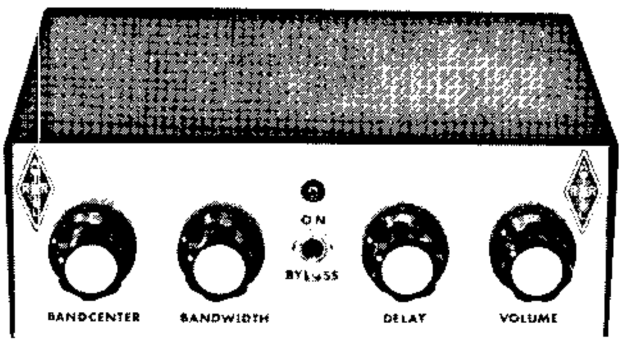
The KC2FR QRM Fighter



Losing the battle with QRM? This filter makes you the champ!

By David Jagerman,* KC2FR

This article presents construction information for a nonlinear, audio cw filter intended to help reduce QRM, which every amateur faces! To alleviate interference, many filter circuits have been devised to operate in the i-f or audio sections of the receiver. These circuits are generally well designed. They allow many QSOs that otherwise might not have been attempted; however, it is still advantageous to consider alternative designs.

Consider some of the qualities desired in a cw audio filter. Its bandwidth should be narrow — otherwise noise and interfering stations will also be heard. Present-day i-f filters are quite narrow; hence the bandwidth of the audio filter should be even narrower — less than 400 Hz to provide an improvement. The passband should be flat, so that tuning in the desired station will be easy. Filter skirts should be nearly vertical, with the shape factor approaching a value of 1, in order to effectively eliminate interference. Furthermore, there should be no ringing under tight passband conditions. Typical linear-filter designs, whether passive or active, provide a narrow passband, but they have a sharply peaked "nose" and are often prone to ringing. Also, their shape factors cannot be made close to ideal, except with elaborate designs. Thus, to achieve the desired characteristics, I tried a nonlinear design.

Design and Construction

A block diagram of the QRM Fighter is given in Fig. 1, and the circuit diagram appears in Fig. 2. For the following discussion please refer to both figures. The first stage is a multiple-feedback, band-pass amplifier with a Q of 10 and a gain of 4. A 200-Ω control is used to adjust the center frequency. The second stage is a comparator whose output (pin 6) is high if the signal from the band-pass amplifier cannot overcome the bias set on pin 3. When the signal is strong enough to overcome the bias, pin 6 remains low. The net band-pass characteristic of these two stages is shown in Fig. 3. It can be seen that the characteristics of a good cw filter are obtained. The flat top in the passband is obtained because pin 6 remains at a constant low level, even though the output of the band-pass amplifier varies. A shape factor of 1 is obtained because of the sharp cutoff that occurs when the signal drops below the bias set on the comparator. A 500-Ω control is used to set the bias level of the comparator, which in turn determines the bandwidth.

The output from the first two stages is an audio signal that is amplitude modulated by the code elements. The signal frequency matches the offset frequency of the receiver. It is the function of the third stage to remove this audio signal and to leave only the baseband code elements. Essentially, it operates as an envelope detector. This configuration also facilitates the later introduction of delay, which serves as a noise blanker. The third stage consists of a pnp switching transistor (Q1) and an NE555 IC. Pin 3 of the NE555 remains at logic high for the duration of a code element, while during a space it remains low; thus the cw envelope is obtained. This detector stage drives a tuning indicator, consisting of an LED that remains lit only for the duration of a code element.

The fourth stage — comprised of a diode, Q2 and Q3 — is used to delay the generation of tone. This stage prevents noise impulses, which have triggered the first three stages and whose duration is *less* than the delay set into the stage, from creating an audible output. A 100-kΩ control is used to adjust the amount of delay from zero to over 16 ms. A code element is of considerably longer duration than most noise impulses; therefore, it will produce an audible output. The envelope detector has a pulse stretching effect of approximately 3 ms, so the net loss affecting a code element is the delay introduced by this stage (less 3 ms). This loss, even at maximum delay, does not affect readability of the code.

The fifth stage is a tone generator keyed through reset-pin 4 by the output of the delay stage. It produces a tone only when that output is high. A 5-kΩ Trimpot is used to adjust the pitch of the generator. The final stage is an audio power amplifier capable of driving a small loudspeaker. The 10-kΩ control is an audio-taper potentiometer.

