Get Ready for Sideband CB! Build EI's SSB Carrier Oscillator

ELECTRONICS ILLUSTRATED

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SIMPLE STEREO SIGNAL FINDER FOR FM TUNERS

A Radio Propaganda Handbook

BUILD A "BIG EAR" ELE

All About Aud

ELECTRONICS ILLUSTRATED

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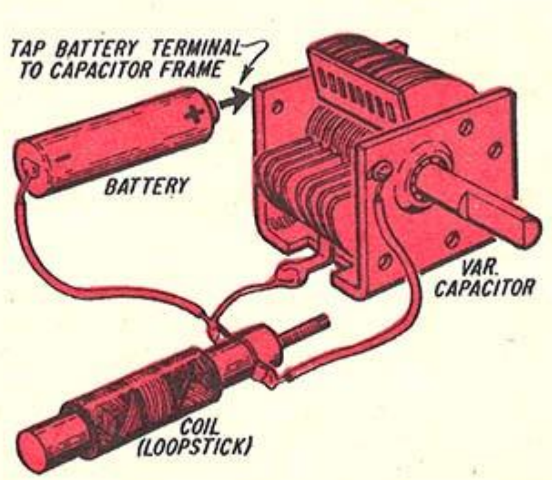
COVER — Photograph by Tom Caffrey, Globe Photos. Transceiver by National Electronic Services.

RADIO WAVES

WITH three components—coil, capacitor and battery—you can create a radio wave. The parts form a simple transmitter (see drawing) whose signals are tunable on a broadcast receiver. Use a variable capacitor of the BC-radio type (if you have a two-section unit, hook up the side with the most plates). An old loop antenna or a Vari-Loopstick is the coil. The battery is 1.5-volt dry cell. After the circuit is assembled as shown, place it about a foot from a broadcast receiver and you're ready to transmit.



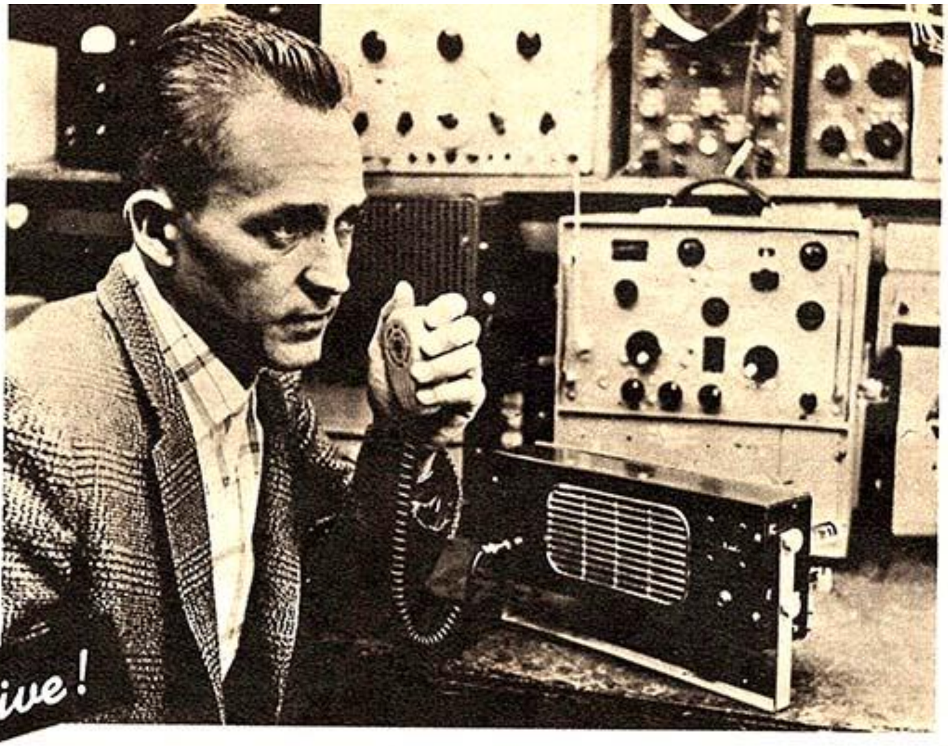
Set the BC receiver dial near the middle and adjust the volume to normal listening level. Tap the positive end of the battery against the capacitor frame. You should hear clicks in the speaker. Next, begin tuning the variable capacitor. At some point the clicks grow louder, then softer as the tuning changes.

The transmitter produces a radio signal through shocking action in coil and capacitor. When battery voltage is applied electrons pour onto the capacitor plates and charge them. Although the battery is removed, the charge is retained. Notice, however, that electrons have a path through the coil. They rush through the turns of wire and set up an electromagnetic field. This invisible field of energy exists as long as the capacitor has electrons to discharge into the coil. When the capacitor is exhausted, the field collapses. Remember that when a moving field cuts across turns of wire it causes electrons to flow. Just so, the coil's collapsing magnetic field sends a new surge of electrons back to the capacitor. The whole process now begins again in give-and-take between coil and capacitor.

The origin of the signal is at the coil. Its electromagnetic field moves so rapidly that a portion does not have time to collapse entirely and this fragment escapes into the surrounding space, where it is picked up by the receiver.

Unlike normal transmitters, this one cannot sustain radio-wave output more than a fraction of a second. The resistance of the wires dissipates power quickly in the form of heat. Thus the battery must be applied repeatedly to replace lost energy. If continuous output were required, a tube or transistor would be coupled to the tuned circuit to inject a power pulse each time electrons flow from coil to capacitor. Such action sets up CW, or *continuous-wave* operation. This transmitter generates a short-lived *damped wave*.

The speed at which the electrons bounce back and forth determines the frequency of the radio wave. If the variable capacitor is rotated to full capacity (plates meshed) the loudest clicks will be found near the low end of the broadcast band. A coil with more turns has the same effect. In both cases the part's storage ability increases and electrons take more time to go back and forth.—*H. B. Morris*



Exclusive!

FIRST SINGLE—SIDEBAND CB RIG ON THE AIR!

EI reports on an SSB CB system that has been in use for months.

By Len Buckwalter, KBA4480

IN RECENT MONTHS the big talk in Citizens Band circles, equipment-wise, has been about sideband operation. Many manufacturers are known to be at work on sideband transceivers and at this writing at least one has announced a *double*-sideband rig. Another is marketing a *single*-sideband receiver adaptor, and EI in this issue presents a build-it-yourself adaptor that can be used with any receiver.

All this suggests we're just now getting into sideband CB. That is hardly the case. In truth, single-sideband transceivers have been operating on the Citizens Band almost two years. In day-to-day field operations they have been *tried and proven,* coming out with incredibly good marks. Only a handful of people have known what was happening, but EI now publishes a full report on these first SSB CB transceivers to go into 27-mc service.

The story begins in early 1961 in a suburb of Washington, D. C. A medium-size company called National Electronic Services never was able to establish a good two-way setup with regular CB equipment. Coverage was spotty and range inadequate. Three mobiles roamed a 50-mile-across circle from the edge of Baltimore on the north to Alexandria, Va., on the south. They simply were unable to maintain good contact with base.

The firm's president, a serious young man named George Mason, thought he saw a way out. As W3IZC, he'd been hamming on sideband for years. So why not design an SSB rig for 27 mc? Thus evolved the first prototype, a large and unwieldly job (see photo) that, nevertheless, worked magnificently. Mason quickly gave one of his top men, Roland Martin, the task of building four neatly-packaged, compact units for actual service in the field.

