The Second Coming of the Argonaut

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Long-time readers of CQ will recall the original "SSB Argonaut" built by W6AVA for W6UOU in 1957 and sent around the world in an effort to give many DX stations an opportunity to put their country on the air with the then-new mode of s.s.b.[1] It is fitting, therefore, that a new low-power portable s.s.b. rig under development at Ten-Tec, Inc. should also be dubbed the Argonaut. The following article describes the development of the rig from an engineering and design standpoint. Note that this is not a review. The product will not be available for testing for a few more months, but we felt that there was strong reader interest in the thinking that goes into the eventual release of a new piece of gear.

IN today's highly mobile society, the need for a small, light, portable rig is rapidly increasing. Reciprocal licensing, low-cost travel trailers, popularity of camping, proliferation of summer (and winter) homes all call for personal ham gear that is easily set up and takes little space.

For emergency service, stand-by equipment that can operate independently of commercial power is often a lifesaver.

Low power operation (QRP) is a growing facet of Amateur radio. Thousands of hams are finding an exciting challenge in conquering distance with a few potent watts.

With these applications in mind, work started several years ago to create an entirely new miniaturized transceiver that would be (1) ultra-compact, (2) easy to service, (3) operable on s.s.b. and c.w., (4) usable at maximum power that can be reasonably supplied with a 12 volt lantern battery, (5) to operate on the ham bands, 80 through 10 meters and (6) to include features that make operating easy and convenient. The Argonaut fulfills these objectives.

Mechanical Considerations

The output stage presented the most serious problem in total miniaturization, due to the size of the variable air capacitor and the placement of the panel controls. Through the encouragement and help of the RCA engineering department, a broadband final amplifier was developed. Surprisingly, the efficiency compared favorably with a tuned unit—and it was as clean. Just for insurance, however, a TVI filter was designed in to prevent any spurious signals generated in the driver stages from causing any difficulty. With 12 volts input the amplifier loads nicely at 5 watts input.

There are certain areas of miniaturization that can be a detriment. These we tried to avoid. The front panel for instance.

A person's hands need space. Controls should be optimumly located for conven-

The Argonaut s.s.b. transceiver by Ten-Tec.

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[1]Ted Henry, W6UOU, "Adventures of the "SSB Argonaut," *CQ*, May 1960, p. 40.

