The Heathkit SB-110. A slide-rule scale at the top of the dial escutcheon refers to the 50 kc points over a 500 kc range, while the circular scale is linearly calibrated in 1 kc steps. The fiducial hairline may be adjusted for calibrating purposes by means of the small knob on the upper right of the escutcheon.

CQ Reviews:

The Heathkit SB-110 6-Meter S.S.B. Transceiver

BY WILFRED M. SCHERER,* W2AEF

ONE of Heathkit's newer units in their popular "SB" series is the SB-110 transceiver which in one package, (less power supply), provides full coverage on the 6-meter band for fixed-station or mobile use on s.s.b., c.w. or a.m. (s.s.b. with carrier). You don't need any accessory trapping—translators, converters, linear amplifiers or what-have-you, usually used with present gear to get on 50 mc s.s.b.

Delivering 100 watts p.e.p. output with stable accurately calibrated v.f.o. frequency control over the entire 50-54 mc range, the SB-110 should set a new standard for this band. Let us take a look at some of its other features and specification that might put it in this category: Sideband generation and receiver selectivity obtained with a h.f. 2.1 kc crystal filter; Nuvistor front end with sensitivity of 0.1 μv for 10 db s./n. ratio; preselector tuning; a.g.c.; automatic receiver-frequency offset for c.w. operation; built-in crystal calibrator; v.f.o. stability 100 c.p.s. per hour; c.w. sidetone monitor; headphone level control; p.t.t. or built-in v.o.x.; v.o.x. type break-in for c.w. phone-patch input; upper or lower sideband operation; adjustable pi-output for 25-100 ohm loads; crystal-control operation for transceive or for transmitter only; panel meter calibrated in S-units or transmitter functions (plate, a.l.c. or relative power output); and an effective noise limiter, a feature missing on most s.s.b. transceivers. There are two power supplies available, one for 120 v. a.c. operation, the other for 12 v. d.c. mobile use.

Like most Heathkit products, the SB-110 comes in kit form, enabling you to have the fun and satisfaction of putting your own gear together at a substantial saving in cost over factory-wired equipment. Although the set appears to be quite complicated, it is not as difficult to build as one might expect. This was borne out by an experiment we tried; namely, turning the kit over to a novice to do the work. Happily this turned out to be a successful proposition from which a few good lessons were learned.

*Technical Director, *CQ*.

Receiver Section

A block diagram for the SB-110 is shown at fig. 1. Double conversion is used for the receiver with the first conversion of 8.4-8.9 mc obtained by heterodyning the input signals with a separate crystal (41.6-45.1 mc) for each 500 kc band segment. The second i.f. is at 3.395 mc, obtained by mixing the 1st i.f. signals with 5.0-5.5 mc signals from the v.f.o. Sideband selectivity is obtained with a 3.395 mc crystal filter and the signal is converted to audio by a product detector.

