.) To print: (1) *Do not use your transmitter* unless you are going to transmit whatever you type over the air to another amateur station. (2) Set the Robot to ASCII mode, wide shift (850 Hz). (3) With the split-screen function operating, set the Robot to the receive mode. Now type what you wish to print, using the SPACE bar for spacing and RETURN for changing lines or beginning paragraphs. Type until the 800C's buffer is full. Hit ESC and SPACE to send the text to the printer. (4) After the buffer contents have been printed, hit ESC and return to the receive mode. Continue steps 3 and 4 until your message is completed.

In its ASCII mode, the 800C's keyboard works just like a typewriter, including the CAPS LOCK function. This letter was composed on a Robot 800C and an SMC TP-1 daisy-wheel printer.—*Clyde W. Preble, WA6OLA, Mill Valley, California*

QSL HOLDERS

☐ While I am a photographer by profession, I rarely use 3- × 5-inch prints. So, when a recent mailing included a sample page of clear vinyl holders for ten 3.5- × 5.25-inch prints in a three-ring binder, I almost threw it out. But I suddenly thought, "Aha! QSLs!" Sure enough, a standard QSL fits quite nicely if you can spare about ¼ inch that must be trimmed from the length. The photo industry offers quite a range of mounts, albums, pages and the like for the 3- × 5-inch size, which is very common in amateur photo processing.

A wide variety of storage and viewing systems are also made for 4 × 5, a common size for professional negatives and 5 × 7, which would probably hold oversize QSLs quite nicely. Put some typical QSLs in your glove compartment and stop into a photo or department store. You might find just what you need to organize and display all those stacks of cards gathering dust.—*Fred Anderson, K0IHG, Nisswa, Minnesota*

RIGHT- OR LEFT-HAND PADDLE OPERATION

☐ Here is a little note for those hams who own paddle keyers. I am a right-handed brass pounder myself, but several of my friends are "lefties." Since the positions of the dot and dash paddles are usually exchanged when the hand of operation is changed, there may be considerable inconvenience when operating from a friend's station.

The problem can be corrected easily by turning the paddle around and placing your hand above the key to operate. Although not quite as comfortable as using the paddle normally, it is a simple practice that works for both left- and right-handed people. It eliminates the need to change paddle wiring for a visitor.—*Robert L. Vandevender II, KR2K, Muncie, Indiana*

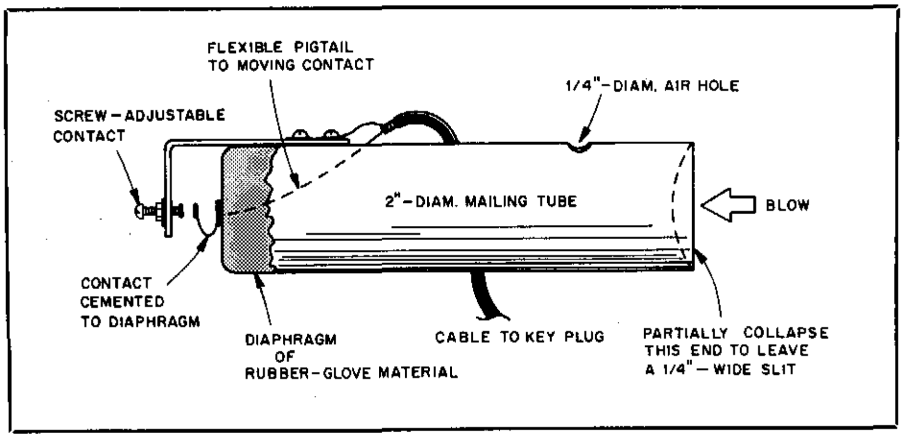


Fig 16—Julian Lorenz sends crisp code with this breath-actuated key. The cable can be fastened to the tube with tape; the KE6VL version uses a screw, washer and bolt for cable strain relief. This gadget is far more than a novelty: Handicapped hams have been using such "Huff and Puff" keyers for years.

CLEANING KEY CONTACTS

☐ In the early days of landline and wireless telegraphy, operators cleaned their key contacts with a special burnishing tool. Here's a method of cleaning key contacts *without* a special tool. The business end of a burnishing tool consists of a thin metal strip coated with fine abrasive. The striking pad of a safety matchbook can also serve as a burnisher. Cut the striking pad from the matchbook cover and pull it slowly through the key contacts: once with the abrasive side up and again with the abrasive side down. Fold the strip to create opposing abrasive faces if you prefer to clean both contacts in one pass.—*Joe Rice, W4RHZ, Covington, Kentucky*

Editor's Note: Burnishing tools are still available from various electronics parts houses. These tools are intended for use on relay contacts. Depending on the composition of the contacts to be cleaned, however, injudicious use of abrasives can do more harm than good to a malfunctioning relay or balky code key. Before you resort to abrasive cleaning, try this first: Pass a strip of uncoated, high-quality (bond) paper between the dirty contacts. Gently close the contacts on the paper and move the strip back and forth until the contacts no longer darken the paper. Next, check the contacts for proper operation. If the problem hasn't cleared, a burnishing tool—or its equivalent—is the next step.

SLOWER KEYING SPEEDS WITH A BUG

☐ The dot speed of a properly used semiautomatic hand key ("bug") is usually adjustable by means of a sliding weight. The minimum dot speed of my stock, 1973-vintage Vibroplex bug is 22 WPM—a little too fast for QRN-battered ears in far-off places. What to do?

Clip a spring-loaded clothespin onto the locking screw of the existing dot weight. Presto! In my case, the key's minimum dot speed dropped to about 17 WPM. To slow the dots even more, I slipped the coupling ring from a PL-259 coaxial connector onto the clothespin. Result: dots at a restful 13 WPM.—*Edward Peter Swynar, VE3CUI, Whitby, Ontario*

NEOPRENE FOAM AIDS KEYER-PADDLE STABILITY

☐ My Bencher keyer paddle slipped sideways too easily for my liking, and I didn't want to use one of the clamps resorted to by some CW operators. By experiment, I confirmed that merely increasing the area of contact between the paddle feet and a smooth surface would not significantly reduce the slippage.

I solved this problem by replacing the stock paddle feet with 1-inch-square pieces of thin neoprene foam mounted on 1 × 1 × ¼-inch pieces of plywood. Now, my Bencher is immovable to anything short of a violent swipe!—*David C. Frost, VE7FJE, 6269 Elm St, Vancouver, BC V6N 1B2*

A BREATH-ACTUATED KEY

☐ When several of us learned the code at about the age of 11, we sent to each other for practice in several ways: saying "dit dah," blowing between our fingers like a Bronx cheer, or blowing on a piece of grass held between our thumbs. Then, when I was at the University of Chicago in the late 1930s, it occurred to me again how rapid and accurate the tongue is when compared with fingers at the straight key—so I made a breath-actuated key out of a cylindrical tube shield with a rubber membrane stretched across one end. Contacts cemented to the rubber did the electrical work.

For over 50 years, I've used an improved version that's based on a varnished mailing tube (Fig 16). To use it, just blow the whispered equivalent of "dit dah" into the open end of the tube; you needn't hum a tone!—*Julian S. Lorenz, MD, KE6VL, PO Box 1765, Chico, CA 95927*

AN AUDIO-TAPE TRANSMITTER KEYER

☐ Need a simple means of transmitting a canned CW message? Use a code-practice or sidetone oscillator to record the message on an "endless" tape cassette (a telephone-answering-machine tape is fine). Play the tape back through the audio-driven keying circuit shown in Fig 17.

I use this circuit to key an experimental 175-kHz beacon—an application that

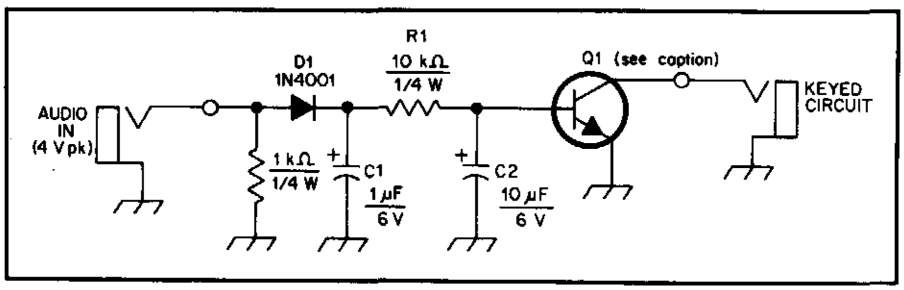


Fig 17—Arthur Erdman uses this audio-driven circuit to key his 1750-meter beacon. D1 rectifies the tape-recorder audio; C1, R1 and C2 filter the rectified audio to drive Q1, and Q1 pulls the keying line low when sufficient drive current flows between its base and emitter. Q1 is any small-signal, silicon NPN transistor capable of withstanding the voltage of the open keying circuit and capable of handling the keyed current. This circuit keys positive (negative-ground) keying lines only.

requires Q1 to key only 10 mA. You may need to add a stage of dc amplification between the rectifier and Q1 to key higher currents.—*Arthur C. Erdman, W8VWX, 224 Chaucer Ct, Worthington, OH 43085*

BRIDGE RECTIFIER SOLVES KEYING-POLARITY PROBLEMS

☐ After replacing my tube transmitter with a solid-state transceiver, I found I had to devise a suitable method of enabling my keyer to switch a positive voltage instead of the tube rig's negative (grid-block) voltage. (A relay is an obvious solution, but I prefer using a solid-state device.) Gary Peterson, KØCX, suggested a simple but effective way to do this: Use a bridge rectifier across the keyer's keying transistor (Fig 18).

For this circuit to work properly, the keyed transmitter line must be connected to the keyer circuit only through U1. Although I used silicon diodes—actually a bridge rectifier from a discarded hair dryer—germanium diodes will work, and add less voltage drop to the keyed line. —*Paul Alexander, K5LZT, 1421 Valmont Dr, Hendersonville, NC 28739.*

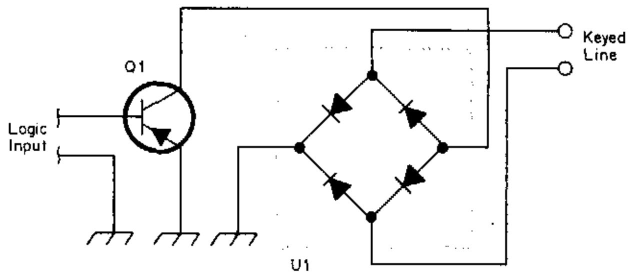


Fig 18—Paul Alexander uses a bridge rectifier, U1, to allow this electronic keyer to actuate CW transmitters with positive *or* negative-polarity keying lines. Q1 is his keyer's keying-line-switch transistor. As noted in the text, this circuit works only if the transmitter and keyer are connected to each other—via keying-line *and* common leads—through U1 only. Multiple equipment grounds (through ground wires, control-lead and coax shields, 120-V ac connections and so on) may prohibit a single keyer-to-transmitter ground connection. The simplest solution to this problem is to modify the keyer circuitry to float its common—here represented by the chassis-common symbol—above chassis.

THE HARDWARE-STORE SPECIAL CODE-PRACTICE SET

☐ Because code-practice oscillators seem to be helpful to some of my Novice students in mastering the Morse code at home, I sought a simple, inexpensive, home-brew code-practice set that the students could build themselves.

First, I tried the 555-timer-based circuit shown on p 36-6 of *The 1990 ARRL Handbook*. The oscillator itself worked well, with a few simplifying modifications (a single resistor instead of R3 and R4—47 kΩ for a 1.5-kHz pitch, 100 kΩ for a 700-Hz pitch, and 220 kΩ for a 400-Hz pitch—and the use of three D cells for a 4.5-V power supply instead of 9 V). Radio Shack®'s standard 555 IC (no. 276-1723) worked fine, but its more-expensive CMOS equivalent (the TLC555, no. 276-1718) did not deliver enough audio in a classroom situation. We used sockets for the timer ICs; even so, assembling each circuit required considerable soldering skill. Keys were a problem, too: A few old junk-box keys were available to students visiting my shack, but we needed to come up with a home-buildable key for students who wished to use their code-practice sets at home.

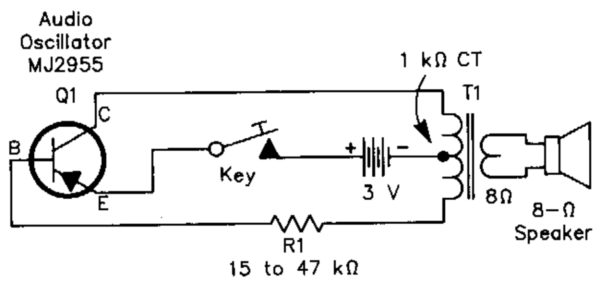


Fig 20—The Hardware-Store Special code-practice oscillator circuit is based on that shown in Fig 58D on page 4-26 of *The 1990 ARRL Handbook*. Q1 is available as Radio Shack no. 276-2043 and T1 is RS no. 273-1380. R1's resistance depends on the pitch you want and the battery voltage: With a 3-V supply, the circuit provides room-filling sound, oscillating at about 450 Hz with an R1 of 15 kΩ, and at about 1 kHz with a 47-kΩ resistor at R1.

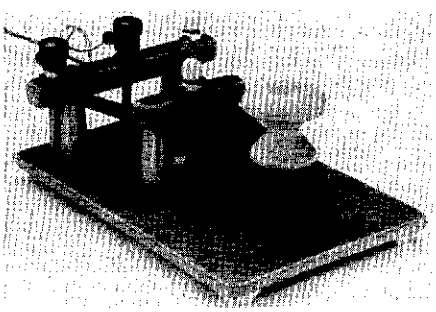


Fig 19—The Hardware-Store Special key. Yes, those hacksaw-blade springs are supported by wire nuts, and, yes, that *is* a drawer pull masquerading as a key knob! No holes need be drilled in the hacksaw blades; wooden cross bars clamp the blades against the wire-nut standoffs. Decreasing the distance between the knob and the first cross bar stiffens the key's feel. Brass no. 6-32 bolts are used for the key contacts; steel no. 6-32 bolts are used elsewhere. You can use standard hex or wing nuts instead of the acorn and knurled-plastic nuts shown at the key terminals and cross bars. To ensure adequate electrical continuity through the key, be sure to sand the tips of the key-contact bolts, and the hacksaw blade pieces where they meet their terminal and key-contact bolts.

What finally evolved is a code-practice set consisting of a key (Fig 19) and code-practice oscillators (Figs 20, 21 and 22) capable of putting out a maximum of audio with a minimum of parts and battery voltage. The key is built on a 4 × 6 × 3/16-inch wooden base of scrap paneling. Its springs consists of two halves of a 10½-inch-long hacksaw blade. (The hacksaw blade can be easily snapped at its midpoint by nicking it with a bench grinder, wrapping it in a piece of cloth [to contain the shrapnel that can fly when the blade breaks] and bending it at its center. Wear eye protection when you do this.) Study Fig 19 closely for more details on constructing the Hardware-Store Special key; don't be afraid to experiment and improvise with the materials you have on hand.

The next problem solved was our requirement for a simple, loud code-practice oscillator. I found a gem on page 4-26 of *The 1990 ARRL Handbook:* a *one-transistor* circuit capable of providing room-filling sound with a low-voltage dc supply. Fig 20 shows the circuit, which is simplified a bit over the *Handbook* version, and Figs 21

Fig 21—The solderless Hardware-Store Special code-practice oscillator. Most of its connections are made with crimp-on terminals —admittedly for a wire size a bit larger than that of the circuit's components! Wire nuts complete the connections to Q1's base and emitter leads. The spherical speaker is a junk-box item; any 8-Ω speaker will do. Standard nuts and bolts can be used instead of the knurled key-terminal nuts.

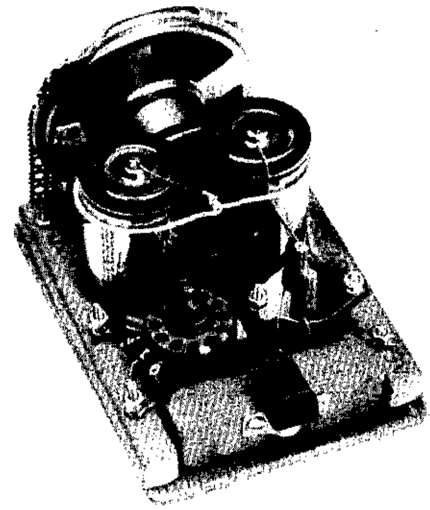


Fig 22—This Hardware-Store Special code-practice oscillator requires some soldering. In this version, R1 consists of a 5-kΩ resistor in series with a 50-kΩ potentiometer, used as a variable resistor, for pitch control. The push-button "key" makes this Hardware-Store Special self-contained, and convenient for paired groups in a classroom.

and 22 show two implementations of the circuit. The oscillator shown in Fig 21 is *solderless*; its connections are made with crimp-on lugs and wire nuts.

Now my Novice students are building their own keys and code-practice sets themselves—at minimum cost, and with commonly available parts and tools.—*Art Zavarella, W1KK, 1702 Main St, Agawam, MA 01001*

TEAMING THE W6OWP KEYING INTERFACE WITH THE HEATHKIT HW-101 TRANSCEIVER

☐ In April 1987 *QST*,[6] F. A. Bartlett, W6OWP, described a circuit capable of eliminating first-character distortion (shortening) that occurs during semi-break-in (keyed VOX) CW operation with some transceivers. Teaming the circuit with my Heathkit® HW-101 involved a few modifications that may be of interest to others who intend to use the interface with older, tube-based transceivers. Here's how I modified the two to work together.

