# ARRL Periodicals Archive – Search Results
## A membership benefit of ARRL and the ARRL Technical Information Service

**ARRL Members:** You may print a copy for personal use. Any other use of the information requires permission (see Copyright/Reprint Notice below).

**Need a higher quality reprint or scan?** Some of the scans contained within the periodical archive were produced with older imaging technology. If you require a higher quality reprint or scan, please contact the ARRL Technical Information Service for assistance. Photocopies are $3 for ARRL members, $5 for nonmembers. For members, TIS can send the photocopies immediately and include an invoice. Nonmembers must prepay. Details are available at www.arrl.org/tis or email photocopy@arrl.org.

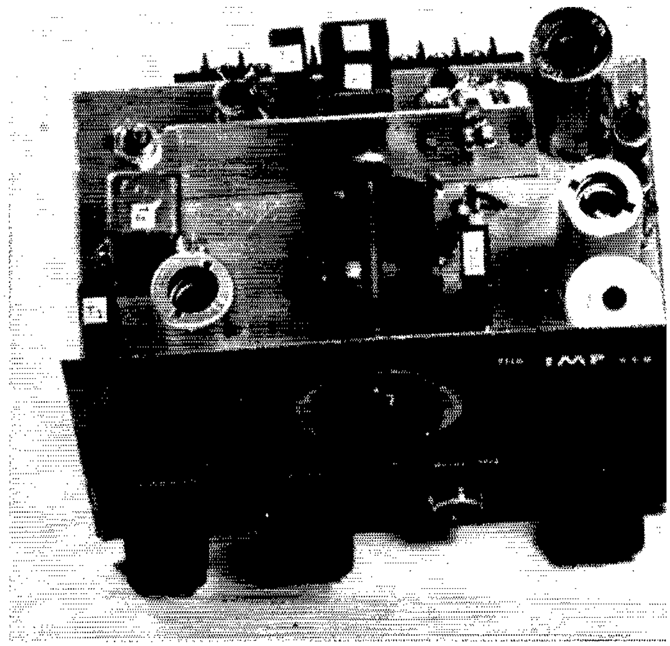
**QST on CD-ROM**: Annual CD-ROMs are available for recent publication years. For details and ordering information, visit www.arrl.org/qst.

**Non-Members:** Get access to the ARRL Periodicals Archive when you join ARRL today at www.arrl.org/join. For a complete list of membership benefits, visit www.arrl.org/benefits.




**QST Issue:** May 1960
**Title:** "Imp"--a 3-Tube Filter Rig, The
**Author:** Joseph Galeski, Jr., W4IMP


Click Here to Report a Problem with this File




*The "Imp" uses a simple crystal filter and VXO frequency control to put a single-sideband signal on the 14-Mc. band. The 5 × 7-inch chassis shown in this photograph contains the entire r.f. and audio circuits of the exciter. Output from the 6CL6 amplifier is about 1 watt.*

*A Single-Sideband Exciter of Simple Design*

BY JOSEPH S. GALESKI, JR.,* W4IMP

# The "Imp"—a 3-Tube Filter Rig

***When a single-sideband generator is stripped to essentials, there isn't much to it; the complications pile on when assorted accessory equipment is added. Here's a basic unit that will get you off to a good start on s.s.b. Built mostly from odds and ends of surplus, including the crystals, it doesn't leave much room for argument on the question of economy.***

On occasion we've all heard the complaint "I'd be on s.s.b., but it's too expensive"—or "It's too complicated." Comments such as these, plus the desire to do a little experimenting with high-frequency crystal filters and VXOs, prompted the development of the "Imp"; I needed an exciter with a minimum number of tubes to use as a laboratory for my experimentation.

The results have been most encouraging. The three tubes and filter generate a very acceptable s.s.b. signal, with variable frequency and a watt or so of output to drive a linear amplifier. I hope this article will inspire others to give s.s.b. a try.

For purposes of simplification this exciter is designed to operate only on 20 meters. However, by the proper choice of filter frequency, VXO crystal, and suitable modification of the three coils it can be made for any band. Components are readily obtainable on the surplus market and substitutions are quite in order where necessary. I was able to purchase crystals for less than twenty-five cents each. The modulation transformer can be any small plate-to-line unit with a turns ratio of about six or eight to one, such as the W2EWL type[1] or the output transformer from an ARC receiver. Suitable transformers are currently advertised in *QST* and other publications at a cost of less than one dollar.