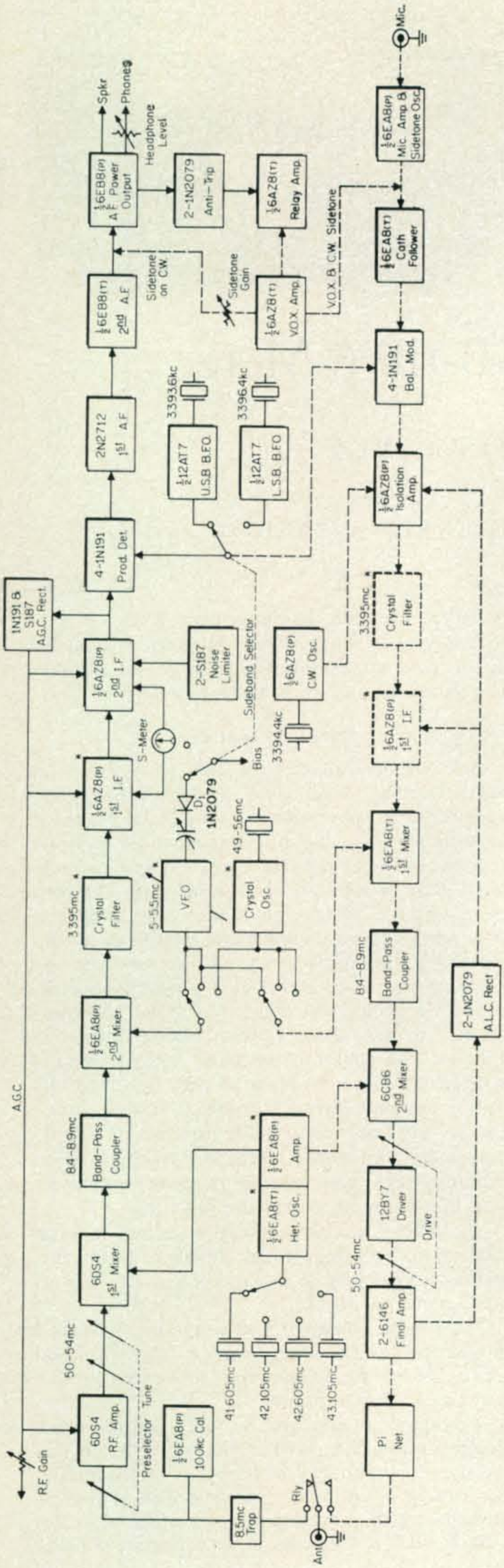
The r.f. stage is a neutralized 6DS4 Nuvistor, coupled to the mixer, another 6DS4, through a double-tuned narrow-bandpass circuit which, instead of being broadbanded with fix-tuned circuits, is resonated by a three-gang variable capacitor to provide "preselector tuning." This arrangement ensures better cross-modulation characteristics and maintains peak sensitivity with minimum noise over the full range.

The 8.4-8.9 mc bandpass coupler after the 1st mixer rejects all frequencies outside of this range, and an 8.5 mc trap in the antenna circuit rejects input signals at the i.f.

The product detector is a ring-type "balanced modulator" affair using four diodes, a method we've always found superior for exceptionally clean s.s.b. demodulation.

Sidebands are changed by switching the b.f.o. frequency to either skirt of the filter. When this is done, the frequency of the v.f.o. is automatically shifted to eliminate retuning. This is accomplished with the sideband selector which activates a diode switch that cuts in a capacitor, shifting the v.f.o. during l.s.b. operation.

For crystal-controlled net operation or work



on MARS frequencies the v.f.o. can be cut out with an OSCILLATOR-MODE switch, substituting a built-in crystal oscillator. Crystal-control is thus obtained on the same frequency for both receive and transmit. Another switch position provides crystal control for the transmitter only, with v.f.o. tuning retained for the receiver. An excellent feature is that the crystal oscillator has a trimmer to permit adjusting the crystal to exact frequency.

The set is supplied with four crystals for the heterodyne oscillator to cover 50-52 mc. For use at the top half of the band and for MARS work below 50 mc, additional heterodyning crystals are required.

The automatic noise limiter, one of the best for s.s.b., is an i.f. type utilizing a pair of silicon diodes in a full-wave circuit shunted across the last i.f. transmformer.[1] An on-off switch is included.

Besides the customary a.f. gain control, there is a separate screwdriver-adjust control to vary the high-impedance output level for comfortable headphone listening without changing the normal loudspeaker level.

Transmitter

The transmitter also employs double conversion, but in the reverse order from that of the receiver. The s.s.b. signal is generated through the crystal filter at 3.395 mc and then is mixed with the v.f.o. signals to produce an 8.4-8.9 mc signal which in turn is combined with the heterodyning signals of 41.6-45.1 mc for output in the 50-54 mc range.

A cathode follower after the speech amplifier matches this amplifier to the low impedance of the ring-type balanced modulator which uses four diodes. As in the receiver, an 8.4-8.9 mc band-pass coupler between the two mixers eliminates undesired responses.