Fig 23 shows the additional circuitry

[6]F. Bartlett, "A CW Keying Interface," *QST*, Apr 1987, pp 51-53.

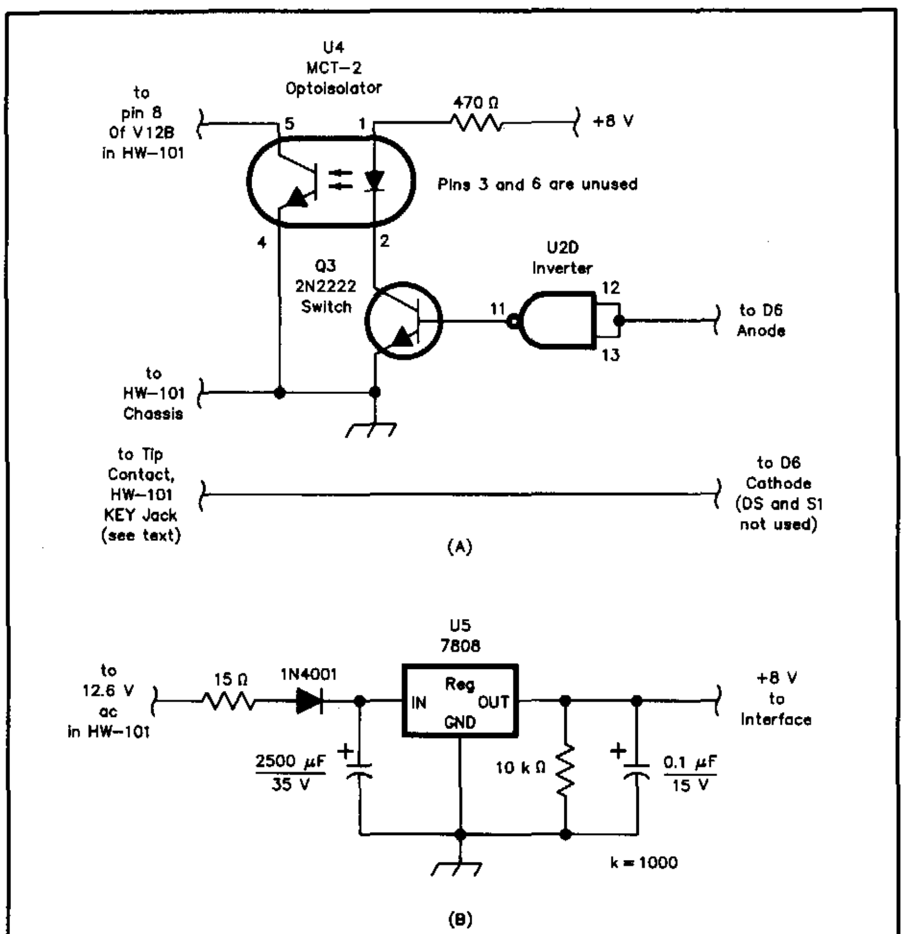


Fig 23—Jim Zvolanek modified F. A. Bartlett's CW keying interface for compatibility with a Heathkit HW-101 transceiver as shown at A. New power-supply circuitry (B), powered by the HW-101's 12.6-V ac heater supply, was necessary, too. Resistors are ¼-W, carbon-film units. See text.

necessary to connect the interface's PTT-control line to V12B, the HW-101's TR-relay driver. U2D, unused in the original interface circuit, is put to work here.

The original interface was designed to be powered from a 13.5-V dc source in its associated transceiver. Such a supply is unavailable in the HW-101, so I used the circuit shown in Fig 23B, deleting the 9.1-V Zener diode, 200-Ω resistor, and 0.1- and 200-μF capacitors that provide 9.1-V dc from 13.5 V in the original design.

Construction and Installation

I decided to build the interface into the transceiver on a Radio Shack® 276-150 Multipurpose Board. This board has ample room to accommodate the original interface circuitry (including the **MARK** and **SPACE** pots) and the additional parts called for in Fig 23A.

I mounted the interface board on the HW-101's main chassis, 3/4 inch to the right of the cage containing the rig's 6146 amplifier tubes and over the 5/8-inch-diameter access hole, which also allows wiring to the underchassis circuits. An aluminum bracket, 3 × 2 inches in size with a 1/4-inch flange, supports the board. Position the board on the bracket so the **MARK** and **SPACE** pots are accessible for easy adjustment.

I built the power supply underneath the chassis on the vertical partition that supports the coil compartment. A bolt suitable for mounting the 7808 regulator is available 3-1/2 inches from the rear of the chassis. Other power-supply parts are wired to a terminal strip mounted over the grounding lug for the socket of RL2 (one of the HW-101's TR relays).

The HW-101's **KEY**-jack wiring must be modified because the interface unit's keying transistor (Q2, an MPSA42; see the article cited in note 6) must operate grounded-collector, with its emitter connected to the HW-101's keying line. Lift the black/white wire at the tip terminal of the HW-101's **KEY** jack and connect this wire to Q2's emitter. Then run a wire from the HW-101's **KEY**-jack tip terminal to the cathode of D6 in the interface circuit. This completes the modification.

Follow the adjustment procedures described in the original article, and you're ready to operate.—*Jim Zvolanek, W9AG, 3827 W 83rd Pl, Chicago, IL 60652*

MODIFYING THE WB4VVF ACCU-KEYER FOR POSITIVE-KEYING SOLID-STATE TRANSMITTERS

☐ Although the WB4VVF Accu-Keyer design is pushing 20 years of age,[7] it's still very much in use—especially with the blocked-grid-keying transmitters and transceivers (positive ground, keying line negative with key up) still in service. Here's how

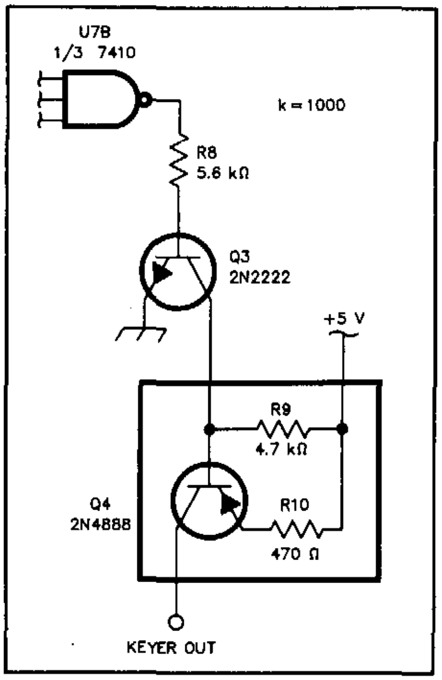


Fig 24—The original Accu-Keyer output circuitry used a 2N4888 transistor to key the blocked-grid-keyed transmitters and transceivers common in its day. The keying line in such radios is negative during key-up periods.

to adapt the Accu-Keyer for use with modern, positive-keyed rigs (negative ground, keying line positive with key up).

Fig 24 shows the original Accu-Keyer output circuit. Modify the boxed circuitry as follows:

1. Lift Q4's base lead from the circuit board.
2. Lift either of R9's leads from the circuit board, or remove R9 entirely.
3. Relocate the keyer output connection from Q4's collector to Q3's collector.
4. Solder a 0.001-μF, 25-V disc-ceramic capacitor across the **KEYER OUTPUT** line (preferably right at the jack), if one is not

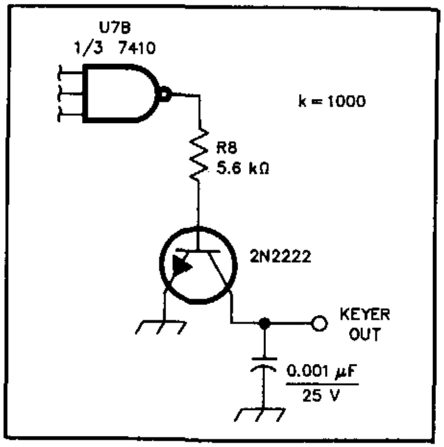


Fig 25—Bob Libbin bypasses Q4, R9 and R10 to modify his Accu-Keyer for use with positive-keying-line transceivers—that is, most modern, solid-state radios.

already present. These steps yield the circuit shown in Fig 25.—*Bob Libbin, AE8L, Cincinnati, Ohio*

AN AID TO COMPUTER CW

☐ The proliferation of computers in Amateur Radio stations has greatly simplified RTTY operation and enhanced high-speed CW operation. Unfortunately, some of the computer/radio interfaces (modems) have default conditions on the radio AFSK and CW-keying lines that are incompatible with some transceivers. Those modems leave the RTTY tone on when placed in the CW mode. This condition makes it impossible to use a VOX feature for CW operation because the AFSK tone keeps the transmitter keyed. Also, many modems leave the CW-keying circuit open when in the RTTY mode, so that the key line must be unplugged when you switch to the CW mode for transmitter adjustments. I use the Hal Communications CRI-200 modem, and it works fine on both RTTY and CW—except for the aforementioned problems.

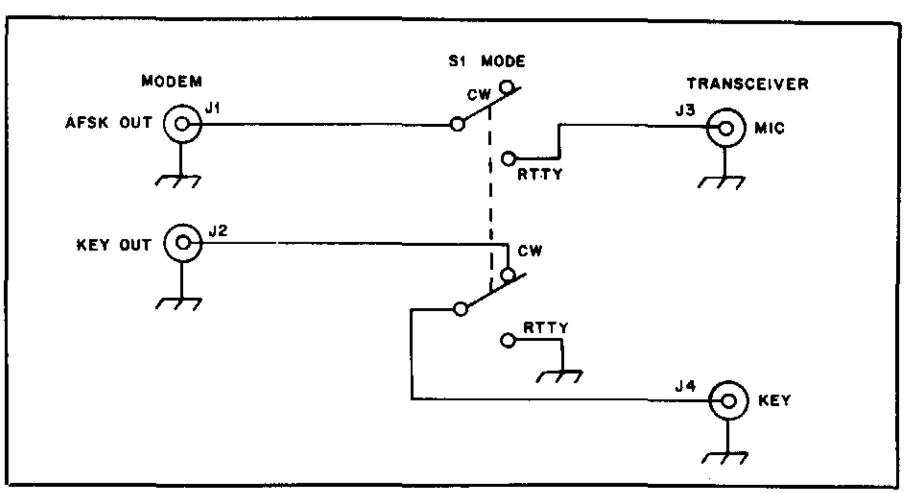


Fig 26—W9CRC's CW/AFSK switch circuit. S1 is a DPDT toggle switch. J1-J4 are phono jacks.

[7] J. Garrett, "The WB4VVF Accu-Keyer," *QST*, Aug 1973, pp 19-23; Feedback, *QST*, Oct 1973, p 36.

Here is a cure for these problems. It consists of an external DPDT switch, a small aluminum box and four phono jacks.

Fig 26 shows my switching arrangement. When the toggle is in the CW position, the modem AFSK/transmitter circuit is opened and the CW-keying circuit is completed. When the toggle is in the SSB position (for RTTY operation), the AFSK circuit is completed and the CW-keying circuit is grounded (to key the transmitter when it is placed in the CW mode).

This external switch allows easy changeover between AFSK and CW modes without the need for internal modem modifications. The project is very easy to build, and it makes computer CW/RTTY operation much more convenient.—*Russ Rennaker, W9CRC, Kokomo, Indiana*

CHEAP AND QUICK RS-232-C-TO-KEYING-LINE INTERFACE

☐ While experimenting with my Tandy® 1000 home computer and some ham code-generation programs, I learned that the computer's RS-232-C DTR line switched from +14 to −14 V when the programs executed the code. In about 1 hour, with a few Radio Shack® parts, I built the interface shown in Fig 27. It works great and easily keys my transceiver. I now send perfect CW!

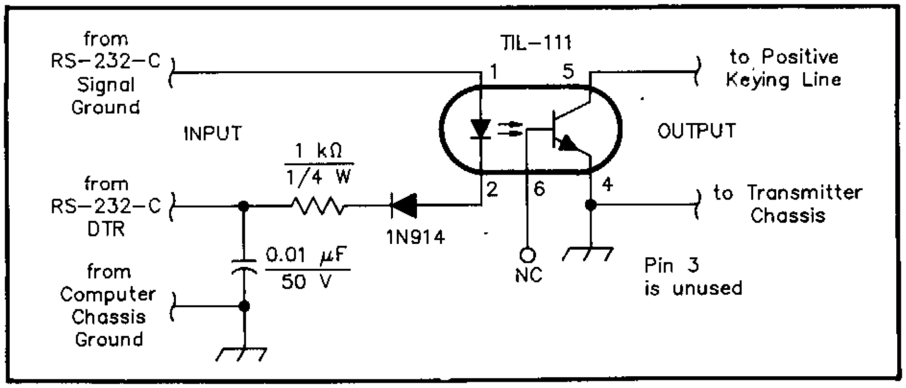


Fig 27—John Swancara's RS-232-C-to-keying-line interface consists of just four parts. You can build the circuit on a piece of scrap copper-clad circuit board. John obtained U1, a TIL-111 optocoupler, as part of Radio Shack's 276-139 optocoupler assortment.

When the Tandy 1000's +14/−14-V RS-232-C DTR signal switches to −14 V, the optocoupler's LED turns on the output transistor, pulling the circuit's OUTPUT line low. If you need a circuit that goes low on positive excursions of the INPUT line, just reverse the 1N914, and the connections to pins 1 and 2 of the optocoupler. If keying your rig involves switching a higher voltage than the optocoupler can handle, you can control a dc relay with the optocoupler and key the rig with the relay.[8]—*John Swancara, WA6LOD, 1002 E Mariposa Ave, El Segundo, CA 90245*

[8]For an all-solid-state solution, see J. Galm, "Simple Control-Signal Level Converters," in the Feb 1990 *QST*, pp 24-27.

A RESONANT SPEAKER FOR CW

☐ Some years back, *QST* published an article on building a resonant speaker for CW.[9] I tried it, but the results were disappointing. That speaker required a glass tumbler of a certain size, and I couldn't closely duplicate it.

I decided to build a closed-tube resonator based on a formula in my old college physics book. I felt that the frequency response of speakers more than 2 inches in diameter would be too wide, so I settled on a 2-inch replacement speaker (Radio Shack 40-245). An empty plastic caulking tube was available, so I cut it to length for 750 Hz. Then I taped the speaker to one end of the tube with electrical tape. During its first trial, the speaker exhibited a pronounced peak, but I wasn't satisfied with its output. As I picked up the speaker, however, I happened to put my thumb inside the tube. To my surprise, the output went up!

To investigate this effect, I installed a movable wooden plug in the tube. Transverse slits in the plug hold fins of thin aluminum stock; these fins can be shaped to center the plug in the pipe. Experimentation consisted of trying the speaker with the plug at various depths in the pipe. Thinking that stiffer resonator material might improve speaker efficiency, I built two more resonators from 2-inch OD PVC pipe (see Fig 28). The results are inconclusive, but each speaker produces a useful peak at 750 Hz. On the average, output at the peak is about 4 to 7 dB over the free-air response of the speaker. I can detect another peak at about 440 Hz, but this is so far down that it causes no problems.

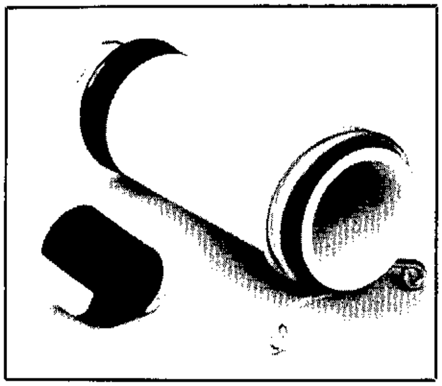


Fig 28—K4JVT's resonant speaker for CW, cut for 750 Hz. The closed-tube resonator consists of 2-inch-OD PVC pipe, 5¼ inches long. The 2-inch speaker (out of view at the far end of the resonator) is mounted to the pipe with electrical tape. The tuning plug is 1-1/8-inch-diameter wooden dowel, 1-1/4 inches long; its positioning fins are thin aluminum stock, press fit into transverse slits in the dowel. The short wire visible at the speaker end of the tube is one of the speaker connections. The speaker stand is heavy-gauge aluminum wire.

I suggest keeping the resonant speaker in the clear by at least 2 feet. Place it on a soft pad. I use a hemostat to adjust the position of the tuning plug. On some of the speakers, two positions of the slug produce a peak—one at the open end of the tube, and another about half-way down toward the speaker. From using both positions on the air, I think the inner position may be best.

I drive the speaker from my Ten-Tec Omni's rear-panel PHONE PATCH jack, turning off the regular speaker with a switch. Slow tuning is essential, because the sharpness of the speaker peak can cause you to overlook signals of weak to moderate strength if you tune too quickly.—*Wally Millard, K4JVT, Camden, North Carolina*

Editor's Note: I'm uncertain as to what formula K4JVT used to calculate the length of his resonator. According to J. E. Williams, F. E. Trinklein and H. C. Metcalf, *Modern Physics* (New York: Holt, Rinehart and Winston, 1976), p 273, the formula for resonance of a closed tube is

$$\lambda = 4(\ell + 0.4d) \qquad \text{Eq 1}$$

where
- λ = wavelength of the tube's fundamental resonant frequency
- ℓ = length of the tube
- d = tube diameter

Assuming that the speed of sound in 25° C air is about 13,622 in/s, this formula can be rewritten to solve for ℓ as

$$\ell = \frac{3406}{f} - 0.4d \qquad \text{Eq 2}$$

where
- ℓ = length of the closed tube in inches
- f = resonant frequency of the tube in hertz
- d = inner diameter of the tube in inches.