Since my own station exciter is a version of George Bigler's "Sideband Package,"[2] and since I had already won a war against its "bugs," I decided that George's basic circuit was a good starting point. It has worked out well.

Every effort has been made to keep circuits simple and with as few parts as possible. These circuits are not original with me and complete descriptions can be found in the handbooks. I have only adapted them to the Imp.

### *Circuit and Construction*

The triode section of $V_1$, Fig. 1, is used as an untuned crystal oscillator to feed carrier to the diode balanced modulator. The pentode section of this same tube will deliver enough audio from a crystal microphone to upset the modulator balance and furnish a double-sideband signal to the filter, which passes only the upper sideband to the triode mixer, $V_{2A}$. The pentode section, $V_{2B}$, is a variable-frequency crystal oscillator which supplies the mixing signal to the grid of $V_{2A}$. About 10- to 12-kc. shift can be expected from an 8-Mc. crystal. The 6CL6 amplifier, $V_3$, uses tuned tanks in both the grid and plate circuits to provide adequate selectivity.

Construction is straightforward. A 5 × 7-inch chassis was used, with the filter mounted on top. A shield separates it from the VXO tuning cap-

* 4318 Hanover Ave., Richmond 21, Virginia.
[1] Vitale, "Cheap and Easy S.S.B.," *QST*, March, 1956.
[2] Bigler, "A Side-Band Package," *QST*, June, 1958.

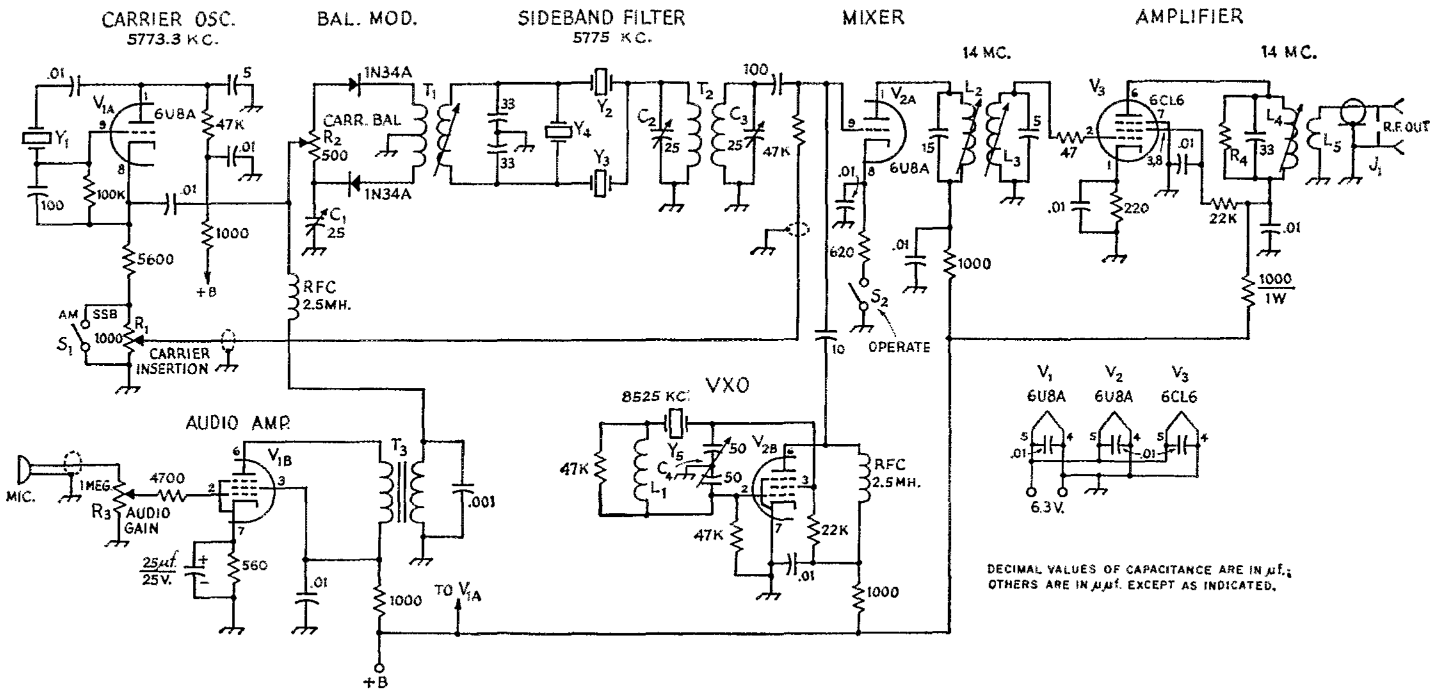



**Fig. 1**—Circuit diagram of the s.s.b exciter. Resistances are in ohms; fixed composition resistors are ½ watt except as indicated. Fixed capacitors with polarities marked are electrolytic; other are ceramic. Power requirements are 6.3 volts at 1.6 amp. for tube heaters and 250 to 300 volts at 50 ma. for plates.