Mason's instant success with SSB CB was no surprise. He had the background from ham radio and he's a sharp chap to boot. NES, his company, had started in the radio-TV repair business but George rounded up a group of talented technicians and began catering to the needs of big federal agencies—a complex audio installation for the State Department; an elaborate timer-recorder for Health, Education & Welfare; some technical work for the FCC. NES suddenly was doing pretty sophisticated electronics. SSB CB was a small problem.

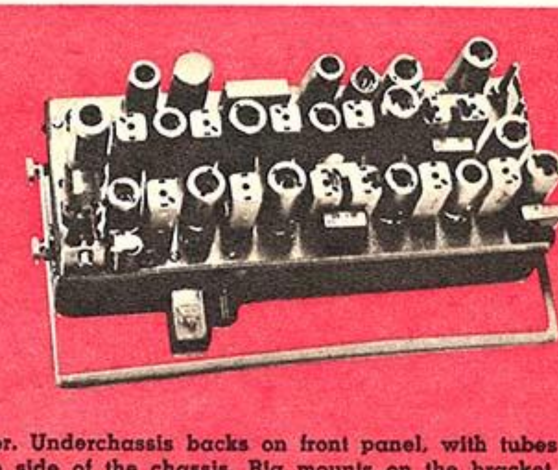
Single-sideband operation at this point looms as CB's biggest technological breakthrough. Via SSB, you can take 5 watts of transmitter power and turn it into a walloping signal packing 20 watts of effective power. It immediately gave George Mason the range and coverage he needed.

From the first, George was wondering what the FCC would think about sideband signals being transmitted right under its nose. So he paid a call at FCC headquarters, learning that SSB would be legal because Part 19 permits AM (amplitude modulation). Sideband assuredly is AM. But George did get a warning not to abuse his privilege. If he started hamming it up there would be swift action, and it could ruin the sideband potential for all CBers.

Since he had no intention of operating outside the rules, the warning didn't bother him. But just to play it safe he began keeping a log of every NES transmission. At the end of three weeks he averaged out the messages handled by all four SSB units and found that total transmission time came to only ten minutes in each 24 hours. A typical message lasted just a few seconds—long enough to transact the business at hand. The log then was sent along to the FCC for study and comment. There was no comment and there never has been a word of complaint.

To find out how the rigs performed, I went along with Roland Martin on a 50-mile trip in a station wagon fitted with a Mason unit under the dash. The antenna was a full-size whip at the rear, and the base was using a Magnum mounted low on a two-story building. A setup like this normally gives you a range of eight or ten miles with flat terrain.

As we rolled to a stop at a light about a mile from base Roland made his first call. Mason's answer from base had the unmistakable tone of a true sideband signal. The voice was slightly hollow but perfectly readable. But the crucial test was stability. Anyone who has tuned SSB on a communications receiver knows that the missing carrier must be supplied by the BFO. If you're more than 50 cps off in BFO frequency, speech becomes garbled or inverted. Could this rig provide a highly accurate BFO signal as the car battery and generator played ping-pong with the volt-



Front panel and chassis of Mason SSB transceiver. Underchassis backs on front panel, with tubes and cans sticking out behind; crystal oven is on side of the chassis. Rig mounts on the bracket.

Mason shows off one of his SSB CB units mounted for mobile operation. Set draws about 42 watts.

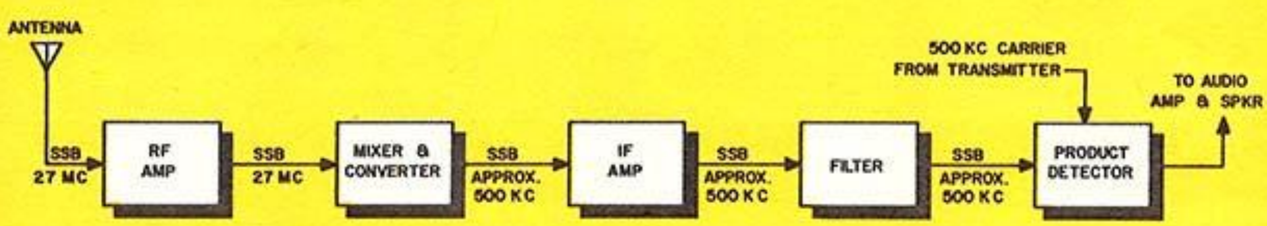
Map shows signal coverage area from Alexandria to Baltimore. Prototype of rig sits on bench.

age supply? It did—by using stiff voltage regulation and the expedient of putting the crystal in a thermostatically controlled oven. The oven is about 2 inches square and holds the crystal at a steady 180 degrees F.

As we headed north toward Baltimore, Roland called for signal reports every two or three miles. At eight miles out noise began to creep behind Mason's voice from base. The combination of distance and hills normally would make for rough going, but signals were still Q5. The sock of the SSB signals really proved out beyond the 15-mile perimeter. From there to 25 miles from base there was no important drop in signal and Mason's voice came through with excellent copy in a remarkable display of what sideband can do.

Range is not the only criterion, however. Speaking in general terms, Mason declared that SSB has proven about four times more effective than conventional CB systems. More importantly, spotty downtown areas now receive reliable coverage.

In a way, George Mason's NES has had a secret channel of communications. So far as is known, no one else in the Washington area had a receiver capable of decoding SSB CB signals. So to any CBer who happened along, the messages were so much hash. As a matter of fact, other licensees were heard now and then wondering on the air about what



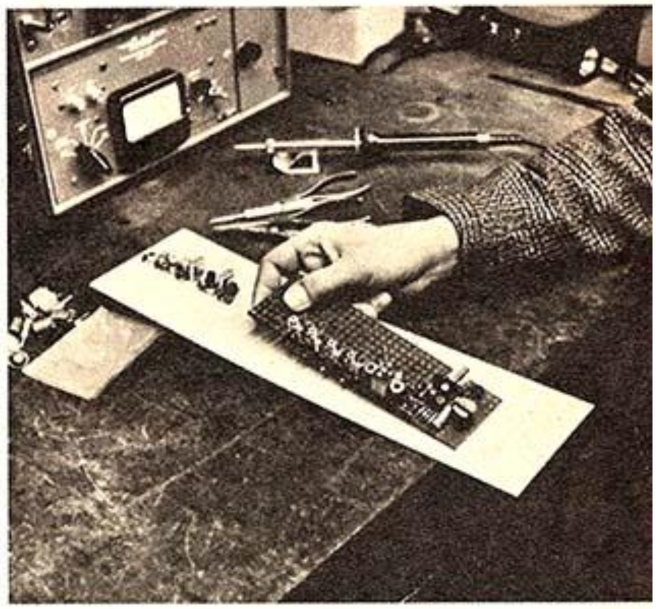
SSB RECEIVER—Block diagram shows three main divergences from usual superhet: the crystal filter, product detector, 500-kc oscillator signal. See text for detailed discussion of the transceiver's operation.

kind of strange stuff they'd been picking up. More than one made some attempt to jam but, in Mason's words: "They just couldn't do it. In a mutual interference situation, sideband can take it. It turned out to be the AM signals from the cut-in stations that got clobbered. We got through."