The unit may be constructed on perfboard or a pc board. The foil side of the circuit-board etching pattern appears in the Hints and Kinks section of this issue, and the component side is shown in Fig. 4. Everything may be mounted in a cabinet measuring 7-3/4 × 4-3/8 in. (Radio Shack 270-232). The unit shown in Fig. 5 was constructed by Circuit Board Specialists,[1] using a pc board specially made for the circuit. An open chassis was also made from pc board.

The rear of the chassis holds three connectors — one for the audio output from the receiver, one for the output of the filter to a small speaker or phones, and one for the power-supply input. Front-panel features include a VOLUME control (with power switch), DELAY control, LED tuning indicator, BYPASS/ON toggle switch, BANDWIDTH and BANDCENTER controls. Small Radio Shack knobs (274-380) are used for the VOLUME control and the BANDCENTER control. Two somewhat larger knobs with calibrated skirts (Radio Shack 274-413) may be used on the DELAY and BANDWIDTH controls to permit calibration of their settings. Rub-on fiducial lines are put on the chassis front for these calibrated controls. A 9-V battery pack consisting of 6 AA cells, or a small dc plug-in wall adapter (at least 100 mA), may be used for the power supply.

Adjustment and Calibration

Adjustment of the BANDCENTER control may be done best through the use of a

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[1]A complete kit of parts, including etched pc board is available from Circuit Board Specialists, P.O. Box 969, Pueblo, CO 81002. The ARRL and *QST* in no way warrant this offer.

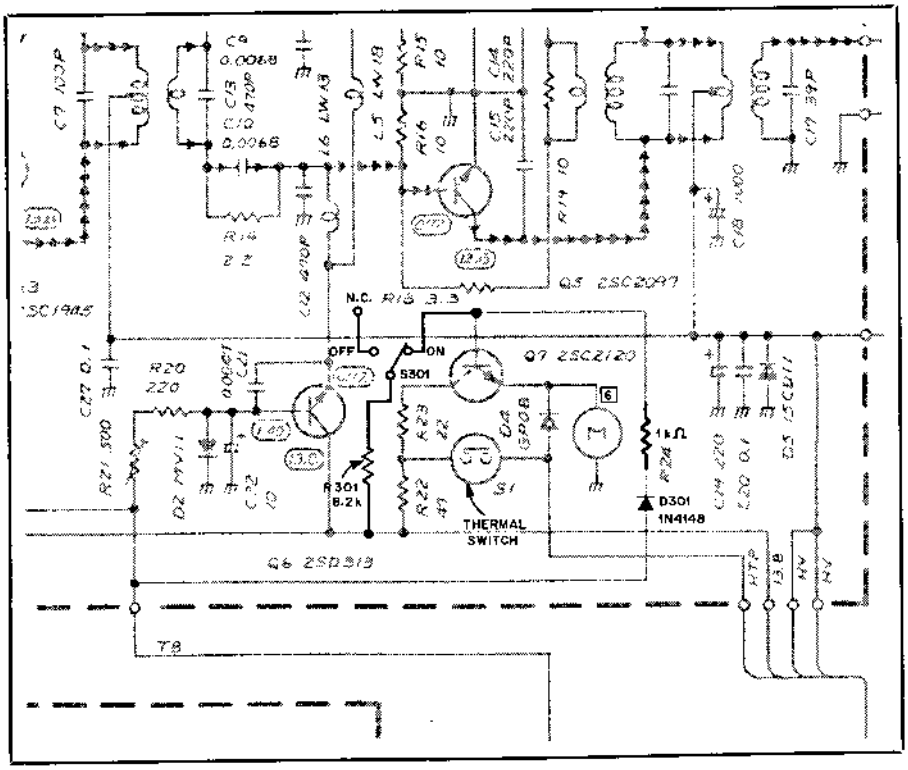

Fig. 4 — Schematic diagram showing changes to the fan-motor control circuit, which allows the fan to run continuously. This diagram is from the owner's manual.

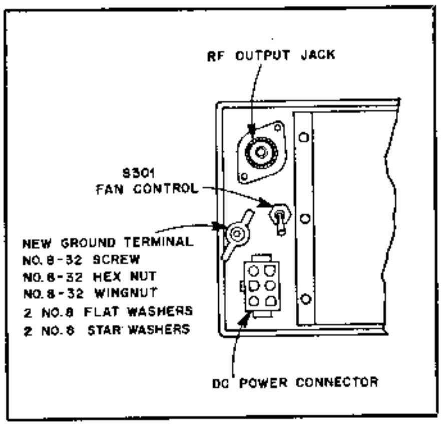

Fig. 5 — A portion of the rear panel is shown, giving the locations of the new ground terminal and the fan-motor control switch.