The inner diameter of the PVC pipe shown in Fig 28 is 1.56 inches. With this value for d, solving Eq 2 for f = 750 gives a tube length of 3.9 inches. This is considerably shorter than K4JVT's resonator. On the other hand, the graph in S. L. Seaton, "A Resonant Loud-Speaker for C.W. Reception," *QST*, May 1936, p 64, indicates that a closed-tube resonator for 750 Hz should be about 4.3 inches long. Seaton states that "A pipe diameter of two to four inches is suitable for ordinary frequencies." Clearly, there's plenty of room for cut-and-try experimentation!

[9]J. B. and R. V. Heaton, "An Electro-Acoustic CW Filter," *QST*, Apr 1983, pp 35-36.

MORE ON RESONANT SPEAKERS

□ I read with interest the article by Wally Millard, K4JVT, concerning the construction of a resonant speaker for CW. Using the editor's note that accompanied Wally's article, I decided on a four-inch-long piece of PVC that has an ID of 42 mm (1-5/8 inches). I mounted a 2-inch-diam speaker (Radio Shack® 40-245) to one end of the tube with electrical tape as suggested by K4JVT.

In order to test the resonance of the system, my son wrote a program in Microsoft® BASIC 3.0 for the Macintosh computer. This program allows me to modify and display the frequency of the tones produced at the speaker port. Using the Macintosh to drive the speaker system, a noticeable increase in volume was apparent at 870 Hz.

With some further experimentation, I found that an even stronger peak occurred—at a frequency somewhat lower than that of the open-ended tube—when the tube is placed open end down on a hard surface with a small space between the tube and supporting surface. Currently, I am supporting the tube on three pennies (Fig 29). This provides maximum output at 670 Hz—approximately 200 Hz lower than the "wide open" tube.

This project is very easy to construct, and is certainly worth the few dollars of investment needed for the parts. Any CW enthusiast should enjoy the result. *—Richard Clemens, KB8AOB, 103 Barbour St, Buckhannon, WV 26201*

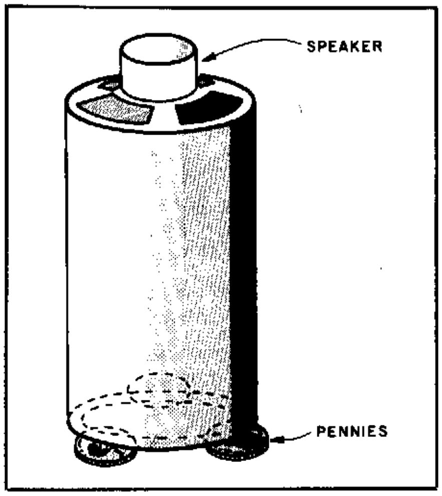


Fig 29—Richard Clemens increased the sharpness of his resonant speaker's peak by upending the tube and supporting the tube on three pennies. This also decreases the assembly's resonant frequency somewhat; see text.

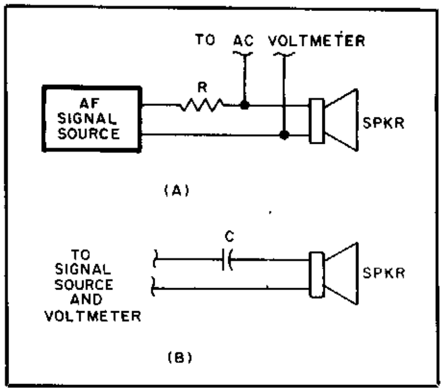


Fig 30—A setup for determining speaker resonance is shown at A. R (5 to 10 Ω) may be necessary for isolation between the audio source and tuned speaker. Speaker resonance is indicated by a voltmeter peak. Jim Weiss suggests enhancing the speaker's free-air resonance by means of a series capacitor or capacitors (B); if you do this, use your receiver or transceiver as an audio source to ensure that the capacitance selected allows for the effects of the rig's audio-output circuitry.

NOTES ON RESONANT SPEAKERS FOR ENHANCED CW RECEPTION

□ Resonant columns are somewhat like antennas: Short, fat pipes are low-Q, like cage or cone antennas; long, thin pipes are high-Q resonators. (Trying to use a resonant column as a sound generator can give you an idea of the importance of "acoustical Q" in a resonator: Blowing across a pop bottle produces a fairly well-defined tone with many overtones, like a flute. Producing any sort of tone with a pop *can* is difficult.)

A fat tube with a speaker in the end is not exactly a closed pipe, so formulas that attempt to characterize a speaker-tube assembly as such will fail. Instead of altering the length-to-diameter ratio with a plug, using *a smaller-diameter pipe* should give a sharper resonance. (Consider the length-to-diameter ratio of organ pipes as a good starting point; their proportions are similar to those of a pencil.)

The 440-Hz peak Wally Millard heard may have been the speaker's free-air resonance (as modified by the presence of the resonant tube), which can be determined with the setup shown in Fig 30A. Matching the pipe length to the speaker's resonance will improve performance. A capacitor can be added to series-resonate the speaker inductance for an even sharper response (Fig 30B). This requires cut and try; use nonpolarized capacitors, paralleling capacitors of different values as needed.

For optimum results with a resonant speaker, especially at slower code speeds, I suggest using a tiny speaker resonating at 300 to 400 Hz (tune the speaker with a capacitor to accentuate the speaker's natural resonance). Once the speaker has been tuned, find the pipe length that matches the speaker's resonance and mount the speaker to the pipe. The speaker's free-air resonance shifts when the speaker is coupled to the pipe, so some fine tuning of the speaker tuning capacitors will probably be required. (Adjustment of the pipe length may also be necessary, so make the pipe longer than necessary to start with.)

I suggest using resonant speakers at pitches between 300 and 400 Hz because the ear is logarithmic in sensing volume and pitch. QRM at 700 Hz is about a whole step removed from a desired signal at 800 Hz, but almost *half an octave* removed at signal and QRM pitches of 300 and 200 Hz, respectively. Thus, lower received-signal pitches generally allow the ear to do a better job of distinguishing adjacent signals from one another.

By the way, graphic equalizers can also be used for tailoring audio response. Boosting a desired pitch and attenuating all other frequencies produces a well-defined passband. A stereo equalizer with both sections connected in series should provide more than adequate audio selectivity for general communication purposes.*—Jim Weiss, W9ZMV, c/o WTAQ, La Grange, IL 60525*

A SWITCH BOX FOR VOICE OR PACKET RADIO

☐ Have you joined the ranks of VHF packeteers? Unless you have a VHF transceiver dedicated to packet-radio operation, you've probably discovered that switching between voice and packet operation is inconvenient because of the different audio feeds necessary for these modes. The simple switch box shown in Fig 31 can allow you to enjoy both modes with a minimum of bother.

J1 must be the same as the connector on the transceiver mic; P1 must mate with the transceiver's microphone connector. I used a male DB9 connector (Radio Shack® no. 276-1537) at P2, TNC. In my installation, J2, AUDIO IN, carries audio obtained from the transceiver's external speaker jack, and J3 carries audio to the external speaker when voice operation is selected. I used a three-pole, double-throw push-button switch at S1; a rotary switch would work fine, too.

Because the switch-box components aren't heavy, I mounted my switch box to the side of the TNC with one of the TNC's cover-mounting screws. With the TNC serving as ballast, the switch box doesn't move when I push S1.

Most recent MF/HF transceivers include rear-panel connections for PTT, AFSK input and audio output. Such auxiliary audio I/O connections need not be disturbed for voice operation. MF/HF transceivers without separate audio I/O connections suitable for digital communications can benefit from the addition of a switch box like that described here.—*Robert L. Dingle, KA4LAU, 657 Dell Ridge Dr, Dayton, OH 45429*

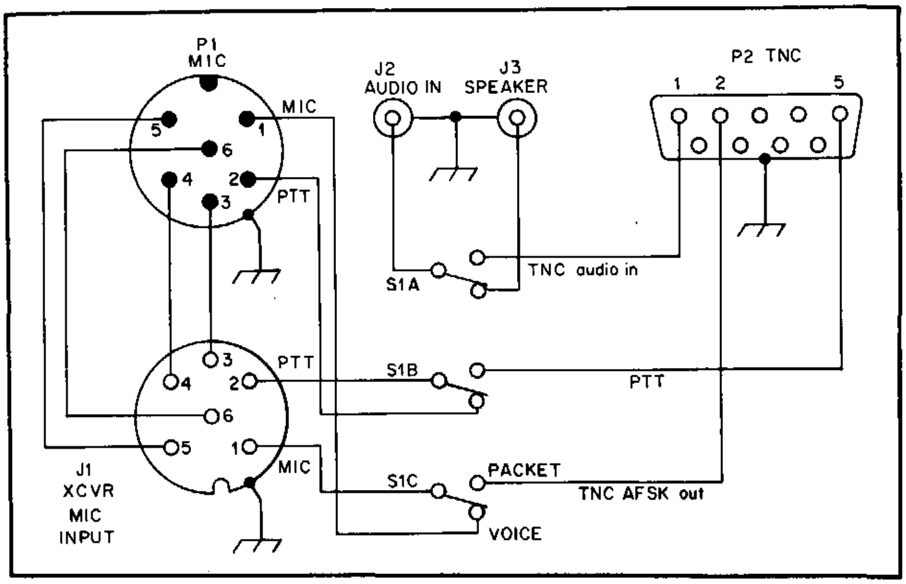


Fig 31—Robert Dingle built this circuit to allow easy switching between voice and packet-radio operation with his VHF transceiver. J1 and P1 complement the mic connectors used on the transceiver; your installation may require connectors of a different type, and pin-number assignments may differ from those shown here. Any microphone-connector lines not affected by packet/voice switch (pins 3, 4 and 6 in this case) should be carried from J1 to P1 to preserve the functions they support. S1 can be a slide or rotary switch. The connector types used at J2, J3 and P2, and the pin assignment at P2, are uncritical and can vary with the connectors available.

A TNC CONNECT ALARM

☐ We wanted an audible alarm for our MFJ-1270 TNCs so we'd know when someone connected to our packet-radio stations. Solution: The simple alarm circuit shown in Fig 32. The alarm uses a 555 timer IC (connected as a one-shot multivibrator) to drive a piezoelectric buzzer when the TNC's CONNECT LED lights. Only eight components are used, including the IC; in addition, we used IC sockets and Radio Shack® dual IC boards (RS 276-159) to hold the components. Layout is not critical.—*George Kammerer, K4HCD, Charleston Heights, and Pat McLeod, WA4NFK, Ladson, South Carolina*

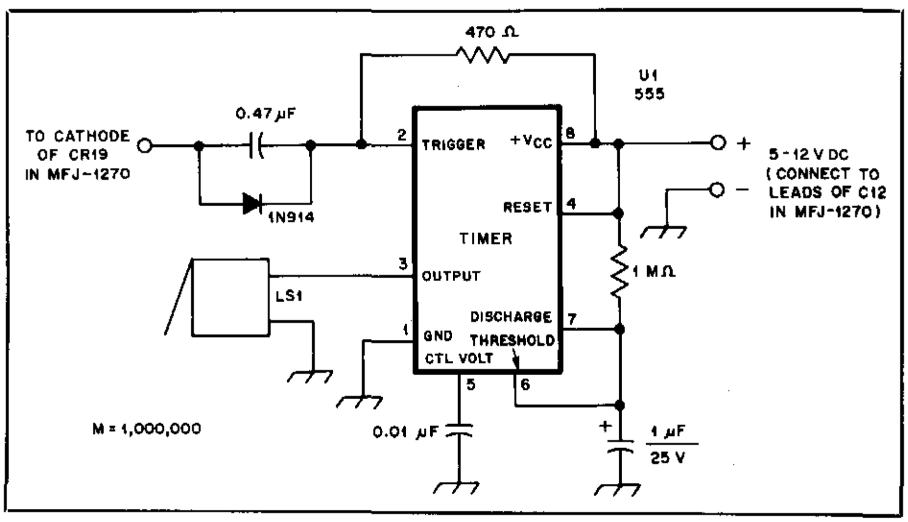


Fig 32—The K4HCD/WA4NFK connect-alarm circuit. CR19 is MFJ's nomenclature for the CONNECT LED on the MFJ-1270 TNC. Its cathode lead is to the *left* as viewed from the front of the TNC. Resistors are ¼-W, carbon film. The 0.01- and 0.47-µF capacitors may be ceramic or plastic film; the 1-µF capacitor is a tantalum electrolytic. LS1 is a piezo-electric buzzer.

IMPROVING THE TNC CONNECT ALARM

☐ K4HCD's Hint shows a very timely TNC-connect-alarm circuit. My version of the connect alarm did not trigger reliably, so I modified the circuit as shown in Fig 33. Now, it works every time. —*Frederick D. Losch, KA9CCZ, RR#4, Box 207, Winchester, IN 47394*

A TNC CONNECT ALARM

☐ Missing a contact on packet by failing to see or hear a connect can be frustrating. To solve this problem on my GLB TNC, I added the circuit shown in Fig 34. When the **CONNECT** LED comes on, the buzzer sounds until the 1000-µF capacitor is charged (about 3 seconds). Pushing S1 (**ALARM**) to **RESET/OFF** disables the alarm and discharges the capacitor through the 470-Ω resistor. Except for the buzzer, all of the components mount on a PC board (mine is about 1¼ inches square) soldered to the terminals of S1.—*Al Smardon, VE3OX, RR 1, Carrying Place, ON K0K 1L0, Canada*

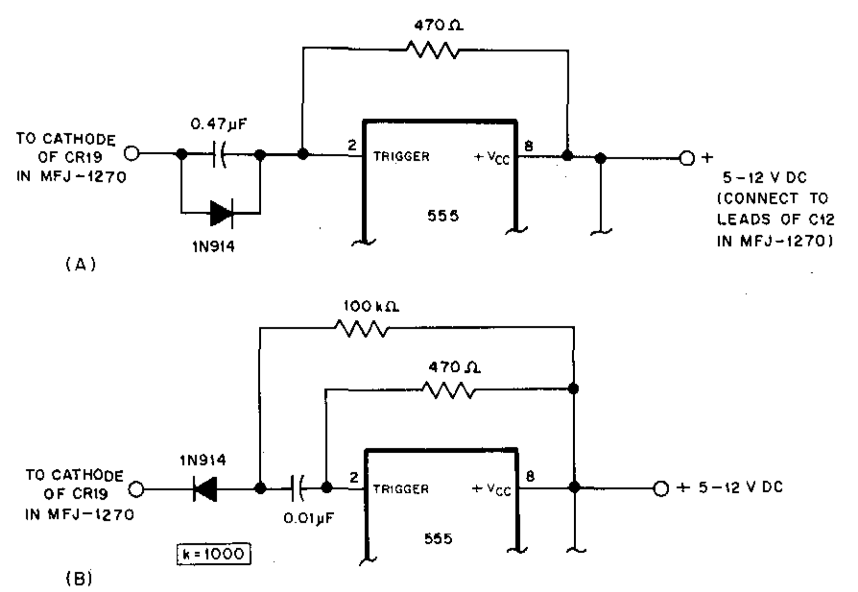


Fig 33—Frederick Losch's TNC connect alarm didn't always sound the alarm when his TNC connected, so he modified part of the original circuit (A) as shown at B. Frederick further reports that the 555's ability to drive more than one piezoelectric buzzer can be put to good use when multiple alarm buzzers are desired (one at the TNC and another at a remote location, for instance). He cautions, however, that electromagnetic transients picked up by long buzzer wires can cause false triggering of the alarm.

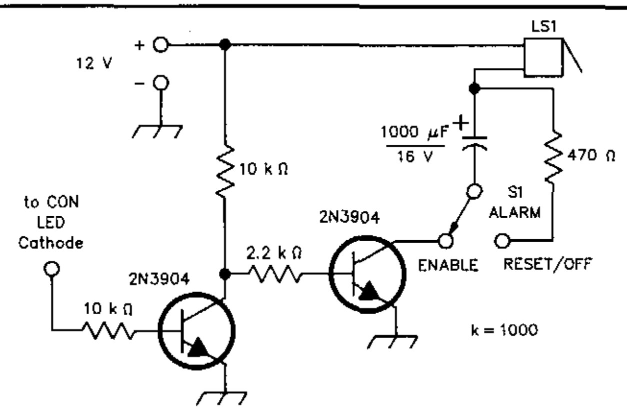


Fig 34—Al Smardon added this connect alarm to his GLB TNC. LS1 is a Radio Shack® 273-055 buzzer.

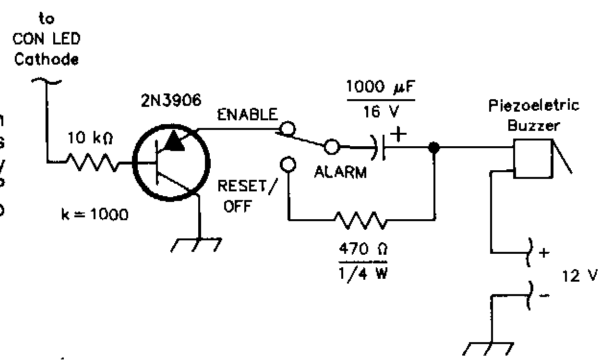


Fig 35—Paul Christensen simplified Al Smardon's GLB TNC-alarm circuit by using a single PNP transistor instead of two NPNs.