The plates of the 2nd mixer and driver are gang tuned and the final has a Pi-network adjustable for 50-ohm output that allows matching to loads having up to a 2:1 s.w.r. The driver and final are each individually neutralized.

In the c.w. mode a phase-shift network is switched into the mike amplifier circuit, so that it now functions as a 1000 c.p.s. tone oscillator. Grid-block keying is used directly at the transmitter mixers and the v.o.x. amplifier. The tone then goes through the v.o.x. amplifier to actuate the v.o.x. relay just as the voice does for s.s.b. The a.f. tone from this amplifier also goes to the receiver a.f. output amplifier for sidetone monitoring using either the loudspeaker or headphones. A sidetone level control is provided too.

[1] "IFNL"—An S.S.B. I.F. Noise Limiter, *CQ*, June '60, p. 42.

Fig. 1—Block diagram for the SB-110. The receiver routing is shown with solid connections, the transmitter section is connected by dashed lines. Elements common to both transmitter and receiver are marked with an asterisk.

The c.w. carrier is obtained from a 3394.4 kc crystal oscillator and is injected at the isolation amplifier, the gain of which can be adjusted with a DRIVE-LEVEL control to produce the required power level for the final amplifier. The c.w. carrier frequency is 800 c.p.s. higher than when the receiver is used in the u.s.b. position. This provides "frequency offset," so that when the receiver is tuned for an 800 cycle beat note on a c.w. signal, the transmitter will automatically be zero beat with the signal for on-frequency operation.

Assembly

Except for the final amplifier and the v.f.o., all stages are built on five printed-circuit boards. This simplifies the work which is further made easier with a preassembled, factory-wired and aligned v.f.o. After the circuit boards have been assembled and installed along with other chassis components, the major part of the work consists of interconnecting the boards and panel controls. There are two preassembled color-coded harnesses provided for the job.

It took our neophyte 42 hours to put the SB-110 together. Several additional hours were required on our part to do some trouble shooting before the rig was aligned and working properly; all due to the fact that although the step-by-step instructions were clear and simple enough, our "eager beaver" was too hasty, admittingly neglecting to carefully read and correctly follow through with some of the steps. He also, no doubt, tired by doing the work in the evenings over stretches of 4-6 hours at a time.