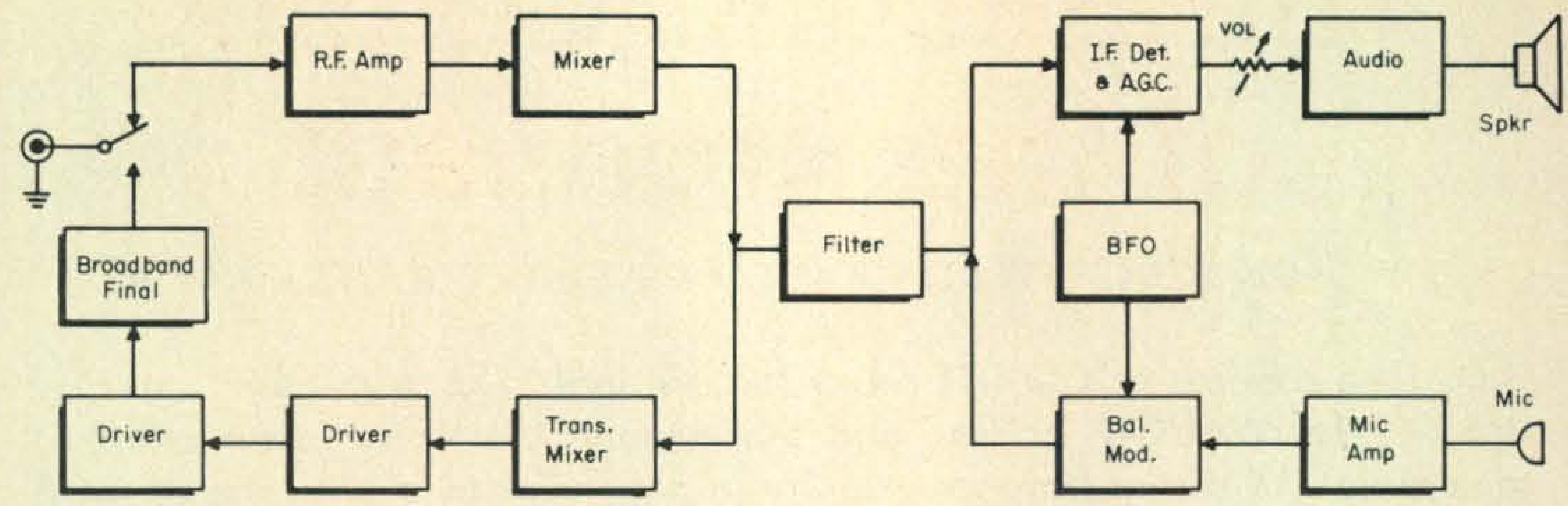


Fig. 1—Block diagram of the Argonaut transceiver.

ience. Dials should be easily read. Accordingly, the geometry dictated a nearly full size front panel, the space saving in depth.

The compact layout meant stacking circuit boards. With conventional inter-wired boards, servicing would be difficult and tedious. A perfect solution was found by designing plug-in boards so that all circuits are accessible. As by-products, field service is minimized and manufacturing done more efficiently.

Circuit

The Argonaut is a single conversion transceiver designed around a 3 mc crystal filter. Figure 1 shows a simplified block diagram of the general circuit layout. The only common elements in the transmit and receive modes are the main oscillator, (v.f.o.), and crystal filter. All switching from transmit to receive is accomplished by applying bias to all the transmit stages or to the receive stages. This method has several advantages. It reduces the standby current drain when receiving and eliminates the usual relay with possible contact trouble and clatter.

The only relay is an r.f. reed relay for switching the antenna from receive to transmit. This allows instantaneous c.w. break-in operation. All stages in the receiver and transmitter are gang tuned by ferrite slugs actuated by an integral molded rack and gear.

Tunable Oscillator

The heart of any transceiver is the main oscillator. In the Argonaut it had to be compact without sacrificing reliability, smooth tuning action and linearity. Linearity on all bands was particularly important so that one slide-rule dial scale reads kc directly. A circular dial below reads 0-100 kc. This construction allows considerable space saving, yet gives the operator a "big set" feel.

With single conversion the mixer injection is at the operating frequency. Consequently, it is difficult to provide identical linear tuning on all bands with this required change in injection frequency without the use of a "premixing" system. The solution was found by using sub-multiples of the injection frequency and shifting the frequency of the v.f.o. Thus, the v.f.o. operates over a narrower range.

The v.f.o. output is then multiplied to the necessary injection frequency. The multiplier output circuits are switched along with the v.f.o. to provide the proper injection frequency. The multiplied output is double tuned to eliminate harmonics and to provide a constant injection voltage across each band. Table I shows the injection frequency, multiple and v.f.o. frequency.

By running the v.f.o. at the frequencies in Table I the linearity can be better than ± 5 kc on 80 through 15 meters and not greater than ± 10 kc on the 10 meter band. However, the entire 10 meter band 28.0-30.0 mc can be covered without additional crystals. This greatly simplifies the dial treatment and enhances the readability of the frequency.

Table 1—Injection Frequencies vs. VFO Frequencies

Band	*Injection Freq.*	*Mult.*	*VFO Freq.*
80	12.5-13.0	×2	6.25 -6.5
40	16.0-16.5	×3	5.333-5.5
20	5.0- 5.5	×1	5.0 -5.5
15	12.0-12.5	×2	6.0 -6.25
10	19.0-21.0	×3	6.333-7.0