SIMPLIFYING THE OCTOBER 1990 GLB TNC MESSAGE-ALERT ALARM

☐ VE3OX provided a circuit for interfacing a connect alarm to a GLB terminal-node controller (TNC). Although the circuit will work well as shown, nearly half of its circuitry can be eliminated through the use of a *PNP* transistor instead of two NPNs.

The first 2N3904 in the original design functions as a logic inverter; the second sinks current from the alarm buzzer. A single PNP transistor (2N3906) can function as a logic inverter *and* current sink for the buzzer, as shown in Fig 35.—*Paul B. Christensen, N9AZ, Jacksonville, Florida*

A TNC MESSAGE-WAITING ALERTER

☐ After recently becoming active in packet radio, I almost immediately became frustrated with having to connect my Tandy® 102 computer to the TNC to see if any messages had been left for me. Because I'm not in the shack most of the day, an audible alarm would have been most trying for my wife. Thinking there must be a better way, I decided to try an approach used in hotel and motel telephone systems.

My solution (Fig 36), a TNC message-waiting circuit, uses exactly the same number of parts as K4HCD's audible alarm. It automatically indicates that a message has been left in the TNC, and automatically resets when the message is delivered to the local terminal. The TNC operates normally all the time, except when the local terminal interface has been "turned off" with the XOFF command character (usually Control-S). When the TNC is in XOFF mode and a remote station connects, the TNC stores received data. When the operator returns the TNC to the XON mode, the TNC responds by sending the message to the local terminal. If a station leaves a message at the TNC while it's in XOFF mode, the CONnect LED flashes (0.5 second on, 0.5 second off) after the station disconnects and until the message is delivered to the local terminal. The flashing CON LED gives the operator a visual indication that the connect occurred, and that a message is probably waiting for him. I built the prototype version on a 1-inch-square piece of "experimenter's" PC board in about an hour; part placement and layout are not critical.

The Circuit

The message-waiting alerter uses both timers in a 556 dual-timer IC to monitor the status of a connect within the TNC. The first timer (U1A) is configured as an RS flip-flop, using active-low inputs. The second timer (U1B) serves as an astable

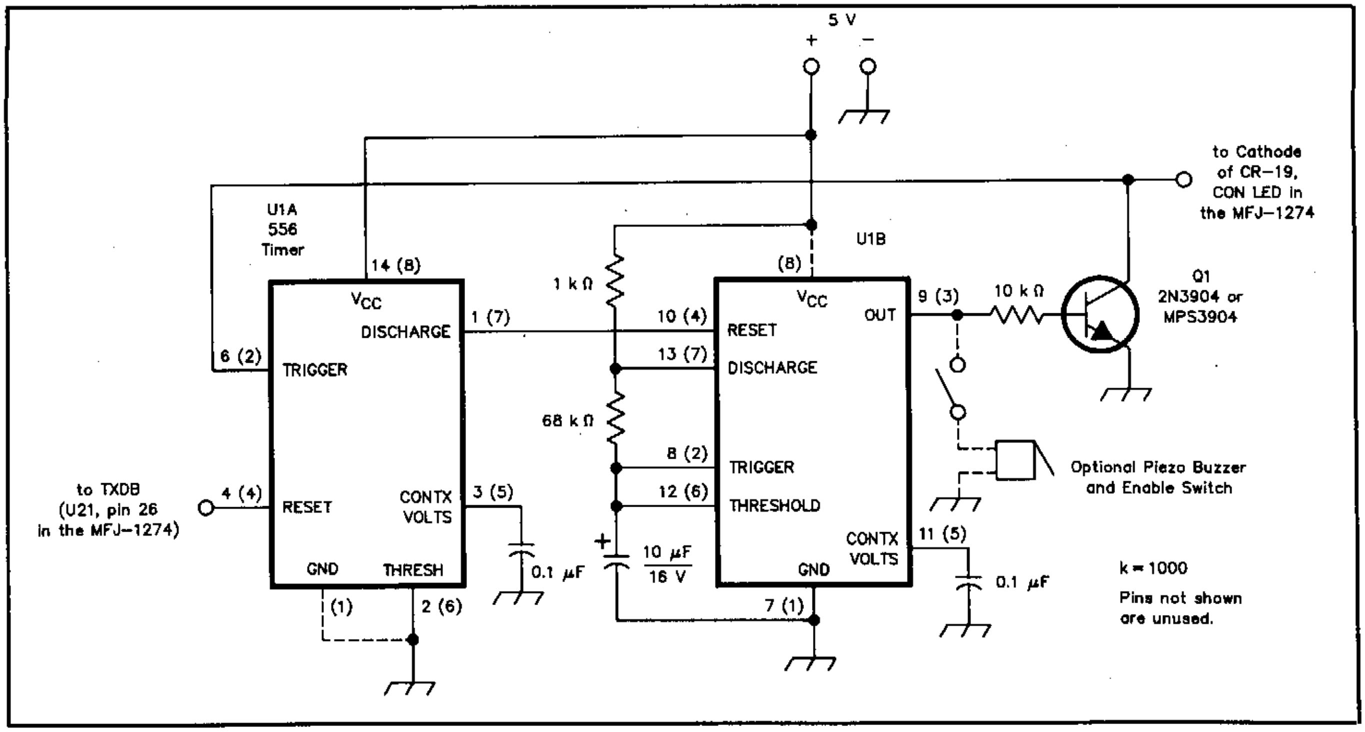


Fig 36—Lynn Hansen's message-waiting alerter flashes his TNC's **CON**nect LED at a 0.5-second rate to indicate that a connection has occurred. The pin numbers outside parentheses refer to a 556 dual-timer IC; use the parenthesized pin numbers if you substitute two 555s for the 556.

multivibrator that is controlled by the first timer.

Under normal conditions, the TXDB line carries data to the local terminal. Each data "space" pulls the **RESET** input of U1A low, resetting the internal flip-flop, and keeping the **DISCHARGE** output low. This output is wired to U1B's **RESET** input, which in turn keeps U1B, the multivibrator, disabled, and the output of Q1 floating in a high-impedance state. Q1's collector is paralleled across that of the TNC's **CON** LED driver transistor; this point is also fed to U1A's **TRIGGER** input.

When a connect occurs, the DTRB output of U21 goes high. This output turns on the TNC **CON** LED driver transistor, triggering U1A's internal flip-flop, which in turn toggles U1A's **DISCHARGE** output high. U1A's **DISCHARGE** output is connected to the **RESET** input of U1B. When U1A's **DISCHARGE** output goes high, it allows U1B to start up as an astable multivibrator, switching Q1 on and off at a 0.5-second rate. This continues until U1A is reset by local-terminal data on the TXDB line.

When a disconnection occurs with the TNC in XON mode, data transmitted to the local terminal on TXDB automatically resets U1A and U1B. The TNC's **CON** LED also goes out, of course.

When the TNC is in XOFF mode, no data is sent to the local terminal, hence, U1A and U1B are not reset. After disconnection, U1B continues to operate, switching Q1 on and off. This flashes the **CON** LED to indicate the likelihood that a message is waiting. As soon as the local terminal commands the TNC into the XON mode, the data flowing on the TXDB line resets U1A and U1B, and the **CON** LED stops flashing.

Installation

Installation is easy. Remove the cover of your TNC and connect the alerter to the following sources:

+5 V dc is available at many spots in the TNC. In my MFJ-1274, this voltage is available at the hot side of R34 (the dropping resistor on the TNC's **PWR** LED).

Ground. This is another easily accessible point. I found it on pin 3 of connector J5, the TTL serial port on my MFJ-1274.

A connecting point for the collector of Q1 on the alerter board. Make this connection to the **CON** LED cathode (in the MFJ-1274) or to the collector of its driver transistor.

***RESET** input for U1A.* Use the TNC's TXDB output (in the MFJ-1274, this is pin 26 of U21 or pin 2 of IC3). Another signal, suitable for Reset (the SIO chip's RXDB input) can be found on pin 1 of J5, the '1274's TTL serial port. Try both signals to see which works best for you.

This circuit operates completely in the background—no operator control is required. It also makes a great little evening project, since all of the parts can be obtained for under $5 at your local Radio Shack® store. One other advantage is that this modification does not deface your TNC should you want to sell it later, and is easily removable.

If you want, you can add a piezoelectric buzzer to this circuit: Just hang it on the output (pin 9 or 3) of U1B. If you do this, you may want to put a switch on it—to help keep peace in the family!

I hope that you find this circuit as useful as I have. It's nice to have packet-mail capability, but it's even nicer to have a flag on the mailbox!—*Lynn H. Hansen, KU7Q, 741 E 300 N, Soda Springs, ID 83276*

CHAPTER 10

Electromagnetic Interference (RFI/EMI)

MODIFIED 300-OHM HIGH-PASS FILTER REDUCES TV FUNDAMENTAL OVERLOAD

☐ If you have TVI, your first inclination may be to install expensive low-pass filters in your transmission lines and power cords. In some cases, however, the interference may be caused by fundamental overload—not by harmonics—against which low-pass filtering offers no protection. Thus, it's a good idea to eliminate the possibility of fundamental overload first, if possible.

Inexpensive *high*-pass filters are available from many electronic supply houses and department stores, but the fundamental-overload reduction afforded by such filters is sometimes disappointing. A simple filter modification may make a substantial improvement in such cases. Fig 1 shows the schematic of a typical 300-Ω high-pass filter. The inductors serve to block VHF television signals and pass lower frequencies to ground; the capacitors pass VHF and tend to block lower frequencies. When the filter is installed *without* a ground connection, however, the inductors form a low-frequency path around the capacitors!

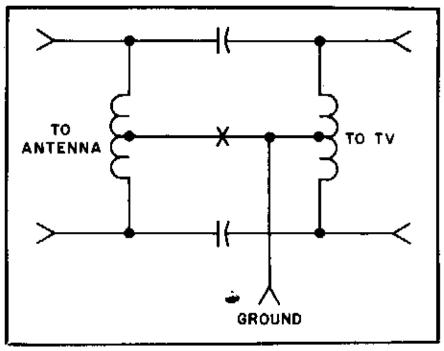


Fig 1—A typical 300-Ω high-pass TV filter isn't much of a filter unless its GROUND terminal is connected to that elusive commodity known as "a good RF ground." Where unavailability of an RF ground renders such a filter ineffective against fundamental overload, KO3D suggests cutting the common connection between the filter's input and output inductors at X. The text tells why this may help.

Obviously, this problem is best solved by connecting the filter GROUND terminal to a good RF ground. But "a good RF ground" is not always available. As an alternative, break the connection between the input and output inductors (at X in Fig 1). This destroys the filter action, but leaves the relatively high reactance (at ham frequencies below 30 MHz) of the capacitors in series with the TV transmission line.

Open the filter case (usually plastic) and break the connection between the input and output inductors. Be sure there is no dc path between the coils. Complete the modification by closing the filter case. (If the case breaks, a little tape and glue can repair it.)

Try the filter and note the results. If the interference lessens, fundamental overload is at least part of the cause. If the improvement is substantial but not complete, try cascading two modified filters.—*James Pentland, KO3D, York, Pennsylvania*

Editor's Note: *Many* variables are involved in TVI cases, including the band(s), powers, TV channels, antenna gains, equipment types and grounding techniques employed. If you clear up a case of TVI with a filter modified as KO3D suggests, fundamental overload was almost certainly the sole interference culprit. *Lack* of success with such a filter, however, does not necessarily prove that fundamental overload is *not* the primary interfering agent. Also, in cases where fundamental overload and harmonic interference occur simultaneously, elimination of the fundamental at the TV antenna terminals is only half of the cure. To learn more about elimination of interference to and from TVs and other electric/electronic devices, see ARRL's *The ARRL Handbook* (Chapter 39) and *Radio Frequency Interference*, and Radio Publications' *Interference Handbook*. These books are available from your dealer or ARRL HQ.

300-Ω FILTER IN 75-Ω TV COAX CURES SHIELD-CONDUCTED TVI

☐ High-frequency RF traveling on the shield of 75-Ω TV feed tends to bypass 75-Ω high-pass filters installed in the line. Solution: Use two 75-to-300-Ω impedance transformer/baluns and a *300*-Ω high-pass filter as shown in Fig 2. Suitable transformers and filters are available from Radio Shack®, TV dealers, electronics stores and similar sources.—*Jim Rafferty, N6RJ, 5693 Grandview, Yorba Linda, CA 92686*

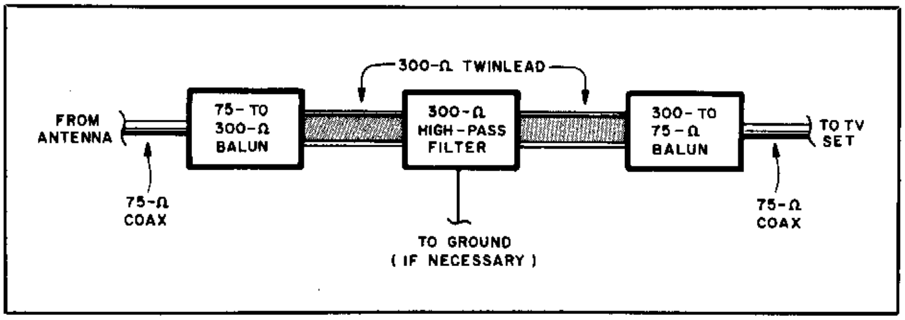


Fig 2—Jim Rafferty's addition to H & K's anti-TVI arsenal: Inserting two transformers and a 300-Ω filter in a 75-Ω TV antenna system quashes RFI caused by shield-borne HF energy.

AK7M: In addition to offering an obstacle to shield-conducted HF energy by breaking the coax shield, this transformer-filter-transformer fix may owe part of its success to inefficiency of the 75-to-300-Ω transformers at HF.

MORE ON CURING TVI WITH 300-Ω FILTERS AND 4:1 TRANSFORMERS

☐ Jim Rafferty, N6RJ, reported curing TVI in 75-Ω systems with 300-Ω high-pass filters and 4:1 transformers. This cure has been making the rounds in many of the 6-Land newsletters for several years. It works, and I have been investigating *why* it works. After all, a 75-Ω high-pass filter should work fine in 75-Ω cable!

The only reason an effective 75-Ω filter may not work in a 75-Ω coaxial-cable system is that a common-mode signal exists. (A common-mode signal travels down coax, particularly on the outside of the coax braid, as if the coax is just one wire of a two-wire circuit.) If coax is doing its job, the RF currents on its center conductor and shield wire are of the same magnitude but opposite in phase. When this is so, the coax acts like the transmission line it is, providing source and return paths for the signals it carries. Cheap (RF-leaky) coax, poorly installed connectors or poorly designed electronic equipment may cause or support common-mode signal transmission.

In cases where such common-mode signals cause interference solvable with a 300-Ω filter bracketed by 75-to-300-Ω transformers, a choke made of ferrite beads slipped over the cable can solve the problem just as well. Neither solution attacks the *cause* of the common-mode signal involved. Seeking to eliminate the cause of common-mode interference at my station, I replaced suspect TV feed line—cheap RG-59—with Belden 9114, an RG-6-type cable that has braid and a continuous aluminum-foil shield. This eliminated my HF TVI without my having to install filters. (I solved 6-meter TVI by replacing an old antenna-mounted TV preamp with a Radio Shack 15-1118.) Result: A TV system that's interference-free without low-pass filters.

Of course, it's not always practical to replace TV feed line. If this is true in your case, try a ferrite-bead shield choke or the filters-and-transformer solution. The latter solution is inexpensive and seems to work every time.—*Steve Lund, WA8LLY, 10180 Mill Station Rd, Sebastopol, CA 95472*

REDUCING TVI IN CABLE-FED TVs

☐ I'm a CATV trunk-line technician. In most of the amateur CATVI cases I've seen, interfering signals get to the TV set on the *outside* of the drop cable's shield braid. (The *drop* is the cable between your house and the pole.) This occurs because the drop cable acts as a random-wire antenna for MF/HF signals.

In every case of such interference I've handled, I solved the problem by wrapping 8 to 10 turns of the CATV cable through a TV-deflection-yoke ferrite core. (Locate the coil within 2 or 3 feet of the point at which the cable connects to the TV system.) This places approximately 60 to 80 μH of inductance in series with the drop-cable shield—an inductance that acts as a broadband choke because of the core characteristics and the low distributed capacity of the winding. Because installing the choke doesn't affect RF transmission inside the cable and doesn't break the coax shield, the choke does not affect the drop's leakage and impedance characteristics.

In stubborn cases, an additional core or cores can be used to choke common-mode MF/HF conduction on the TV system's ac line cord(s).—*Mark S. Graalman, WB8JKR, 5004 South Ave, Toledo, OH 43615-6429*

Maybe the Transformers Do Most of the Filtering!

[illegible] Lo and behold, they had a better high-pass characteristic than 75-Ω RS filters! Figs A and B show the details.

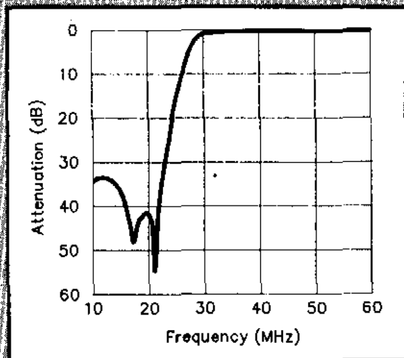


Fig A—Measured attenuation of a Radio Shack (no. 15-579) 75-Ω high-pass filter.

