# The Porta-Peater — the Instant Communicator

## — quick and easy does it

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Emergency situations always seem to happen where there is limited repeater coverage available or limited HT range, or when no one's HT has a crystal frequency which matches anyone else's (sound familiar?). The Porta-Peater™ solves these problems and provides capability and versatility beyond any commercially-available repeater package — and for a lot less money.

The system is an audio-driven command and control module which takes any two rigs and converts them into a QRP, frequency-agile, VOX-driven repeater with CW IDer, hang, and cycle timers. All this with absolutely NO modifications to any of the radios. All connections are made via the available audio input and output jacks on the radios. You can run any mode, any band, cross band, etc. Do whatever your heart desires! You are limited only by your imagination and the FCC for Porta-Peater applications.



Photo A. Field Porta-Peater hookup with FT-227 and Tempo VHF-1. This Porta-Peater is housed in a minibox on a 19" rack panel (original prototype).

A complete Porta-Peater should run you less than $100 for all new parts including an enclosure (but no printed circuit board).

Photo A shows a Porta-Peater field repeater in action. Notice the simple installation. This one is set up on two meters.

### Birth of Porta-Peater

The idea for Porta-Peater came from AC2A's desire to be able to erect an instant repeater at hamfests on a frequency fitting most of the HTs in use that day. Since one could never be sure who would be along on the day of a hamfest, there was no way of knowing whose rigs would be available to build into a temporary repeater. This meant no modifications could be made to anybody's unit. Also, we were too cheap to want to invest $600 in a fixed-frequency repeater for what basically was just playing around.

Photo B shows the first Porta-Peater. It was a simple control system with IDer capability but limited timer ability. It was set up at a local Philadelphia hamfest using a Tempo VHF One-Plus, a Yaesu FT-227R, and two separate Larsen 5/8-wavelength antennas about fifty feet apart (one on the ground, the other about 10 feet up). Both rigs were set to low-power output. Fantastic! Everybody liked it and used it. We switched frequencies, splits. You could do whatever you wanted, with limitations depending on what rigs you used, not the repeater control.

Passersby suggested using split band/mode, etc., and its application to emergency usage. This thing was really more than just a toy. It had the makings of being the basis for an instant emergency repeater system, with super possibilities. With the Porta-Peater, you could put

a repeater on the air as fast as you could hook up two audio cables and two antennas.

Porta-Peater I was a hand-wired, non-reproducible model with diode matrix IDer. Definitely not the stuff articles are made of. It was ugly, but it did work and work well. Porta-Peater II had a nice PCB layout with a new PROM CW IDer. It looked good, worked lousy. Six months (part-time, with spurts of midnight-oil genius) were spent creating Porta-Peater III which looks good, works well, and is capable of being reproduced by other hams. Photos C and D show a boxed unit, and Photo E shows a rack-mount version.

### Theory of Operation

The basic concept behind the Porta-Peater was the creation of a repeater by taking any two readily-available amateur radios. One rig acts strictly as a receiver and the other as a transmitter. Fig. 1 is a schematic representation. One rig (any band/mode) receives an incoming signal; it is taken off the external speaker jack and fed into the Porta-Peater. Here it is amplified, and the audio is used to trigger the other rig's transmitter (any band/mode) line via the Porta-Peater VOX. Incoming audio also starts the time-out timer. A separate internal timer controls the CW IDer cycle. Porta-Peater is an interface link between the audio output jack of one rig and the microphone jack of the other rig.

If you use two 2-meter rigs, a duplexer is not necessary since separate TX and RX antennas work quite well with about 40 or so feet between them at QRP levels. The quality of the particular rigs in use (front end specs) determines individual antenna-spacing requirements. Also, since the
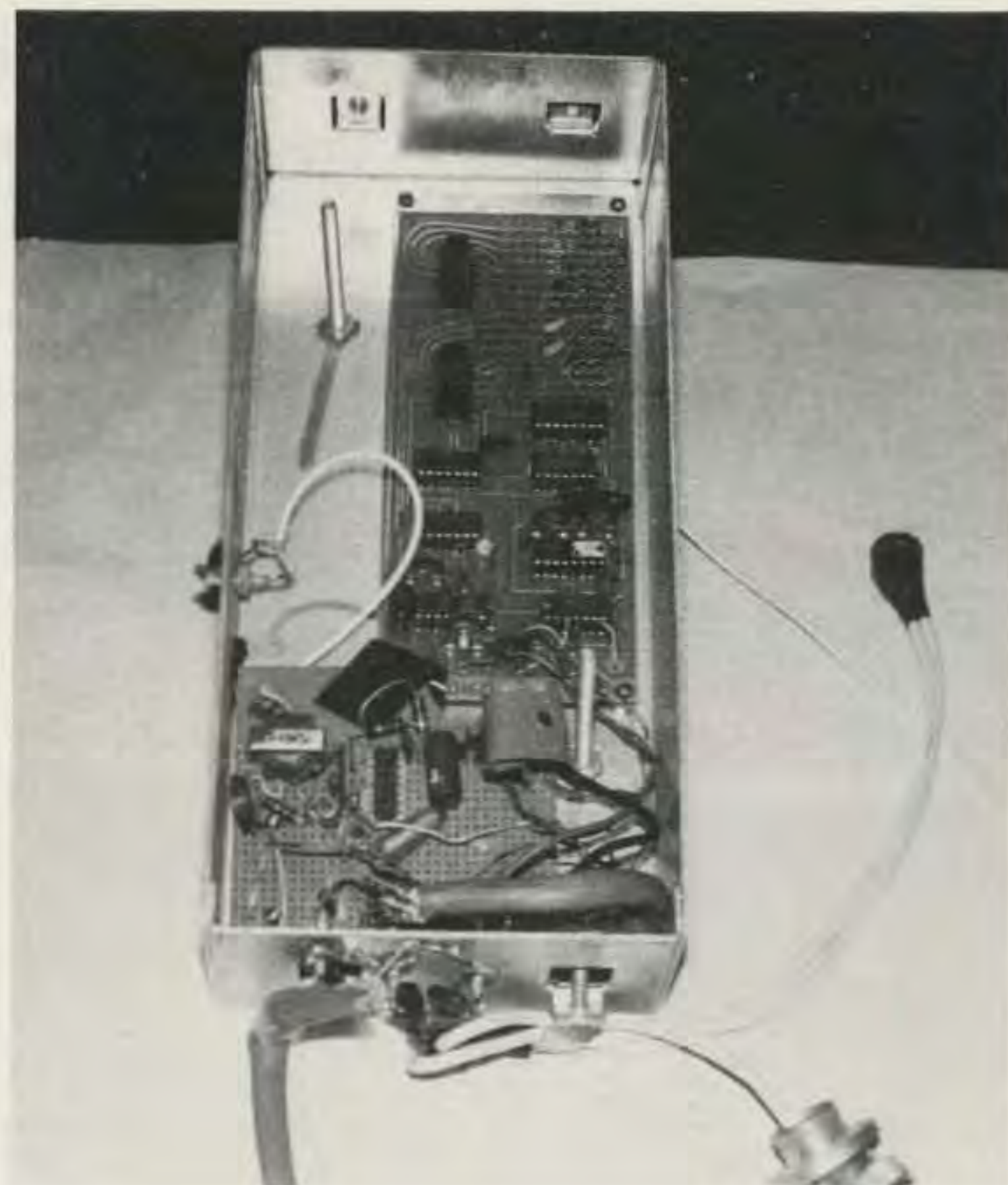