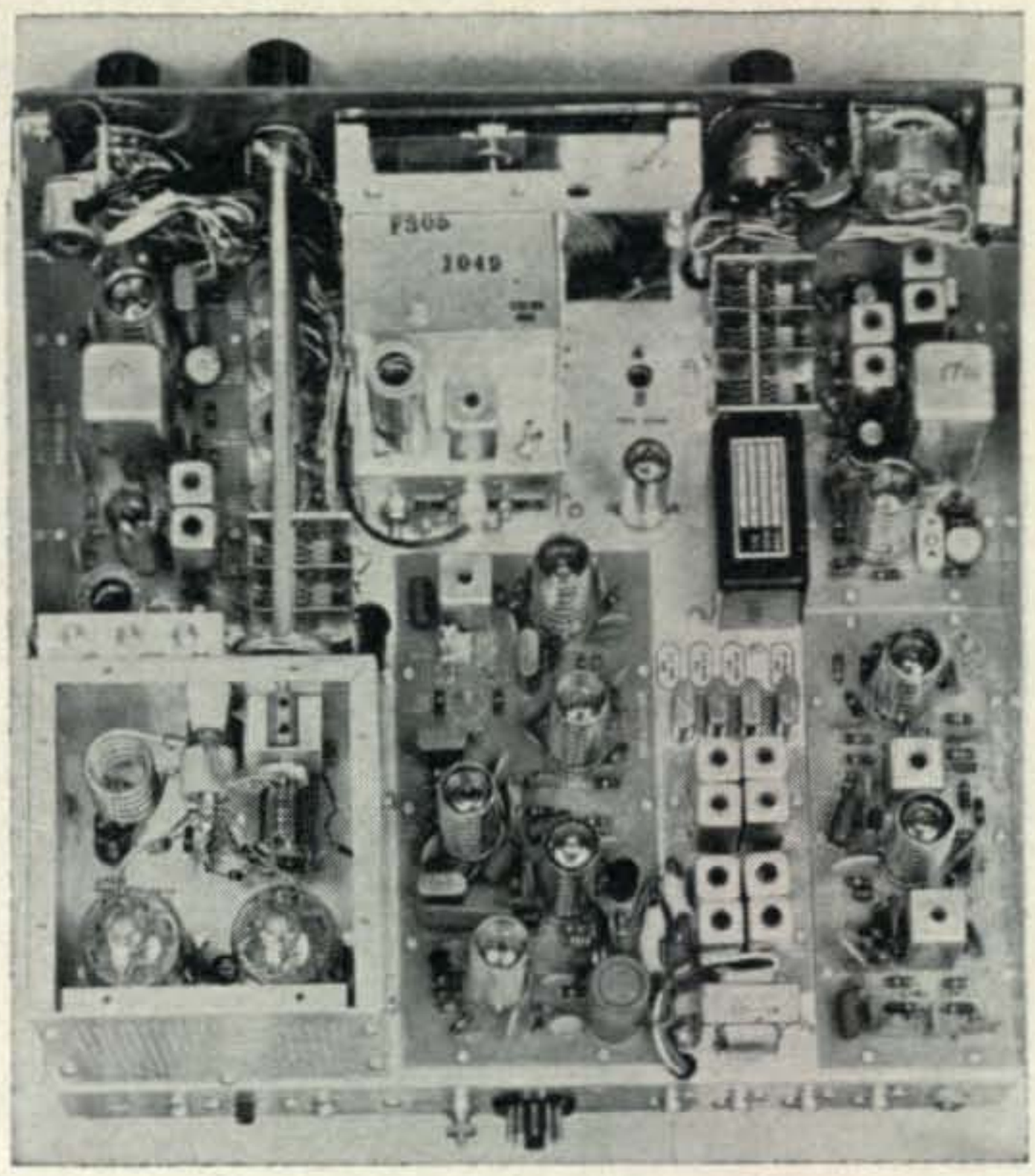
We therefore cannot emphasize too strongly the necessity for taking enough time to study each assembly step thoroughly and to "think it through" before proceeding. Also, do not work more than 1-2 hours at a clip, in order to minimize the chance of errors due to fatigue. Remember the old adage, "haste makes waste!" These suggestions apply to *any* kit work whether it be simple or complicated, and regardless of whether you're a newcomer or an old hand.

Performance

Let us now take a look at the results obtained with the finished product. The receiver sensitivity for the SB-110 was better than usually found with 6-meter gear, measuring within the rated 0.1 μv for 10 db s./n. and could be maintained over the whole band. Strong-signal handling capabilities also were excellent.

The following other measurements were up to specifications, except as noted: SELECTIVITY: 2.1 kc at 3 db, 5 kc at 60 db; UNWANTED-SIDEBAND SUPPRESSION: 55 db; IMAGE REJECTION: rated at 50 db, 48 db; I.F. SIGNAL REJECTION (8.5 mc): rated at 50 db, was 60 db; at 3.395 mc, 80 db (not rated); INTERNAL SPURIOUS RESPONSES: rated at 0.1 μv equivalent signal, except 0.3 μv at 51.250 mc—none was found in the 50-52 mc range except the specified one (crystals were not supplied for the upper half of the band).