Mason's transceiver draws about the same number of watts (approximately 42) as a conventional rig. When you speak into the microphone of a normal unit, the RF output signal is divided into two sidebands and a carrier. The sidebands bear the modulation. The carrier merely generates them in the final RF tube. Moreover, the sidebands are mirror images of each other and only one is needed. An SSB rig produces carrier and sidebands in an early, low-power stage and then kills everything except a single sideband. This is fed to the final RF amplifier, which expends *all* its power to boost only this one valuable part of the signal. In the usual rig about two-thirds of the transmitted power is wasted. With SSB, nothing is wasted. And a peak power input to the final of a full 10 watts is legal.

The Mason transceiver looks much like a factory-made product but every one is hand-wired and costs somewhere in the vicinity of $500. Production-line techniques could reduce this figure considerably but George's plans at this point for licensing out the circuit or marketing the unit himself are indefinite.

The future looks bright. In months of steady operation NES's rigs have experienced no difficulty beyond normal

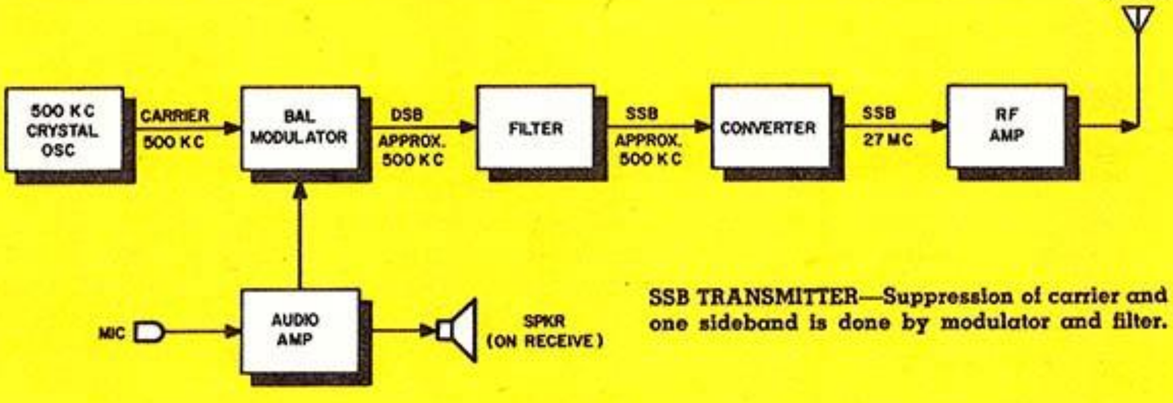


Transistorized version of transceiver is under construction; whole circuit will fit on board.

tube failure. And something even more startling is on the way. On Mason's workbench lies a transistorized version of his SSB transceiver. When completed, it will be a fraction of the size of its big brother, which has 17 tubes and exhibits a dozen transformer cans. The absence of tube filaments will reduce power consumption to a ridiculously low figure. All the breadboard job required at the time of our visit was a husky RF transistor in the final.

The operation of Mason's transceiver —or any other SSB rig—is both similar to and different from that of a conventional set. SSB *is* AM, but with a difference. In the receiver (see Fig. 1) we

[*Continued on page* 110]



SSB TRANSMITTER—Suppression of carrier and one sideband is done by modulator and filter.

Continued from page 41

find three key differences. A sideband signal comes down from the antenna and is boosted by the RF amplifier. Then, through regular heterodyne action, the mixer-converter reduces its 27-mc frequency to about 500 kc and feeds it to the IF for further amplification. At that point we hit something new —a crystal lattice filter that acts like a sharply tuned circuit. So narrow is its tuning slot that only the slim sideband signal gets through. Any remnants of the suppressed carrier and the other sideband, which the transmitter may have passed, are filtered out. The filter also limits the receiver's response to noise.

In the next block of the receiver diagram we find the product detector which, as in a normal rig, has the job of converting the RF signal into the audio pattern of the voice. In conventional AM, the carrier provides the mixing frequency, but SSB has no carrier. In this case, a substitute carrier is provided by the 500-kc crystal oscillator in the transmitter section (see Fig. 2). As an example, let's say the operator at the transmitter hums a 400-cycle tone into the mike, giving you a sideband frequency of 500.4 kc. When this is mixed with the 500-kc oscillator signal, you get a difference signal at 400 cps, representing the recovered audio. Product detectors are more suited to SSB than the common diode type because of their ability to keep the proper voltage relationship between the mixing frequencies.

In the final receiver stage the audio is applied to the audio amplifier and then to the speaker for reproduction.

In the transmitter (Fig. 2) we find the 500-kc crystal oscillator, mentioned earlier, as the first stage. It takes the place of the 27-mc crystal in regular CB rigs. It generates an RF carrier which is applied to the balanced modulator. An audio signal from the audio amplifier beats with the RF carrier in this stage, producing two difference signals or sidebands. In the case of the 400-cycle hum discussed above, the sidebands would be at 500.4 and 499.6 kc (the carrier's frequency plus and minus the audio frequency). In normal modulation the output would be the carrier and the two sidebands. But in a balanced modulator, after mixing, the carrier in effect beats with itself and cancels itself out. With the carrier thus suppressed, the output is the two sidebands—or a double-sideband (DSB) signal. We have no further use for the carrier and, since one sideband is a mirror-image of the other, we can get rid of one of them, too.

This is done by the crystal lattice filter—the same one used in the receiver. The filter permits only one narrow side-

[*Continued on page* 113]

An Easy-to-Build SIDEBAND ADAPTOR for your CB receiver

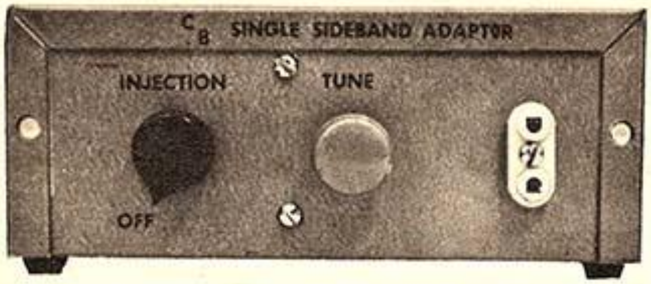
By Herb Friedman, 2W6045

SINGLE-SIDEBAND operation, a technique that multiplies effective transmitter power, is now a reality on the Citizens Band. But try to tune an SSB signal on your transceiver and all you'll get is a slightly seasick Donald Duck. Though sideband has much to offer CBers, it is not compatible with normal AM signals or equipment. It needs additional processing (see our article, FIRST SINGLE SIDEBAND CB RIG ON THE AIR, in this issue) to convert a carrier-less signal to something which can be detected by any CB receiver. EI's SSB adaptor does this processing.

Without modifying your rig, you can add our adaptor and be able to monitor any SSB signal that comes your way. The adaptor actually is a crystal-controlled oscillator that generates the carrier missing from an incoming SSB signal. Both signals mix in the receiver and sideband modulation is made intelligible. The adaptor may be used with any type receiver, tunable or crystal controlled. Oscillator drift in the receiver, a problem in receiving SSB, is not a factor in this system. Since the carrier is generated outside the receiver, a tuning control on the adaptor permits fine frequency adjustment of the injected carrier. The unit is easy to build and the parts cost only about $6.