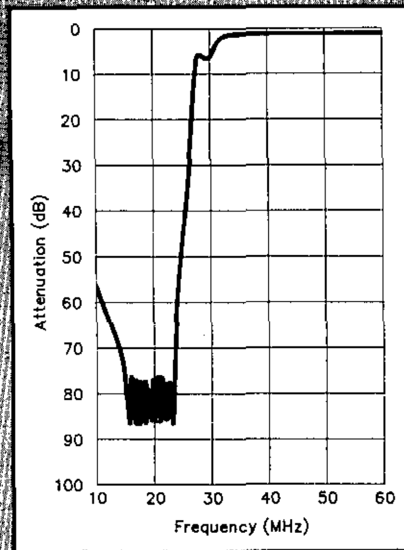


Fig B—[illegible] Radio Shack filter evaluated in Fig A.

All 75-to-300-Ω TV-feed-line transformers [illegible] have a much higher μ and work well all the way down to [illegible] high-pass filter.—WJ1Z

WJ1Z: A *deflection yoke* is a coil assembly that mounts around the neck of a TV CRT (*cathode-ray tube*, also called a *picture tube*). The magnetic fields of its coils *deflect* (steer) the tube's electron beam(s) to draw the picture you see, in light emitted by electroluminescent phosphors, on the inside surface of the CRT screen. Deflection-yoke coils are usually wound on cores consisting of *ferrite*, an iron-bearing ceramic-like material that increases the coils' inductance while supporting and shaping the coils' windings. Radio amateurs sometimes wind interference-suppression chokes on discarded deflection-yoke cores; you may be able to find such cores at shops that repair TVs or computer monitors.

Better yet, consider using *new* toroidal cores instead. Assuming loop 10 turns of coax through one of Mark's cores results in an 80-μH choke, the A_L (inductance [in this case, millihenries] per 1000 turns) value of his cores works out to 800—roughly midway between that of a 1.14-inch-diameter Mix-43 ferrite toroid (A_L = 603) and a 1.14-inch-diameter Mix-77 ferrite toroid (A_L = 1140). You may have trouble winding much CATV coax around a core of this size, though, so consider using 2.4-inch cores (A_L = 1240 for Mix 43, and A_L = 3130 for Mix 77) and winding 6 to 8 turns of coax through them. Check with Amidon (2216 E Gladwick St, Dominguez Hills, CA 90220, tel 213-763-5770, fax 213-763-2250), Palomar Engineers (Box 455, Escondido, CA 92033, tel 619-747-3343), Ocean State Electronics (Box 1458, Westerly, RI 02891, tel 800-866-6626, fax 401-596-3590) or other suppliers to see who carries what.

Although deflection-yoke cores can help suppress MF/HF interference, they're intended for use only at frequencies up to a few tens of kilohertz. Concerning the toroidal cores I've mentioned, Palomar Engineers' *RFI Tip Sheet* suggests that "Mix 77 is the best below 40 MHz [and] Mix 43 can be used from 1-1000 MHz and is the best from 30-150 MHz." The frequencies mentioned are for *the interfering signal*, not the interfered-with signal. Thus, use a Mix-43 core to suppress interference from a 50- or 144-MHz transmitter. A Mix-77 core would be the better choice if, for instance, a 10-MHz transmitter is the cause.

A BROKEN-SHIELD COUPLER CAN ELIMINATE TVI

☐ Fundamental-overload TVI happens when nonharmonic Amateur Radio signals—often in the MF and HF range—overload a TV receiver's front-end circuitry. The key to solving MF/HF fundamental-overload TVI is to keep MF/HF signals out of the TV front end while allowing TV signals to pass. One means of doing this is the Faraday-shielded coupler shown in Fig 3.

Faraday shields can take several forms, but all have one thing in common: They support *magnetic* (inductive) coupling while thwarting *electrostatic* (capacitive) coupling. The coupler shown in Fig 3 breaks the feed-line shield, disallowing shield conduction of MF and HF energy into the TV set. Each center-conductor-to-shield connection forms a coupling loop; the presence of the cable shield over most of each loop provides electrostatic shielding. Magnetic coupling occurs because the broken shields allow the loops to "see" the other magnetically.

Install the coupler near the TV antenna terminals, taping or lacing the loops together, side by side, for tight coupling and mechanical soundness. Don't allow the loops' braids to touch or otherwise connect them together electrically; that would bypass the coupler and render it useless! Gerald Dale, ZS6AUB, suggested this idea to me during an on-air conversation about TVI.—*Wayne W. Cooper, AG4R, 9302 NW 2nd Pl, Miami Shores, FL 33150*

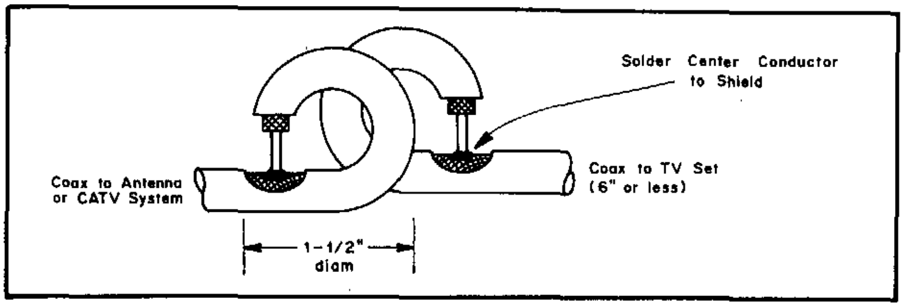


Fig 3—Wayne Cooper suggests this Faraday-shielded coupler as a means of combating fundamental-overload TVI. The loops, shown offset and separated here, should be fastened together side by side in practice. See text.

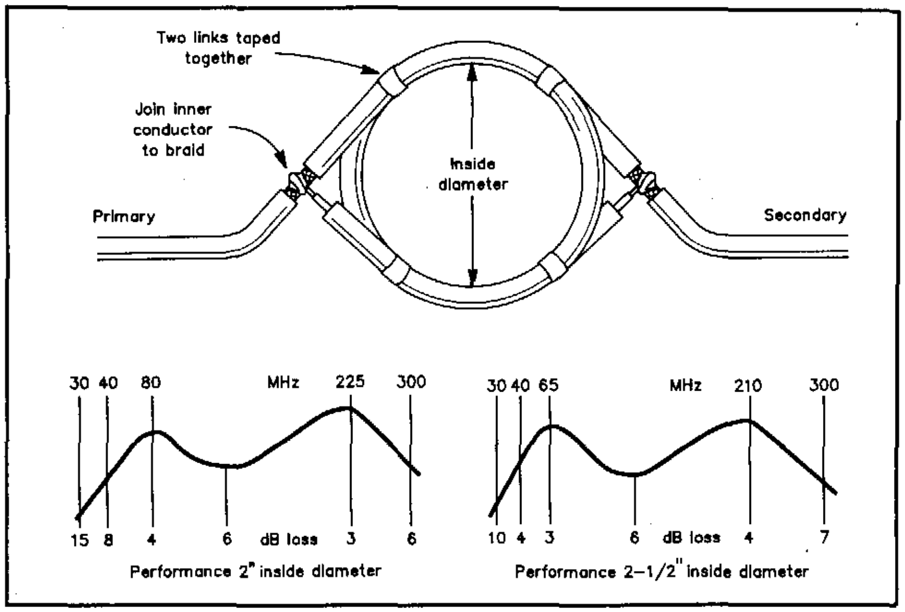


Fig 4—Known to British amateurs as a *braid-breaker*, the broken-shield coupler stymies interfering signals flowing on the outside of coaxial-cable braid by breaking the cable shield (and center conductor). As these double-humped response curves reflect, the braid-breaker restores the VHF signal path with two overcoupled, electrostatically shielded tuned circuits. Because breaking the braid also allows RF to leak out of the cable, ***don't use a broken-shield coupler in a cable-TV system!*** (Drawing after Fig 17.51, RSGB *Radio Communication Handbook*, 5th ed)

FEEDBACK: A BROKEN-SHIELD COUPLER

☐ In "A Broken-Shield Coupler," Wayne Cooper, AG4R, described a long-time interference fix: a Faraday-shielded broken-coaxial-shield coupler intended for use in coax-fed TV systems. Although a broken-shield coupler is somewhat lossy at best, it *may* help in some interference situations (Fig 4). One very common situation in which you *shouldn't* use a broken-shield coupler, however, is in coax that's part of a CATV system! Brian Hemmings, KA3CTP, of Continental Cablevision of St Louis County, Inc, St Louis, Missouri, tells why:

"If you construct this Faraday-shielded coupler for use in a CATV system, you will risk radiating the signals from the CATV system, so the method should only be used when you are using off-air antennas. If you are connected to a cable television system, it is not wise to use this method, since most cable companies use aeronautical frequencies and leakage of those signals could interfere with aircraft voice communications. CATV-system operators are acutely aware of the dangers of interfering with these services, and take the leakage seriously. Most have their hands full just maintaining the existing problems and would appreciate not having more created by amateurs. We are pleased with the assistance we receive from fellow hams in locating CATV leaks."

How much of a leak can a Faraday-shielded broken-shield coupler cause? Hugo P. Marquart, NØDYZ, of Bismarck, North Dakota, did some measurements:

"I work for Bismarck-Mandan Cable TV, and my duties are to attain minimum CLI (Cumulative Leakage Index) as required by the FCC. Using RG-59 coax, I made the coax coupler shown in Fig 3 on page 37 of July 1990 *QST*. The coupler was so lossy that, with a signal level of +9 dBmV on channel 4 and channel 11 from the signal source (0 dB = 1 mV), the signal into a TV—−5 dBmV and −6 dBmV as measured on a meter—produced 'very noisy video.'

"Using a Comsonics, Inc, 'Sniffer III' (an RF-leakage detector that includes a 1/2-λ horizontal dipole cut for 108 MHz), the CLI measurement at 10 feet was more than 2 millivolts per meter—very, very unacceptable.

"Part 76 of the FCC Rules requires that a leak of 20 microvolts per meter must be repaired within a reasonable length of time."

Bottom line: *Don't use a broken-shield coupler in a CATV system.—David Newkirk, AK7M, Assistant Technical Editor*

CURING CORDLESS-PHONE RFI

☐ After disabling two cordless-phone base units—one base unit and its replacement—with my 100-W transmitter, I knew I needed a *real* RFI solution. I solved the problem by adding ferrite-core RF chokes in *all* cords leading into and out of the base unit. I made each choke by winding a single-layer coil of as much cord as possible on a 4-inch-long ferrite rod (material 33, permeability 800).[1] Nylon cable ties hold the windings in place. I formed each choke as close to the body of the phone base unit as possible for maximum interference suppression.—*Jack G. Hollenbeck, W6JIC, 3166 Bryant St, Palo Alto, CA 94306*

[1] Amidon Associates carries such rods as part no. R33-050-400; Palomar Engineers carries them as part no. RF-4-33; and RADIOKIT carries them as part no. R33-50-400.—*AK7M*

ANOTHER TELEPHONE RFI CURE

☐ A hint by Mikio Maruya, WA6BSJ, in April 1984 *QST*, page 43, suggested the addition of line filters to eliminate telephone interference. Each of WA6BSJ's filters contained four RF chokes and three capacitors. After experiencing telephone RFI with my Yaesu FT-101EE transceiver, I found a simpler—and possibly more universal—cure. First, I installed an ac-line filter in the transceiver power cord within *2 inches* of the rig. Next, I connected the filter case to a cold-water-pipe ground by means of heavy wire. This simple solution entirely eliminated my interference problem.—*Dave Zinder, W7PMD, PE, ARRL Technical Advisor, Phoenix, Arizona*

Editor's Note: The use of plastic pipe fittings in modern plumbing makes the "cold-water-pipe ground" an increasingly unsure option. Before depending on cold-water plumbing for electrical grounding of *any* kind, be sure that the system is conductive between your intended ground point and the main water inlet for the house.

GARAGE-DOOR-OPENER RFI

☐ The other day, my neighbor called me over the back fence and told me that he was having a problem with his automatic garage-door opener (an Ultra Life Model 800): It was opening and closing without him giving it any commands. Even though a serviceman had been out several times and had changed the opener unit, the problem persisted.

When my neighbor told me the time of day and night the door operated on its own, I was almost sure that *my transmitter* was the cause. I contacted my radio club's RFI group—of which I'm a member!—and scheduled some interference tests. In the meantime, I checked my local library for information on garage-door openers. No luck.

Inspecting my neighbor's door opener, I discovered the problem quickly: Almost 30 ft of wire connected a push-button at the garage door to the opener. This long stretch of wire acted as an antenna, picking up enough energy at 14 MHz to cause false triggering of the door-opener control circuitry. (My antenna is about 70 ft from the affected garage-door opener. The interference occurred only when I operated at the maximum legal Amateur Radio power limit with my beam pointed toward the door opener.) I solved the problem by connecting a 125-pF mica capacitor across the opener's switch terminals. This capacitor exhibits a low enough reactance at 14 MHz to short circuit the switch terminals for RF and stop false triggering.

In a spirit of cooperation, and hoping that my information might be of use to others, I wrote the garage-door-opener manufacturer, telling of the problem and how we cured it. (Surprisingly, my collection of RFI-proofing literature contained nothing on an interference fix of this kind.) Last, but not least, the Lee De Forest Radio Club got some good publicity for its fast action in solving the problem. —*K. C. Jones, W6OB, 25085 Howard Dr, Hemet, CA 92344*

SOLVING GROUND-FAULT-CIRCUIT-INTERRUPTER RFI

☐ Here's an interference conundrum: My 35-watt CW transceiver tripped the ground-fault circuit interrupter (GFCI) at my house's service entrance panel. My half-wavelength, 7-MHz dipole is mounted at one end of the house; the GFCI, at the opposite end of the house, protects two bathrooms and three outdoor outlets. The transceiver, which has a three-wire power cord, is also grounded via a rod at the back of the house. The shield of the antenna feed line (RG-8) is also grounded where it enters the house.

The SWR on the dipole feed line was lower than 1.5:1 when the GFCI tripped. With a 50-Ω dummy antenna installed in place of the dipole, the GFCI did not trip. On the strength of this dummy-load test, I first assumed that RF energy was being radiated directly into the GFCI. But before undertaking the difficult job of shielding the GFCI, I tried running the transceiver on an isolation transformer instead of plugging it directly into the ac mains. *This cured the problem.*[2] The isolation transformer was a bit bulky, however, so I replaced it with a Radio Shack ac interference filter (no. 15-1111). The filter seems to suppress the interference as well as the isolation transformer did.

My tentative conclusion: Under conditions of other than a near-perfect match between the RF load and feed line, enough reflected RF energy was getting back through the house wiring to the service panel to cause the GFCI to trip. Although I've solved the problem, I have not done much work on determining the exact mechanism of RF interaction with the GFCI circuit. I hope that *QST* readers with experience in solving ground-fault-circuit-interrupter RFI will respond with their views and experiences. Why did this problem come up? Is there a better solution?—*Warren Jochem, WB2IPF/4, 1118 Braenar Ct, Cary, NC 27511*

[2]An isolation transformer is a transformer intended for use between the ac mains and a device containing a "transformerless" power supply. Usually, isolation transformers do not transform one voltage to another; instead, they provide current limiting and isolate the powered device from the mains by breaking the direct wire connection between the mains and the powered device. Apparently, Warren's installation of an isolation transformer cured this case of mains-conducted GFCI because of the inefficiency of the isolation transformer at HF—especially its inefficiency in transmitting *common-mode* HF energy.—*AK7M*

MORE ON SOLVING GROUND-FAULT-CIRCUIT-INTERRUPTER PROBLEMS

☐ Having been an electrician for over 50 years, I read Warren (WB2IPF) Jochem's account of GFCI interference with great interest.

First off: The neutral wire of a GFCI unit must *never* be used as a neutral of any other circuit! To do so will cause the GFCI to trip whenever *anything* in the second circuit is turned on! This can happen *whether or not the GFCI is connected to a load.* A GFCI responds to overload, and to current differential between the line's neutral (white) and hot (black or red) wires. As long as the GFCI "sees" the same amount of current going through both the wires at the same time, it does not trip, provided there is no overload. A second circuit connected to the same neutral upsets this balance and trips the GFCI; a short circuit in the load does the same thing.

It's easy to determine whether or not a second circuit is connected to the GFCI neutral. Turn off all power to the house electrical panel. Next, disconnect the neutral wire leading *from* the GFCI to the system neutral and tape the end of this wire back. Turn the panel back on, and with *all* breakers in the panel back on *except* the GFCI, check throughout the house and see if all outlets and lights are on. They should be. If all circuits are normal, you've eliminated the possibility of another circuit sharing the GFCI neutral. If any outlets or lights are off, a problem exists. Turn the panel off and return the GFCI wiring to normal. *Have an electrician make the necessary repairs.*

Concerning RF interference to GFCIs, the basis of my September 1989 cordless-phone RFI hint ("Curing Cordless-Phone RFI"[3]) may be of some use. I've found that ferrite-rod-core chokes do a very good job of reducing RFI to VCRs, computer equipment, and the like. For each choke, use a rod with a μ of 800[4] and wrap the lead(s) of the affected device around the full length of the rod.[5] Do this on *all* of the leads entering or leaving the affected device.

I suggest doing a bit of experimental work with ferrite-core chokes in the leads leaving and entering RF-prone GFCIs. This may or may not help. (I can't say for sure, having never had GFCI RFI.) I am not in favor of solving GFCI RFI by using an isolation transformer in the line unless the transformer used is capable of handling *at least 15% more current than necessary.* In my experience, the extra current capacity is necessary to avoid undue transformer heating.—*Jack G. Hollenbeck, W6JIC, 21110 Phoenix Lk Rd, Sonora, CA 95370*

[3]J. Hollenbeck, "Curing Cordless-Phone RFI," (p 10-3).

