Updating the SX-28

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The Hallicrafters SX-28/SX-28A is perhaps the most widely owned communications receiver of World War II Vintage. While it embodies many praiseworthy features, the specifications that an adequate receiver must today meet are considerably more demanding than they were when the "Super Skyrider" was designed. With these facts in mind, we set about the task of updating the receiver to modern day standards; namely:

1. Improved Sensitivity, with a minimum of cross modulation on nine plus signals.
2. Increased Selectivity.
3. Additional Image Rejection.
4. High degree of stability in both the High Frequency and Beat Frequency oscillators.
5. Selectable Product Detector for SSB reception.
6. Bandspread calibration for the 15 meter band.

General Alignment

The first thing to be done to the SX-28 is to give it a thorough and accurate alignment to be sure that the existing circuitry is operating at the highest possible efficiency previous to making the modifications. This may be simply accomplished by injecting a low power signal from either a signal generator, *vfo* or stable grid dip oscillator to the antenna terminals on the rear of the chassis apron. Starting with 10 meters, set the reeciver frequency to the center of each ham band and align the proper slugs and trimmers beginning with the first *rf* stage and working through to the mixer. Figure 12 on page 15 of the receiver instruction manual shows a chart giving various slug and trimmer locations on the underside of the receiver. As an indication of peak tuning of each respective circuit, we can either use the S-Meter or (preferably) connect an *ac vtvm* across the 500 ohm output terminals of the audio amplifier. The vtvm is the superior method as it may be difficult to observe S-Meter variations due to instability when the receiver is sitting on end during the alignment procedure. *NOTE:* Unless it is necessary to align the receiver with the dial, the oscillator trimmers and slugs should not be altered.

After the *rf* amplifiers and the mixer (converter) have been aligned, inject a signal at 455 kc from the signal generator and peak the vtvm with each *if* slug starting at the first *if* and working through to the last. Be sure to use an insulated tuning wand for all above operations to minimize capacity detuning effects while working under the chassis. The alignment is now complete.

