ceiver uses a series-parallel heater string, it was necessary to change the 6U8 to a 12AX7 and connect the nuvistor in parallel with the 12AX7. Another solution would be to add a second nuvistor as an rf amplifier.

The results are amazing, as the limiter completely eliminated all ignition noise from my XK-140, which was so noisy that I gave up trying to operate 2 meter mobile from it. With very little effort, it should be possible to add this limiter to any receiver, and eliminate almost all qrn. . . . WA2INM

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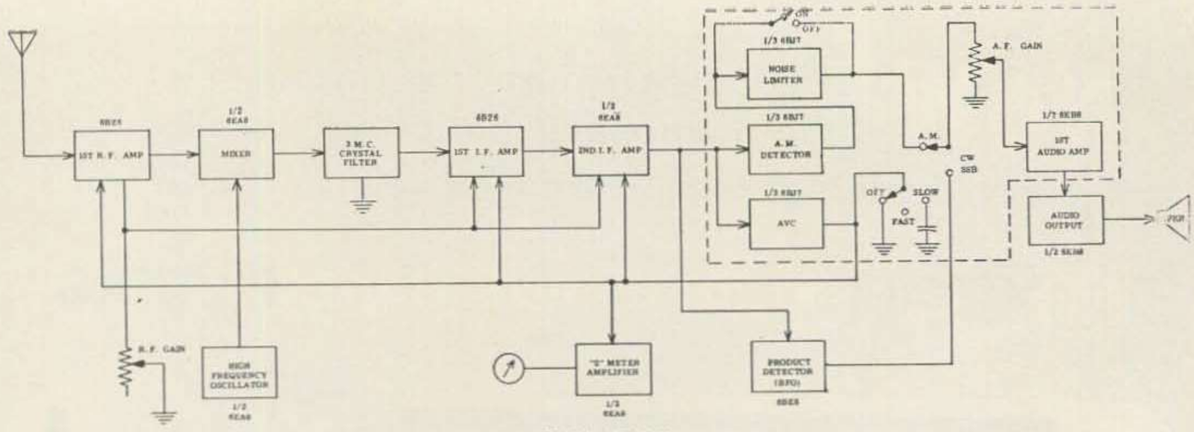
73 Tests the Heath HR-20 Mobile Receiver

—ANOTHER MOBILE RECEIVER? Well, not exactly. While Heath calls their new HR-20 kit a mobile receiver, an SSB receiver and, at times, a mobile SSB receiver, it is more than this. The HR-20 is an advanced design amateur band receiver, less power supply, which provides, in a compact package, those receiver characteristics and features which Heath believed would provide the most performance for the money. As far as the writers are concerned, Heath has a winner.

The HR-20 Receiver is a 7 tube (plus gas regulator, Zener diode and transistor regulator) single conversion superheterodyne receiver designed for CW, SSB and AM reception in the 80 through 10 meter amateur bands. Modern design techniques and components insure excellent performance in all modes. Before we go into the circuit details, a few comments regarding the design philosophy and history of the HR-20 Receiver are in order.

As shown in the photograph, the physical configuration of the HR-20 is similar to that of the previous Heath mobile receiver, the MR-1 Commanche. Much of the circuitry, the panel layout and physical dimensions of the original model have been retained. The major changes are in new features for improved SSB reception. Included in these are replacement of the original variable frequency BFO with a dual frequency, crystal controlled oscillator for selectable sideband operation, selectable AGC time constant and a transistorized high frequency oscillator filament voltage regulator for 12 volt dc mobile operation.

The initial design concept for the HR-20 was as mobile receiver to be used in conjunction with the Heath HX-20 Mobile SSB Transmitter. When used in this application, both units may be mounted on an accessory base which is available as the AK-6 Mobile Base Mount. Such an installation is shown in the second photograph. An external, 8 ohm speaker is required and the AK-7 Mobile Speaker is available for this purpose. Heath also markets the HP-10, 12 volt dc power supply for mobile use. This transistorized, 120