Table 2

Parts Changes In PA Unit to Allow Fan to Run Continuously

R24	*Change from 2.2 kΩ to 1 kΩ*
Added Parts	*Value*
R301	8.2 kΩ, 1/2 W
D301	1N4148, silicon
S301	spdt toggle switch

the rear panel below the rf-output connector. I removed the clamp type of ground connector and installed a no. 8-32 ground-stud screw with locking hardware, and a wing nut. The toggle switch was mounted next to the ground screw (Fig. 5). Care must be taken to locate S301 so the terminals and body clear the end of the band-switch shaft. Parts changes for the fan control are shown in Table 2.

Conclusion

Comments received from operators hearing the cw from this modified IC-730 have been gratifying. I hope others making the changes described here will be pleased with their results. I wish to thank Bill Skipper (KØARG), Jack Fewer (N2CJV) and Bob Ziolkowski (W2HER) for taking the time and trouble to machine copy my high-speed transmissions, and for making helpful comments. Thanks also to Dorothy Pratt (KA2MEU) for typing the original manuscript.

New Books

☐ *Why Do You Need A Personal Computer?* by Lance A. Leventhal and Irvin Stafford. Published by John Wiley & Sons, Inc., New York, NY. First edition 1981. Soft-bound, 7 × 10 inches, 278 pages, $8.95.

Computers, computers, computers — they're as much a part of our lives today as the family pet, car, or the air we breathe. We just can't seem to do without them in this fast-paced world. Grade-school kids are learning how to use them, and the chances are you have at least one member of the computer family in your ham shack. Many hams already have personal computers assisting them, and many more are contemplating planting one foot in front of the other on their way to the computer store.

Before you take that decisive step and put your money on the counter, it might be a good idea to know a little about what you're getting into. You can find that information in this book. It's geared to the prospective personal computer owner as well as the person who already owns one.

While there a lot of computer primers on the market, many of them bury the newcomer in technical jargon — not so here! This text is easy to read, from the standpoints of clarity and size of type. You're given a bit of computer history; a description of the component parts of a computer and an explanation of what the terms and acronyms mean; a touch of BASIC programming; how to write programs; computer peripherals and how to select what you need; interfacing the components; some hints and kinks of computer operation and maintenance; and some ideas on how you can find out more about the fascinating world of computers and select the computer you need.

The 16-page glossary is a handy item to have when you run across some new terminology. A 22-page appendix will be helpful even after you've purchased your computer. It contains tables that provide interface pin-out information as well as pin and signal information for a number of popular buses: S-100, Heath H8, Radio Shack, SWTP, Apple, KIM and OSI. A table describing the different cassette data recording standards is included, too.

I'd recommend this book to anyone interested in learning something about computers, even if you don't have the purchase of a computer in mind at present. You'll want to have it around for a handy reference manual and a memory refresher as you continue the learning process. I think you'll find the $8.95 was well spent.
— *Paul K. Pagel, N1FB*

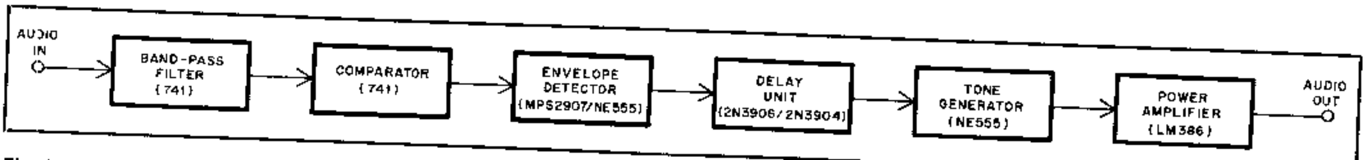

Fig. 1 — Block diagram of the QRM Fighter.