Increasing the Sensitivity

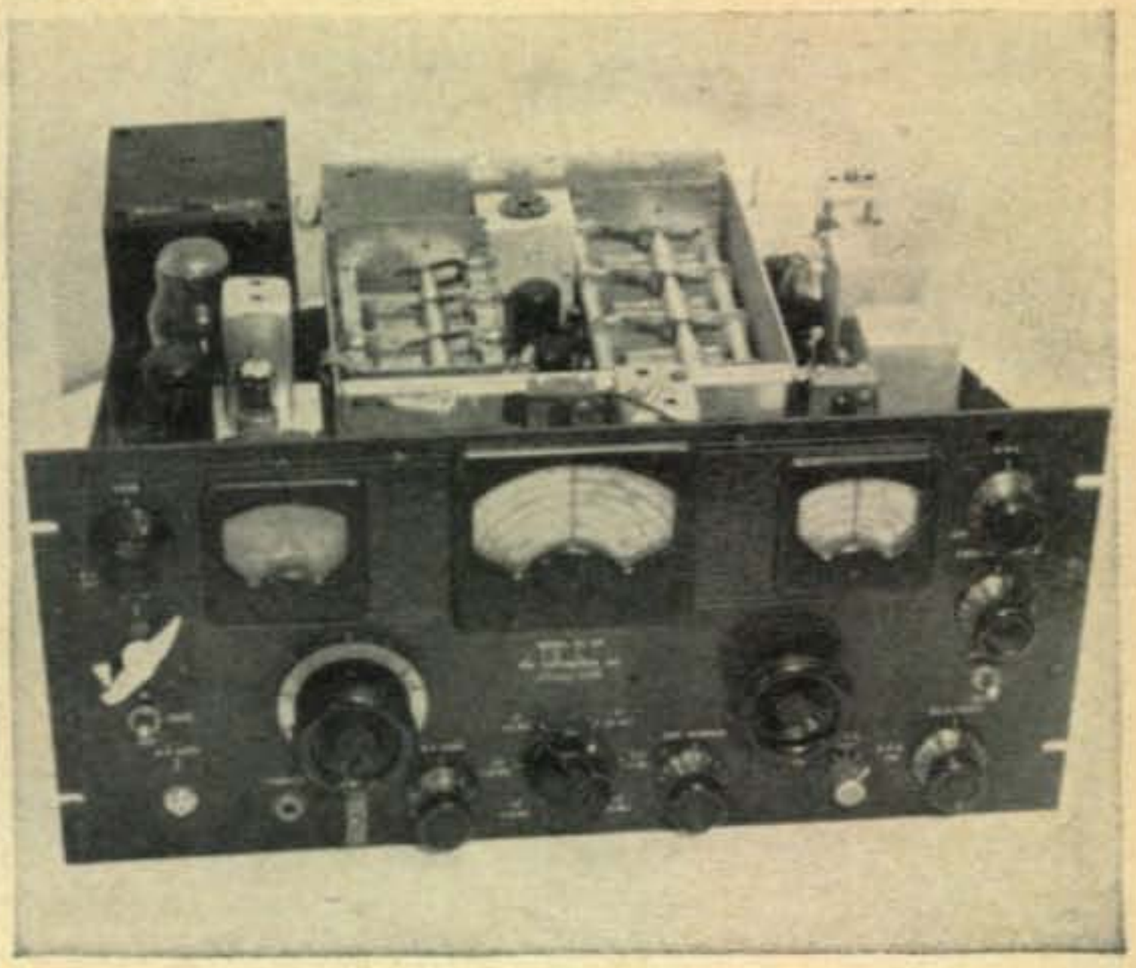
The sensitivity of the SX-28 seems perfectly adequate on all bands below 20 meters, however, it is greatly reduced on 20 and just about non-existent on 15 and 10. While the simplest solution appears to be the addition of an external preselector, it is a rather costly one, and therefore it seems more practical to add a S-9er type device in place of the first *rf* stage for improved sensitivity. At about the half way point of the first draft of this article, Wayne informed me that he had received an article dealing with an S-9er designed specifically for application to the SX-28 receiver. I made a hasty copy of all the pertinent data and decided that I'd build one and include it as part of this conversion. The S-9er was constructed and added to my receiver with the results being every bit as good as was suggested by Jim Kyle, K5JKX in his article. There was not only a marked improvement in the overall sensitivity of the SX-28, but also a definite improvement in signal to noise ratio. No performance deterioration due to increased cross modulation was observed as a result of the additional gain introduced by the S-9er.