BLOCK DIAGRAM

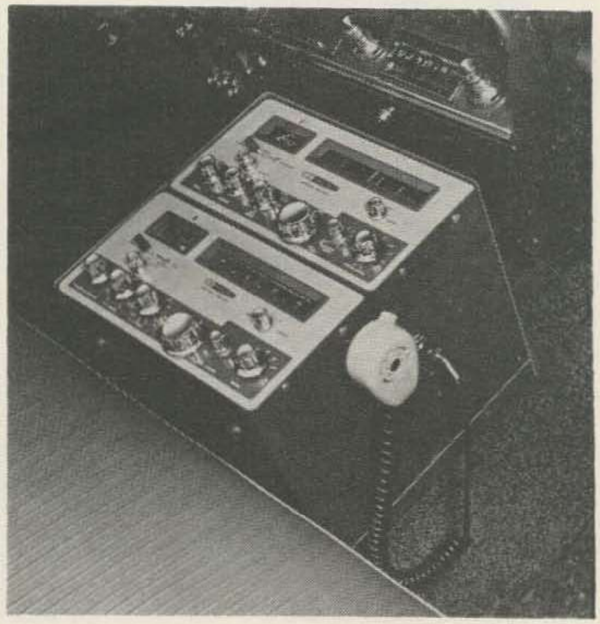
watt unit supplies power for both the HR-20 Receiver and the HX-20 Transmitter in the normal mobile installation.

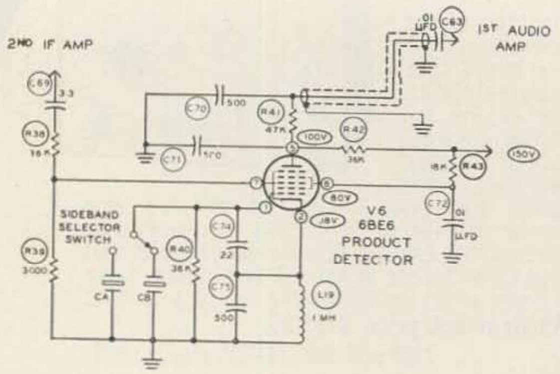
Both the HR-20 Receiver and the HX-20 Transmitter are well suited for home station use and, in this application, Heath recommends their HW-20 Utility ac Power Supply. Although the HR-20 is designed for easy integration into the home station or mobile installation, it may of course be used as a straight, ham band receiver. In this case, all that is required is an antenna, speaker and a power supply considerably less elaborate than those mentioned above. Power supply requirements for the receiver alone are shown in the specification chart.

The HR-20 circuit diagram is a bit large to include in a review article, however the block diagram shown in Fig. 1 will aid in understanding the following discussion. The receiver is a single conversion superhet using a 3.0 mc *if* with a crystal lattice filter. A 6BZ6 rf stage feeds a 6EA8 mixer-oscillator stage which in turn feeds the crystal lattice *if* filter. Use of the relatively high, 3.0 mc *if* frequency, along with the selectivity provided by the high Q rf and mixer grid circuits, gives good image rejection. The crystal lattice filter provides the *if* bandpass characteristics required for effective SSB reception. The HFO tuned circuits are individually temperature compensated to insure low drift. This coupled with rugged construction and the use of a transmitting type variable capacitor provides a high order of stability for the HFO. This capacitor is a two section unit which also tunes the mixer grid circuit. The rf input circuit is resonated by a single section capacitor designated "ANTENNA TUNING." While slightly unconventional, this arrangement allows use of the compact transmitting type capacitor for the oscillator-mixer tuned circuits and permits better physical layout of the stages.

The selectivity characteristics of the crystal filter, listed in the specifications, provide a very good compromise between the requirements for AM and SSB reception. Selectivity is sufficently sharp for effective SSB reception while an AM signal may be centered in the passband without loss of intelligibility. Two stages of *if* amplification, using a 6BZ6 and the pentode section of a 6EA8, follow the crystal filter and provide most of the receiver gain. The second *if* amplifier feeds either a conventional diode detector for normal phone operation or a product detector for CW, SSB and exalted carrier AM reception.

A conventional diode gate noise limiter, which is disabled when the product detector is used, is provided for AM reception. A separate diode AGC detector is used for gain control and to drive the triode section of a 6EA8 tube which is used as an S-Meter amplifier. The AGC circuit used in the HR-20 provides AGC operation for both AM and SSB reception. A front panel switch provides





short or long time constant or disables the AGC as desired.