We often marvel at the overall frequency sta-

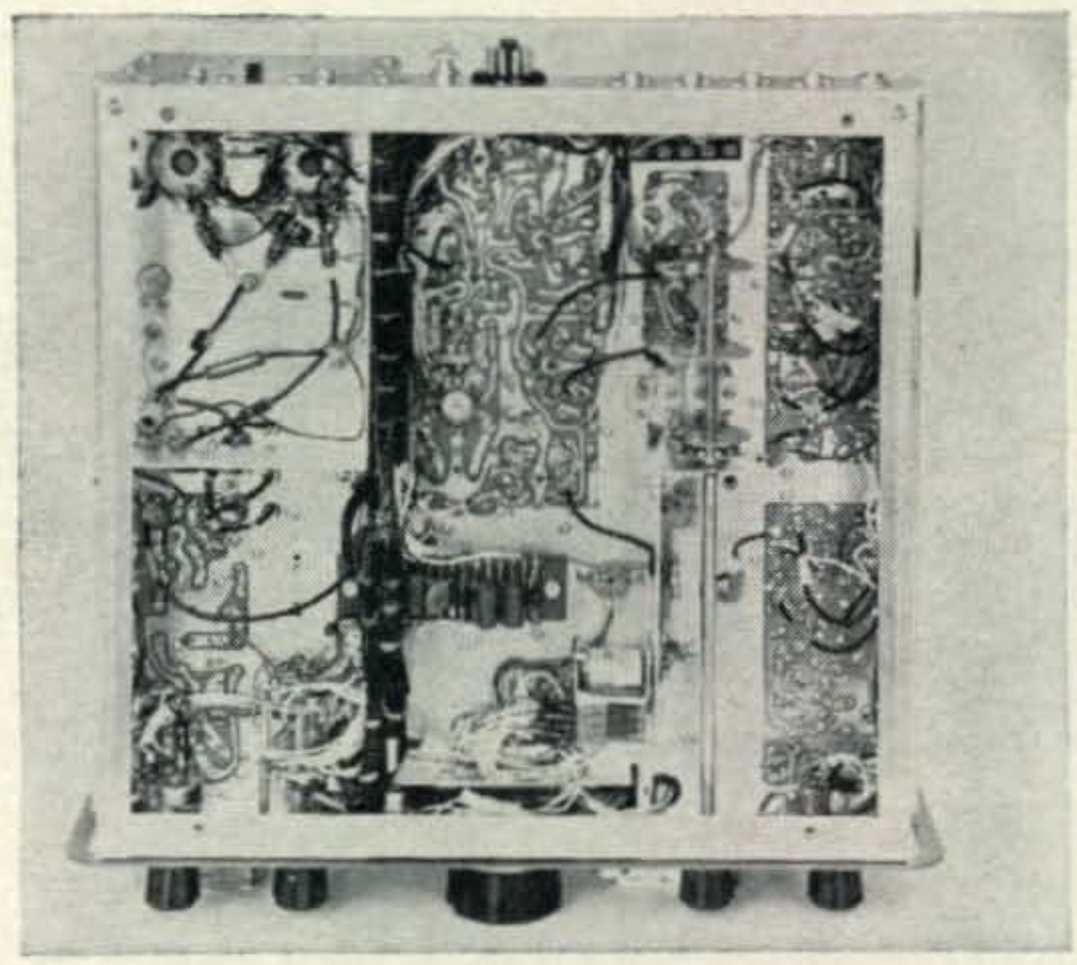


Top view of the SB-110. The v.f.o. is at the upper center. The final is shown "uncovered" at the lower left. The other stages are assembled on the various printed-circuit boards.

bility and calibration in the Heathkit SB-series of gear of which the SB-110 is typical. The stability, rated at less than 100 c.p.s. drift after 20-minutes warmup and less than 100 c.p.s. for $\pm 10\%$ supply-voltage variation, was 250 c.p.s. after 10 minutes warmup, 80 c.p.s. the next hour and 40 c.p.s. per hour or less thereafter. Line voltage variation of $\pm 10\%$ produced ± 70 c.p.s. change. In addition, mechanical stability as may be encountered in mobile service, was such that not a whimper of frequency twitter or microphonics was evident when the set was dropped an inch or so above the table.