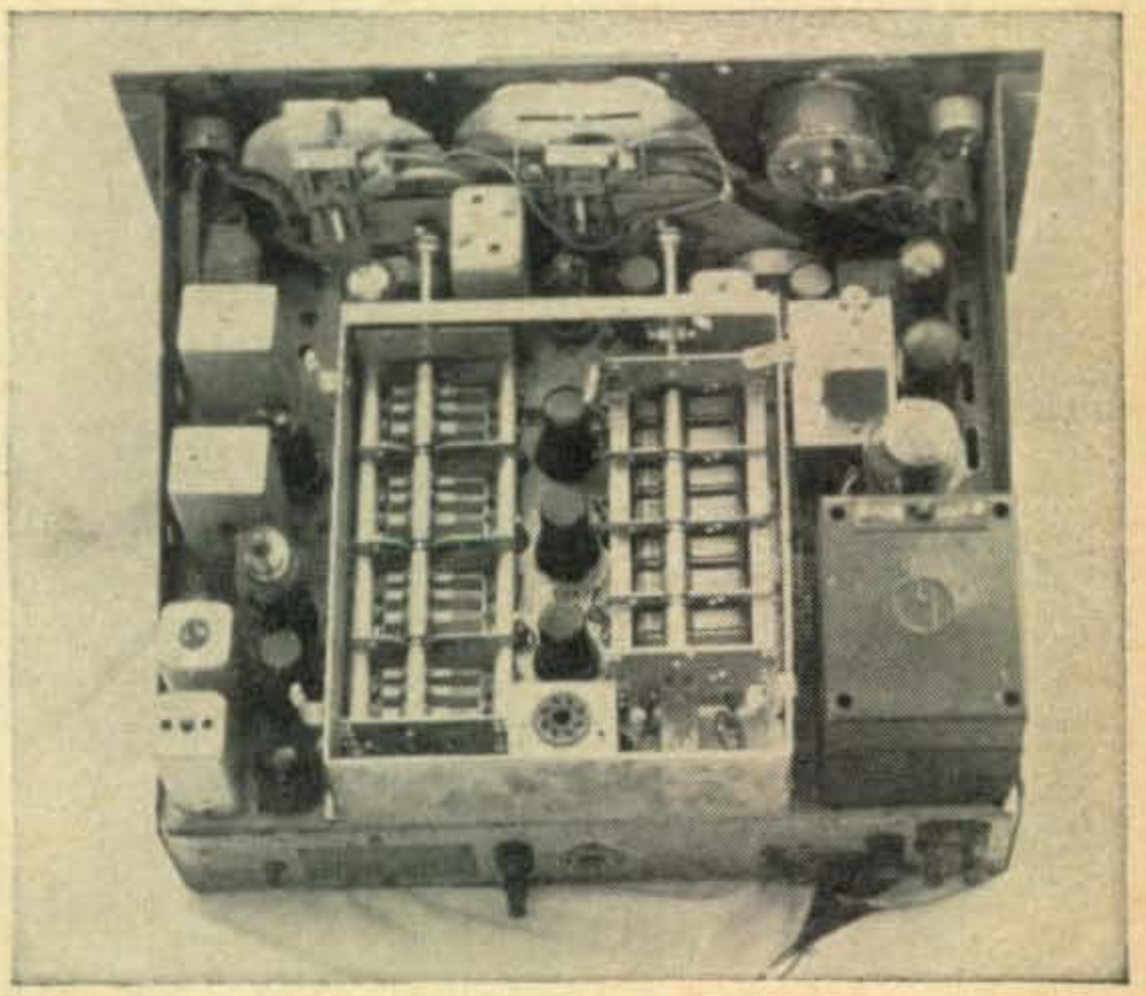
Selectivity; Modifying the *if*

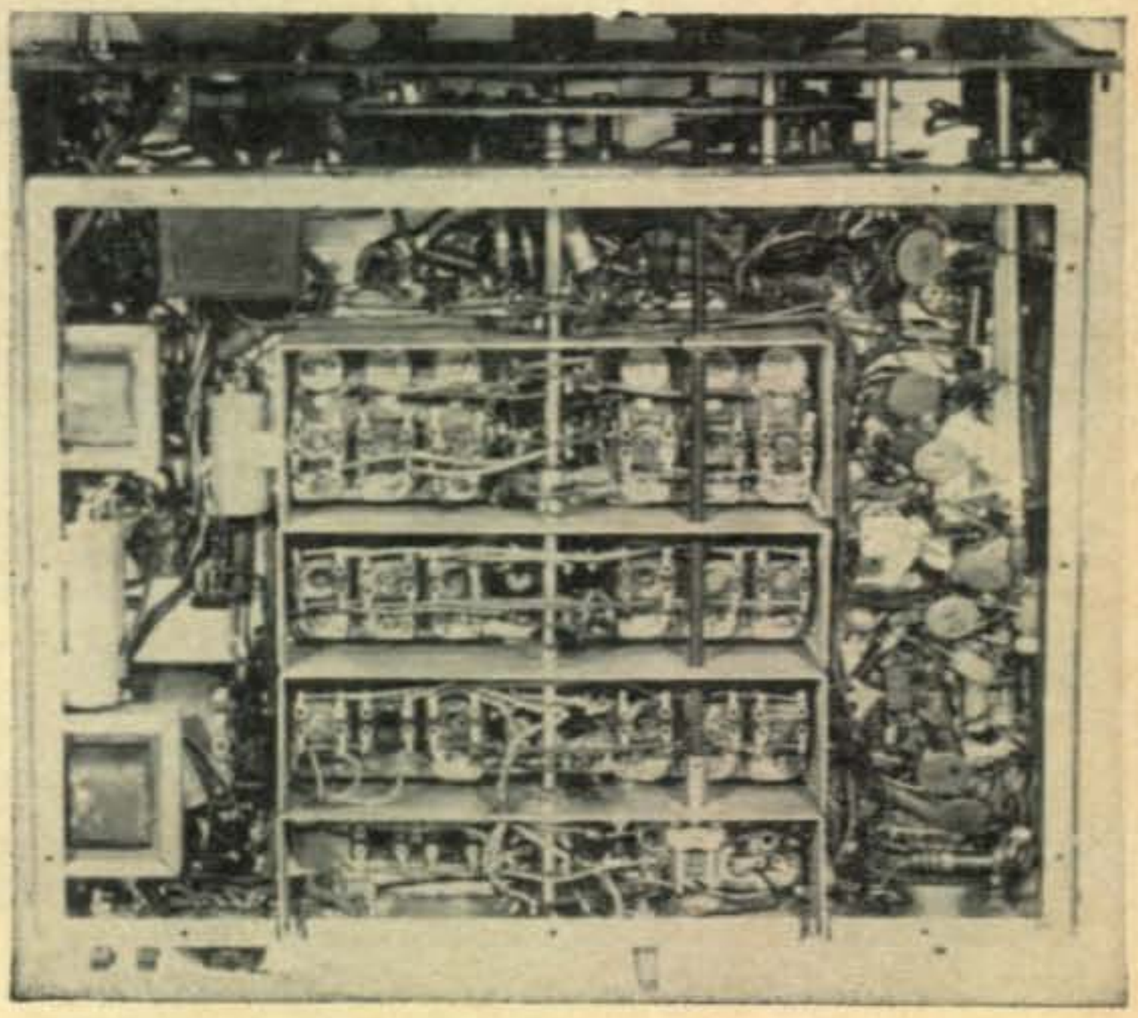
In order to achieve the proper degree of selectivity, it is necessary to add an additional stage of *if* at 455 *kc*. A 6BA6 (alternates 6AU6, 6BJ6) tube, miniature slug tuned *if* can and a handful of resistors and capacitors makes for a very simply constructed *if* stage at a minimum of expense. Best results are

obtained by adding this stage between V6 (6SK7) and V7 (6B8) as shown in fig. 1.

While the construction and insertion of this *if* stage is relatively simple (the only construtcion hint to observe is that of keeping lead lengths at a minimum) the problem is to locate a blank spot on the receiver chassis on which to mount the tube socket and transformer. It seems the designers of the SX-28 packed the components on the chassis like so many sardines in a small tin can. The only solution is to mount the stage on a small aluminum chassis box (about 3 x 3 x 2) and locate this on the left hand top of the chassis next to the 6V6 audio tubes and the output transformer. The leads are then run down through a grommet on the chassis and around to the front underside where the last *if* (T3) is located. It is necessary to make the lead which runs from pin 1 of the new *if* transformer to the plate of V6 (6SK7) out of RG-58/U Coaxial Cable, and do likewise with the lead running from Pin 5 of the 6BA6 to the top of T3. Now locate a 250 Volt point with a *vtvm* and connect a lead from the 2.7 K resistor on the primary of the new *if* transformer (Pin #2) to this point. Run the lead from the 100K resistor marked "To *avc* Buss" in fig. 1 to the bottom of R15, 100 K on T1. This allows you to keep *avc* on the new stage. An alternate arrangement is to merely ground the bottom of the secondary of the new *if* transformer, but experience has shown that the *avc* is necessary on this stage to prevent overloading on strong signals. Connect the cathodes return point to the slider of the *rf* gain potentiometer. The filaments of the 6BA6 are 3 and 4. Ground pin 3 and run a lead from pin 4 to pin 7 on either 6V6 audio tube. The new *if* stage is now installed. Turn on the receiver and tune in a signal from the generator. Adjust the trimmers on the new *if* can until a maximum deflection is observed on the S-Meter or vtvm. It may be necessary to re-tune T3 as well since the new stage presents some additional loading of the transformer. Having done this, you will note that the overall performance of the receiver with respect to selectivity, image rejection and S-Meter reading on the high bands has been vastly improved.