[4]Amidon Associates part no. R33-050-400; Palomar Engineers part no. RF-4-33; and RADIOKIT part no. R33-50-400.

[5]The plural case, *leads*, here refers to *all of the wires of a particular cable.* For example, a device whose only connecting wires comprise a two-wire ac cord and a two-wire speaker cable requires two chokes, one in the ac cord and the other in the speaker cable; don't wind its ac cord and speaker cable on the same rod. And silly as this next reminder may seem, it's possible to go overboard in your anti-interference zeal, so *don't put a choke in a conductor that's intended to serve as an RF ground!—Ed.*

VHF Amplifiers Trip Ground-Fault Circuit Interrupter

☐ I recently had the pleasure of finding out just how sensitive modern GFCIs are. GFCIs are employed for extra safety in electrical outlets in or adjacent to damp environments, such as kitchens, bathrooms and outdoors.

Over a period of a few weeks, the GFCI-protected circuit that I used to power my radio gear began sporadically tripping—always overnight, while I was asleep. This was puzzling, because nothing on the circuit should have been drawing current at night.

I began looking for the cause of this problem by unplugging every piece of gear in the shack, and plugging them in one at a time over a few nights, after my usual evening radio activities. The problem showed up after about three nights. The only thing plugged into the radio circuit was one of my amplifiers.

I own two 15-year-old FAA-surplus tetrode VHF amplifiers, each of which uses a single 8930. These popular "mil-spec" amplifiers are designated AM-6154/6155, and at one time were available through Fair Radio Sales.[6] Each of these amplifiers contains a pair of tubular ac-line bypass capacitors, as well as a gas-discharge tube between the hot and neutral ac-line leads. This isn't an unusual protection scheme (except that in more modern equipment, gas-discharge tubes have generally been replaced by metal-oxide varistors [MOVs]). The bypass capacitors—rated at 0.1 μF at 600 V—caused the GFCI to trip. It seems that after regular use in the evenings, the leakage of at least one of the capacitors increased as the amplifier cooled. This allowed enough current to flow on the ground wire to trip the GFCI. My solution: Replace the old bypass capacitors with 0.01-μF units rated for 125-V-ac service,[7] and replace the gas-discharge tube with a V130LA10A or equivalent MOV. All's been well ever since I made these minor changes in both amplifiers.—*Rus Healy, NJ2L, Assistant Technical Editor*

[6]Fair Radio no longer carries these amplifiers, but they can frequently be found at hamfests. Putting these amplifiers on any Amateur Radio band between 144 and 432 MHz is possible; a few simple modifications are required.

[7]Although hams have for many years used 1-kV-dc-rated capacitors for ac-line bypassing, *capacitors designed, tested and rated for ac-line service are best and safest.* Digi-Key carries them.—*Ed.*

Ground-Fault Circuit Interrupters and Power-Line Filters May Not Mix

☐ Last Field Day, I was assigned to take my packet station, which runs on 120 V ac, up to the operating site. I set the station up in my car to avoid having to do it on-site. Before I left, though, I plugged the station into a garage ac outlet to make sure I had everything right. As soon the plug entered the outlet, the house breaker for that outlet tripped. Needless to say, I was worried! To rule out coincidence, I unplugged the packet station, reset the breaker and tried again—with the same result.

After some thought, I removed the power-line filter in series with the computer's ac cord and repeated the trial. *This time, the breaker didn't trip!* No, the power-line filter was not defective. It includes bypass capacitors connected between the hot and neutral ac leads and ground. These capacitors caused a small current to flow on the ground lead, and the GFCI sensed it and tripped.

The house outlet I normally plug my computer into isn't protected by a GFCI, so I did not experience this problem before. I might not have tripped the garage circuit anyway, because whether or not a particular filter can trip a GFCI depends on whether or not it contains line-to-ground capacitors capable of conducting enough 60-Hz current to trip the GFCI.—*Mike Fullmer, KZ7O, 1974 W 4600 S, Roy, UT 84067*

The 1987 *National Electrical Code Handbook* (P. Schram, ed [Quincy, MA: National Fire Prevention Association, 1987], p 76) characterizes GFCIs as tripping on 5 mA ± 1 mA. What might this mean in practical terms? A purely reactive 0.1-μF capacitor, for example—a reactance of about 27 kΩ at 60 Hz—connected between the hot and ground wires of a 60-Hz, 120-V RMS (169.7 V peak) circuit, allows 4.5 mA RMS (6.3 mA peak) to flow in the ground wire. This means that line-filter circuitry that includes hot-to-ground capacitors totaling near 0.1 μF may cause ground-wire current flow sufficient to trip a GFCI. Add the possibility of line-voltage rise with load changes and noise, and you can see why such a problem may occur only sporadically. Plugging two or more filter-equipped devices into one GFCI-protected outlet may increase the likelihood of filter-capacitance-related tripping.—*Ed.*

CURING AIR-CLEANER INTERFERENCE

☐ My Heathkit® GDS-1297 electrostatic air cleaner worked fine as assembled, with the exception that it caused a loud frying noise in nearby MF and HF receivers, and snow on a TV in the same room. The unit's power supply—approximately 6 kV—is clean. Only when the air-filter cell was connected to the supply did the noise appear. My cure? A simple T-section filter consisting of two 1-MΩ resistors and a 500-pF, 7.5-kV capacitor to ground between the power supply and the air-filter cell (see Fig 5). This filter reduced the noise to an acceptable level.—*John L. Morris, W6YAR, 14427 Allingham Ave, Norwalk, CA 90650*

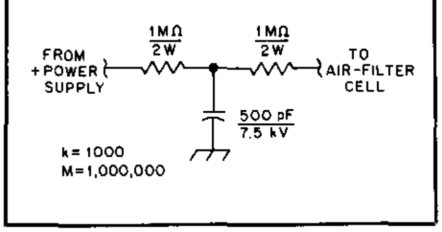


Fig 5—John Morris cleaned up air-cleaner interference with this simple T-section filter. See text.

MORE ON RFI TO MICROPROCESSORS IN AUTOMOBILES

☐ After installing my 25-W, 2-meter radio in a 1981 Oldsmobile Cutlass, a "valve knock" became evident when climbing hills. This would not be unusual except that it occurred only while transmitting! I suspected a voltage drop, and rewired the power cable directly to the battery, but there was no improvement—not even at a 1-W input level.

It then occurred to me that my problem was RFI! At the same time, the Jan 1983 *QST* Hint of W4MJB encouraged me to investigate an RFI cure to the "central processor unit." The CPU is in a metal case that is not grounded to the metal of the car, but "floated" in a plastic cover in front of the right front door, below the glove compartment. The CPU has bypass capacitors and ferrite beads on every edge connection, but only two of many wires are shielded. Simply grounding the metal case to the firewall with ¼-inch braid solved the problem. (The braid length is only about 5 inches.)

This problem and cure is important because future vehicles will no doubt have more and more microprocessors. Vehicle designers must be alert to RFI problems at all frequencies.—*Dave Porter, K2BPP, Hope, New Jersey*

WHISTLE-SWITCH TVI

☐ *Another* source of TVI: whistle-actuated switches. On almost every band I tried between 1.8 and 30 MHz, interference characterized by horizontal color streaks, and sometimes picture tearing, occurred on VHF TV channels as received by the living-room TV. These effects seemed to occur with voice peaks in my SSB transmissions.

Using a tape recorder to modulate my transmitter, I went to a TV in a nearby bedroom to see if that set was similarly affected. The bedroom TV can be turned on and off by remote control—*sonic* remote control by means of a power-receptacle switch that responds to a squeeze-whistle device. Hmm: When I turned the bedroom TV *on*, my wife told me that the interference had vanished from the living room TV! As I turned off the bedroom TV with the whistle, the TVI returned!

I deduced that the remote-control device, in its off state, was somehow generating bursts of VHF RF on my MF/HF SSB voice peaks. I wired a 0.01-μF disc capacitor, rated for 120 V ac service, across the ac input terminals of the device. Problem cured.—*Charles J. Michaels, W7XC, Phoenix, Arizona*

CURING RODENT-REPELLER INTERFERENCE

☐ A strong pulsing signal across the entire 2-meter band made moonbounce and weak-signal tropospheric communications impossible at my location. Using a multimode transceiver, and the two-element feed from my dish as a direction-finding antenna, I tracked down the noise by driving around in my pickup truck. The noise emanated from a neighbor's house. The culprit was a device used to irritate rodents and insects to the point that they move out (probably to the neighbors'!).

The repeller had a small pilot light that flashed in step with the interfering oscillator. Bypassing this indicator with a 0.01-μF capacitor cured the problem. I'm happy, the neighbors are happy, and their mice are happy in my shop!—*Gary Gerber, KB0HH, Anthony, Kansas*

...AND STREET-LAMP INTERFERENCE

☐ A defective sodium-vapor lamp can cause a great deal of interference to MF/HF reception. As the lamp [or perhaps its timer or photoelectric sensor—Ed.] ages, it may cycle on and off during periods when it would normally be lit continuously. Wide-band "hash" interference may be the result. (The noise occurs as the lamp tries to switch on; when the lamp is fully off or on, there is no interference.)

I solved a case of street-lamp interference by watching the street lamp on the pole adjacent to the shack as I listened to 40 meters on the station receiver. I called the local utility company and reported the problem. Within 24 hours, they replaced the defective lamp and the interference disappeared.—*James E. Mackey, K3FN, West Hartford, Connecticut*

UNPOWERED COMPUTER GENERATES RFI

☐ Reception from 160 through 10 meters at my location was marred by severe splatter from a "broadcast band" station located 1½ miles away. The interference wasn't continuous, though; it came and went for no apparent reason. After putting up with this for several weeks, I went to work tracking down the interference source. The interference appeared to be emanating from a 30-foot shielded RS-232-C data cable connected to my unpowered computer. Disconnecting the cable from the computer made the interference go away. Problem solved?

No! Attaching a new cable brought the interference back! Further investigation revealed a poorly soldered joint at pin 1 (equipment ground) on the computer's RS-232-C DB25 connector. Evidently, this solder joint was acting as an effective frequency multiplier. So, when hunting for sources of frustrating RFI, consider checking equipment that's not turned on —it *may* just be the culprit!—*David Barker, 38486 Cheldon, Mt Clemens, MI 48044-2312*

Turned-off electronic equipment can generate such interference even *without* faulty wiring. Investigating interference similar to David's—pops, sizzles and crackles that occurred by day on all medium and high frequencies—I discovered that my unpowered, solid-state general-coverage receiver was generating the junk in step with the modulation peaks of a medium-wave broadcaster 1¼ miles away. Hunch: The interference is caused by the unpowered receiver's unbiased input-network switching diodes and/or RF-amplifier MOSFET. (Further hunch: The interference occurs only during the day because the station changes its antenna pattern at night, resulting in a considerably weaker RF field at my location.) Evidence: Turning the receiver on makes the problem disappear. Solution: Disconnect the antenna from the receiver when the receiver is not in use.—*AK7M*

RFI-PROOFING A PHONOGRAPH TURNTABLE

☐ I recently discovered that my wife's hi-fi setup (a Hitachi turntable and a Sherwood receiver) did *not* like me operating on 15-meter CW at 100 W output: Every time I tapped my key, a sound akin to a bass drum emanated from the speakers.

The first thing I checked was whether or not the speaker leads were acting as antennas and feeding RF into the receiver. I verified that the RFI was *not* entering the receiver via this route by disconnecting the speakers and listening to the stereo receiver with a pair of headphones. The interference persisted.

Working through the rest of the system interconnections in a systematic way, I discovered that the most significant interference reduction occurred when the phonograph input cables (shielded cables equipped with phono plugs) were disconnected from the back of the stereo set. This, of course, pointed to the record player as the primary culprit in my RFI problem.

I removed the bottom cover of the phonograph. At the exit point of the two phono cables, inside the turntable itself, I installed ferrite beads and 0.001-μF bypass capacitors as shown in Fig 6.

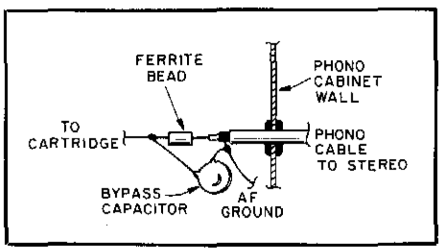


Fig 6—Battling a case of "hi-fi-I," Edward P. Swynar installed two RF-filter components at the phonograph end of each phono input lead as shown here for one cable. See text.

As a further measure, I took the precaution of bypassing the ac-power-cord wires to ground with two more 0.001-μF disc-ceramic bypass capacitors. Then I reassembled the phonograph.

To choke common-mode RF currents on the shields of the phono input cables, I wound both cables several times through a large ferrite toroid (the core of a discarded TV deflection-yoke coil). This concluded my modification of the record player.

Because many TVI/RFI solutions come about only with application of *several* cures in combination, I also replaced the "zip cord" stereo speaker leads with foil-shielded wire. Again using ferrite beads and 0.001-μF capacitors, I bypassed the speaker leads at the stereo-receiver speaker terminals. As a further precaution, I installed a good-quality high-pass filter at the receiver's FM-antenna terminals. Finally, I wrapped the receiver's ac-line cord around a 7-inch-long ferrite rod, securing the turns to the rod with electrician's tape. (This choke, I felt, would minimize common-mode conduction of RF up the line-cord wires.)

The result of all these maneuvers? My wife and I are friends again—and the RFI has gone for a hike!—*Edward Peter Swynar, VE3CUI, 48 Evergreen Dr, Whitby, ON L1N 6N6*

AK7M: For golden-eared audiophiles who cringe at the thought of bypassing high-impedance phono inputs ($Z = 50$ kΩ for many magnetic cartridges) with 0.001-μF capacitors ($X = 10.6$ kΩ at 15 kHz, the upper limit of the Record Industry Association of America's standard phono equalization curve), I suggest replacing the ferrite beads and 0.001-μF capacitors in VE3CUI's phono-cable filters with 1-mH chokes and 100-pF disc-ceramic capacitors, respectively. At 3.5 MHz, 100 pF looks like 455 Ω and 1 mH looks like 22 kΩ; such a filter should be reasonably effective in suppressing HF interference. At 15 kHz, 100 pF looks like 106 kΩ and 1 mH looks like 94 Ω—reactances that should have a minimal effect when used in parallel and series, respectively, with a 50-kΩ audio circuit. Beware of one potential snag when using solenoidal chokes in this application, through: They *may* introduce hum into the phono circuit in the presence of strong mains-ac fields.

TRACKING DOWN DIODE-INTERMODULATION INTERFERENCE

☐ After several years of good success with a G5RV antenna fed with polyethylene-insulated 450-Ω ladder line, I noticed a severe case of cross-modulation across the spectrum from 1.8 to 15 MHz in my receiver, particularly at night. It was present in signals from this antenna and a tribander located nearby.

After testing my receiver for several weeks, fox hunting the interference source in my neighborhood, and other investigations, I finally found the cause: a broken no. 18 solid Copperweld™ conductor in the G5RV's ladder-line feeder near where it enters the house. The invisible ends of the break, oxidized by RF heating during transmit, formed an effective diode. The antenna itself radiated the interference, causing S9 + 50 dB spurs from local AM broadcast stations to appear every few kilohertz from medium frequencies to above the 20-meter band. I observed this condition over half a block from my QTH!

After I fixed the problem, which I thought was a fluke, everything was fine. However, it recently occurred again. Perhaps broken-wire rectification and spur radiation is more common than I thought! I attribute the wire breaks to wind-driven motion of the free-hanging part of the transmission line below the dipole.[8] Hopefully, after seeing this item, others will recognize and solve this problem faster than I was able to.—*Cy Humphreys, W6IKH, 2520 Medina Cir, Bellevue, WA 98004*

[8]Richard Measures described one solution to this problem in "Constructing Ladder (Open-Wire) Transmission Line," (p 7-9).

BAND-PASS FILTERS FOR 80 AND 160 METERS

☐ Using the 80- and 160-m preamplifier described by Doug DeMaw in August 1988 *QST*[9] with a Beverage antenna, I encountered intermodulation from strong medium-frequency broadcasting stations. (The intermod was absent with a small, shielded loop.) To solve this problem, I designed the band-pass filters shown in Figs 7 and 8. The design is based on standard capacitor values and should not require adjustment if the specified wire sizes and silver-mica capacitors are used. Fig 9 shows the filter responses.

Don't attempt to transmit through these filters; they are intended for receiving purposes only. In addition to suppressing broadcast-band intermod, these filters may also be useful in reducing adjacent-band interference in multiple-transmitter installations.—*Gary Nichols, KD9SV, 4100 Fahlsing Rd, Woodburn, IN 46797*

[9]D. DeMaw, "Preamplifier for 80- and 160-M Loop and Beverage Antennas," *QST*, Aug 1988 pp 22-24.

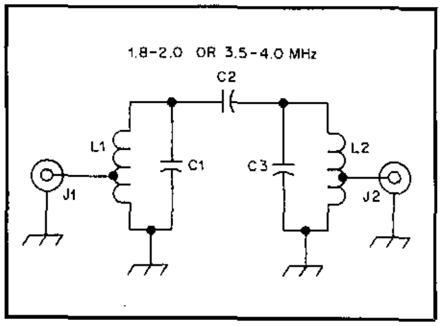


Fig 7—Schematic of the band-pass filters for 160 and 80 meters. Fig 8 shows the constructed filters; Fig 9 shows their response curves.