$C_1$, $C_2$, $C_3$—4.5-25 μμf. ceramic trimmer (Centralab 822-AZ).
$C_4$—50 μμf. per section (Hammarlund MCD-50-M).
$J_1$—Coax connector, chassis mounting.
$L_1$—22 turns No. 22 enam. close-wound on 1½-inch diam. form. Modify as necessary to give desired VXO frequency shift.
$L_2$, $L_3$—22 turns No. 22 enam. close-wound on ⅜-inch diam. slug-tuned form. $L_2$ and $L_3$ mounted side by side with ¾-inch spacing, center to center.
$L_4$—20 turns No. 22 enam. close-wound on ½-inch diam. slug-tuned form.
$L_5$—Output link, 5 turns same as $L_4$ wound at cold end of $L_4$.
$R_1$—1000-ohm potentiometer, linear taper.
$R_2$—500-ohm potentiometer, linear taper.
$R_3$—1-megohm control, audio taper.
$R_4$—25,000 to 50,000 ohms, 2 watts, as needed for swamping and for stabilizing the 6CL6 amplifier.
$S_1$—S.p.s.t. mounted on $R_1$.
$S_2$—Rotary, single-throw, with additional poles as needed for controlling external circuits.
$T_1$—Tuned winding: 60 turns No. 28 enam. scramble-wound to length of 7/16 inch on ⅜-inch diam. slug-tuned form. Primary winding: 8 bifilar turns on same form close to tuned winding.
$T_2$—Each winding 50 turns No. 28 enam. scramble-wound to length of ⅜ inch on ⅜-inch form (no slug); windings spaced 3/16 inch between adjacent ends.
$T_3$—Plate-to-line audio transformer, approx. 20,000 ohms to 500–600 ohms (Stancor A-3250, ARC-5 receiver output, or similar).
$Y_1$, $Y_2$, $Y_4$—5773.3 kc., surplus FT-243 type (see text).
$Y_3$—5775 kc., surplus FT-243 type (see text).
$Y_5$—8525 kc., surplus FT-243 type.

acitor. A reasonable effort should be made to keep the circuits separated. If the unit is not to be put in a metal box, I would suggest putting a shield can over the carrier crystal and over the filter, because hand capacitance tends to throw the carrier balance out of kilter.

The selection of crystals for the filter permits a wide latitude of frequencies. However, the harmonics of the filter frequency and of the mixing frequency should be well removed from the desired 20-meter output.

### *Selecting Crystals*

On the surplus market are several groups of 5- to 9-Mc. crystals that have a frequency difference of 1.7 kc. I obtained about ten at 5773.3 and ten more at 5775 for experimenting, but I now feel that for a similar project seven at 5773.3 and three at 5775 would be enough. While the crystals are marked as having these frequencies few of them are "on the nose," and you will find that they will differ from one another by as much as a kilocycle.

Mark each of the 5773.3 crystals with an identifying letter and determine the *relative* frequency of each by inserting them one at a time in the crystal socket of $V_1$ and tuning them in on your receiver. If your receiver covers only the ham bands, use a second crystal at approximately 8500 kc. in the VXO to bring the sum frequency to the 20-meter band. A difference in audio tone against the receiver b.f.o. will permit you to get the crystals in order of frequency from highest to lowest. Record this order by the letters previously marked on them.

Select two of the lower-frequency crystals of the 5773.3-kc. group having a separation of a couple of hundred cycles or so and call the lower one $Y_4$ and the higher $Y_2$. You will later use one of the remaining crystals of this group for $Y_1$. Use one 5775-kc. crystal for $Y_3$. Peak $T_1$ and the trimmers on $T_2$ with a 5775-kc. crystal at $Y_1$.