Photo B. Inside view of first unit from Photo A. CW IDer takes up most of box. Control system is in front.

emergency usage of the Porta-Peater is based on the fact that you don't know in advance what bands on which you may be setting up a repeater (6, 2, 1-1/4, 3/4, etc.), a carload of duplexers in one's back seat generally is not appreciated by the family. Also, it ain't cheap!

The Porta-Peater would be extremely effective in hooking up a VHF link into a low-band rig command center via a repeater, with easy crossband communications. Since the system is VOX driven, you could create multiple-rig and repeater systems in any configuration needed. Just keep a supply of audio jumper cables handy.

### Circuit Description

The Porta-Peater circuit

is composed of six basic functions: a local mike amp, VOX amplifier, VOX trigger, reset timer, ID timer, and a selectable four-message PROM CW IDer. All circuit symbols are on Figs. 2 and 3. Audio from a receiver source is fed into an input transformer (T1), which provides a voltage transformation of 5-to-1 to drive the LM 3900 amp (section U1A), and the audio input of the transmitter. The LM3900 is a quad Norton current-mode amplifier. U1A and U1B form the VOX system. The VOX also can be triggered by closing the local PTT contact, which removes U1A pin 3 current bias and turns the VOX on. R2 and C1 form the hang-timer components for VOX hold-in.
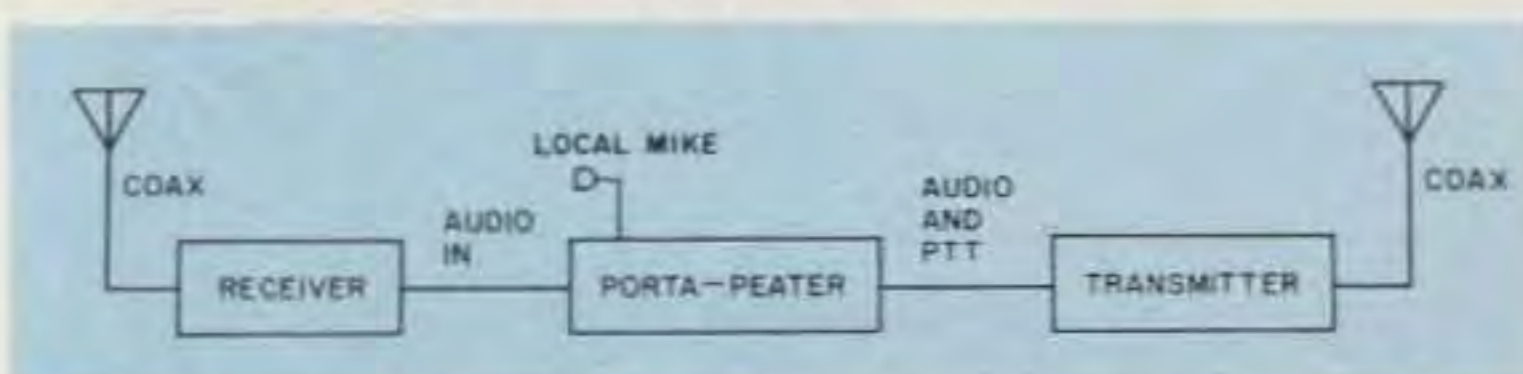