Construction. The adaptor is built on the U section of a small Minibox. Lead dress is somewhat critical so follow the pictorial as closely as possible. J1 and J2 are coaxial jacks which must match your existing connectors. Battery B1 can be any miniature 9-volt transistor type, strapped to the Minibox by a length of wire passed through two solder lugs.

L1 must be wound carefully on the coil form. Scrape the insulation off one end of a length of #22 enameled wire and attach it to the coil terminal *adjacent to the mounting nut.* Tightly wind six close-wound turns and bring the wire away from the form about 3 inches. Loop the free end back to the form and continue to wind five more close-wound turns in the same direction as the original six. Scrape off the insulation and fasten the free end to the other coil terminal. Scrape all the insulation off the middle loop, twist it and tin with solder. This



Transmitting crystal plugs into socket at the right. Both the injection and tuning knobs are carefully adjusted for the clearest audio signal from an SSB transmission.

SSB signal on the *same* channel marked on the crystal. Many rigs, however, use *parallel* crystals and require different treatment. (You can identify crystal type by examining the schematic of your CB transmitter: if the crystal goes from the grid of the oscillator tube to ground, it's a parallel type.) When parallel crystals are used, they must be one channel higher than the one you wish to receive. Thus, an SSB signal on channel 6 requires a channel 7 crystal of the parallel type.

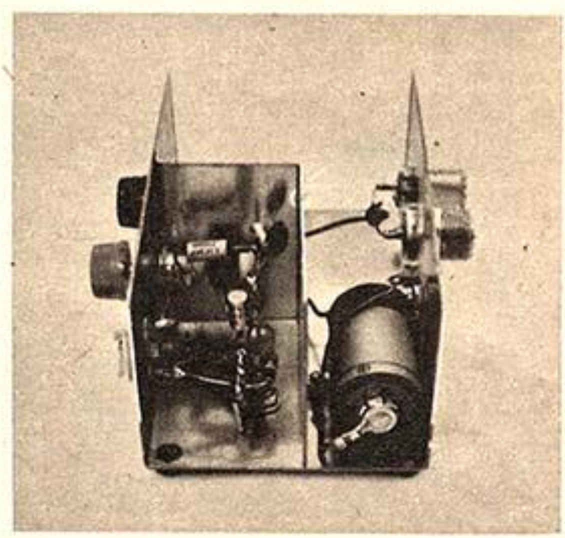
Now connect a 0-10 milliammeter in series with the negative lead of the battery and start rotating L1's slug from its full-in position. Turn counterclockwise until the meter shows a noticeable increase in current. This indicates the crystal is oscillating properly.

The adaptor next is hooked to your receiver. Connect J1 to the antenna input on the CB rig and J2 to the antenna. Tune the receiver to a normal CB signal on the desired channel and turn on the adaptor's power switch. If everything is operating correctly, you should hear a heterodyne (or whistling sound) along with the modulation. When the slug of L1 is rotated slowly the pitch of the heterodyne changes from high to low—then back to high. The precise point to find is the zero beat. It occurs *between* the two high-pitch points. In this tuning position the heterodyne should disappear.

After you get an SSB signal, make a fine adjustment on the adaptor. Begin by tuning the signal for maximum audio. You won't be able to make out words, but it's not difficult to judge strongest sound. With the adaptor power on, adjust both R3 and the coil slug until the speech becomes intelligible. It's a little tricky at first, but the technique is soon learned. Just be sure that the coil slug is never rotated too far from the zero-beat setting found earlier on a normal station. (The heterodyne is not present on an SSB station, regardless of coil setting.)

Until you get the hang of tuning an SSB signal, we suggest you practice this way: Tune in an SSB signal of moderate strength—not too strong and not too weak. Set R3 to approximately mid-position. Slowly adjust L1's slug until the high-pitched chatter becomes recognizable speech. Then adjust R3 for optimum signal.

On weak SSB signals, it's possible for the adaptor to inject excessively strong signals into your receiver. The remedy is to reduce R3 (full counterclockwise). If this doesn't help, remove the adaptor from the transceiver and antenna leads. The antenna is plugged back into the transceiver in normal fashion. Add a short length of wire to J1 or J2 and move the adaptor away from the receiver until signal injection is reduced to lower levels.



End view reveals main oscillator components in shield. Rubber feet (lower left) may be installed.

BASIC CB CIRCUIT THEORY

In our concluding discussion on Citizens Band transceivers we take a look at the circuits found in typical rigs. An understanding of the fundamental theory of operation makes any set easy to analyze.

By Len Buckwalter, KBA4480

PART II

IN PART I we analyzed the functions of each section of a CB receiver, using block diagrams. Now let's get down to specifics and take a look at the schematics inside those blocks. The schematics represent composites of currently popular circuits, not specific rigs offered by manufacturers. In the interest of simplicity, minor components have been eliminated—chiefly bypass capacitors and voltage-dropping resistors. The switching discussed previously is omitted also.

RF and Mixer Stages

The path of a received signal begins at the antenna. From the antenna, it is fed to an RF amplifier (shown in simplified form in Fig. 1) or a broadly tuned input coil (L1 in Fig. 2) which accepts all channels in the 27-mc band. Signals are then boosted in the RF amplifier tube and introduced to RF coupling transformer L2. Both the primary and secondary of L2 are tuned to 27 mc. Up to this point, the receiver displays a moderate amount of selectivity. The tuned elements (even the antenna, which is cut to length, may be considered one) have narrowed the response of the receiver to the CB band. Next is the heterodyne process for pinpointing a given channel.

As shown in Figs. 1 and 2 there are two types of mixers in use. The circuit of Fig. 2 utilizes a separate oscillator tube (seen in Fig. 3) to provide the oscillator signal. Shown are a crystal oscillator, whose frequency is determined by the crystal (A), and a tunable oscillator (B). Note that unlike standard broadcast-band superhets, the oscillator alone is tuned to select the CB operating frequency. As explained earlier, when frequency-mixing occurs only the desired channel creates an IF signal of 1650 kc.

The IF signal is applied to the IF stages (Fig. 4), where each IF transformer is double-tuned. This, plus the comparatively low operating frequency, adds up to a highly selective path with great rejection to undesired signals from the mixer.

The signal is considerably amplified by the time it reaches the detector, which is fed by the IF strip.

Diode detector D1 (either a crystal or part of a tube) recovers

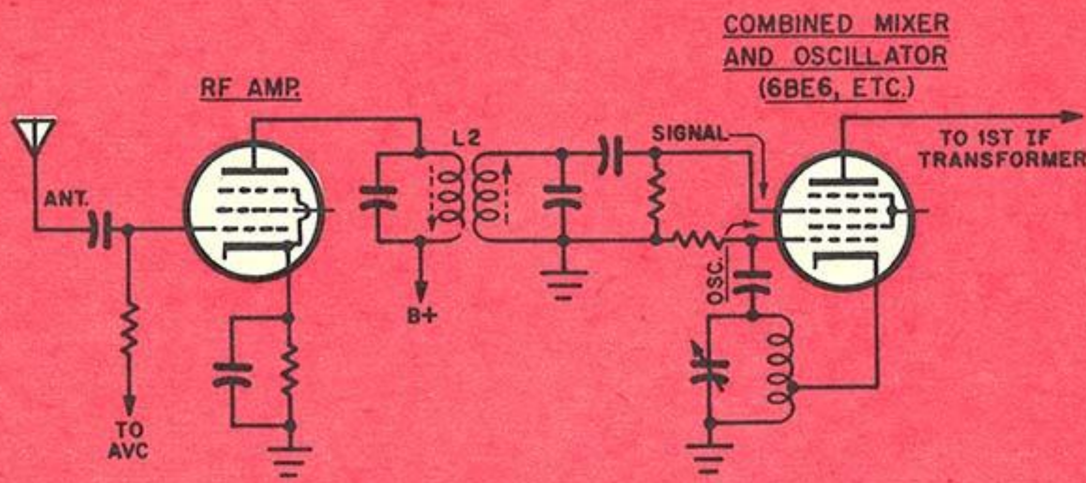


Fig. 1. Typical front-end found in the receiver section of a CB transceiver. Note that RF amplifier input is shown untuned and that oscillator and mixer are combined. Coil L2 is double-tuned.