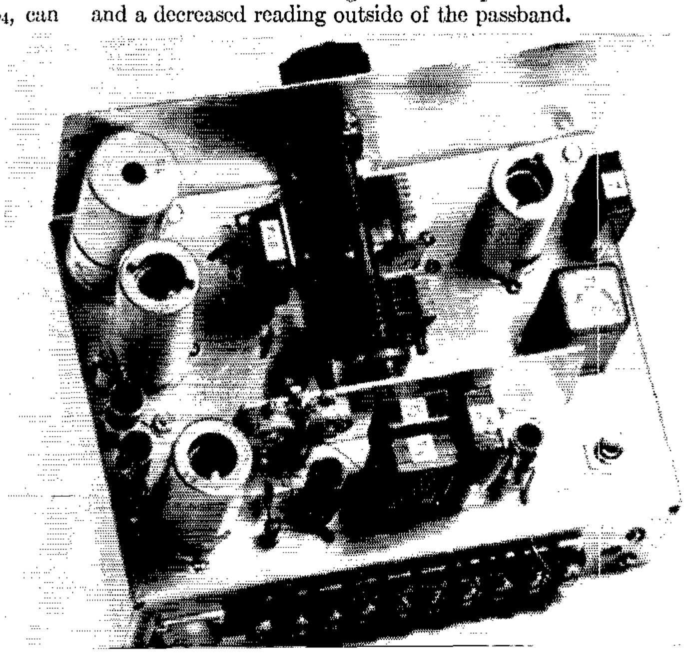
### *Circuit and Filter Alignment*

The three tuned circuits, $L_2$, $L_3$, and $L_4$, can best be aligned by first removing both $Y_1$ and the VXO crystal and then, with a signal generator set at 14,300 kc. connected to the grid of $V_{2A}$, peaking the coils. An alternate method would be to use a 7150-kc. crystal in the VXO and peak the coils on its second harmonic. This procedure should be followed to avoid the possibility of alignment of the coils on a harmonic of the VXO or a harmonic of $Y_1$.

Alignment of the filter is the next step, and a BC-221 frequency meter or other slow-tuning oscillator is necessary. I used a 221 on its low range, which gives approximately 30 dial divisions per kilocycle. Insert a crystal about 150 to 225 kc. lower than the passband frequency at $Y_1$; this would be in the 5550- to 5625-kc. range. Exact frequency matters little as long as the 221 output and the temporary $Y_1$ add to tune across the filter passband. A difference frequency may also be used if you remember that in such case *increasing* the 221 frequency *decreases* the resultant frequency.

Connect a capacitance of a few $\mu\mu$f. between the output terminal of the 221 and a shielded lead running to the arm of the carrier-balance potentiometer, $R_2$, which should be turned to one end of its rotation. Remove the 6CL6 from its socket and connect a lead from the ungrounded end of $L_3$ to your receiver antenna terminal. You should be able to get an S-meter reading on the 20-meter band. If the meter goes off scale, loosen the coupling between the Imp and the receiver until a mid-range reading is obtained. You are then ready to plot the passband.

Tune the 221 so that the output frequency of the diode balanced modulator, which is now acting as a diode mixer, sweeps across the filter passband. Keep the receiver in tune with the signal and observe the action of the S meter. It takes a little practice, but after a few moments of using one hand on the receiver and one hand on the frequency meter this process becomes quite easy. You should be able to observe a definite increase in S-meter readings within the passband and a decreased reading outside of the passband.



**Behind the panel. Most of the parts are from surplus. $L_4$ is in the can (from a roll of film) at the upper left. Following down along the left edge of the chassis are the output tube, $V_3$, the mixer-amplifier coupling coils, $L_2L_3$, and the mixer-VXO tube, $V_2$. The VXO crystal is alongside the tuning capacitor, which is 100 $\mu\mu$f. per section with 100 $\mu\mu$f. fixed in series with each section to give the 50 $\mu\mu$f. specified in Fig. 1. $T_2$ is on the coil form at the left near the rear edge of the chassis; its associated trimmers, $C_2$ and $C_3$, are mounted on the shield alongside. The filter crystals and $T_1$ are also near the rear edge of the chassis. The carrier crystal is at the right in the far corner; $V_1$ is alongside, followed by the audio transformer, $T_1$, and, in the lower right-hand corner, the carrier balance control, $R_2$. $C_1$ is adjusted through the hole in the rear wall of the chassis at the right.**

Using a sheet of graph paper, plot the S-meter readings on the vertical scale against 500-cycle dial settings from the 221 calibration book on the horizontal scale. Run a series of points and sketch in the curve. After you have plotted one or two of these curves you will be able to visualize what happens to the passband by watching the S-meter action after each adjustment of the filter trimmers. It will only be necessary to plot the final curve for your records.