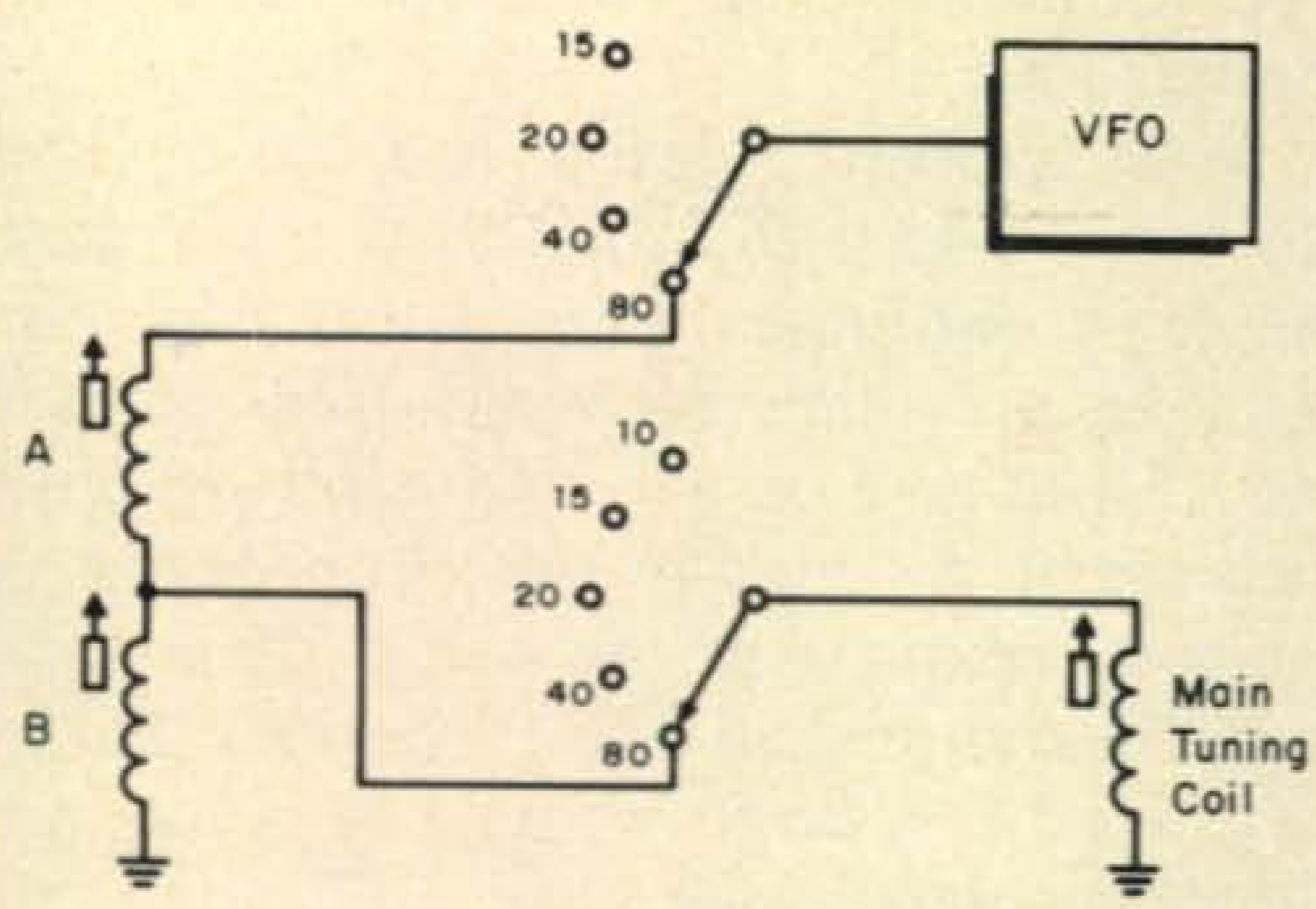


Fig. 2—V.f.o. frequency is shifted to the desired ranges by adding a combination of series and parallel inductances to the main inductor which is permeability tuned through the v.f.o. tuning dial. Different A and B inductances are switch selected for each band.

The round dial is calibrated directly in kc from 0-100. The horizontal slide-rule dial uses the conventional 0-5 markers to indicate which 100 kc segment of the band is being tuned. Ten meters is calibrated separately and covers the range of 28-30 mc. On this band the 0-100 dial will actually read 0-400 kc. This dial is a planetary drive, friction driven from the main shaft and can be precisely calibrated by checking with a frequency standard and the dial rotated to correspond.

The v.f.o. was designed around a permeability tuned coil. Band switching is accomplished by switching an auxiliary coil across the main coil and another in series as shown in fig. 2.