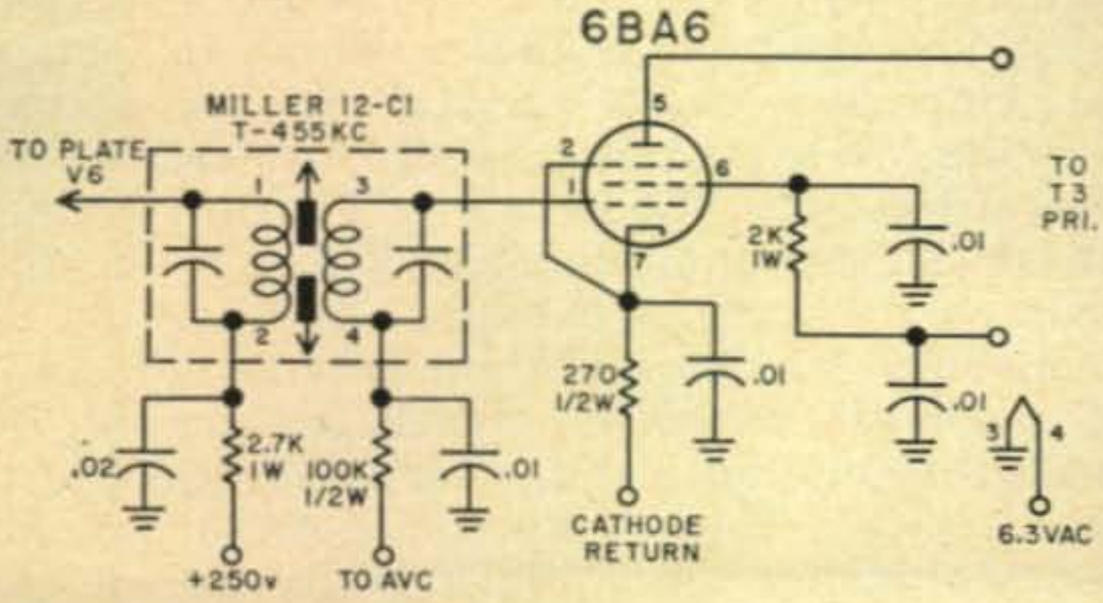


Fig. 1—Schematic of the added if stage.

Receiver Stability

One of the most serious problems that confronts us is the lack of stability in both the High Frequency and Beat Frequency Oscillators. This is due in part to the mechanical construction of the high frequency oscillator, but is mainly attributable to voltage fluctuations in these circuits.

Most of the paper bypass capacitors on the underside of the receiver have most probably deteriorated with age and moisture over the years. It is advisable to replace as many of these as is practical with either new papers of the proper voltage ratings or disc ceramics rated at 600 volts. This step is a good idea in general and may save hours of grief spent in searching for sources of difficulty at a later date. Firstly, it is necessary to add a voltage regulator tube to the oscillator circuits to stabilize the voltage applied to the plates of these tubes. The *hf* oscillator is V4 (6SA7) and the *bfo* is V11 (6J5). The voltage present on the plate of V4 (pin 3) is about 150 volts. An OB2 (VR-105) is mounted on the top left of the chassis next to the 5Z3 rectifier tube and the new *if* stage. As shown in fig. 2 pins 1 and 5 are tied together and connected to the junction of R6 (6.8K) and R71 (4.7K). This puts 105 volts regulated on the plate of V4. Condensers C68 and C69 are 10% tolerance units. They should be replaced with Silver Micas of like value but with a tolerance of 5% or better. This action results in greatly improved *hf* oscillator stability and tends to minimize overall receiver drift. Another suggestion is to include a tiny 6.3V, 1 amp filament transformer strictly for the filaments of V4. This would be connected directly across the line cord and would serve to keep V4 filaments on even when the main ac switch is in the off position. This particular feature is included in the SX-101 and is a real boon to receiver stability. The receiver will now require no warm up time before stability is achieved.