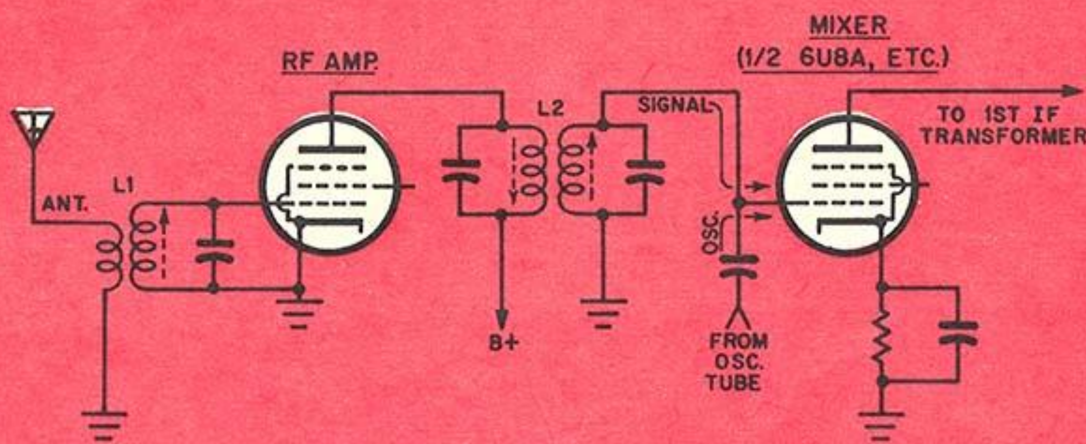


Fig. 2. Another variation on the receiver front-end. Here a broadly tuned coil (L1) tunes the RF amplifier, and the mixer tube is fed from a separate oscillator. L2 is broadly tuned also.

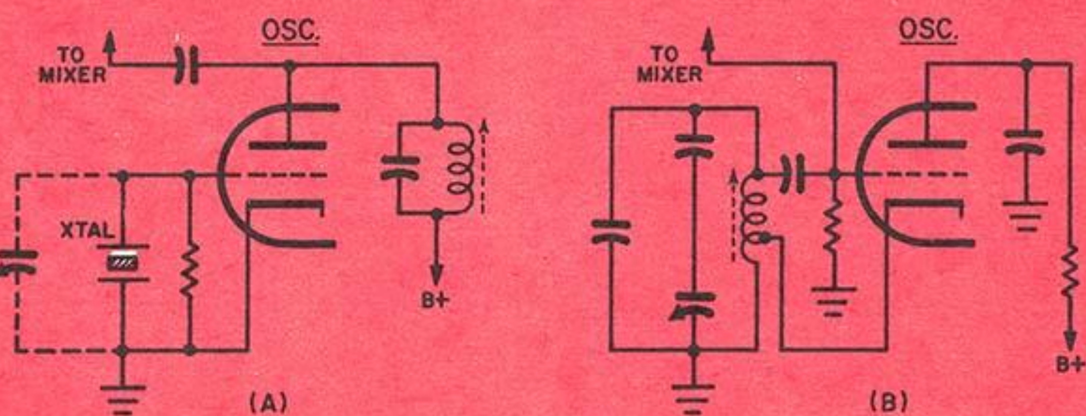


Fig. 3. Two oscillators designed to feed the separate mixer shown in Fig. 2. A is fixed-tuned crystal type. B is tunable oscillator. Most rigs can switch from one to the other via a panel control.

the audio from the RF (now IF) carrier. Note that the original signal enters the receiver at approximately 27 mc. The fact that it has been converted to 1650 kc in no way disturbs the audio modulation. The AF modulation of the IF signal is identical to the AF in the 27-mc carrier. During the detection process not only is audio picked off the IF carrier, but automatic volume control (AVC) is developed. This is a DC negative voltage that varies with the strength of the RF carrier. The AVC voltage is fed from the detector back to the control grids of the RF amplifier, first and second IF tubes and reduces

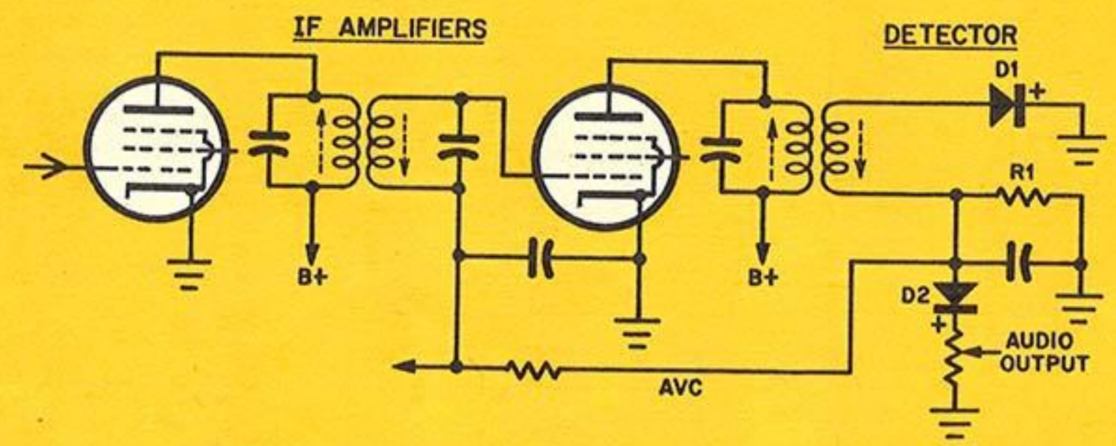


Fig. 4. IF amplifier and detector stage showing AVC and noise limiter circuit. Diodes D1 and D2 may be crystal types or diode elements in a vacuum tube. See text for noise limiter theory.