Adjusting both coil A and coil B will set the tuning range and frequency. The powered iron core is driven by a threaded shaft. This is coupled to the planetary speed reducer and results in 25 kc per revolution of the knob.

Receiver

Dual-gate diode protected MOSFETs are used in both the receiver r.f. and mixer stages. The advantages of low noise and efficiency have been covered frequently in past articles. The filter is a four-crystal cascade half-lattice type. It provides a pass band of 2.5 kc at 6 db down points and a 6/50 db shape factor of 1.7. While not the ultimate in selectivity, on-the-air tests prove it to be more than sufficient for reliable communication.

I.F., Detector, A.G.C. and Audio

A single stage bipolar i.f. amplifier feeds another dual-gate MOSFET as a product detector. The detector output is amplified by a three-transistor high gain audio pre-amplifier. The audio derived a.g.c. is taken from this output and controls the r.f., mixer and i.f. stage. The a.g.c. has a fixed fast-attack, slow-decay operation. The point at which the a.g.c. "takes hold" may be varied with the manual r.f. gain control. The a.g.c. figure of merit (the change in input voltage for a 10 db change in audio output) is over 100 db. The audio amplifier drives a self-contained loudspeaker to 1 watt at 2% distortion.

Transmitter

The carrier generator is crystal controlled. Transistor switches select capacitors in series with the crystal to place the oscillator at the proper frequency for u.s.b., l.s.b. and c.w.

The balanced modulator is designed around an integrated circuit differential amplifier. This type of circuit has an excellent balance. All the transistors that make up the differential amplifier are on the same silicon chip. This insures that all the transistor parameters are identical. This type of balanced modulator will hold characteristics quite satisfactorily over a range of supply voltages, input variation and temperature.

The output of the crystal filter and the main injection oscillator is combined in another integrated circuit differential amplifier used as a balanced mixer. The differential balanced mixer is excellent for the suppression of spurious signals. The output is brought to approximately ½ watt by two tuned driver stages. Between the mixer and the final amplifier are three tuned circuits. These tuned circuits aid in further suppression of any spurious signals.

Final Amplifier

The final amplifier is a broad-band design. It will amplify any signal between 3 and 30 mc. It is, therefore, important that all driver stages and mixer are clean. The final output is designed for a 50-75 ohm load. This type of final amplifier has several advantages. It is extremely compact, complicated band-switching and tuned circuits usually found in transistor power amplifiers are eliminated and transceiver tune-up and band-changing are simplified. In addition, the final amplifier may be placed in a convenient location in the transceiver instead of being tied to the usual controls.