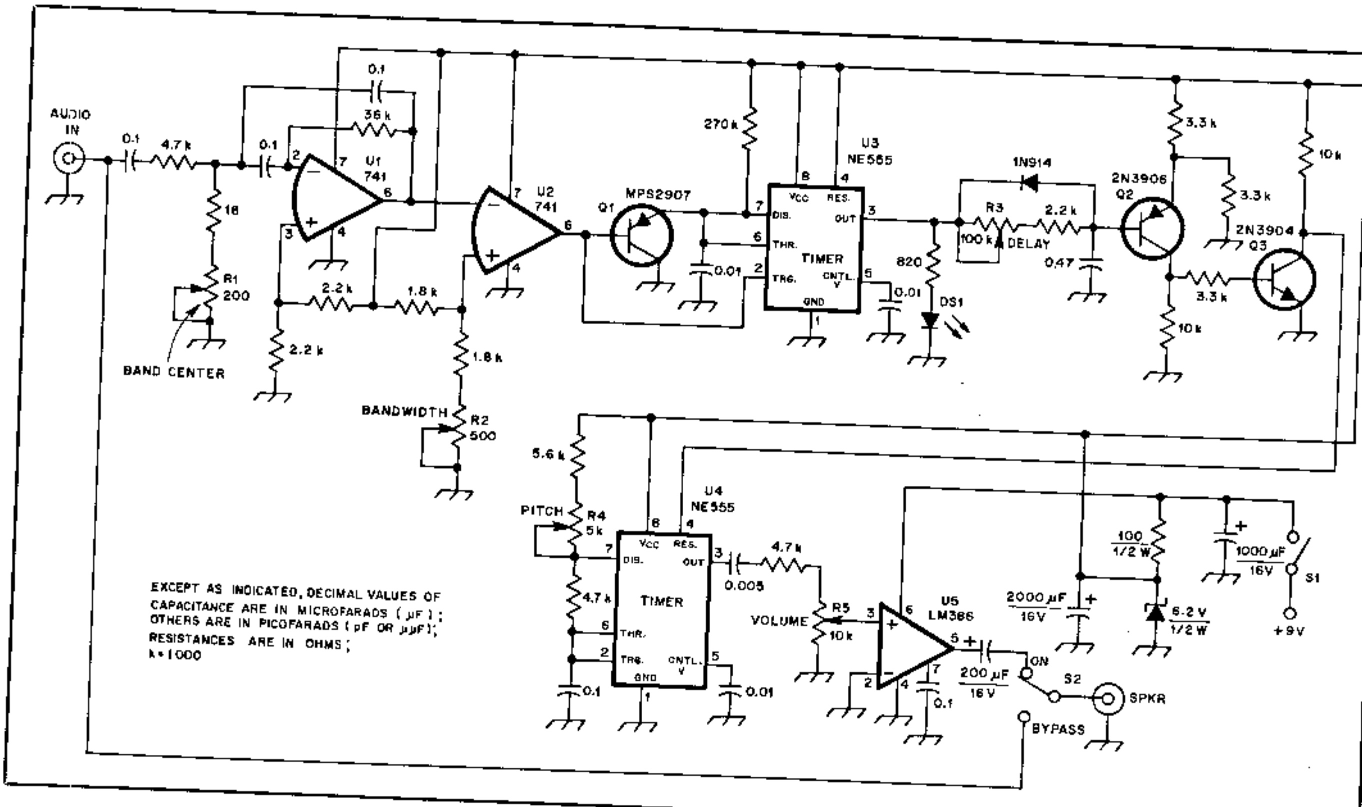

Fig. 2 — Schematic diagram of the filter. All resistors are 1/4-W, carbon-composition or film types; capacitors are 25-V, disc-ceramic types. Those with polarization marked are electrolytic.

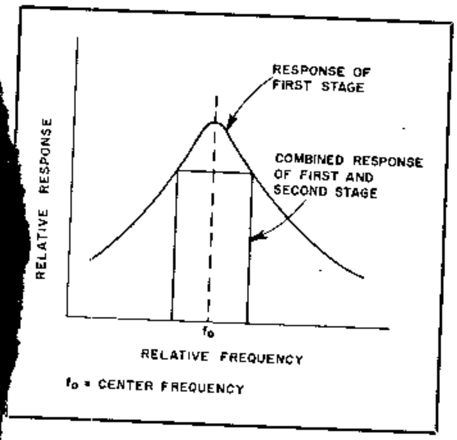

Fig. 3 — Graph showing relative response of first two stages.

steady carrier picked up by the receiver. A crystal calibrator can be used to supply the carrier. The receiver should be tuned for maximum deflection of the S meter and not disturbed for the remainder of the adjustments. With the receiver audio level set no higher than needed for detection by the filter, and the BANDWIDTH control set for maximum bandwidth, the BANDCENTER control is adjusted until the LED is lit and a steady tone is heard. Filter bandwidth is reduced progressively, and the BANDCENTER control adjusted, always maintaining minimum excitation necessary from the receiver. Eventually, an adjustment of the BANDCENTER control is obtained, which exactly matches the receiver offset frequency. This control should thereafter not be disturbed. At this point, the 5-kΩ pitch-control Trimpot may be adjusted to produce a pleasing tone. The pitch may be lowered further, if necessary, by paralleling the 0.1-μF capacitor in the fifth stage with a 0.05-μF unit.