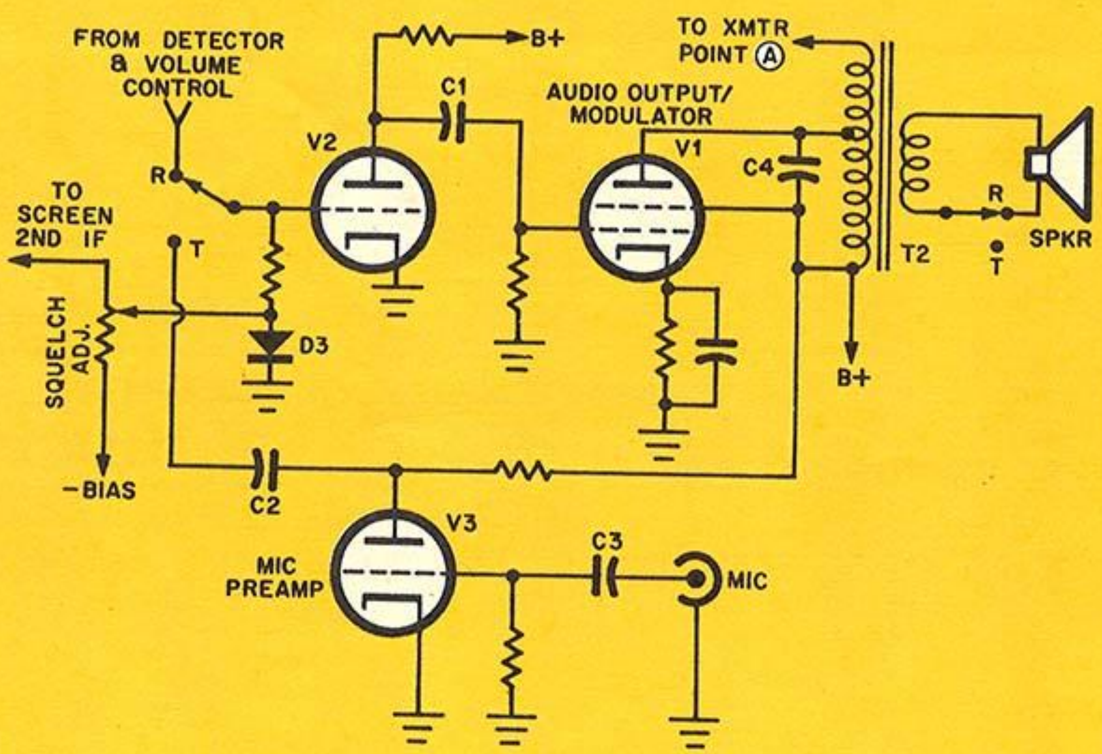


Fig. 5. Complexity of audio output stage in transceiver is due to its dual purpose. Transformer T2 serves both as the audio output in receive position and for modulation in transmit position.

gain on strong signals. This cuts down blasting and overloading.

The signal next encounters noise limiter D2 in Fig. 4. Normal signal levels have little difficulty passing through D2. However, the voltages on D2 are so balanced that any signal above a certain level is clipped and noise is thereby reduced. Output of the noise limiter is fed through the volume control to the audio amplifier.

Figure 5 shows one of the many squelch circuits in common use. Almost all of them operate by turning off the first audio tube in the absence of a received signal. The AVC line or the screen voltage on the last IF amplifier tube (both of which respond to the RF strength of the received signal) is used as a source of the shut-off voltage. The squelch adjust pot in Fig. 5 is connected between a source of positive voltage (the screen grid) and a negative bias supply. In practice, the pot is set so that the negative bias during no-signal conditions is high enough to cut off amplifier tube V2. When a strong signal comes in the screen voltage of the IF tube rises and, therefore, applies more positive voltage to its end of the pot. The voltage at the wiper arm of the pot goes less negative, the tube turns on and a signal is heard. Diode D3 serves only to keep the grid from going positive (which would distort the audio signal) by grounding out any positive voltage that may appear on the wiper arm. Voltagewise the grid of V2 sees approximately zero volts bias on strong signals and a high negative bias in the absence of a signal.

The Transmitter

A logical place to start here is at the crystal oscillator, shown in Fig. 6. The crystal circuit generates the RF energy which is fed to the RF amplifier. A 27-mc signal at output coil L1 is coupled via C1 to the RF output amplifier for RF amplification to the 5-watt level.

For the origin of the modulation we'll have to refer back to Fig. 5. Modulation energy begins at the microphone. After the mike preamp, the audio travels through the same audio stages used earlier by the receiver. However, at the final audio amplifier tube the signal does *not* feed the speaker but instead it ultimately reaches the bottom end of the RF output amplifier coil (Fig. 6). The audio signal adds to and subtracts from the B+ voltage at the plate and screen of the RF amplifier tube and thereby modulates the RF energy that is present. The RF at the plate of the RF amplifier (whether modulated or not) is transferred to the pi-type output network.

Thus we have an overall view of the circuits. Variation in actual units is mostly in the number of stages, switching arrangement and choice of IF frequencies. You can analyze any transceiver if you know basic theory.

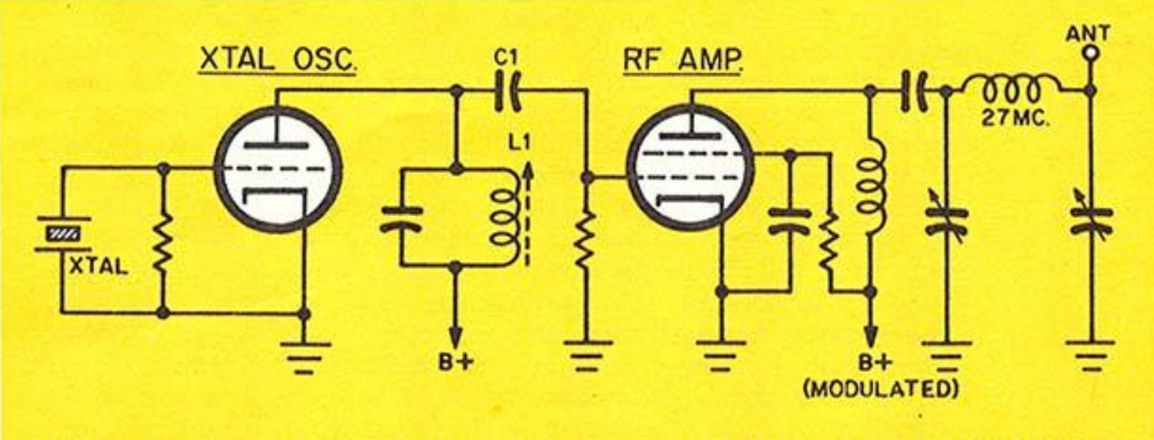


Fig. 6. Note comparative simplicity of transmitter section. The crystal oscillator provides the 27-mc RF signal which is fed to the RF amplifier. Modulation is applied to plate of RF amp.

CB CORNER

BY LEN BUCKWALTER KBA4480

The FCC's Bombshell

ACTION on the FCC proposals for revising Part 19 was postponed early in the year to permit more individuals and organizations to file comments, but long before that it was evident the Commission had dropped a bombshell in the laps of CBers and manufacturers. And while the Commissioners—seven good men and true—sat contemplating the fate of the Citizens Radio Service, shrill cries of anguish rang out, along with some rumblings of support. The docket in question, you no doubt know, contained some stiff new regulations. Most significant was a section setting aside channels 12, 13, 14, 15 and 23 for contacts between stations of different call signs. The rest would be restricted to calls between units of the same station.

Some disagreement showed up in comments by manufacturers about the proposals. The group naturally is sensitive about any new rules which would affect equipment sales. For these men, a clamp-down on hobby-type CB activities might discourage potential buyers.

Market threats notwithstanding, ECI president Peter Robins went on record in agreement with the proposals. He felt the FCC should exercise needed control. Robins pointed out, however, that rules are one thing and enforcement another, suspecting that outlaw CBers would continue to ignore rules in view of the Commission's demonstrated inability to track down every violation.