As far as the *bfo* is concerned several modifications are required. Those lucky souls possessing an xtal in the range 456.5 to 457.5 *kc*[1] might do well to add this xtal and modify the *bfo* to a highly stable crystal controlled oscillator. The above mentioned crystal would be for upper sideband reception. For lower sideband the frequency would be between 454.5 and 453.5 *kc*[2]. Both crystals could be added and an upper-lower SB switch installed on the front panel (see figure 3). Figure 3 should be disregarded if you have no desire to include a crystal controlled *bfo*. The *bfo* tube is V11 (6J5). To stabilize the existing circuit disconnect R45 (20 k) from the plate of V11 and run a 100 ohm 2 watt resistor from the plate (Pin 3) to the B plus side of the OB2 voltage regulator previously installed. Replace C73 (500mmf) in the *bfo* transformer (T4) with a 1% zero temperature coefficient ceramic or silver mica. Also replace C71 (100mmf) with a 5% or better silver mica and replace C75 (2 mmf) with a 5 to 7 mmf silver mica. This latter step results in improved *bfo* coupling to the product detector to be discussed later.

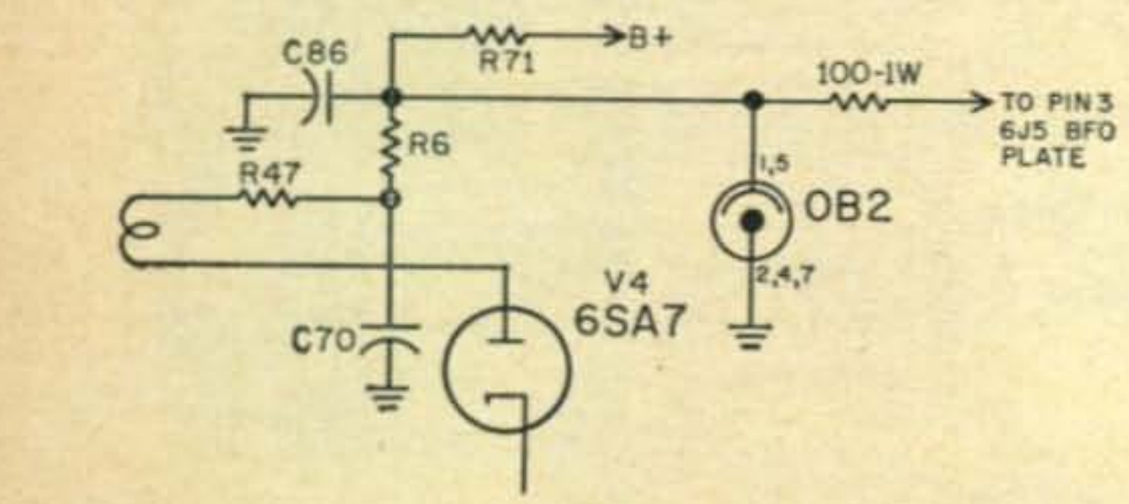


Fig. 2—OB2 regulator stabilizes the hf osc and bfo.

Bandspread Calibration for 15 Meters

In order to achieve bandspread calibration for the 15 meter band (this band was not yet allocated when the SX-28 was designed) one merely pastes a heavy piece of white paper over the upper logging scale on the bandspread dial, sets the main tuning and marks frequency calibrations on this paper in 5 *kc* divisions. An accurately calibrated frequency source will be required for this operation.