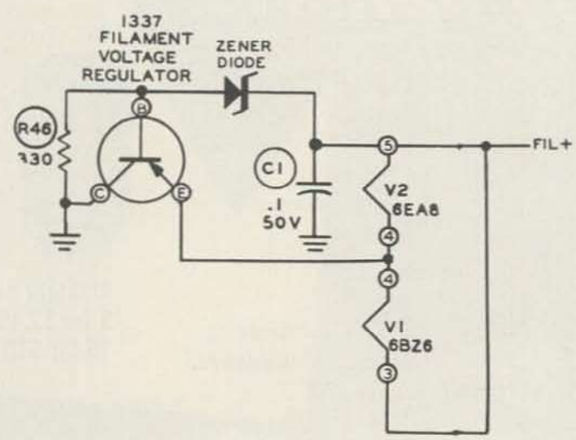
The product detector utilizes a 6BE6 pentagrid converter as the mixer and crystal controlled oscillator. This circuit provides very good performance with a minimum of components and should be of interest to amateurs seeking improved SSB reception with their conventional home brew or commercial receivers. Fig. 2 shows the schematic diagram of this circuit. Crystals CA, 2998.5 kc, and CB, 3001.5 kc, are positioned 1.5 kc below and above the 3.0 mc center frequency of the crystal filter. Therefore, selectable sideband reception is possible by positioning the oscillator on the upper or lower slope of the crystal filter selectivity curve. It should be noted that the "SIDEBAND SELECTOR" switch only selects the appropriate product detector crystal. It is still necessary to tune the main tuning dial to zero beat the crystal oscillator with the actual or suppressed carrier of the *if* translated, desired signal.

An OA2 gas regulator tube supplies a constant 150 volts to the plates of the two oscillators and to the screens of the rf amplifier, 1st mixer and the *if* amplifiers. The balance of the receiver circuitry is more or less conventional with the exception of the transistorized filament voltage regulator. This circuit, shown in Fig. 3, supplies a constant voltage to the heater of the 1st mixer-oscillator and rf amplifier tubes. This feature, used only in the 12 volt dc power supply wiring option, stabilizes the oscillator filament voltage and therefore contributes to the excellent frequency stability of the high frequency oscillator over the wide range of primary voltage encountered in mobile service. Regulation of the rf stage is incidental to a simple 6 or 12 volt wiring option.

This circuit should be of value to those who have been fighting the complex problem of mobile VFO stability. The parallel connected heaters of V1 and V2 are wired in series with the emitter follower transistor circuit. The base input voltage of the transistor is the breakdown voltage of the Zener diode which is relatively constant for a wide range of supply voltage. Resistor R46 provides the base drive current for the transistor and breakdown current for the Zener diode. Since the base to emitter resistance is quite low, the emitter potential is held to a value slightly lower than the base. The overall effect is that the unwanted voltage variations appear between the emitter and collector of the transistor while the voltage applied to the tube heaters is regulated.

One of the first kits off the production line was shipped for this test. The kit was well packed and, on unpacking, no damage of any kind was noted. All components were examined and found to be of excellent quality. Dipped mica and disc ceramic capacitors are used extensively. The only paper capacitor in the receiver is a high quality molded plastic cased unit. Insulation on all rotary switches is apparently one of the new plastic laminated fiberglas materials. Mechanical parts are high quality. Dial drive gears are spring loaded where required and nylon, brass and steel gears are used. All exposed steel surfaces are heavily plated.

Mechanically, the receiver is quite complex, consisting of a main chassis assembly secured to a heavy, die cast front panel. Subpanels are used to mount the various controls, gear drive for the dial and some other components. Extensive shielding is used. The result, when everything is bolted together, is an extremely rugged assembly that contributes greatly to the stability of the receiver. However, construction is not unduly complicated. The main chassis consists of a flat plate on which most components are mounted and most of the wiring completed prior to mechanical assembly of the chassis parts is accomplished. As Heath points out in the form letter packed with the kit, "This receiver is one of the more complex and compact products marketed in kit form by



the Heath Company." Assembly, wiring and testing is not difficult but plenty of time and careful attention to detail are required.

The instruction manual supplied with the HR-20 was evaluated as the kit was constructed. This manual is quite comprehensive, consisting of 64, 8½" x 11" pages. The manual contains some 50 drawings showing the assembly, wiring and installation of the receiver. Many of the more complex assembly drawings are printed on large, fold-out sheets. In addition, a separate "giant size" schematic diagram is supplied for wall mounting. Construction, testing and installation are covered by nearly 500 "check off" steps. These instructions are arranged so as to be self checking and it would indeed be difficult to goof any part of the construction.

Three minor errors, possibly typographical, were found in the instructions. Since the errors are obvious and Heath is correcting them with an errata sheet, they will not be listed here. The pictorials were remarkably good and the only error noted was omission of a small nylon washer in the gear drive assembly. All parts are shown in drawings in the front of the manual so that even the relatively inexperienced amateur should have little difficulty in identifying the components. Separate sections of the manual are devoted to installation and noise suppression. All in all, the manual is extremely good.