Fig. 1. System layout shows how simply a portable system can be constructed.
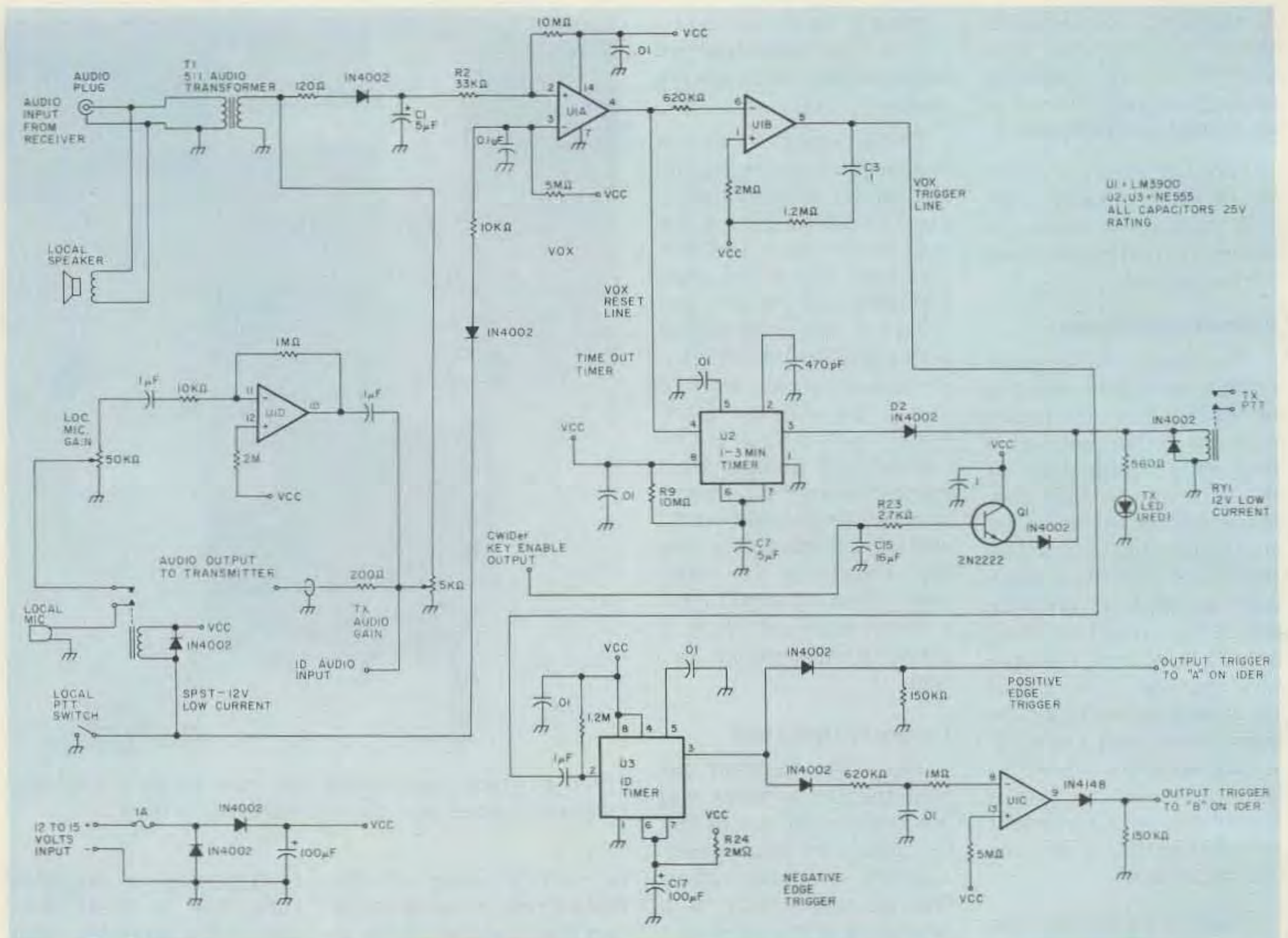
Fig. 2. Schematic of command and control logic for the Porta-Peater.

U1A output is normally low, which defeats the 555 timer, U2. The presence of an audio signal at U1A pin 2 shifts pin 4 to Vcc and enables the timer. U1B inverts the audio signal and pro-vides a negative pulse through C3 and triggers U2 on, which is the 1-minute (adjustable via R9 and C7) time-out timer, and drives PTT relay RY1 on. Time-out timer U2 resets every time the VOX reset line goes low. D2 serves to isolate U2 from spikes due to RY1 operation.

Q1 is a relay driver driven by the CW ID source. The emitter follower is held rea-sonably high between ID pulses by R23 and C15. The 5-minute ID timer (adjust-able via R24 and C17) is keyed by the VOX but is not reset by the VOX. When the 5-minute timer runs out, if
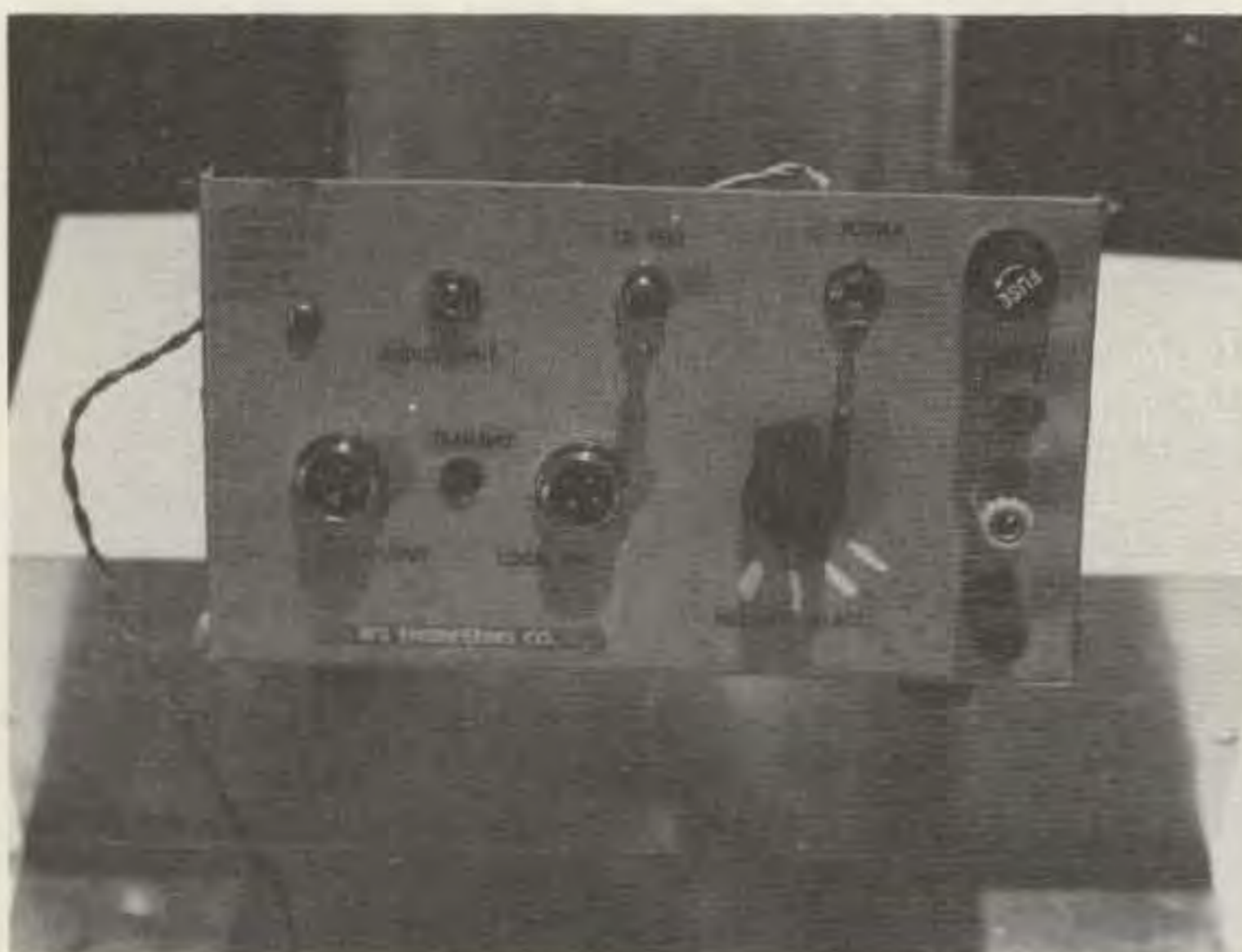


