# A Radical Approach to Improved 'Phone Reception

## *Simple Circuit Tricks for Better Receiver Performance*

BY LARSON E. RAPP,* W1OU

RADIO-RECEIVING techniques are substantially the same as they were five or ten years ago. They have definitely not progressed as fast and far as have other facets of amateur radio communication, despite the steady influx of new tubes and components intended for the more lucrative field of television reception. It is high time that amateurs appreciated their responsibility to the art and started adopting new receiving techniques.

**• It has been some time since *QST* has been able to present an article describing revolutionary new receiver techniques. Although the *QST* laboratory staff has not had an opportunity to confirm Mr. Rapp's findings, past experience with his disclosures has shown us (and our readers) what we can expect from this counselor.**

There is little or nothing that can be done to improve code reception, except perhaps to make use of a modern method like the Charactron,[1] which eliminates the need for learning the code. However, radiotelephone reception as we practice it today is still a rather primitive attack on the problem, and it is the object of this paper to point out a few fruitful avenues of approach. Scholars will recall that current receiving techniques give a 15-db. advantage to code reception over 'phone reception [2] — it will be shown that this advantage can be reduced to a minimum.

There are three characteristics that any receiver must have: stability, selectivity, and sensitivity. Current methods for obtaining stability are, in general, satisfactory, although there are still a few receivers that cannot pass a 15-G shock test without a slight change in beat note (at 50 Mc.). The solutions are known, however, and need not be discussed. The only refinement that might be suggested at this time is that receivers be built with rounded edges and corners, and that they be covered with sponge rubber to decrease injury to the hand or fist making the test. Wherever drift is a problem, the receiver can be anchored to the table or other reference plane.

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[1] McNaney & Jackson, "The Application of the Charactron as a Morse Code Converter," *QST*, March, 1954.

[2] Vilbig, "Lehrbuch der Hochfrequenztechnik, VI," *Akademische Verlagsgesellschaft M.B.H.*, Leipzig, 1937.

[3] As, e.g., Goodman, "Selectivity and 'Phone Reception," *QST*, March, 1954.

### *Selectivity*

It is amusing to follow some of the valiant but futile attempts on the part of a few engineers and amateurs to improve the selectivity of receivers. Some discerning operators have built receivers that cover a wide range of frequencies, and they have observed that the receivers tuned sharper than they did before the tuning range was increased. This is an inexpensive approach, and has its followers. Others have approached it by restricting the bandwidth of the i.f. amplifier, through the use of either a multiplicity of high-$Q$ tuned circuits or an "electromechanical" filter. In either case the result is substantially the same. A few operators will struggle along with this alleged selectivity,[3] in an effort to receive signals that they might not otherwise be able to copy, but the discerning majority knows the basic fault of this approach. Ask any operator why he doesn't like selectivity, and he will reply, "Because it tunes too sharp." A few pioneers have even tried to decrease the tuning rate of the receiver by one means or another, in an effort to utilize high i.f. selectivity, but it isn't popular. And for a good reason: When the tuning rate is reduced, it takes longer to tune across a band! This is untenable.

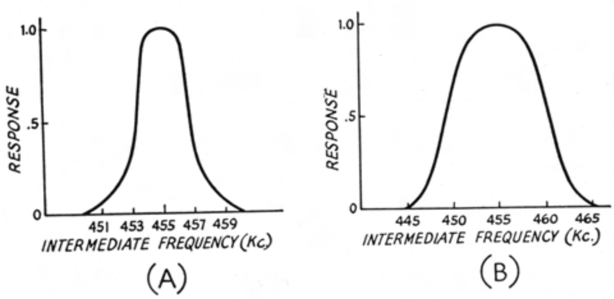


*Fig. 1* — The usual type of selectivity (A) gives sharp tuning that is readily overcome by the type of selectivity shown in (B). (These are idealized curves and only represent the general form — they cannot be applied to a particular receiver without modification.)

Obviously the only way that selectivity can become acceptable to all operators is to make the tuning with it just as broad as with an unselective receiver, so that a fast tuning rate (for covering the band quickly) can be used. And the approach is so simple that it is surprising that this is the first time it has been mentioned anywhere. It is,

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no prospect of looking at the set-up and saying, "This is it from now on in"!

Most of the transmitting units have been described in *QST* during the past few years, and many of them appear in current *Handbooks*. The low-frequency rig uses the 6AG7-6AG7-6146 transmitter to drive the pi-network 4-250A amplifier; both these units are in the *Handbook*. The power input on the 4-250A can be run up to a kilowatt if necessary, although most testing is done at around 600 watts since that has been found to be sufficient for the purpose. The v.h.f. gear varies according to the particular type of test under way, and includes the 2-meter push-pull 6146 exciter described in November, 1952, *QST*, the 50-Mc. 2E26 exciter, and the 4-65A, 4-125A and 4-250A amplifiers described in recent *Handbooks*. The outputs of the v.h.f. transmitters are fed to 6- and 2-meter beams on the roof of the building through coax. An 80-foot center-fed antenna, with tuned feeders, is usually used for the low-frequency transmitter together with coax-coupled antenna tuners, although other antennas have been used at times, particularly on 10 meters.

While it doesn't take long to describe, the set-up is the product of several years of evolution, at stages discouraging, frequently exasperating, and sometimes rewarding. Very often the agenda acquires new items at a faster rate than the old ones are crossed off, so there is no present prospect that we will be able to write "finis" on it in the foreseeable future! — *G. G.*

## Improved 'Phone Reception

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however, a good example of a "blind spot" in our philosophy. Statistically, it can be shown that, while it is fairly common to find two 'phone signals on or near the same *frequency*, it is rare indeed to find them with exactly the same *signal strength*. But with this fact staring him in the face, every engineer and amateur has been trying to separate the signals by some *frequency*-discriminating means! Obviously, all that is needed is a device that separates them according to their *strengths* (amplitudes). Such a device is an amplitude-discriminator, and might be nothing more or less than a pair of limiters back-to-back, one limiter setting the upper threshold level and the other setting the lower threshold level.