The BANDWIDTH control may be calibrated by use of an audio sine-wave generator set for 100-mV output. By "rocking" the frequency dial of the generator, the filter bandwidth may be determined. Dial calibration of the BANDWIDTH control can then be noted.

For calibration of the DELAY control, a source of pulse-modulated audio set to the offset frequency of the receiver, and a dual-trace oscilloscope, are used. A suggested circuit for the signal source is given in Fig. 6. This circuit provides a series of dots with equal dot and space durations; the dots consist of several cycles of audio from the sine-wave generator, whose amplitude is set to 100 mV. If a known code speed is desired, the frequency of the NE555 switch should be set to 2.4 × wpm. This frequency is equal to 0.722/RC; for example: R = 91 kΩ, C = 0.47 μF produces a code speed of 40.5 wpm, which is a good speed to use.

The simulated cw signal is connected to the input of the filter. Pin 3 of the third stage, NE555, is connected to one channel of the oscilloscope, and the collector of Q3 is connected to the other channel. Relative time delay between the two signals may now be observed, and the dial of the DELAY control can be marked correspondingly.

When the QRM Fighter is connected to a receiver and has sufficient delay dialed in, the LED will occasionally flash on strong noise impulses, but no sound will be heard. This is indicative of the extraordinary noise filtration that the delay discrimination can produce.

Operation and Comments

It is my usual procedure to tune the

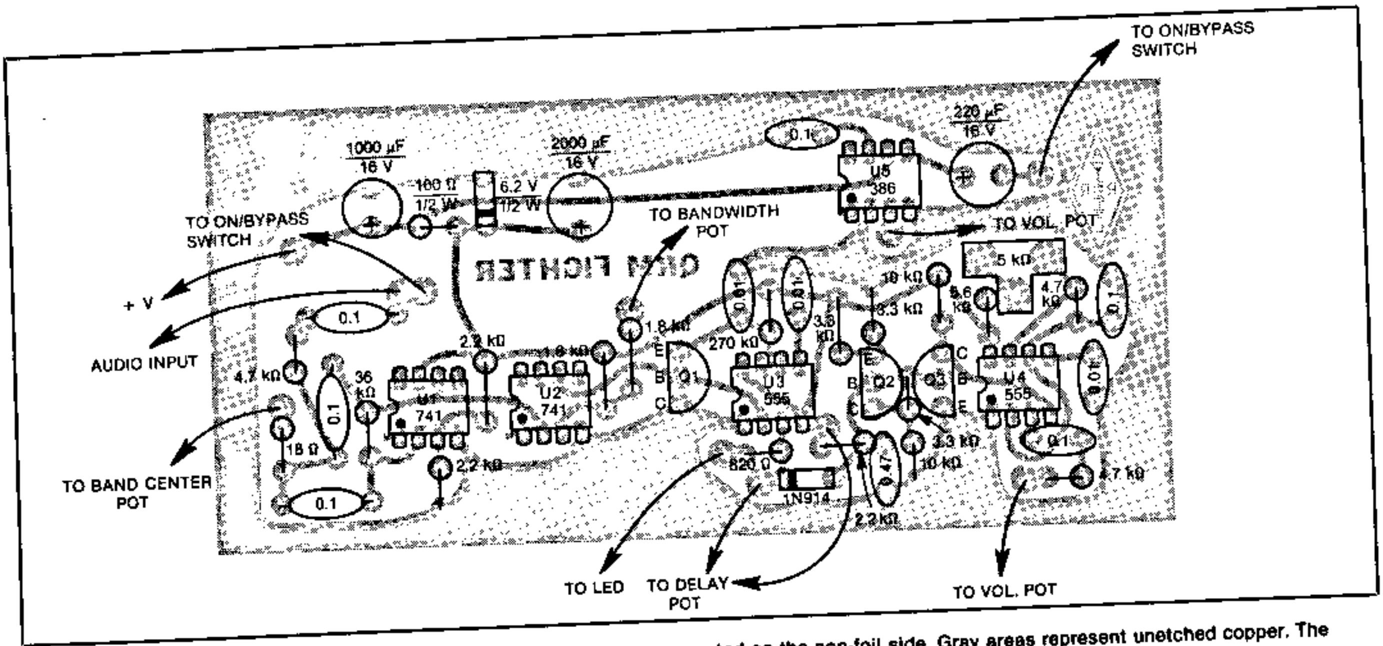

Fig. 4 — Parts-placement guide for the circuit board. Components are mounted on the non-foil side. Gray areas represent unetched copper. The circuit-board etching pattern appears on page 39.