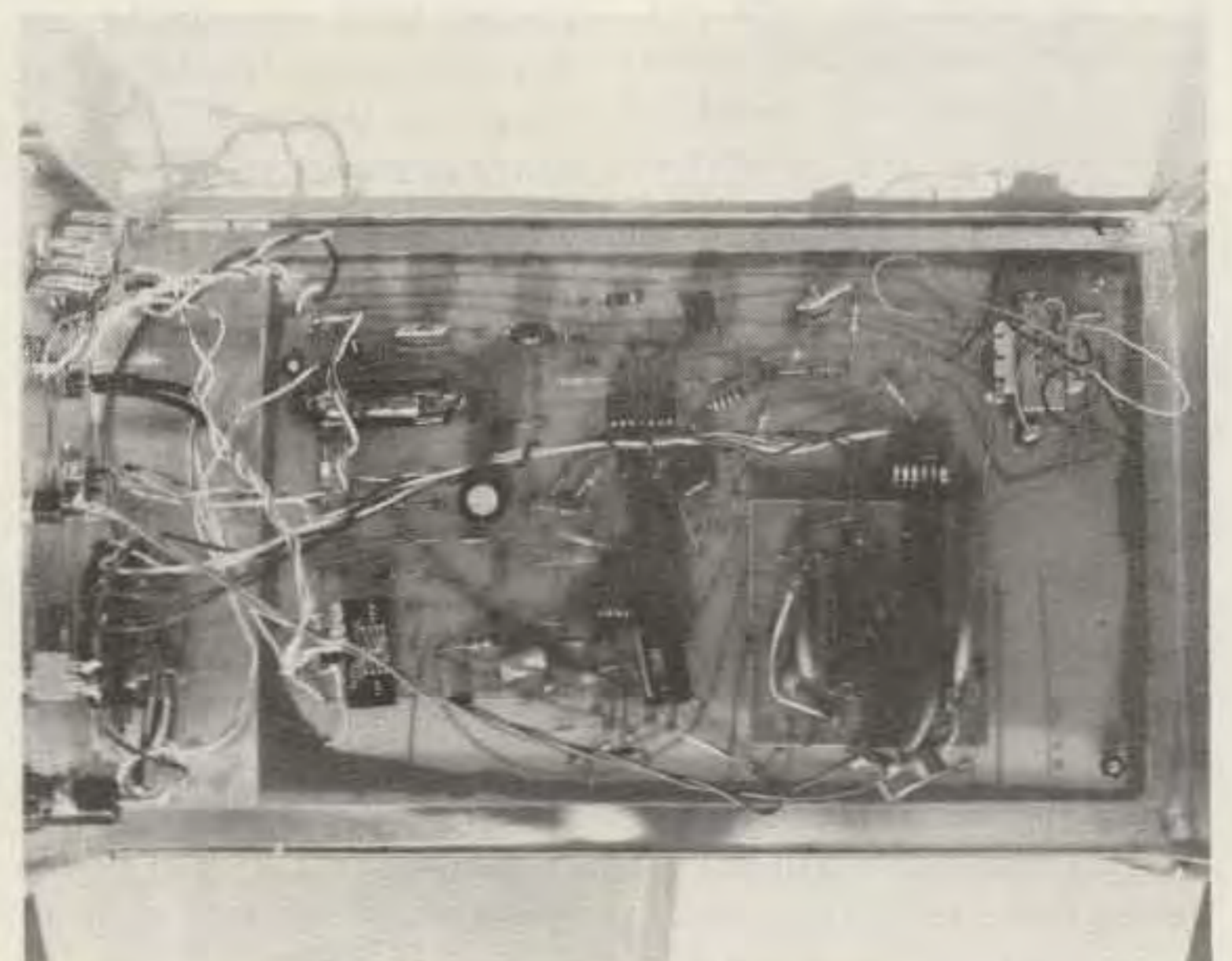Photo C. Front view of the third version unit with four se-lectable IDs.



Photo D. Inside view of the same unit shown in Photo C.

the Porta-Peater is not in use, U1C inverts the falling pin 3 pulse and provides a positive trigger output to turn on the CW IDer, which in turn drives Q1 on and turns on the transmitter for the final ID as required by the FCC.

The CW IDer is based on an 82S126 PROM, which is a 4-by-256 device. In the PROM, 1 bit is a dit and space, 3 bits a dash and letter space, and 7 bits a word space. The message is played back from memory by being sequentially addressed by the 4020 binary counter driven by one half of the 4011 in an oscillator mode. The particular 256-bit message grouping is selected by switching pins 12, 11, 10, or 9 of the 82S126. The output is combined with the clock signal in the remaining NAND of 4011 and available as a tone at the 10k pot. The output is adjusted to provide drive as needed.