Tuning with such a receiver is a revelation. The operator uses a fairly "broad" receiver (frequencywise) for rapid tuning, and then sets the limiter levels at a convenient value. A DX man would set it for weak signals just above the noise level, while a rag-chewer might set it at a higher level. Tuning across the band reveals only the signals falling within the amplitude limits set by the limiter levels. For general operation, the limiter levels can be made wider apart than normal — if QRM is encountered on a particular signal, the limit levels are closed in until only the desired signal is heard. In this respect the limit-

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levels control is similar to the old-fashioned crystal filter, but it lacks all of the touchiness and can be made purely logarithmic.

### *Sensitivity*

In a previous paragraph, it was mentioned that code enjoys a 15-db. advantage over 'phone. There are two operations necessary to eliminate this disadvantage. The first has been hinted at in the literature but has never been used, for some reason that escapes the writer. Several experimenters have made use of "selectable-sideband" reception to improve the selectivity of a receiver, but its real *forte* is the improvement of sensitivity. Visualize a selectable-sideband receiver that is receiving, say, the upper sideband of a given signal. The other (lower) sideband has been eliminated by high-$Q$ selectivity. But if the lower sideband were to be accepted instead of rejected, and made to appear at the detector *on the same side as the upper sideband,* it would be equivalent to a 6-db. gain at the detector. This is the principle of "superimposed-sideband reception," and the techniques are obvious to anyone familiar with selectable-sideband practice. The sidebands could be superimposed at the transmitter, of course, but then the receiver wouldn't have the 6-db. gain. Doing it all in the receiver is more economical. *In hoc veritas.*

This is only part of the story. For years receiver designers have been handicapping themselves by making their receivers "voltage sensitive," or with an output proportional to the input-signal voltage. Thus if the signal drops to half its value (half its voltage), the output signal decreases by 6 db. But suppose we make the receiver *power* sensitive. Now when the input signal is halved, the output signal is only reduced by 3 db., a gain of 3 db. over the voltage-sensitive case.[4]

Thus by the simple expedient of making the receiver power-sensitive, another 3 db. is gained over conventional reception. This, added to the 6 db. gained by superimposed-sideband reception, gives a 9-db. improvement in 'phone reception, without adding any complexity to the operation of the receiver. While it is true that a receiver built like this is a little harder to service, this is no problem if the receiver is built well enough to require no servicing during its normal life.

Having gained back 9 db. of the 15, one is left with only 6 db. Anywhere from 2 to 6 of this can be obtained by using a suitable preamplifier (sometimes called "preselector").

### *Three-Dimensional Reception*

One further improvement is readily available. Any reader must be aware of the great progress that has been made in the television and home-phonograph field through the use of several loudspeakers to give "stereophonic" sound. This same principle can be applied to the reception of amateur 'phone signals. By the use of two or

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[4] For nonmathematical readers, a voltage ratio of ½ is —6 db., and a power ratio of ½ is —3 db. See page 537, *The Radio Amateur's Handbook,* 31st edition. — Ed.

more loudspeakers, this same stereophonic (or "3-D") effect can be obtained, and to the same degree. This gives more "body" to the signal and makes for "solid" copy. Its worth should be obvious.

### *Summary*

There is absolutely no reason why amateurs should struggle along with primitive receiving techniques when all could be enjoying the benefits of the few simple improvements outlined above. It is suggested that every reader lose no time in demanding of the manufacturers, and of his ARRL director, that these receivers be made available. If the manufacturers won't build receivers like we want them, boycott the manufacturers and let's build them ourselves!

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## 21-Mc. Beam

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also to provide a means for balancing the beam at its center of gravity. If necessary, the center ¾-inch sections can now be bent up, to counteract any sagging.

### *Matching*

A wire gamma match using No. 12 TW [3] house wiring is fastened to the radiator with an iron (not brass) nut and screw and given a coating of rust preventive.[4] The coax feed line may be hung over the radiator clamp by using a soldering lug attached to the outer conductor.

Not shown in Fig. 1 is the mica condenser in the wire of the gamma match that was used to tune out residual reactance and minimize the s.w.r. Its value was determined by inserting a small 100-$\mu\mu$f. variable and adjusting it for minimum s.w.r. In this particular case the s.w.r. went down to a minimum of 1.1 when the condenser was half meshed, so the variable was replaced by a 50-$\mu\mu$f. mica condenser and the mounting screws given a coating of rust preventive. A Cornell-Dubilier No. 9 condenser was used, which is rated at 1200 volts d.c. and is ample for a kilowatt of power.

A point mentioned recently in *QST* well illustrates the difficulty experienced by the author in trying to bring down the s.w.r. on previous installations.[5] That is, be sure that the r.f. source used with the s.w.r. bridge is harmonic free.

### *Installation*

Initial adjustment completed, the beam should be unfastened from the rotor, and the mast mounted on the roof. If you have decided to use a ten-foot mast section, the whole beam, mast, rotator and all, can be taken up to the roof in one

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[3] Designation for a standard type of moisture-resistant thermoplastic-covered wire. Your electrical-supply house will know about it. — Ed.

[4] Debatable point. Some prefer to take their chances with brass. The important point is a protective coating. See Woodward, "Your Beam — Will It Stay Up?" *QST*, Oct., 1949. — Ed.

[5] Tech Topics, "Note on S.W.R. Measurement," *QST*, May, 1952.