Information on the operation of transistors for linear power amplifiers is very

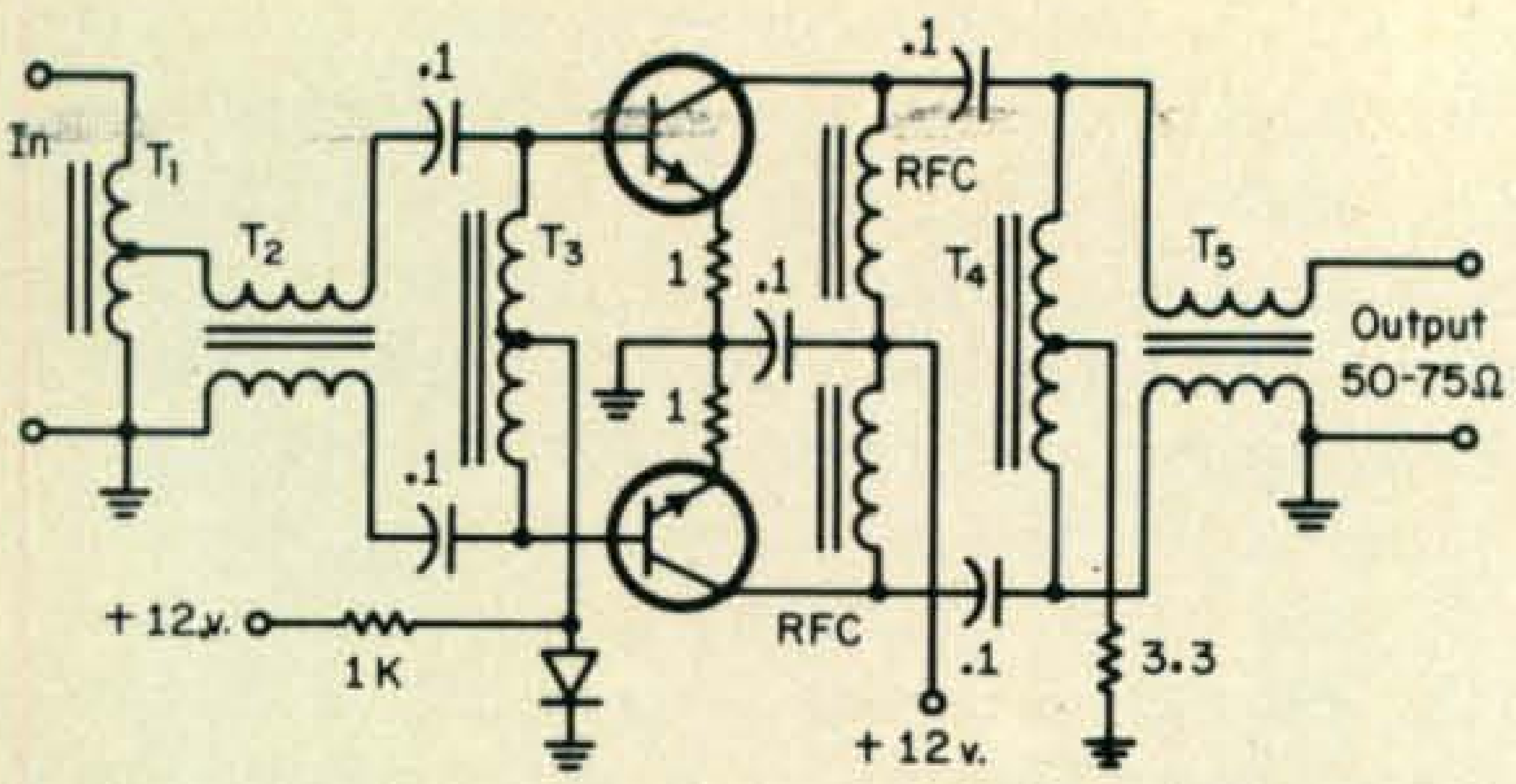
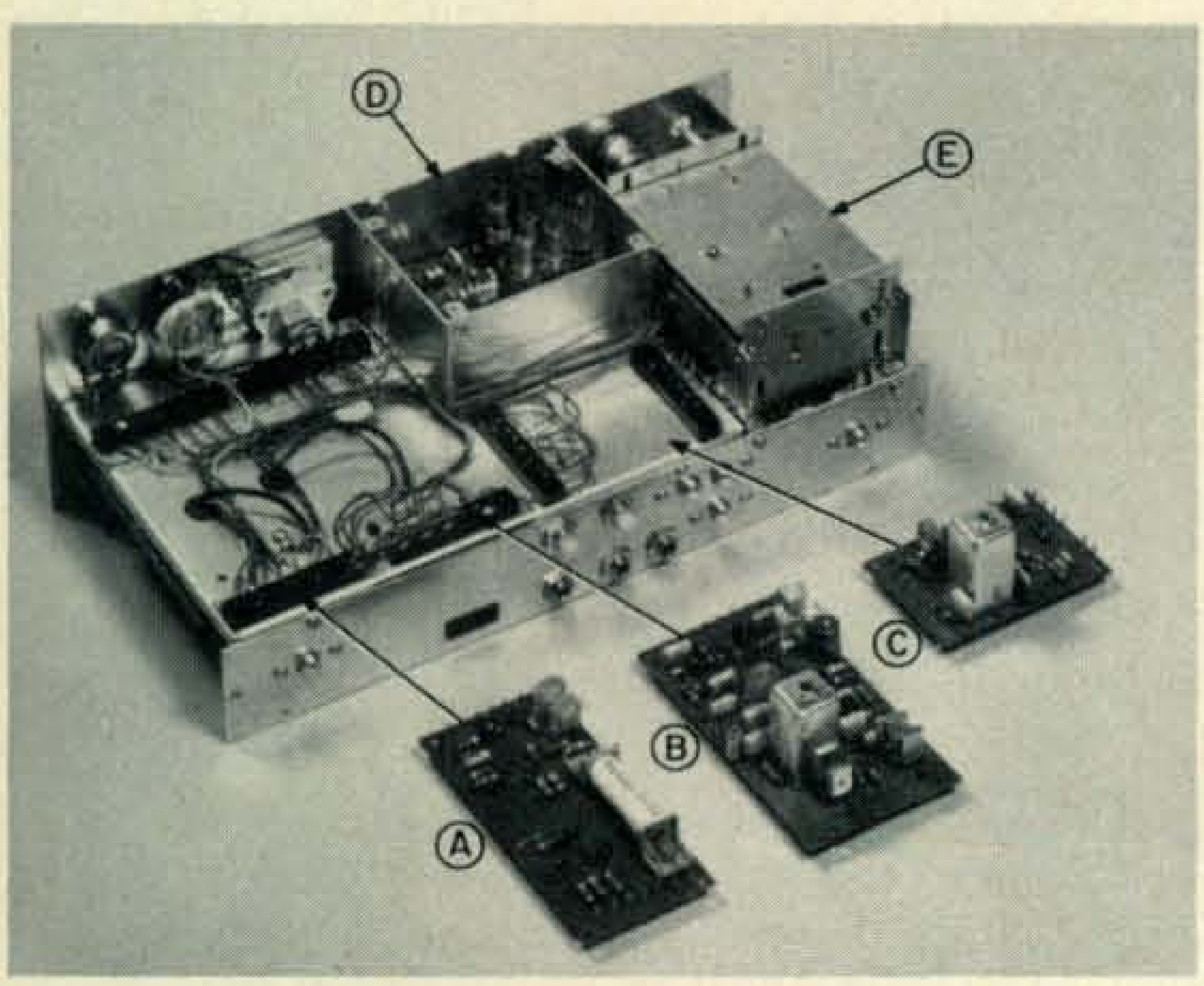