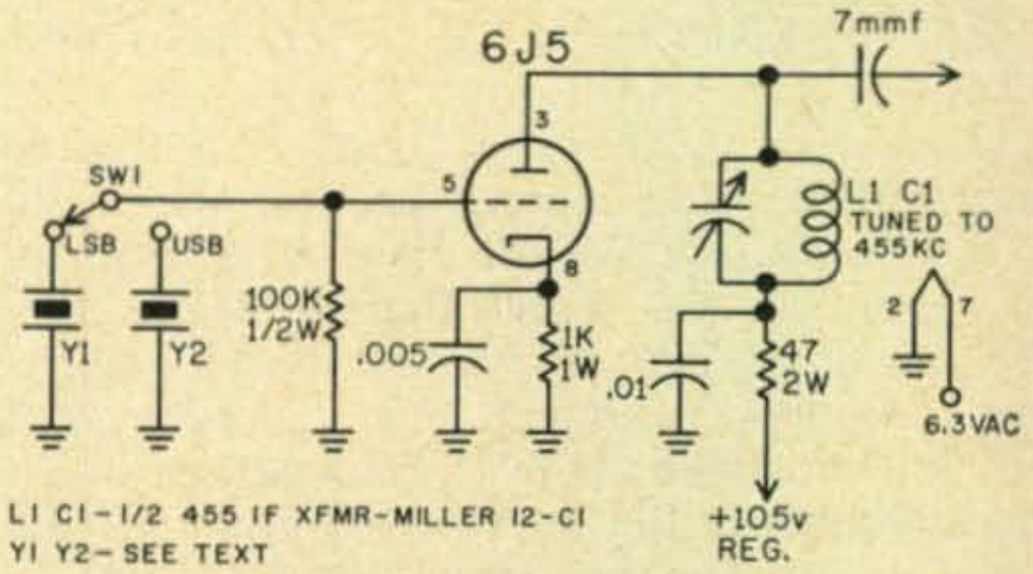


Fig. 3—Crystal controlled bfo.

Modifications for SSB Operation

In order to facilitate ssb reception it will be necessary to add a product detector to the SX-28. Figure 4 shows the circuit that was found to be the most advantageous.

Two 12AU7's are used as three triodes in this circuit. In order to allow distortionless reception with the *rf* gain fully advanced while receiving ssb, proper mandates require that the incoming signal from the *bfo* be ten times as great in amplitude as the incoming *if* signal; this latter is generally about 1 volt and therefore the *bfo* should be capable of delivering at least 10 volts to the detector. The *bfo* in the SX-28 delivers approximately 9 volts with 105 volts on the plate of the 6J5, and reception is completely free of distortion with the *rf* gain at maximum, except on signals of over 40 *db* strength. I did not feel that the additional effort of installing a stage of amplification for the *bfo* was worthwhile since the majority of signals