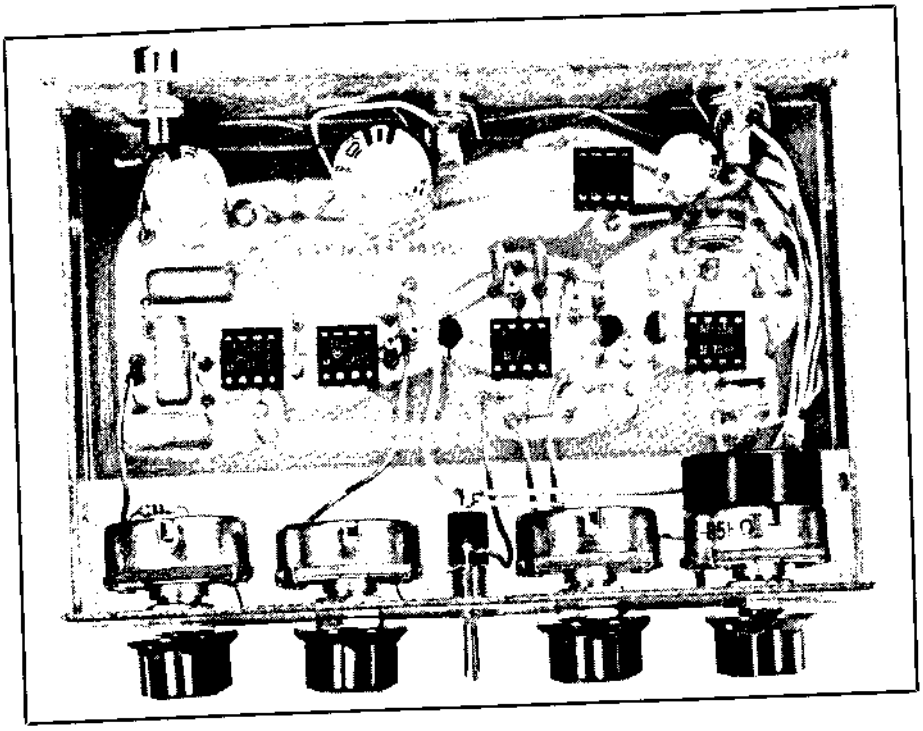

Fig. 5 — Inside view of completed QRM Fighter.

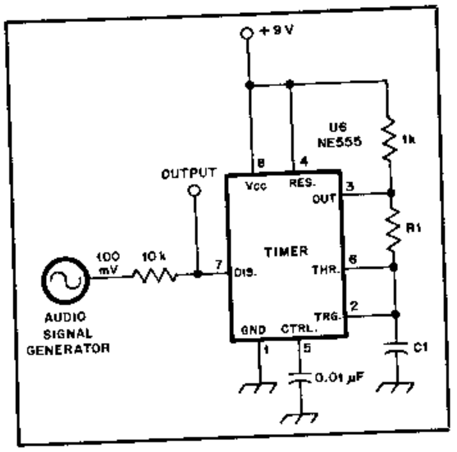

Fig. 6 — Simulated cw generator used for alignment purposes.

receiver with the filter in the BYPASS mode and while observing the LED, making sure the signal is properly tuned in. The BANDWIDTH control is normally set at 100 Hz, and the DELAY control at zero. If QRM suppression is desired, the filter is put into the ON position. Sometimes the filter is used when there is no QRM, simply for the pleasure of listening to a signal against a quiet low-noise background. If noise persists when the filter is in, delay may be dialed in to eliminate it. Usually a delay of 8 to 10 ms is adequate.

I was not able to test the QRM Fighter against the Russian Woodpecker. The duration of its pulse is known to be 15 ms, however, so the filter should be effective in suppressing it.

One characteristic of this filter is that the bandwidth increases with the input level. Also, noise that actually triggers the circuit will appear in the output at the same level as the desired signal (but not with the same duration or pitch). Both problems are alleviated by using minimum drive from the receiver, consistent with filter excitation.