Burning the messages into the PROM is not particularly easy unless you are equipped to do it properly. If you don't have a PROM programmer, it is best to buy a chip and have the supplier burn the memory. Any IDer will work with the Porta-Peater (i.e., diode matrix, or other PROM/ROM types) as long as an audio output signal and an external trigger input line are available. The original model used a VHF Engineering kit. Alternatively,
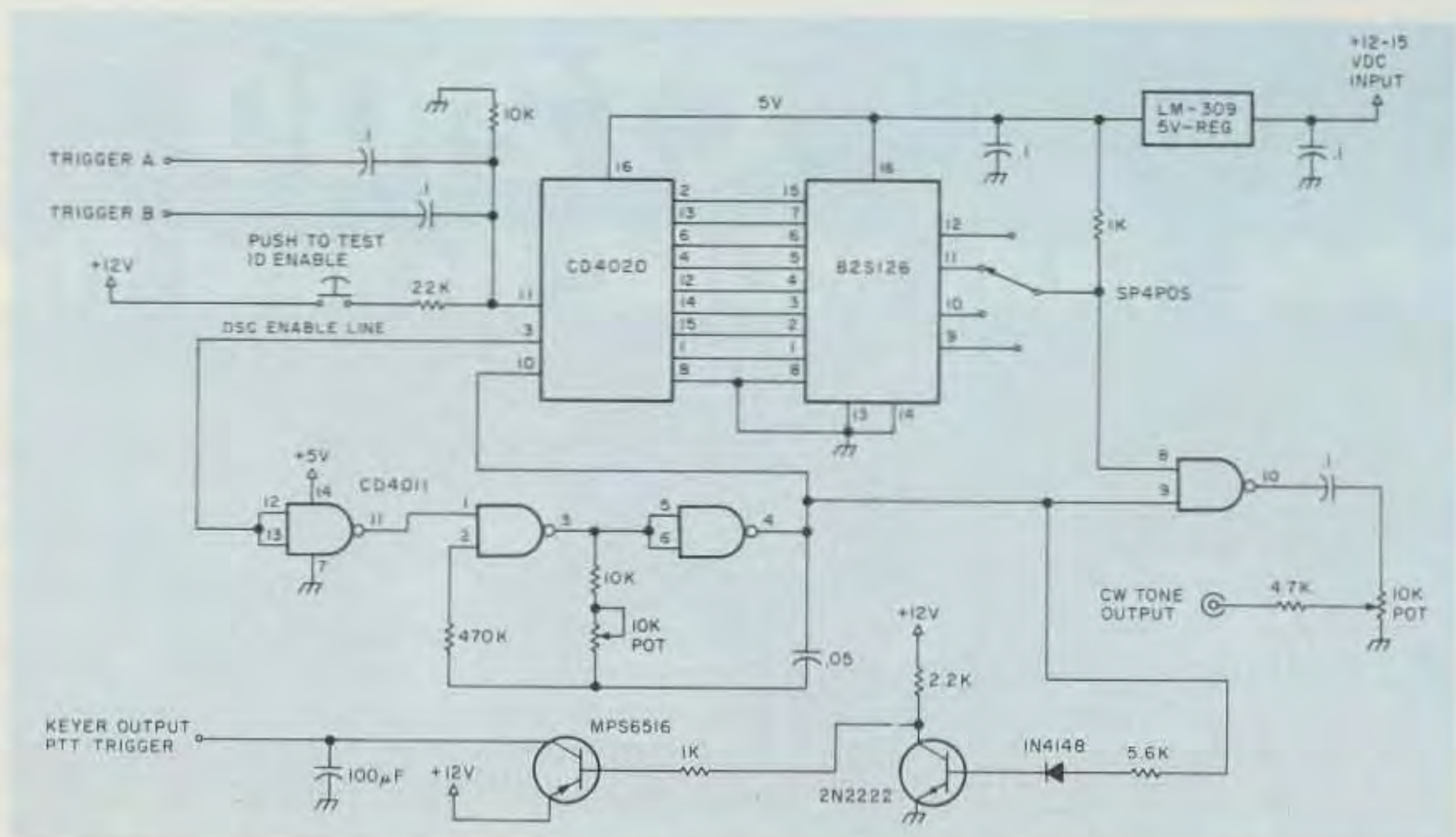


Fig. 3. Schematic of CW IDer. Any IDer can be used with the basic system shown in Fig. 2.

you can build the system without any IDer at all and use voice ID.

The circuit as designed uses an isolated single-pole relay for switching. Depending on your radio, you may have to use an SPDT relay for electronics-switched radios to move 12 volts from the RX to TX enable lines. For relay-switched rigs, simply use the SPST to complete the relay circuit in your radio.

### Construction

The latest version of the Porta-Peater is mounted on two printed circuit boards, a mother and a daughter board. The mother board is shown in Photo F. Most of our units used a hand-wired panel instead of a daughter board. The mother board

contains all of the command, control, and ID functions. All signal I/O, ground, and power buses are brought out to a standard 0.156-inch, 22-pin edge card connector. The daughter board interfaces to the mother board via the connector, or you can hand-wire the two boards together.

The daughter board has the TX LED, audio input jack, PTT output jack, local mike jack, ID-message-select switch, and ID-test switch mounted on it. This approach makes for a design that can be put in various enclosures easily without rewiring. Photo F shows how jumper wires were used instead of a daughter board.

The selection of enclo-

sure is a matter of personal choice. The only requirement is that it be reasonably rf tight. The last thing you need is rf floating around inside an audio-frequency-control system.

### Cable Assembly

Two interface cables are required to use the system. One is a shielded audio line and the other is a four-conductor microphone push-to-talk line. Since normally you will use the Porta-Peater physically close to the two rigs forming the repeater pair, a short convenient length is all that is needed. Two-foot lengths are a good starting point.