The filter passband of the Imp is shown in Fig. 2. It has a very sharp cutoff on the low-frequency side and is suitable as a filter for the upper sideband for transmission, but is too wide for receiving purposes. The curve has a dip and a bump or so, but they do not seem to affect the speech quality too adversely. Final filter adjustment will be a compromise between flatness of passband and maximum suppression of the unwanted sideband.

### *Carrier Balance*

There should be little trouble with the carrier balance. If the trimmer, $C_1$, does not add to the carrier suppression that can be obtained by adjusting $R_2$, connect it at the other diode. This is a matter of cut and try. You will find that different crystals at $Y_1$ require different settings of $R_2$ and $C_1$. Any r.f. indicator, such as an r.f. probe and v.t.v.m. or a receiver S meter, can be used for setting the balance. Be sure $S_1$ is closed.

Selecting $Y_1$ is also a bit of cut and try. If its frequency is too low you will find that the sideband suppression is excellent, but the signal is difficult to copy because the low voice frequencies are cut off by the filter. If it is too high, the signal will sound fine, but you've lost suppression of the unwanted sideband. Don't be afraid to move the frequency around a bit by loading the crystal with a pencil mark. The final frequency of $Y_1$ should be as low as possible consistent with good voice quality.

### *Other Bands*

Operation on other bands may be accomplished by using this same filter. For example, *lower*-sideband output at the high-frequency end of the 75-meter band can be realized by (1) replacing the VXO r.f. plate choke with a parallel-tuned circuit at 9760, (2) using a 4880-kc. VXO crystal, and (3) changing $L_2$, $L_3$, and $L_4$ to tune to 3980 kc. You could leave the plate choke alone and obtain a fundamental crystal at about 9760 kc.

In any frequency combination that may be used, the sum of the filter frequency and the mixing frequency gives output on the original (in this case the upper) sideband. Subtracting the mixing signal from the filter frequency will still give you upper-sideband output. However, if the sideband filter frequency is subtracted from the mixing frequency, a reversal will occur and the output will be on the lower sideband.

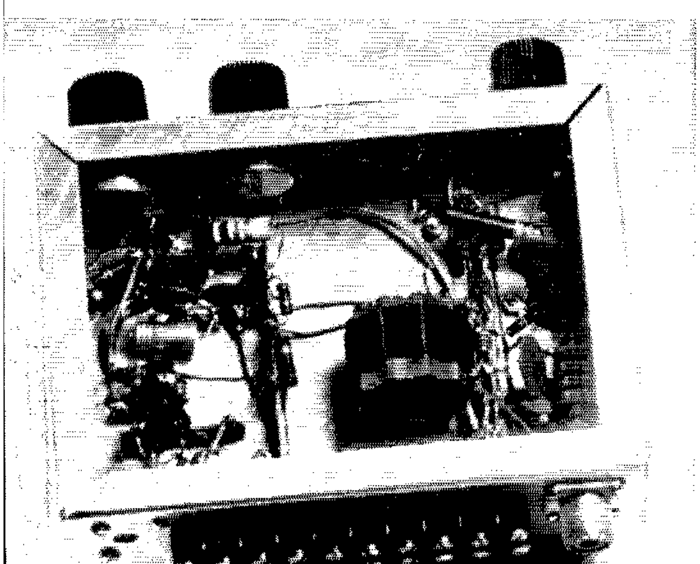
I made an attempt at 15 meters using a 7825-kc. crystal, doubling in the VXO tank to 15,650 to give exciter output at about 21,423. It worked fine except that $L_2$, $L_3$, and $L_4$ did not give sufficient selectivity for adequate attenuation of the third harmonic of 7825 kc. Construction of a filter at about 4125 will permit using an 8650 crystal for better rejection of harmonics in the tuned circuits.

Build an Imp around any group of crystals you may have, but watch out for the harmonics. See you on s.s.b.!

### *Results and Afterthoughts*

I have had the rig on the air with an amplifier, and while adequate drive is not available for my Thunderbolt, the Imp will drive a 6146 or 6DQ5 quite well. Carrier and sideband suppression are quite good. W4IYC describes it as sounding "like a well-adjusted phasing rig." I worked a number of Ws, TI2HP, and ZS6AQQ, with the Thunderbolt tied on and doing the best that it could. The VXO could probably be replaced with a v.f.o., but I have not tried it. It is quite stable with the crystals and there is no detectable drift in operation.