Gar Greene, president of Browning Labs, expressed a contrary view. He said CB radio has become a "positive force in the country." Rural areas in particular, Greene opined, have been drawn together by a communications link not provided conveniently by other means. He also cited cases of police and fire departments utilizing CB as an adjunct to normal equipment. Thus, argued Greene, the FCC should encourage, rather than restrict, the band.

In support was Sonar's executive sales manager, Jim Liebman. He saw the new rules as a means of dividing business and personal users. In the past, Liebman felt, a conflict existed between the two activities.

As a rule, CB kit manufacturers were singing the blues, feeling that a large fraction of their customers are personal users. Businesses, they felt almost to a man, usually buy ready-made units and have them installed as well.

Individual CBers also were divided for and against. Not a few predicted trouble for the medium. Others saw the rules mainly as undercutting operators of the hobby type.

But no amount of teeth-gnashing can change such proposals. Only logical arguments for or against hold water with the Commission. You might think Washington was hit by a whirlwind as a result of its bombshell. Not so. Ivan H. Loucks, CB's head man at the FCC, said a lot of letters were received, but most were of no value because they said only that the writer was for and against. Mr. Loucks expressed disappointment that more did not contain constructive comments worthy of consideration.

Regardless of the outcome, the law-abiding Citizens Band licensee will be little affected by the Part 19 changes. The frivolous operator, however, is in for trouble.

CB

Jack S. Watts, proprietor of our Prize CB Shack, runs a base station and one mobile unit at 18B3278 in Griffith, Ind. Both units are Heath GW-10's and he uses a GC heavy-duty ground-plane antenna. Other equipment includes a signal generator, tube and capacitor checkers, VTVM, signal tracer and R-100 receiver, along with a Johnson 6 and 2 meter converter. He's studying for an amateur license. Jack is a machinist.

PRIZE SHACKS

YOU CAN WIN $20 with a picture of your ham, CB or SWL shack! Just send the photo, along with a list of your equipment, to EI Prize Shacks, 67 West 44th St., New York 36, N. Y. We prefer 8x10-inch glossy prints. Negatives should be available if you send a snapshot. Color pictures cannot be reproduced. Pack your picture well to prevent damage in the mails, and be sure to put your name and address on the back of each print. Enclose a note describing your activities in SWL, CB or ham radio. Unused pictures are returned.

HAM

First YL Prize Shack winner is Leslie Johnson, WA4EEZ, of St. Petersburg, Fla. Leslie works CW on 40 and 15 meters, and phone and CW on 6 and 2. She sports no less than four antennas. In the shack are a Heath Twoer, Clegg 99er, VFO, Heath HX-11, Globe Hi-Bander and NC-57, NC-300 receivers. She belongs to six ham groups.

SWL

Ken Greenberg's SWL shack in Chicago is a convenient table loaded with equipment. On it are Heath DF-2, National NC-125, Monitoradio DR-200 and Gonset 3156-B receivers, plus an RME preselector and a Bud crystal calibrator. Ken uses a 50-ft. long-wire and two coax antennas. He teaches, and has been an SWL the last 15 years.

sure to install the crystals in the correct sockets or you'll be transmitting and receiving out of Citizens Band limits.

Spacephone S2100

The Spacephone Model S2100 obviously is intended for license-free operation by youngsters who have become interested in electronics. With a circuit of only three transistors, the S2100 is

a tightly packaged (2½ inches wide by 5 inches high) transmitter, audio amplifier, modulator and superregenerative receiver. The small size does not mean it is a toy, however, nor does the low price. The unit came on the market at $21.95 but is now being reduced in price to $9.95 to make it competitive with other walkie-talkies of similar design.

We built this truly pocket-size transceiver in about two hours. Unlike other kits that have large construction manuals and many pictorial diagrams, the Spacephone's manual consists of an eight-page booklet and two large foldout pictorial sheets. Forty-four steps and it's done.

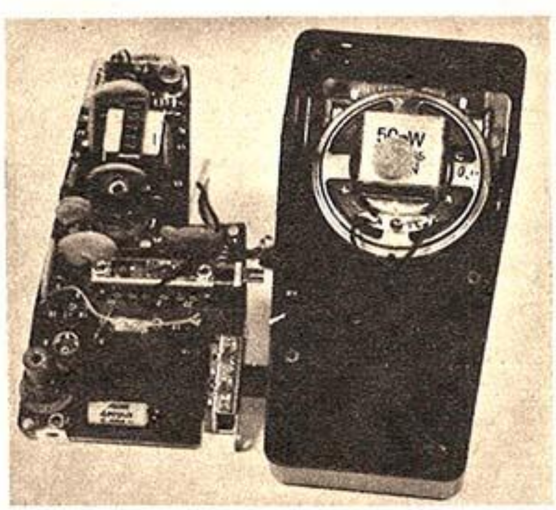
But the compactness of the printed-circuit board causes problems in mounting and soldering components. It is unfortunate that construction does require so much skill and care because this consideration makes the kit inadvisable for those it is designed and priced for—the young beginners. The S2100 cannot be recommended for anyone who has not had previous experience building kits and, in particular, kits with printed circuit boards.

No space has been wasted between components on the top of the printed-circuit board. When soldering components, be careful of excessive solder which could cause shorts between strips of the etched foil. Watch the heat too when installing the transistors. Their leads are joined directly to the board.

Since the receiver is a superregen, alignment is not a problem. The regeneration level is set by adjusting a small pot for loudest hiss. The antenna coil is pretuned. Power is furnished by a 9-volt transistor-radio battery.

We measured 83-mw input power. Modulation quality is good, there was no RF splatter and we could not detect distortion. Audio quality was good. We had no difficulty in distinguishing who was talking when we made our tests. The three-inch speaker doubles as a microphone. However, the "half mile" range claimed is stretching a point. Intelligible conversation could be carried on up to a few hundred feet but it is doubtful that even a straight shot over water would give you a half-mile range.

Since the receiver is a superregen, tuning is somewhat broad and you may hear stations on adjacent channels.

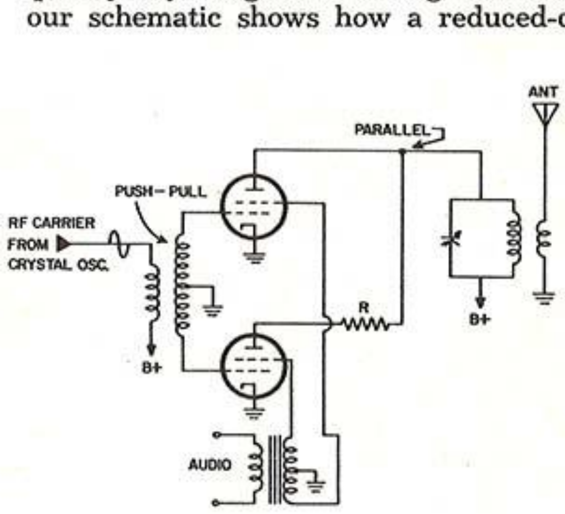


Some parts cover eyelets yet to be soldered on the Spacephone's compact printed-circuit board.