Because of the narrow band-pass characteristic, it may not be possible to hear your transmitter sidetone. This can be corrected by adjusting the frequency of the sidetone oscillator, or simply by switching the filter back to the BYPASS mode while transmitting. It is an amusing consequence that listening to both sides of a QSO without readjusting the VFO is usually not possible because of the extreme selectivity!

The pleasure of using this filter will repay the time spent in designing and building it. It is my hope that you will derive as much satisfaction from it as I have.

References

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Berlin, H. M. *555 Timer Applications Sourcebook, with Experiments.* Indianapolis, IN: H. W. Sams and Co., 1976.

DeMaw, D., and W. Hayward. *Solid State Design for the Radio Amateur.* Newington: ARRL, 1977.

Nicholls, D. "Blanking the Woodpecker," *Ham Radio,* Jan. 1982.

Rakes, C. D. *Integrated Circuit Projects.* Indianapolis, IN: H. W. Sams and Co., 1981.

These capacitors should not be used at rf power levels above a few watts. The insulation may melt, as I found when I used a couple of them in a 144-MHz to 432-MHz varactor tripler. — *Joseph Fleagle, WØFY, Chesterfield, Missouri*

[Editor's Note: We tried making some of these capacitors in the ARRL lab, using a piece of ribbon cable found in a junk box. When the ribbon cable is cut to a given length from the same piece, the capacitance was nearly the same each time. Fine trimming of the value is easily accomplished with a pair of wire cutters. The Q of these capacitors compared very favorably with similar-value silver-mica units. We tested them up to 150 MHz.]

LOSS OF AUDIO ON THE ICOM IC-215

□ My IC-215 had no audio output, even though the S meter indicated plenty of received-signal strength. I traced the problem to the audio-output chip, IC2, on the receiver board. This chip has an internal resistor connected between pins 2 and 6, which had failed, removing power from part of the IC.

The simple cure for this problem is to connect a 220-Ω, 1/2-watt resistor from J13 to IC2 pin 2 on the bottom of the board. Check your operator's manual for a schematic diagram and a parts layout to locate the connection points for this resistor. If the entire chip fails at a later date, be sure to remove the resistor before replacing IC2. A replacement chip is the GEIC-138, a 2-W af power amplifier. — *Lance Aue, KA2EJD, Bellmore, New York*

MURCH UT-2000A TRANSMATCH

□ I had two problems with my Murch Ultimate Transmatch. Both had simple solutions from which others may benefit.

The first problem was that the brass roller wheel, which slides along a brass shaft to contact the inductor windings, would skip turns or even land between turns. This would cause false readings on the turns counter. The cure was to clean the mechanism, and then apply a thin coat of lubricant to the brass shaft. I used GC Electronics Tunerlub, no. 26-01. This reduced the sliding friction and eliminated the problem of the wheel jumping turns. Electrical performance remained the same.

Another problem involved arcing inside the cabinet when certain antennas were used. Examination revealed that the sheet metal screws protruded too close to the variable-capacitor stator. I replaced the six screws that fasten the wrap-around chassis bottom to the main unit with shorter ones. — *Richard Regent, K9GDF, Milwaukee, Wisconsin*

HEATH SA-5010 μMATIC KEYER MODIFICATIONS

□ I like many of the useful microprocessor-controlled features of my new Heath keyer. I experienced some difficulty with the capacitive-touch paddles, though. Sensitivity settings were extremely critical, and the keyer was susceptible to stray rf pickup, causing erratic keying.

I made the following changes to correct these problems:

1) Add a 0.001-μF ceramic capacitor between pins 8 and 9 of U8.

2) Change C24 and C25 to 33 pF.

3) Provide a ground plane for your keying hand. This can be a sheet of aluminum foil under a plastic table-top cover. Staple a wire lead to the foil and connect it to ground. Do not place the keyer over the ground plane, however. — *Samuel Bases, K2IUV, Yonkers, New York*

OLD TIMERS' NOTEBOOK

Toothpaste-Tube Cap Insulators

□ Toothpaste-tube caps are an excellent source of material for constructing feed-through and standoff insulators, as illustrated in Fig. 6. The feedthrough in example A is made by mounting a toothpaste cap on each side of a metal plate and passing a threaded rod through both caps. A spacer of insulating material is mounted at the center of the rod to prevent accidental contact between the rod and the metal plate. The nylon wheel of a curtain runner is ideal for this purpose. In example B, the necessary hardware is bolted to the cap and the cap in turn glued to the plate.