Most newer transceivers use subminiature jacks for external speakers. The jack



Photo E. Rack-mount version of the Porta-Peater.

| Symptom | Possible Cause | Fix |
|---|---|---|
| 1. Erratic time out | 1. Leaky tantalum | 1. C7 |
| 2. Erratic ID timer | 2. Leaky tantalum | 2. C17 |
| 3. Erratic VOX or distorted audio | 3. LM3900—low gain at Vcc | 3. LM3900, or remove protective input diode to raise Vcc by 0.8 V |
| 4. No ID | 4a. No clock | 4a. 4011 |
|  | 4b. No count | 4b. 4020 |
|  | 4c. No data | 4c. 82S126 |
|  | 4d. No audio | 4d. 4011 |
|  | 4e. No trigger | 4e. 2N2222, MPS6516 |
| 5. Erratic ID | 5. Poor voltage Regulation | 5. LM309K |

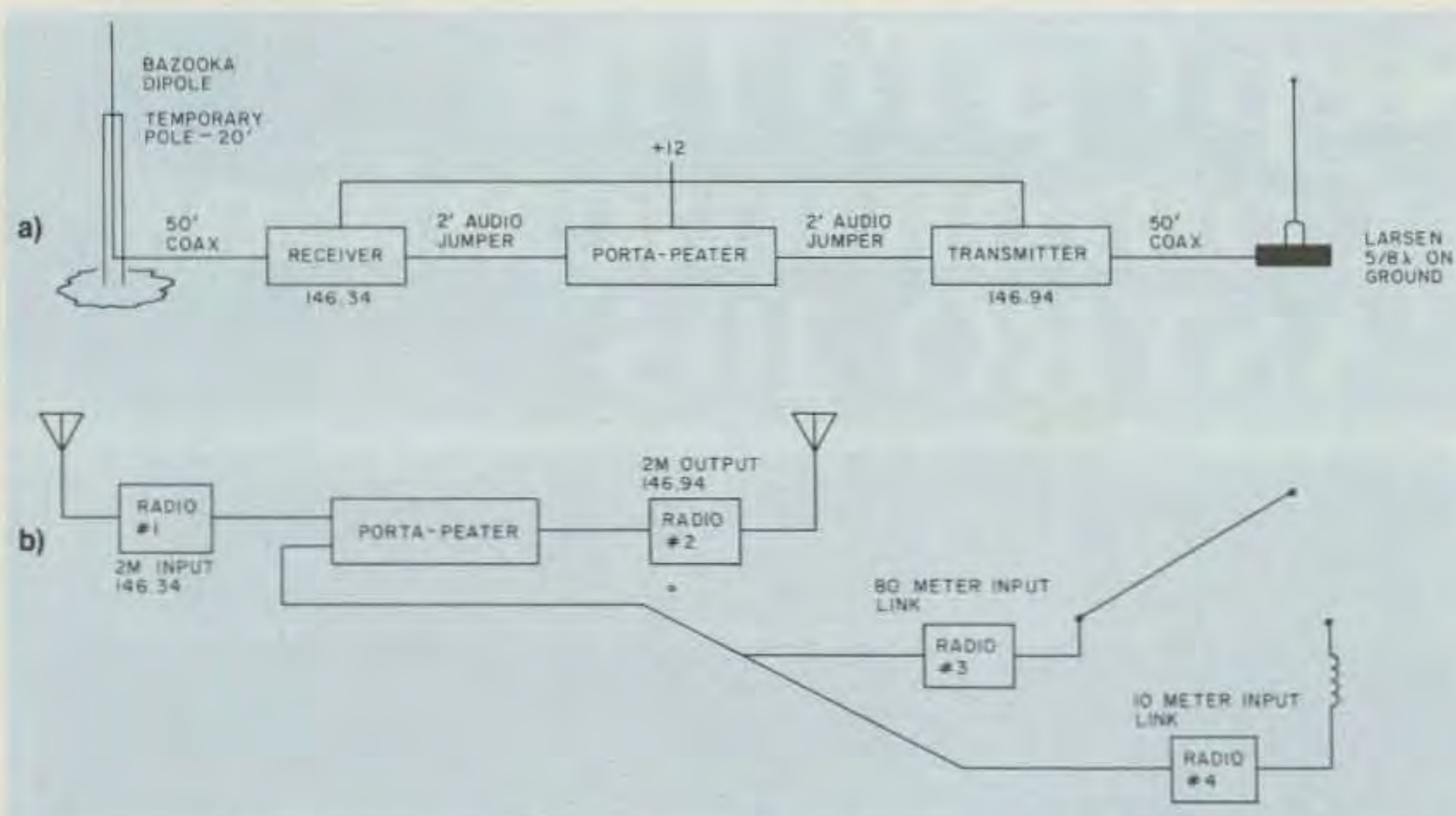Fig. 4. A troubleshooting chart of symptoms, causes, and possible fixes.

*Fig. 5. Layout (a) shows a typical 2m hookup, and (b) a 3-band input command center. All inputs show up on 146.94 out. Mode has no effect on the system (i.e., CW, SSB, FM).*

on the audio input of the Porta-Peater is also subminiature. Therefore, make up or buy a shielded jumper with subminiature connectors at both ends. In order to cover more possibilities, you might want to purchase several connector converters to change the subminiatures to PL-55 or whatever you have. Remember, the cable must be shielded.

The Porta-Peater uses a standard 4-pin, screw-on microphone plug. Again, most new rigs use this type, also. It is important that you make up this cable with the proper pin assignments. If you know in advance with which rigs you most likely will be using the Porta-Peater, you can make up a couple of dedicated jumpers. Alternatively, a small minibox can be made with a terminal block inside and the proper jumper assignments made for the rig to be used. Fig. 6 shows a possible design. This approach permits fast and easy field changes. Again, use only shielded cable.

## Circuit Assembly

Figs. 2 and 3 show the entire circuit for Porta-Peater III. PCB construction is recommended but not required. (A commercially-manufactured PCB is available for purchase; write WA2BHB or AC2A for information.) Any type of perfboard assembly is fine. Layout is not critical except for isolating the inputs and outputs of the high-gain LM3900. Parts substitutions can be made except for the low-leakage tantalum capacitors. These must be used where specified because otherwise the circuit performance will be degraded or it will not work at all.

## Alignment and Adjustment

The adjustments of the audio gains on the Porta-Peater are set to the particular rigs it is connected to. Simply hook up two rigs as per the schematic in Figs. 1, 2, and 3. Apply power and adjust for best audio. Select your ID message, push to

test, and you are finished. If things don't seem all peaches and cream, perform troubleshooting procedures.

## Troubleshooting

If your unit does not function, use the fail/cure list in Fig. 4 and you should be able to home in on the problem in a few minutes. (This list assumes that you have previously looked for broken connections and bad solder joints and taken corrective action.) Before taking apart your unit, be sure you have checked and tried the full range of adjustments on all the pots for gain, output, and oscillation on the Porta-Peater.