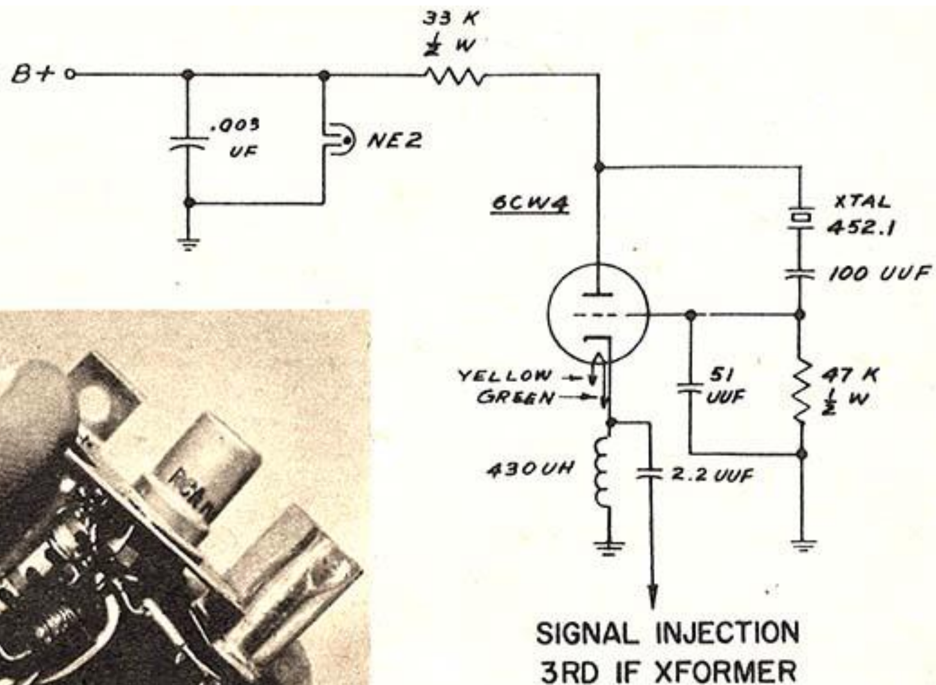
SIDEBAND CB NOTES

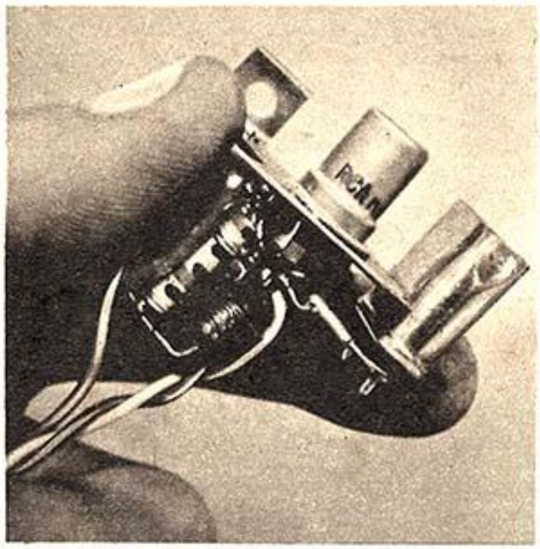
ELSEWHERE in this issue is an article on a privately-built single-sideband transceiver which was first to get into operation on the Citizens Band. But many manufacturers are busy designing SSB CB sets for the market (Heath, Cadre, Sonar, Webster and Olson are among them). And a few pieces of sideband gear already have been introduced. First complete transceiver to bow is a *double*-sideband job by Regency Electronics (see photo above). We usually think of sideband, double or single, as having a suppressed carrier. But the Regency product, priced at $250, puts out a *reduced*-carrier signal. Rather than being completely suppressed, the carrier in this case goes along with the sidebands, but in a much-weakened form. The idea, evidently, is to make the rig more compatible with existing AM equipment. The vestigial carrier would permit the local oscillator in a normal receiver to lock in on the signal.

The Regency DSB transceiver has 23-channel crystal control, a four-way meter (S reading, power, final plate voltage and current), final plate tuning and frequency-adjusting delta tuning. The company hasn't revealed its DSB circuit but our schematic shows how a reduced-carrier signal could be achieved. A low-level RF carrier is introduced to the grids of a balanced modulator (which replaces the RF amplifier of a conventional rig). The carrier is applied in push-pull. Since output is in parallel, the carrier bucks itself out through cancellation. Audio is applied to the screens in push-pull, causing the tubes to unbalance *in step* with voice frequencies. Thus, at the output, only the modulated RF—the two sidebands—will be present. Note resistor R in the plate lead of one tube. It unbalances the stage just enough to let a vestige of carrier through. Increasing its value would unbalance the modulator until a normal AM signal appeared at the output. Eliminating it would produce truly balanced modulation and a



Balanced modulator can produce a DSB signal with carrier that is reduced or suppressed (see text).





General Radiotelephone's SSB adaptor (left) uses one tiny Nuvistor tube. The circuit (above) is oscillator that injects carrier in the detector.

suppressed carrier. Regency claims the system quadruples effective power.

General Radiotelephone has taken an add-on approach to sideband, the philosophy apparently being not to obsolete conventional equipment but to update it with adaptors. First out is a *single*-sideband adaptor for the receiver section (see photo). The unit, designed specifically for General's MC line of transceivers, is being marketed as an experimental circuit. The company has said it is not intended for commercial applications. The adaptor uses one tiny Nuvistor tube and can be mounted right on the chassis. It is priced at $19.95, plus installation charges.

The adaptor provides the missing carrier for an SSB signal, just as a BFO does in a ham receiver. An incoming sideband signal mixes with the adaptor signal to produce audio. The schematic (above) reveals a crystal-controlled oscillator whose output (taken from the 6CW4 tube's cathode) is fed in at the output of the last IF stage; it and the sideband heterodyne in the detector.

The adaptor's frequency is 452.1 kc, matching the nominal IF frequency of the MC line. The frequency is unusual in that most IF frequencies in comparable CB equipment are 455 kc. In operation, the adaptor frequency remains the same. The transceiver's manual tuning knob is used to change the incoming IF signal to the right frequency with respect to the adaptor frequency. Manual tuning *must* be used because receive crystals wouldn't be accurate enough.

Assume a sideband representing 400-cycle audio is fed to the mixer stage, causing it to produce an IF frequency of 452.5 kc (452.1 plus .4 kc). The 452.1 kc signal injected by the adaptor will beat with the 452.5-kc IF signal and the result will be 400-cycle audio (452.5 minus 452.1 kc). Spacing between the adaptor frequency and the IF must be exact. This adjustment is made with the manual tuning knob, as mentioned earlier.

Refinements not shown in the schematic include an RF gain control to reduce receiver sensitivity on strong SSB signals. Sideband energy could overmodulate the adaptor signal and cause

[*Continued on page* 106]

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distortion. (The same control adjusts squelch when the receiver is switched to conventional AM.) Finally, a neon bulb is added to the receiver's B-plus circuit to provide voltage regulation and reduce drift.

The General adaptor *could* be used with receivers having a 455-kc IF but results would be questionable.

General's second adaptor is a *double-*sideband transmitter unit which is of unusual design. The adaptor, like a linear amplifier, is a separate unit. Its input is the full 3-plus watts of modulated RF power from the transmitter's final. The circuit amounts to a normal balanced modulator (see our first schematic). The RF carrier is applied in push-pull and bucks itself out in the adaptor (resistor R in our schematic is not present so the carrier is suppressed completely). Audio for application to the screens (causing the tubes to unbalance and put out a two-sideband-only signal) is obtained by the simple expedient of connecting a diode detector between the unit's RF input and its audio input (at the bottom of the schematic).