Assembly, with minor exceptions, proceeded according to the instructions. The hermetic seal bushings on the bottom of the crystal filter would not quite pass through the chassis clearance holes. A pass with a file took care of this problem. The same was true of the crystal socket mounting holes. Wiring was easily accomplished. The flat, open main chassis plate makes it a snap to achieve professional results. Despite the apparent complexity of the dial drive assembly, it goes together quite easily. One "E" retaining washer required bending to make a snug fit in the shaft groove. Only one case of crowded assembly was noted. The audio output stage screen filter capacitor, a 20 mfd 350 volt unit, barely fits as shown in the instructions. This is probably accounted for by the increase in value (and physical size) over the 8 mfd capacitor shown in the pre-production schematic diagram.

The completed receiver was carefully checked before power was applied. Everything checked out so power was applied, with no smoke resulting. Alignment was started but stopped when high pitched, audio feedback was noted at certain settings of the audio gain control. Wiring, lead dress and components were checked with no luck. Finally, the .001 mfd capacitor across the primary of the audio output transformer was replaced with a .002 mfd unit. This proved to be a permanent fix. The oscillation was probably caused by an unusual combination of extreme tolerance components. However, to avoid the possibility of this occurring in other receivers, we recommended to Heath that this change be incorporated in all kits. The balance of the alignment went smoothly with no complications of any kind. Heath proved correct in their estimate of the time required to complete the kit, roughly 30 hours from start to finish.

Then came the pay-off—the "on the air" tests. Be advised that the performance of the receiver is all that the specifications say it is. Sensitivity is extremely good, with receiver noise way down. The selectivity, as previously mentioned, is a very fine compromise between the requirements for SSB and AM reception. CW is of course another story; a valid comparison is the CW performance of the Collins 75S-1 with SSB filters. Interference on one side of the desired signal may be "dropped over the edge" of the crystal filter bandpass but you have to live with what is left on the other side. While audio gain is adequate, there is no great reserve.

Tuning SSB signals is a pleasure. The dial ratio is about the optimum compromise between SSB tuning requirements and the need to scan each amateur band in one receiver tuning range. While a dual speed drive would probably be better, the resultant complexity might prove prohibitive for kit construction. Although the gears are spring loaded, a slight roughness was noted in the tuning drive. Based on experience with previous Heath gear drives, this is expected to diminish with use. The AGC system used in the HR-20 is excellent, with very effective action being obtained on SSB signals. Use of selectable AGC time constants really pays off in SSB reception.

Frequency stability of the HR-20 is extremely good. After all, the stability requirements for mobile SSB reception are demanding to say the least. Total warm-up drift on 20 meters was 3 kc from an absolutely cold start. After warm-up, the receiver is rock stable. The receiver was heterodyned with a 10 meter signal; lifted a couple inches off the bench and dropped. The result was an instantaneous "gurgle" but the beat note did not change. Try this test with other receivers; it is quite revealing.

The frequency stability of the HR-20 is of great interest to the writers. It would appear possible to convert the HR-20 Receiver to an SSB transceiver, using a small inboard or outboard adaptor unit. The performance of the receiver circuitry that would be used in such a conversion has proved more than adequate for the job. Therefore, plans are in the mill for this conversion. If it all pans out, this will be the subject of a future article.

For a really rugged final test, the HR-20 was compared side by side with a Collins 75S-1. The 75S-1 uses a system of sideband selection where both the HFO and BFO frequencies are shifted with a single switch. This feature, coupled with the better dial ratio, made the 75S-1 easier and more convenient to operate. However, for actual performance, the Heath receiver did not suffer in comparison. Dollar for dollar, the HR-20 will be extremely difficult to beat. In the opinion of the writers, the HR-20 is the best buy on the market today.

. . . W4WKM and W4SYJ

SPECIFICATIONS

Frequency Coverage
- 80 Meters—3.5 to 4.0 mc
- 40 Meters—7.0 to 7.3 mc
- 20 Meters—14.0 to 14.35 mc
- 15 Meters—21.0 to 21.5 mc
- 10 Meters—28.0 to 29.7 mc

Intermediate Frequency
- 3 mc

IF Crystal Filter
- Mid-frequency—3.0 mc
- Bandwidth at —6 db—3.0 kc
- Bandwidth at —60 db—10.0 kc maximum.

Sensitivity
- 1 microvolt or less, at 10 db signal-to-noise ratio.

Panel Controls
- SB1-SB2
- RF GAIN
- AF GAIN, power OFF
- CW/SSB-AM
- NOISE LIMITER OFF-ON
- AVC, OFF-FAST-SLOW
- Main Tuning
- BAND switch
- ANT TUNING