## Field Hookup

In a field installation, all that is needed is two rigs and a 12-volt source to set up a Porta-Peater repeater. Remember, you can configure any setup you wish by proper interconnection of the audio output and microphone PTT lines to the rigs in use. The Porta-Peater gives you the capability to set up a reasonably sophisticated communications network based simply on whatever random collection of amateur rigs happens to be available in any emergency situation. Fig. 5 shows some configuration possibilities.

For a typical 2-meter QRP repeater setup, follow these instructions:

1) Select the rig to act as a receiver.

2) Set the desired input frequency on this unit.

3) Run a jumper from the external-speaker jack of the receiver rig to the audio-input jack of the Porta-Peater.

4) Connect the PTT-microphone-output jack of the Porta-Peater to the microphone-input jack of the rig selected as the transmitter. Make sure all ground audio and switching lines are wired correctly; otherwise the system will not work or could damage the
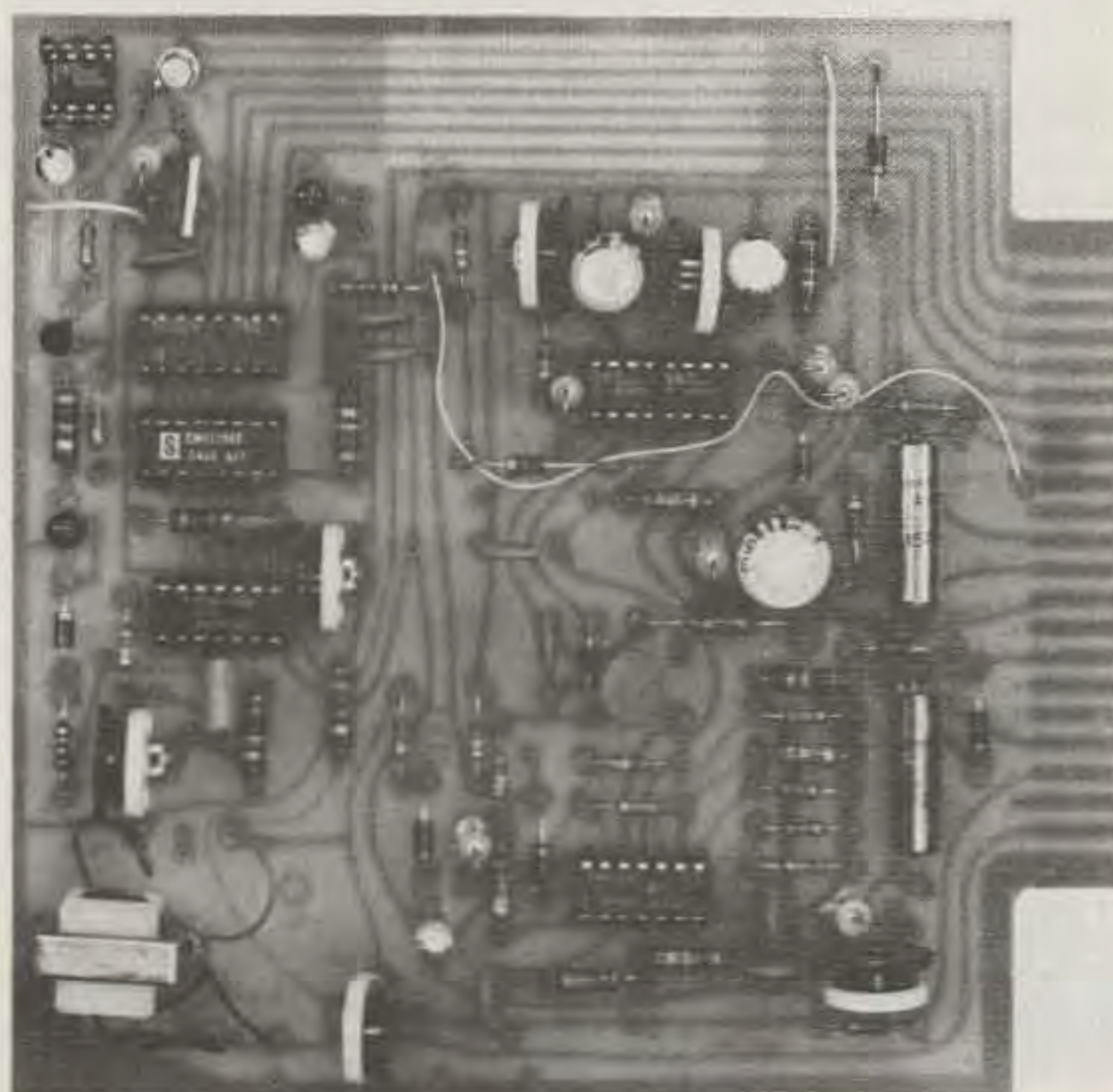


*Photo F. Populated printed circuit board with externally mounted IDer on right side. Final version was all on one board.*

units. Set up the transmitter frequency.

5) Apply +12 volts to all units.

6) Set the receiver squelch to the desired trigger level.

7) Adjust the receiver volume control (when receiving a signal) to a level which doesn't overdrive the Porta-Peater and distort the transmitter signal (a quick on-the-air check is best; monitor with an HT).

8) Turn the volume on the transmitter rig to low or off (volume, not power).

9) Locate antennas for minimum interference and overload. (See Antenna Setup Hints.)

10) Operate and enjoy!

### Antenna Setup Hints

If you want frequency agility and you are not using a duplexer, all of your isolation comes from antenna separation. Our standard setup uses two 50-foot lengths of RG-8 coax and a pair of 10-foot poles. One pole is aluminum, the other is bamboo. The two poles are lashed together, with the bamboo on top. A vertical dipole is made from the RG-8 by turning down the braid 19 inches leaving the insulated center conductor as is. This forms a bazooka dipole for one antenna; the Larsen 5/8 wavelength is used for the other. A 1/4 wavelength can be used, but in either case, ground-level mounting is employed.