The dial, (which has an adjustable hairline

[*Continued on page 100*]



Bottom view of the SB-110. Wiring for the grid side of the final is done in the partitioned section at the upper left. Most of the other wiring is made using two harnesses.

ville. Send GCR (General Certification Rule—certified by Club Officer or two other licensed amateurs) and $1.00 to Amateur Radio Club of Florida, Box 7326 Euclid Station, St. Petersburg, Florida 33734. If contacts are all v.h.f., work only 8 cities. Available to s.w.ls on heard basis. This is very beautiful award Art Designed in two color and printed on Semi-Gloss paper.

J. A. R. S. Twenty-Fifth Anniversary Award: In conjunction with its 25th Anniversary celebrated during 1965, The Joliet Amateur Radio Society (W90FR), is issuing a ceritficate to anyone who worked W90FR during 1965. Anyone who worked *W90FR* during 1965, especially on Field Day or on one of our "on the air" sessions for the 25th Anniversary Station during September, October and November. We are very anxious to collect QSL cards, so please send your QSL and a s.a.s.e. for this award to, Joliet Amateur Radio Society, c/o Jim Rainford, WA9KPW, 813 Fisk Ave., Joliet, Illinois.

Sure glad that JA7CEK finally got his Marianas Amateur Radio Club Award. It seems that his first application was lost but it took about 7 months for the award to be issued from the application that MARC acknowledged receiving, and this after much pressure from several California stations.

An apology to W7DZB as by error his called was listed as W7JZB in the December full list of USA-CA Award holders.

Don't know who sent it but I enjoyed the card for my recent birthday which was addressed: To the "HAM" of Station H-O-P-P-E-R who sparks from 103 watts on Whitman St., Rochelle Park. Note on it read: Happy Sparking to a swell Ham & Cheese on Rye. From an Old Crystal Set. Also a drawing of a tower and crystal set on the card, and a photo of a dog with big ears, and my nickname used to be "big ears," not because I'm another Clark Gable, but I was pretty good at digging out the weak/rare signals. Or does the sender (?) think I'm a dog? Hi. . . . Anyway, Thanks. Hope you got some of those needed QSLs and counties, write and let me know, how was your month? 73, Ed., W2GT

Ham Clinic [*from page 80*]

Frequency Drift Measurement—"What do you suggest is the best way to measure frequency drift? I have a receiver that I would like to stabilize once and for all. Any hints?"

Try to borrow a frequency counter such as is made by Hewlett Packard. Be sure not to confine your drift measurements to one band or only one or two frequencies within a band—you'll find that the drift will vary according to frequency. If you can't locate a counter, then you will need a good stable heterodyne frequency meter. With both the receiver and meter warmed up good (48 hours or more), put the meter and set on the same frequency. Then let both alone for a couple of hours. Now come back and re-zero the meter to the receiver frequency. If your dial can be read closely, you plot the *difference* frequency on a chart. Do this for many frequencies. At the end, you'll have a good idea of the amount and duration of drift. The counter is easier though.

Thirty

Readers are requested to make their letters short and to the point. Always include two IRC's or 25¢ for airmail postage from our present overseas address, 4 Lutzelmatt St. Luzern, Switzerland. If you are in no hurry, then send your letters to me at *CQ*. We shall do the best we can to answer your questions; but please remember we cannot answer them all—for if we could we would not have to work for a living. Your kind letters and cards commenting on HAM CLINIC are always appreciated, believe me. To those of you who have asked many times if a HAM CLINIC Anthology is coming—the answer is *yes* . . . we hope you'll buy a copy.

73, Chuck, W6QLV

The RPHTSSR [*from page 30*]

a five watt transceiver, Jeep mobile, in the old home town. What a test! This would be the supreme effort. With the additional gain setting barely cracked he was extremely difficult copy on kilowatt alley. We called and listened without result. We called again and advanced the gain. No result. A third call and up went the additional gain control even more. Contact! ! Conditions were bad—he was fading. Up went the additional gain control even more. Just about Q5 copy now, maybe a little bit less. This had to be it. We cracked her wide open and just barely ducked aside in time to avoid a hurtling jeep that came screaming right through the loud speaker cone and into the room. Breathless and shaken we snapped off the switch and hastily penned a note to ourselves. THIS RIG MUST NOT BE OPERATED UNTIL THE I.P.S. IS INSTALLED.* ■

**Editor's note:* The Idiot Proof Switch was installed and man's progress out of the depths resumed. We are currently negotiating publishing rights for those other amazing developments.