C1, C3—Silver mica; 160 m: 560 pF; 80 m: 330 pF.
C2—Silver mica; 160 m: 47 pF; 80 m: 33 pF.
J1, J2—Coaxial RF connectors.
L1, L2—Wound on T-50-2 powdered-iron toroidal cores. 160 meters: 48 turns of no. 28 enam wire tapped at 8 turns from ground ; 80 meters: 29 turns of no. 24 enam wire tapped at 4 turns from ground.

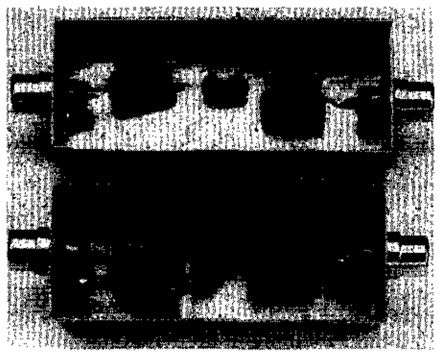


Fig 8—Bent brass sheet forms the enclosures for the 160-m (upper) and 80-m (lower) band-pass filters.

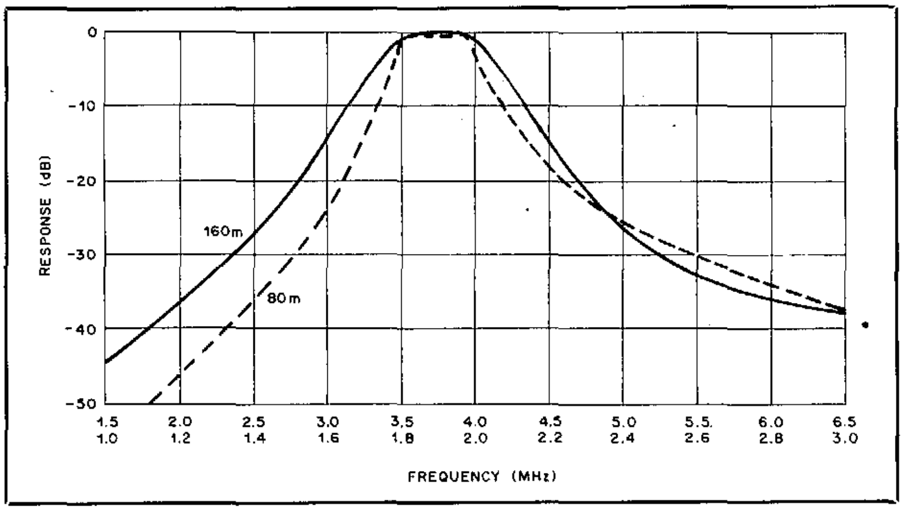


Fig 9—Responses of the 160- and 80-meter band-pass filters. The measured insertion loss of both units is less than 1 dB; for these curves, the 0-dB reference is the minimum filter attenuation. The −3-dB points of the 80-m filter curve barely miss the edges of the 80-m band; judicious squeezing or spreading of the inductor turns can place either band edge safely within the filter passband if band-edge attenuation is a problem in your version of the 80-m filter. The entire 160-m band falls safely within the −3-dB passband of the 160-m filter.

TRANSFORMER HUM

☐ After purchasing a Yaesu FT-901DM transceiver several years ago, I discovered that there was 60-Hz hum on my signal when I operated SSB. A careful redo of station grounding, replacement of the '901's audio-input IC, changing microphones and so on, failed to provide a cure. Finally, I just gave up and operated—despite the annoying hum.

Recently, I decided to reactivate a Collins 32S-3 transmitter for SSB operation. (It had been sitting on the shelf for several years unused, having been purchased as a spare.) At the same time, I constructed a boom for the microphone to allow hands-free VOX operation.

Once on the air with the 32S-3, I immediately received reports of 60-Hz hum. The hum was severe enough to be clearly visible on a monitor scope—as it had been with the Yaesu. Tube changes, double shielding of the microphone cable and other potential remedies all failed to solve the problem. Quite accidentally, while using a hand-held mic, I noticed that the hum increased when the mic was hung over the edge of the bench. Suddenly, I remembered that there was a power supply beneath the bench: the autotransformer-controlled high-voltage supply for my two homemade 4-1000A amplifiers! The hum came up when I held the mic close to the transformer.

The autotransformer, sitting on a shelf a foot above the floor, was unshielded. The shelf above the transformer was plywood; it contributed no shielding. Grounding the transformer case did not reduce the hum. Finally, I eliminated the hum by putting the transformer on the floor and pushing it farther away from the transmitter. Next, I reconnected the FT-901DM and tried it on SSB. The hum was gone! Moving the transformer resulted in a definite and complete fix.—*Joe Hertzberg, N3EA, Bryn Mawr, Pennsylvania*

BYPASS CAPACITORS CURE POWER-SUPPLY NOISE

☐ I sometimes use the general-coverage capability of my HF transceiver for SWLing from locations where an outside antenna is unavailable. This isn't a problem because the transceiver's high sensitivity allows satisfactory reception with just a short whip antenna plugged into the rig's ANTENNA jack. General-coverage monitoring with the whip *did* reveal a problem, however: Reception was marred by strong, wide-band RF noise similar to

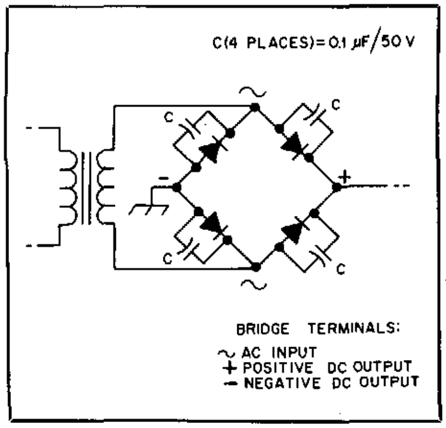


Fig 10—*Bypassing* means providing a low-impedance ac (in this case, RF) path around a component; here, 0.1-µF disc-ceramic capacitors do the trick across rectifier diodes in a low-voltage dc supply. This drawing shows a full-wave bridge rectifier circuit; in some applications, the bridge diodes are contained in a single unit, the leads of which are usually marked as shown in the drawing. When bypassing a diode, use a capacitor with a voltage rating equal to or greater than the PIV rating of the diode. Capacitors rated at 50 V should suffice for a 12 V dc supply with a bridge rectifier. See text.

that sometimes caused by fluorescent lights. The noise was strongest between 3 and 4 MHz. Tests indicated that the noise was coming from the rectifier diodes in the transceiver power supply (an Astron VS35M). Apparently, the switching characteristic of the diodes resulted in the generation of wide-band noise.

Installing 0.01-µF capacitors in parallel with each of the diodes significantly reduced the noise, but did not eliminate it. Bypassing each diode with a 0.1-µF disc-ceramic capacitor (with a voltage rating equal to or greater than the peak-inverse-voltage [PIV] rating of the bypassed diode) reduced the noise to inaudibility. The operation of the power supply was not affected by the addition of the capacitors.—*Michael Dees, N3EZD, Ellicott City, Maryland*

Editor's Note: Although there is some controversy connected with the practice of bypassing power-supply rectifiers (see Steven D. Katz, "Diode Failure," Technical Correspondence, *QST*, April 1988, pp 46-47), unbypassed power-supply diodes can produce an even more mysterious effect: Hum during AM (rectification) detection of strong AM signals. Hummy AM reception with two borrowed transceivers—an ICOM IC-735 and a Kenwood TS-430S—had me stumped until, on a hunch, I bypassed each arm of the bridge rectifier in my Kenwood PS-20 power supply (see Fig 10). Hum eliminated! (Bypass capacitors across the power supply's 120 V ac input from hot to neutral, and from hot and neutral to ground, had failed to improve the situation.)

Like Michael, I was using an indoor "random wire" antenna at the time. The hum was also audible on strong CW signals, but it was easiest to detect during rectification detection of strong AM signals. Another mystery: Further tests revealed that the hum was present only in transceivers that use step-tuned PLL VFOs; the hum was nonexistent when I used the PS-20 with a TS-130V transceiver! (The '130V has a mechanically tuned LC VFO.) Your theories on the why of these phenomena will be greatly appreciated!

REDUCING KEY CLICKS

☐ Key clicks are an annoyance to other operators and may mar your neighbors' radio and television reception. As explained in *The ARRL Handbook*, clicks are most commonly caused by turning the transmitted carrier on or off too quick during the keying process. The cure for such clicks is

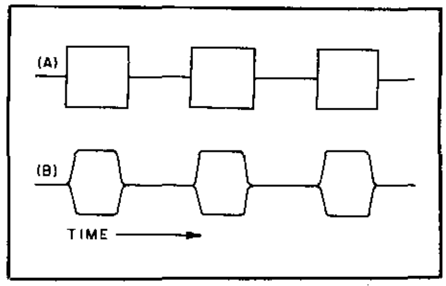


Fig 11—Stylized oscillogram of a string of dots sent with (A) ALC clipping and (B) ALC circuitry and/or DRIVE control adjusted to minimize ALC action. On the air, the signal at B sounds "softer"—has less key clicks—than the signal depicted at A.

to lengthen the transmitter turn-on and turn-off times.

One cause of key clicks is improperly adjusted ALC (automatic level control) in modern transmitters. If a transmitter's drive level is increased to the power at which its power output is limited by ALC, the driving signal may be clipped enough by ALC action to shorten its rise and fall times.

The solution to this is simple. On a rig that has a DRIVE control *and* an ALC threshold control, adjust the ALC to limit output power to slightly more than the desired level. Then, adjust the DRIVE control to provide the desired output power. (As an example, I often adjust the ALC on my Ten-Tec Corsair transceiver for an output of 100 W and then turn down the drive until the rig's output is 80 to 90 watts. This power reduction is unnoticeable to the other operator. Fig 11 shows the stylized oscillogram of a string of dots emitted by

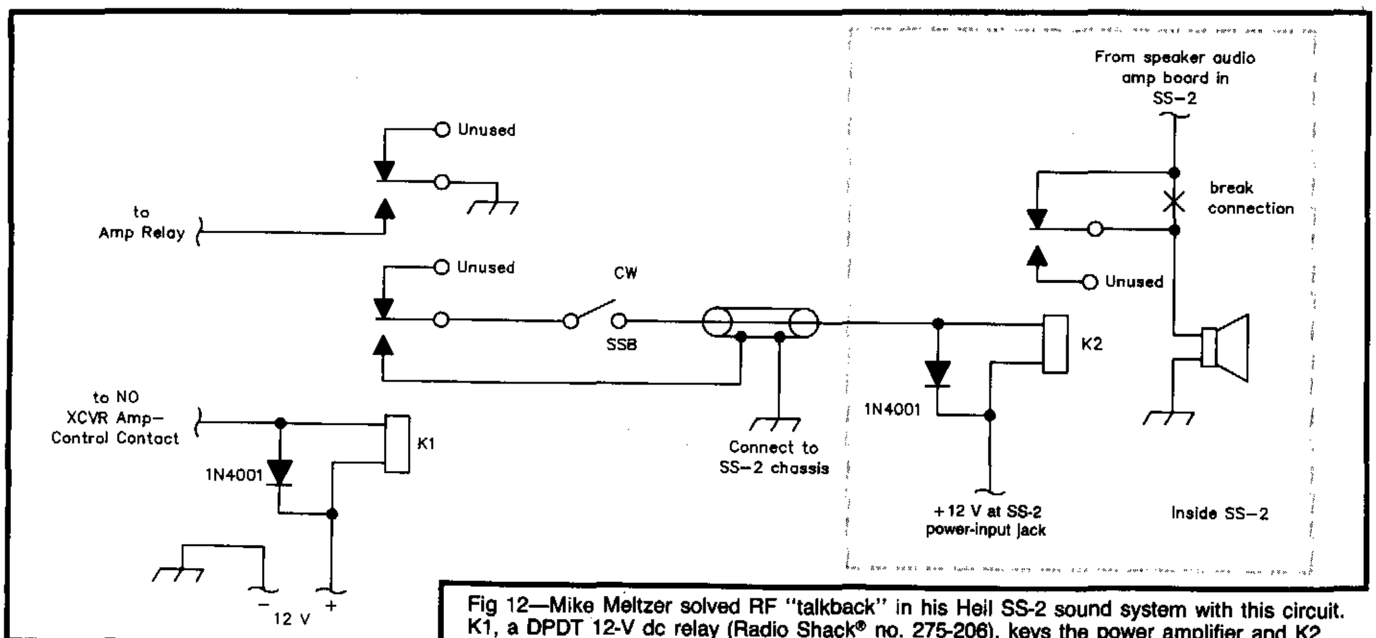


Fig 12—Mike Meltzer solved RF "talkback" in his Heil SS-2 sound system with this circuit. K1, a DPDT 12-V dc relay (Radio Shack® no. 275-206), keys the power amplifier and K2. K2, a SPDT 12-V dc relay (RS no. 275-248) mounted inside the SS-2, disconnects the SS-2's speaker in transmit. S1 disables the speaker-cutoff relay for CW operation. The diodes clamp the transients that occur when K1 and K2 are switched off. See text.

my transceiver before and after I adjusted the rig to reduce key clicks.

Even if the ALC threshold of your rig cannot be adjusted, you can keep your keying from sharpening up too much by adjusting the transmitter drive to just below the point at which the rig's ALC meter begins to deflect.—*H. H. Hunter, W8TYX, 1106 Carolyn Ave, Columbus, OH 43224*

RFI FROM A MULTI-OUTLET BOX

☐ After installing computerized RTTY gear, I experienced RFI in the form of "steel wool" on my monitor screen when my beam was aimed over the roof of the shack. One day, when the interference was especially intense, I decided to take another whack at plugging the RF leak. I unplugged cables one at a time from the RTTY modem until only the ac line remained. Keying the transmitter between each cable disconnect had so far demonstrated no reduction in the interference. Obviously, the RF was coming in on the ac line or through the modem cabinet. Because grounding the cabinet did not reduce the interference, I reckoned that the ac line was the source of the leak.

As I studied the Drake LF-6 multi-outlet box that served as the ac connection point for the station gear, I discovered that the three-sided box cover was floating above ground—even at dc. I filed the finish off the mating surfaces of the box and reassembled the box with a star washer under each screw head. I reconnected all the gear exactly as before and presto—no RFI! Three years of frustration were over. —*Sid Kitrell, WØLYM, 926 Leisure Ln, Sevierville, TN 37862*

SPEAKER SWITCHING AVOIDS RFI PROBLEM

☐ My Heil SS-2 sound system suffered RF interference when I operated my linear amplifier. Installing bypass capacitors and ferrite rings and beads, and grounding the SS-2's chassis, did not help. Unable to cure the illness, I decided to work on its symptom.

Most MF/HF transceivers include a relay or transistor switch that's intended to control an external power amplifier. I used this feature to key an *outboard* DPDT relay, which, in turn, keys the amplifier and actuates a second relay mounted inside my SS-2. The inboard SS-2 relay disconnects the SS-2 speaker in transmit. No speaker connection, no RFI! (Fig 12 shows the circuit.) Not wanting to drill holes in my SS-2, I rewired the external speaker lines in the SS-2's DIN jack to carry the drive for the speaker-disabling relay (K2).

I have modified five Heil SS-2 systems as described here for myself and my friends, and we are all very happy with the results. One system can be modified in two to three hours; the parts necessary for the modification cost under $10.—*Mike Meltzer, K2SDD, 121 Clearview Rd, Dewitt, NY 13214*

RF *NOT* THE CAUSE OF MOBILE-DIGIPEATER-TRIGGERED CAR ALARM

☐ Seeking to demonstrate the portability of packet radio at the Shreveport (Louisiana) Hamfest packet-radio forum, Sid Wilson Jr, WB5GFM; Bob Funck, KB5GQ; and I set up Sid's van and my van to operate as mobile digipeaters. The system allowed us, operating from inside a building with a laptop computer, TNC and hand-held transceiver, to connect with a Dallas PBBS. All went well until someone reported hearing an intrusion alarm sounding from a white van—*Sid's* van. The police officer on duty located Sid; Sid reset the alarm and returned to the forum. The alarm went off again when we next attempted to connect with the Dallas PBBS. Sid and the policeman checked the van out again. Suspecting that RF energy from his transceiver or my transceiver (two cars away) was the cause, Sid turned off the alarm.