In our field trials, it did not seem to matter which antenna was used for receiving or transmitting. You probably will want to try the different combinations for yourself in case there is some incremental improvement for a particular location. Under any circumstances, the two antennas should be separated as far as possible or until desensitization ceases. I often bring up the Porta-Peater before laying out the antennas, then, while the rig is

madly squealing, walk the ground-level antenna away until the squealing stops.

In severe space-limitation situations, we sometimes put an attenuator in the receiver transmission line and eliminate desensitization by lessening receiver sensitivity. It is very easy to get radio coverage of a hamfest (i.e., several acres) when a 10- to 20-dB pad is ahead of the receiver.

### Operating Notes

One of the things discovered in using the Porta-Peater with various 2m rigs was how really poor many amateur and commercial transceivers are in terms of their rf tightness. Several instances occurred where we thought the Porta-Peater was not performing right and was causing problems but found out that it was a manufactured rig which was at fault. Microphones with unshielded cables, no 12-volt lead rf bypassing, and plastic cabinets or face plates all contributed to problems. In a high-density rf environment (like the Dayton Hamvention), a rig which is not truly rf tight will give a lousy performance.

Therefore, if the Porta-Peater exhibits problems which could be contributed to rf leakage, check the rigs you are using first. A tight enclosure, with shielded and bypassed leads, will make a world of difference.

### Pocket Porta-Peater?

The development and construction of this unit was really a challenge for us. Generally, it was fun (although WA2BHB seems to have less hair now than at the beginning of this project!). However, since the Porta-Peater was designed, Icom has, of course, come out with its new IC-2A synthesized HT. So, if we had a miniaturized Porta-Peater and two IC-2As, we literally could have a pocket-sized
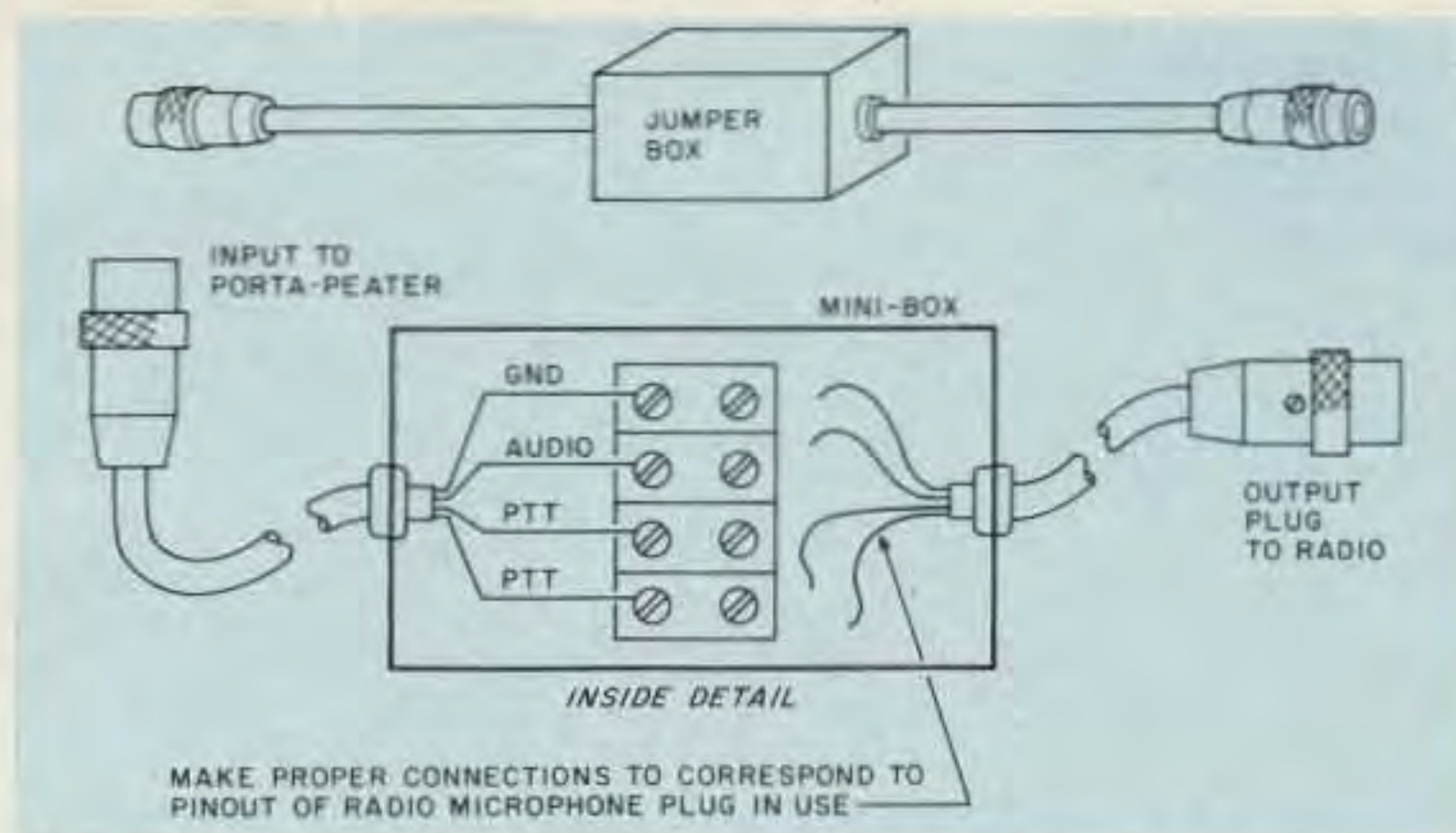


Fig. 6. A jumper box will solve the problem of a fistful of audio cables. Use shielded box and cables only.

repeater that was no less frequency agile!

Well, the Pocket Porta-Peater is in development. It uses a lower current drain IDer, advanced IC VOX system, is smaller in size, but it does cost more (unfortunately, some smaller parts cost more than their bigger brethren). However, if you don't need to carry a repeater in your pocket, the present version represents the best bet.

### Follow-Up

I will gladly answer any questions on the Porta-Peater, but you must include an SASE if you expect a response. Please remember, I'm a ham, not an electronics engineer, so the quality of answers must be gauged accordingly. 73s, and I hope you have as much fun with your Porta-Peater as we have had with ours. ■