A non-insulated standoff is constructed by directly bolting the toothpaste cap to the plate as illustrated in example C. An insulated version is made by cementing a machine screw to the concave recess in the top of the cap and gluing the cap to the plate. The cap can also be bolted to the plate as shown in example D. — *D. P. Taylor, ex-G8OD (Reprinted from* Hints and Kinks for the Radio Amateur, *8th ed., 1968, p. 123)*

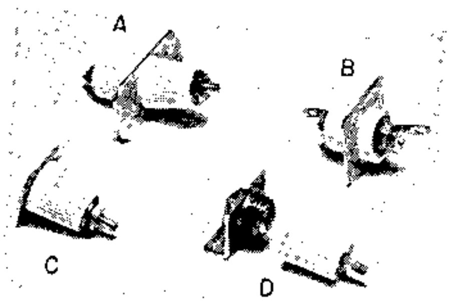
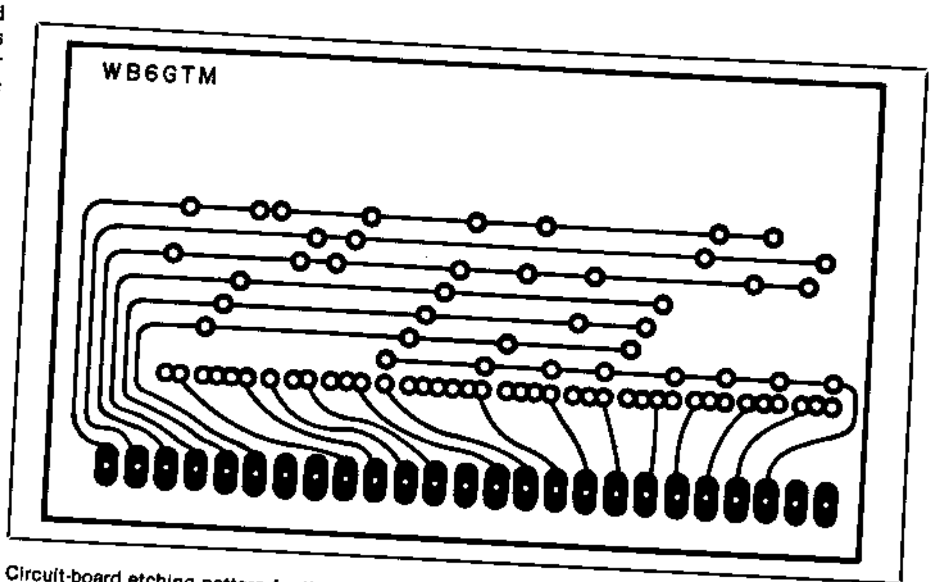
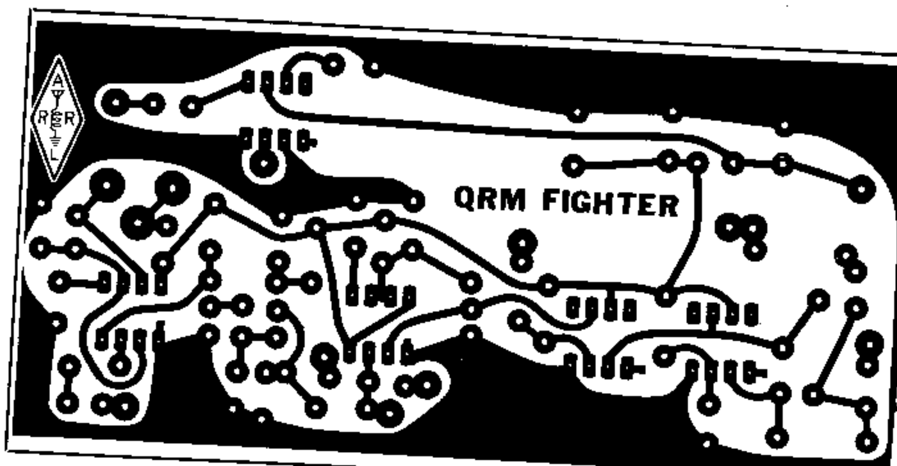


Fig. 6 — Toothpaste cap feedthroughs and standoffs.



Circuit-board etching pattern for the TR-7 programming board. Black represents copper. Pattern is shown in full-size from the foil side of the board. The parts-placement guide appears on page 21.



Circuit-board etching pattern for the QRM Fighter. Black represents unetched copper. View is from the foil-side of the board. Parts-placement diagram appears on page 30.