I would like to say here for the benefit of those without access to a BC-221 that they should not lose heart. Any existing v.f.o. can be used if it is given additional bandspread with a trimmer so that a 180-degree turn of the dial will cover about 10 kc. It doesn't even have to tune the



The large coil is $L_1$, in the VXO circuit. Knob-adjusted controls are, left to right, carrier insertion, audio gain, and operate switch. The microphone jack is between the latter two. The extra contacts of the operate switch, $S_2$, are brought out to the terminal strip on the rear edge of the chassis. These can be tied in with a linear amplifier and other accessory equipment as the operator may desire.

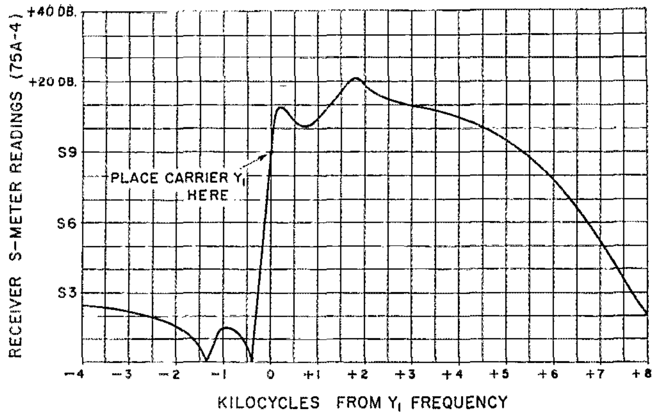



**Fig. 2—Pass-band of crystal filter use in the Imp, in terms of S-meter readings on the 75A-4 receiver used by W4IMP. The frequency measurements were made by using a BC-221 frequency meter as a signal source.**

filter frequency. Use the heterodyne principle as described above with the BC-221. After all, in this case we want to know only that the passband has the desired shape. A VXO on a separate chassis could also be used.

Since only one crystal, $Y_3$, is needed for the higher channel, all filter crystals may be purchased for the same frequency and a couple etched or ground up 1½ to 2 kc. This job is easier to do than one can imagine. Refer to your handbooks. Of course, commercial high-frequency filters are available that will do a beautiful job, but this makes the task too simple and we side-banders will lose our "exclusiveness."

The three tubes and two diodes are the best that I could do. Anybody for a two-tube exciter? A triple triode is available!

My thanks to Art, ZS6AQQ, and Myron, W4IYC, for their encouragement and ideas for this little rig. QST

## Strays

### FEEDBACK

The "Self-Contained Portable Station for 50 Mc. (March *QST*, page 11) is bringing in plenty of mail. Some of this indicates that readers don't read very carefully. About a dozen letters ask for a 2-meter version, despite a statement on the first page of the article giving the reasons for using 50 Mc. instead of 144 for this kind of work.

Several inquiries concern the 1AF4 tubes. Ours were made by Sylvania, and obtained from a local radio parts store. They are among the newer filament-type tubes, but have been made for several years.

Some ask about the small transformers. Don't worry if you don't find exact duplicates of those used in the article. There are many makes of transistor transformers on the market. The impedance values are not too critical. Anything roughly approximating the impedances given under Fig. 1 should be satisfactory.

Sharp-eyed W5VCJ asked if there isn't a continuous drain on the transistor battery, with the circuit as shown, even with $S_2$ open. We blushingly admit that there is — though it is not a serious matter. After more than four months with the batteries connected the penlite voltages are 10 and 7½, respectively, in place of the original 12 and 9 volts, and there is still plenty of audio available. If you want to get rid of the 200-microampere drain, return the 1500-ohm resistor in the receiver to the plus side of $S_{2A}$S, rather than to ground.

There is a dimension error in Fig. 2. As shown in the diagram, the two small chassis are 2½ by 3¾ inches after bending. The large surface should be 3¼ inches long, not 3¾ inches.

The crosstown QSO of K9ORP, K9MBS and K9MBR was monitored by KN9SVV . . . on his TV set.

W1CTW/W1IQD recently worked a KP4 on 50-Mc. phone. So what, say you? Well it so happens that Cal has been an active amateur since 1924. He has a country total of 164 on 21 Mc. He has been a leading New England v.h.f. enthusiast since the earliest days of activity on 5 meters — but this 6-meter contact with Puerto Rico was his first phone QSO outside the United States and Canada.

Additional copies of the Golden Jubilee yearbook of the Radio Club of America, published earlier this year, are available at $4.50 per from the Club at 11 West 42nd St., New York 36, N. Y.

When WA2HRD QSOd W2CTH, W2CTH said this was his 100th contact on 6 meters. WA2HRD checked—it was his 100th on 6 too.