Later investigation revealed that *system voltage drop* had triggered the alarm. Sid's 45-W mobile transceiver draws considerable current in transmit. With the van's engine off, this pulls the van's battery voltage down far enough to shift the alarm's trigger threshold. RF in the alarm, our strongest suspect, turned out *not* to be the culprit. You may be able to save time by keeping our experience in mind when investigating apparent RF-caused glitches in level-sensitive equipment.—*Van Flynn, N5ARU, New Orleans, Louisiana*

Abbreviations List

These abbreviations, revised to conform with contemporary electronics and communications standards, appear in League publications.

a — atto (prefix for 10^{-18})
A — ampere (unit of electrical current)
ac — alternating current
ACC — Affiliated Club Coordinator
ACSSB — Amplitude-compandored single sideband
A/D — analog-to-digital
ADC — analog-to-digital converter
AF — audio frequency
AFC — automatic frequency control
AFSK — audio frequency-shift keying
AGC — automatic gain control
Ah — ampere hour
AIRS — ARRL Interference Reporting System
ALC — automatic level control
AM — amplitude modulation
AMTOR — Amateur Teleprinting Over Radio
ANT — antenna
ARA — Amateur Radio Association
ARC — Amateur Radio Club
ARES — Amateur Radio Emergency Service
ARQ — Automatic repeat request
ARS — Amateur Radio Society (Station)
ASCII — American National Standard Code for Information Interchange
ASSC — Amateur Satellite Service Council
ATC — Assistant Technical Coordinator
ATV — amateur television
AVC — automatic volume control
AWG — American wire gauge
az-el — azimuth-elevation

B — bel; blower
balun — balanced to unbalanced (transformer)
BC — broadcast
BCD — binary-coded decimal
BCI — broadcast interference
Bd — baud (bit/s in single-channel binary data transmission)
BER — bit error rate
BFO — beat-frequency oscillator
bit — binary digit
bit/s — bits per second
BM — Bulletin Manager
BPF — band-pass filter
BPL — Brass Pounders League
BT — battery
BW — bandwidth

c — centi (prefix for 10^{-2})
C — coulomb (quantity of electric charge); capacitor
CAC — Contest Advisory Committee
CATVI — cable-television interference
CB — Citizens Band (radio)
CBMS — computer-based message system
CCTV — closed-circuit television
CCW — coherent CW
ccw — counterclockwise
CD — civil defense
cm — centimeter
CMOS — complementary-symmetry metal-oxide semiconductor
coax — coaxial cable
COR — carrier-operated relay
CP — code proficiency (award)
CPU — central processing unit
CRT — cathode-ray tube
CT — center tap
CTCSS — continuous tone-coded squelch system
cw — clockwise
CW — continuous wave

d — deci (prefix for 10^{-1})
D — diode
da — deca (prefix for 10)
D/A — digital-to-analog
DAC — digital-to-analog converter
dB — decibel (0.1 bel)
dBi — decibels above (or below) isotropic antenna
dBm — decibels above (or below) 1 milliwatt
DBM — doubly balanced mixer
dBV — decibels above/below 1V (in video, relative to 1 V P-P)
dBW — decibels above/below 1 watt
dc — direct current
D-C — direct conversion
DEC — District Emergency Coordinator
deg — degree
DET — detector
DF — direction finding; direction finder
DIP — dual in-line package
DMM — digital multimeter
DPDT — double-pole double-throw (switch)
DPSK — differential phase-shift keying
DPST — double-pole single-throw (switch)
DS — direct sequence (spread spectrum); display
DSB — double sideband
DTMF — dual-tone multifrequency
DVM — digital voltmeter
DX — long distance; duplex
DXAC — DX Advisory Committee
DXCC — DX Century Club

E — voltage
e — base of natural logarithms (2.71828)
EC — Emergency Coordinator
ECAC — Emergency Communications Advisory Committee
ECL — emitter-coupled logic
EHF — extremely high frequency (30-300 GHz)
EIRP — effective isotropic radiated power
ELF — extremely low frequency
EMC — electromagnetic compatibility
EME — earth-moon-earth (moonbounce)
EMF — electromotive force
EMI — electromagnetic interference
EMP — electromagnetic pulse
EPROM — erasable programmable read-only memory

f — femto (prefix for 10^{-15}); frequency
F — farad (capacitance unit); fuse
fax — facsimile
FD — Field Day
FET — field-effect transistor
FL — filter
FM — frequency modulation
FSK — frequency-shift keying
ft — foot (unit of length)

g — gram (unit of mass)
G — giga (prefix for 10^9)
GaAs — gallium arsenide
GDO — grid- or gate-dip oscillator
GHz — gigahertz
GND — ground

h — hecto (prefix for 10^2)
H — henry (unit of inductance)
HF — high frequency (3-30 MHz)
HFO — high-frequency oscillator
HPF — highest probable frequency; high-pass filter
Hz — hertz (unit of frequency)

I — current, indicating lamp
IC — integrated circuit
ID — identification; inside diameter
IF — intermediate frequency
IMD — intermodulation distortion
in — inch (unit of length)
in/s — inch per second (unit of velocity)
I/O — input/output
IRC — international reply coupon

j — operator for complex notation, as for reactive component of an impedance ($+j$ inductive; $-j$ capacitive)
J — joule (kg m^2/s^2) (energy or work unit); jack
JFET — junction field-effect transistor

k — kilo (prefix for 10^3); Boltzmann's constant (1.38×10^{-23} J/K)

K — kelvin (used without degree symbol) (absolute temperature scale); relay
kBd — 1000 bauds
kbit — 1024 bits
kbit/s — 1000 bits per second
kbyte — 1024 bytes
kg — kilogram
kHz — kilohertz
km — kilometer
kV — kilovolt
kW — kilowatt
kΩ — kilohm

l — liter (liquid volume)
L — lambert; inductor
lb — pound (force unit)
LC — inductance-capacitance
LCD — liquid crystal display
LED — light-emitting diode
LF — low frequency (30-300 kHz)
LHC — left-hand circular (polarization)
LO — local oscillator; League Official
LP — log periodic
LS — loudspeaker
LSB — lower sideband
LSI — large-scale integration

m — meter; milli (prefix for 10^{-3})
M — mega (prefix for 10^{6}); meter
mA — milliampere
mAh — millamperehour
MDS — Multipoint Distribution Service; minimum discernible (or detectable) signal
MF — medium frequency (300-3000 kHz)
mH — millihenry
mho — unit of conductance (use siemens)
MHz — megahertz
mi — mile, statute (unit of length)
mi/h — mile per hour
mi/s — mile per second
mic — microphone
min — minute (time)
MIX — mixer
mm — millimeter
MOD — modulator
modem — modulator/demodulator
MOS — metal-oxide semiconductor
MOSFET — metal-oxide semiconductor field-effect transistor
MS — meteor scatter
ms — millisecond
m/s — meters per second
MSI — medium-scale integration
MUF — maximum usable frequency
mV — millivolt
mW — milliwatt
MΩ — megohm

n — nano (prefix for 10^{-9})
NBFM — narrow-band frequency modulation
NC — no connection; normally closed
NCS — net-control station; National Communications System
nF — nanofarad
NF — noise figure
nH — nanohenry
NiCd — nickel cadmium
NM — Net Manager
NMOS — N-channel metal-oxide silicon
NO — normally open
NPN — negative-positive-negative (transistor)
NR — Novice Roundup (contest)
ns — nanosecond
NTS — National Traffic System

OBS — Official Bulletin Station
OD — outside diameter
OES — Official Emergency Station
OO — Official Observer
op amp — operational amplifier
ORS — Official Relay Station
OSC — oscillator (schematic diagram abbrev.)
OTC — Old Timer's Club
OTS — Official Traffic Station
oz — ounce (force unit, 1/16 pound)

p — pico (prefix for 10^{-12})
P — power; plug
PA — power amplifier
PAM — pulse-amplitude modulation
PC — printed circuit
PEP — peak envelope power
PEV — peak envelope voltage
pF — picofarad
pH — picohenry
PIA — Public Information Assistant
PIN — positive-intrinsic-negative (transistor)
PIO — Public Information Officer
PIV — peak inverse voltage
PLL — phase-locked loop
PM — phase modulation
PMOS — P-channel (type) metal-oxide semiconductor
PNP — positive-negative-positive (transistor)
pot — potentiometer
P-P — peak to peak
ppd — postpaid
PRAC — Public Relations Advisory Committee
PROM — programmable read-only memory
PSHR — Public Service Honor Roll
PTO — permeability-tuned oscillator
PTT — push to talk

Q — figure of merit (tuned circuit); transistor
QRP — low power (less than 5-W output)

R — resistor (schematic diagram abbrev.)
RACES — Radio Amateur Civil Emergency Service
RAM — random-access memory
RC — resistance-capacitance
R/C — radio control
RCC — Rag Chewers' Club
RF — radio frequency
RFC — radio-frequency choke
RFI — radio-frequency interference
RHC — right-hand circular (polarization)
RIT — receiver incremental tuning
RLC — resistance-inductance-capacitance
RM — rule making (number assigned to petition)
rpm — revolution per minute
RMS — root mean square
ROM — read-only memory
r/s — revolution per second
RST — readability-strength-tone
RTTY — radioteletype
RX — receiver, receiving

s — second (time)
S — siemens (unit of conductance); switch
SASE — self-addressed stamped envelope
SEC — Section Emergency Coordinator
SET — Simulated Emergency Test
SGL — State Government Liaison
SHF — super-high frequency (3-30 GHz)
SM — Section Manager; silver mica (capacitor)
S/N — signal-to-noise (ratio)
SPDT — single-pole double-throw (switch)
SPST — single-pole single-throw (switch)
SS — Sweepstakes; spread spectrum
SSB — single sideband
SSC — Special Service Club
SSI — small-scale integration
SSTV — slow-scan television
STM — Section Traffic Manager
SX — simplex
sync — synchronous, synchronizing
SWL — shortwave listener
SWR — standing-wave ratio

T — tera (prefix for 10^{12}); transformer
TA — Technical Advisor
TC — Technical Coordinator
TCC — Transcontinental Corps
TD — Technical Department (ARRL HQ)
tfc — traffic
TR — transmit/receive
TTL — transistor-transistor logic
TTY — teletypewriter
TV — television
TVI — television interference
TX — transmitter, transmitting

U — integrated circuit
UHF — ultra-high frequency (300 MHz to 3 GHz)
USB — upper sideband
UTC — Coordinated Universal Time
UV — ultraviolet

V — volt; vacuum tube
VCO — voltage-controlled oscillator
VCR — video cassette recorder
VDT — video-display terminal
VE — Volunteer Examiner
VEC — Volunteer Examiner Coordinator
VFO — variable-frequency oscillator
VHF — very-high frequency (30-300 MHz)

VLF — very-low frequency (3-30 kHz)
VLSI — very-large-scale integration
VMOS — vertical metal-oxide semiconductor
VOM — volt-ohm meter
VOX — voice operated switch
VR — voltage regulator
VRAC — VHF Repeater Advisory Committee
VSWR — voltage standing-wave ratio
VTVM — vacuum-tube voltmeter
VUAC — VHF/UHF Advisory Committee
VUCC — VHF/UHF Century Club
VXO — variable crystal oscillator

W — watt (kg m^2s^{-3}, unit of power)
WAC — Worked All Continents
WARC — World Administrative Radio Conference
WAS — Worked All States
WBFM — wide-band frequency modulation
Wh — watthour
WPM — words per minute
WVDC — working voltage, direct current

X — reactance
XCVR — transceiver
XFMR — transformer
XO — crystal oscillator
XTAL — crystal
XVTR — transverter

Y — crystal
YIG — yttrium iron garnet

Z — impedance; also see UTC

5BDXCC — Five-Band DXCC
5BWAC — Five-Band WAC
5BWAS — Five-Band WAS
6BWAC — Six-Band WAC

° — degree (plane angle)
°C — degree Celsius (temperature)
°F — degree Fahrenheit (temperature)
α — (alpha) angles; coefficients, attenuation constant, absorption factor, area, common-base forward current-transfer ratio of a bipolar transistor
β — (beta) angles; coefficients, phase constant, current gain of common-emitter transistor amplifiers
γ — (gamma) specific gravity, angles, electrical conductivity, propagation constant
Γ — (gamma) complex propagation constant
δ — (delta) increment or decrement, density angles
Δ — (delta) increment or decrement, determinant, permittivity
ϵ — (epsilon) dielectric constant, permittivity, electric intensity
ζ — (zeta) coordinates, coefficients
η — (eta) intrinsic impedance, efficiency, surface charge density, hysteresis, coordinate
θ — (theta) angular phase displacement, time constant, reluctance, angles
ι — (iota) unit vector
K — (kappa) susceptibility, coupling coefficient
λ — (lambda) wavelength, attenuation constant
Λ — (lambda) permeance
μ — (mu) permeability, amplification factor, micro (prefix for 10^{-6})
μC — microcomputer
μF — microfarad
μH — microhenry
μP — microprocessor
ξ — (xi) coordinates
π — (pi) 3.14159
φ — (rho) resistivity, volume charge density, coordinates, reflection coefficient
σ — (sigma) surface charge density, complex propagation constant, electrical conductivity, leakage coefficient, deviation
Σ — (sigma) summation
τ — (tau) time constant, volume resistivity, time-phase displacement, transmission factor, density
ϕ — (phi) magnetic flux, angles
Φ — (phi) summation
χ — (chi) electric susceptibility, angles
ψ — (psi) dielectric flux, phase difference, coordinates, angles
ω — (omega) angular velocity $2\pi f$
Ω — (omega) resistance in ohms, solid angle

Suppliers List

This list covers only suppliers that are mentioned in this book. The information was verified before printing. A much larger list of suppliers (which is updated annually) appears in each edition of *The ARRL Handbook*. In addition, several of these suppliers regularly advertise in *QST*.

Advanced Receiver Research
Box 1242
Burlington, CT 06013
203-582-9409

Amateur Electronic Supply
5710 W Good Hope Rd
Milwaukee, WI 53223
414-358-0333

Amidon Associates, Inc
PO Box 956
Torrance, CA 90508
310-763-5770
fax 310-763-2250

Amphenol
(Check with local 2-way shops and parts suppliers.)

Antique Electronic Supply
PO Box 27468
Tempe, AZ 85285-7468
602-820-5411

Barker & Williamson
10 Canal St
Bristol, PA 19007
215-788-5581

Circuit Board Specialists
PO Box 951
Pueblo, CO 81002-0951
719-542-4525

Digi-Key Corporation
701 Brooks Ave S
Box 677
Thief River Falls, MN 56701-0677
800-344-4539
fax 218-681-3380

Eastern Bearings, Inc
7096 S Willow
Manchester, NH 03103
603-668-3300

Fair Radio Sales Co, Inc
PO Box 1105
1016 E Eureka St
Lima, OH 45802
419-227-6573
fax 419-227-1313

Int'l Radio and Computers, Inc
3804 South US 1
Fort Pierce, FL 34982
407-489-5609

GLB Electronics
151 Commerce Pkwy
Buffalo, NY 14224
716-675-6740
(no longer sells TNCs)

Industrial Polychemical Service
17109 S Main St
Gardena, CA 90247
213-321-6515

J. W. Harris Co, Inc (solder)
10930 Deerfield Rd
Cincinnati, OH 45242
513-891-2000
fax 513-891-2461

J. W. Miller Co
(distributed through Digi-Key)

Johnson Mfg Co
Princeton, IA 52768
319-289-5123

Kester Solder
515 E Touhy Ave
Des Plaines, IL 60018-2675
708-297-1600
fax 708-390-9338

MFJ Enterprises
PO Box 494
Mississippi State, MS 39762
601-323-5869

Motormite Manufacturing
3400 E Walnut St
Colmar, PA 18915
215-997-1800

Mouser Electronics
2401 Hwy 287 N
Mansfield, TX 76063
800-346-6873

Ocean State Electronics
PO Box 1458
Westerly, RI 02891
800-866-6626
fax 401-596-3590

Palomar Engineers
PO Box 462222
Escondido, CA 92046
619-747-3343

RADIOKIT
PO Box 973
Pelham, NH 03076
603-635-2235
fax 603-635-2943
Telex 887697

Small Parts Inc
PO Box 4650
Miami Lakes, FL 33014-0650
305-557-0822

About The American Radio Relay League

The seed for Amateur Radio was planted in the 1890s, when Guglielmo Marconi began his experiments in wireless telegraphy. Soon he was joined by dozens, then hundreds, of others who were enthusiastic about sending and receiving messages through the air—some with a commercial interest, but others solely out of a love for this new communications medium. The United States government began licensing Amateur Radio operators in 1912.

By 1914, there were thousands of Amateur Radio operators—hams—in the United States. Hiram Percy Maxim, a leading Hartford, Connecticut, inventor and industrialist saw the need for an organization to band together this fledgling group of radio experimenters. In May 1914 he founded the American Radio Relay League (ARRL) to meet that need.

Today ARRL, with about 160,000 members, is the largest organization of radio amateurs in the United States. The League is a not-for-profit organization that:

- promotes interest in Amateur Radio communications and experimentation
- represents US radio amateurs in legislative matters, and
- maintains fraternalism and a high standard of conduct among Amateur Radio operators.

At League Headquarters in the Hartford suburb of Newington, the staff helps serve the needs of members. ARRL is also the International Secretariat for the International Amateur Radio Union, which is made up of similar societies in more than 100 countries around the world.

ARRL publishes the monthly journal *QST*, as well as newsletters and many publications covering all aspects of Amateur Radio. Its Headquarters station, W1AW, transmits bulletins of interest to radio amateurs and Morse Code practice sessions. The League also coordinates an extensive field organization, which includes technical information for radio amateurs and public-service activities. ARRL also represents US amateurs with the Federal Communications Commission and other government agencies in the US and abroad.

Membership in ARRL means much more than receiving *QST* each month. In addition to the services already described, ARRL offers membership services on a personal level, such as the ARRL Volunteer Examiner Coordinator Program and a QSL bureau.

Full ARRL membership (available only to licensed radio amateurs) gives you a voice in how the affairs of the organization are governed. League policy is set by a Board of Directors (one from each of 15 Divisions). Each year, half of the ARRL Board of Directors stands for election by the full members they represent. The day-to-day operation of ARRL HQ is managed by an Executive Vice President and a Chief Financial Officer.

No matter what aspect of Amateur Radio attracts you, ARRL membership is relevant and important. There would be no Amateur Radio as we know it today were it not for the ARRL. We would be happy to welcome you as a member! (An Amateur Radio license is not required for Associate Membership.) For more information about ARRL and answers to any questions you may have about Amateur Radio, write or call:

ARRL Educational Activities Dept
225 Main Street
Newington, CT 06111
(203) 666-1541

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