Heathkit SB-110 [*from page 61*]

for calibrating), has 1 kc divisions spaced a little over ⅛" apart, permitting visual interpolation to about 200 c.p.s. The electrical accuracy obtained from the dial reading is rated at within 400 c.p.s. after calibration at the nearest 100 kc point. This averaged within 250 c.p.s. even with only one calibration indexing near the center of the v.f.o. range. One revolution of the tuning knob covers about 25 kc, making tuning easy. Dial backlash was well within the rated 50 c.p.s.

Transmitter Performance

With a power-line input of 120 v.a.c., the transmitter power output was 95 watts on c.w. (steady state—rated at 90 watts), 105 watts p.e.p. on s.s.b. and a.m., with a 52 watt carrier (ratings are 100 and 50 watts respectively). Sideband suppression was same as on receive, carrier suppression was at least 55 db down.

The SB-110 has been in regular use on the

air by one of our local 6-meter enthusiasts who is also a contest competitor. On-the-air reports indicate excellent s.s.b. quality, while the sensitivity, stability, calibration and the noise limiter are particularly superior features. V.o.x. operation was found to be good, except with the lower-level microphones where the v.o.x. gain was marginal. C.w. keying is every bit as good as that common on the lower-frequency bands as long as good line voltage regulation is available, otherwise a frequency "lilt" will be noted. The sidetone monitoring is a handy feature, although there is some tone leakage that appears as a low-level backwave.

Since there are no provisions for normal a.m. detection with the b.f.o. turned off, such signals have to be read by tuning the receiver to exact zero beat with the a.m. carrier. Although good demodulation can be obtained, occasional retuning may be required, should the a.m. signal drift or if one or more a.m. stations in a round-table QSO are not all on the exact same frequency.

The SB-110 measures 6⅝" × 14⅞" × 13⅜" (H. × W. × D.) and weighs 17 lbs. The kit is priced at $320.00. Operating voltages for the unit are obtained separately from either the HP-23 120 v.a.c. power supply for fixed-station use or from the HP-13 transistorized 12 v.d.c. unit for mobile service. The HP-23 measures 6¾" H. × 4¾" W. × 9" L., weighs 19 lbs. and it is priced at $39.95 (kit). The HP-13 measures 7¾" W. × 7 5/16" L. × 2⅜" D., weighs 7 lbs and is priced at $59.95 (kit). A separate loudspeaker also is required. The producer is The Heath Company, Benton Harbor, Mich. —*W2AEF*

Audio [*from page 48*]

characteristic. Note that if an input signal of 0 db (1 mv) is put into the device, there is an amplification of about 12 db. The same holds for all levels up to about 14 db (5 mv input), but above this level the gain starts to decrease. For instance with an input level of 28 db (25 mv) the amplification has dropped to 8 db. From this point on the amplification decreases–(finally becoming negative if we carry the curve farther to the right), so that the output level can never exceed about 70 mv, no matter how much is put into the input. You can see that the objective of amplifying low levels and holding down high levels mentioned earlier is achieved. We don't get something for nothing, however. Some distortion is introduced in the process. For instance, a voice component at 500 cycles, when clipped, produces harmonics at 1000 and 1500 cycles, which are still within the passband. This type of distortion is held to a minimum by the filtering in the output. When you're way down in the mud and trying to get a message across, the listener doesn't mind the distortion, and if at the other extreme, you have a good signal in his receiver, you don't need clipping, so the device should be turned off. You can't make a good circuit much better, but when the going is rough, a little audio shaping and the use of a noise-cancelling mike will make the difference between a QSO and none at all. ■