1. Surplus crystal channel 47
2. Surplus crystal channel 326

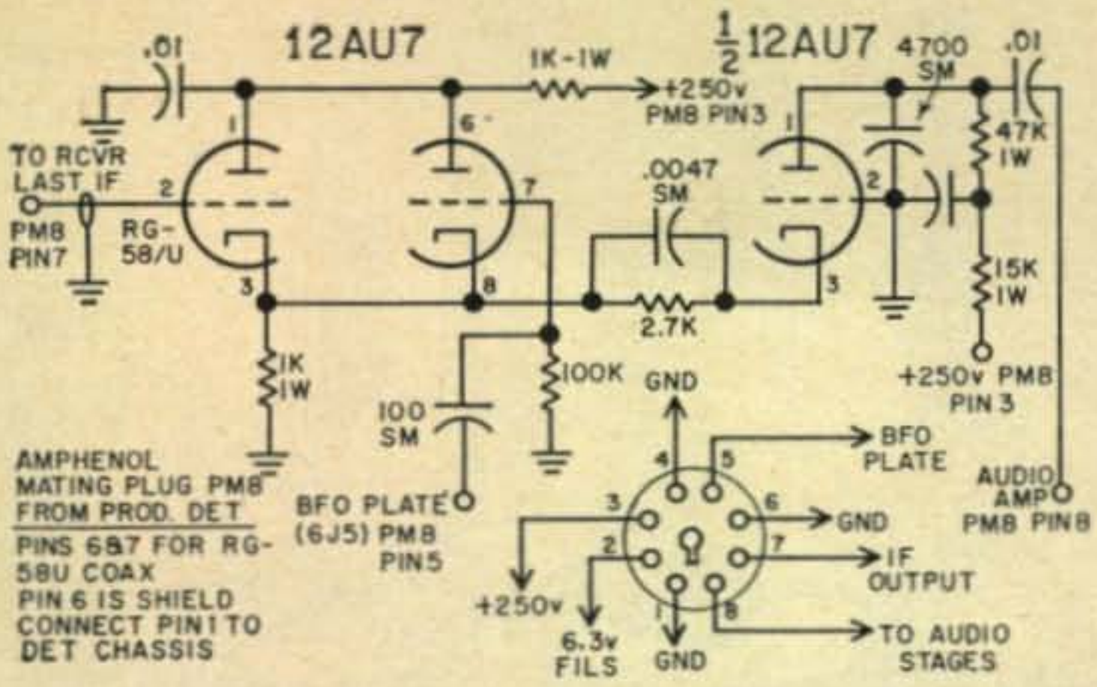


Fig. 4—Product detector and plug wiring. Socket connections are made to the receiver as indicated and the detector plug is wired to match.

received are below the 40 *db* level.

The product detector is simplicity exemplified to build and should be constructed on a small chassis box. An octal socket is mounted on the rear apron of the receiver and the product detector is mounted alongside this socket and connected to it by means of a Amphenol PM-8 plug on a 8 conductor shielded cable.

AVC Modification

Ordinarily, when the receiver mode switch is thrown into the *cw* position, the *avc* buss is grounded through the action of SW_3A. It will be necessary to lift the wire running from the *avc* buss to this switch section in order to keep *avc* on the receiver at all times. The S-Meter will now function on CW and SSB.

For those really finicky amateurs, it may be desirable to increase the delay on the *avc* buss. You can experiment by hanging various values of C between .1 and 1 mf from any point on the buss and observing both the sound of the received ssb signal and the S meter action. Surprising results can be obtained this way, but since every amateur has his own idea of perfection it must be left to individual discretion.

Once you have dragged out the soldering iron and actually performed the above operations, the resulting improvement in the SX-28 will give you many more years of listening pleasure; for the receiver is truly "Updated," 1959 style. Good luck. ■

CQ Reviews

The Knight-Kit Span-Master

The Allied folks have come up with another "simplicity exemplified" Knight-Kit. The Span-Master is a regenerative type receiver which covers standard broadcast as well as short wave, including American and foreign broadcasts, amateur phone and cw, ships at sea, and aircraft. The professional, contemporary styling of the cabinet makes this a receiver you'll be proud to display. The dials are clearly marked in white against black for added tuning ease and the panel is anodized aluminum.

The money you conjure up by scrimping on lunches for a while buys you a host of features and the actual construction of the unit requires about 5 hours of the time you'd normally spend watching "The One eyed Monster" Like most Knight-Kits the assembly instructions are of a simple, clear and concise, step-by-step nature.

The Span-Master covers the frequency range 54 to 30 *mc* in four bands The unit also has electrical bandspread, which simplifies tuning crowded amateur bands and a built-in 4″ *pm* speaker as well as a headphone jack located on the rear panel. A Speaker-Phones switch is also included.

Technically, the Span-Master contains a 6B-Z6 operating as a regenerative detector. Two regeneration controls are brought out to the front panel; one for coarse and one for fine adjustment. By carefully adjusting the fine control, signals of extremely low intensity can be received. Once the signal is detected, it drives a half of a 6AW8 (triode section) which functions as an audio driver stage. This in turn drives the pentode section of the same 6AW8 which serves as the audio power amplifier and feeds the output transformer and phone jack.

One praiseworthy construction feature of the Span-Master is that the hook-up wire supplied is pre-cut to length and has the insulation already removed.

All in all, the Span-Master is a technically excellent and economically sound investment. ■