Fig. 3—Circuit of the broad band final amplifier used in the Argonaut. T_1, T_2 and T_3 are 20 t. twisted #32 bifilar wound on an Indiana General CF102 toroid. T_4 and T_5 are 15 t. twisted #28 bifilar wound on a CF108 toroid. *RFC* is 25 t. #28 on a CF102 toroid.

sparse. In general, the output transistor should be capable of a slight forward bias, necessary for linear operation, without catastrophic failure. It should also have a linear gain with respect to the final current. Tubes are usually capable of greater power output in the s.s.b. mode than in c.w. Transistors are just the opposite. It is generally possible to obtain several times as much power in c.w. than s.s.b. This is due to the lack of sufficient current in the device to handle high peak. The distortion products increase rapidly as current saturation is approached. When the transistor is overloaded in the c.w. mode this current saturation does not affect



The Argonaut s.s.b. transceiver soon to be released by Ten-Tec. (A) Control board contains antenna relay, regulated power supply, transmit-receive changeover, S-meter and receiver offset tuning circuits. (B) S.s.b. generator contains mic amplifier, balanced modulator, carrier oscillator, mode switching, and crystal filter. (C) Transmitter and receiver mixers. (D) Main v.f.o. compartment. (E) Rack drive for gang-tuning receiver and transmitter.

the performance. The schematic of the final is shown in fig. 3.

A word about the design may be of interest to those who would like to try it in some home brew equipment. Transistor input impedance usually runs between a few ohms to 10 or 15 ohms. For a broad-band design it is necessary to match this impedance to roughly 50 ohms over the bands of interest. This is accomplished with toroidal baluns T_1, T_2 and T_3. A large inductance is required for low frequency response and small distributed capacity for the high frequency response. Cores having high permeability, such as Indiana General Q1 material, should be used. The input transformers are approximately 20 turns of twisted wire on a CF102 toroid form. All transformers are bifilar wound to reduce stray capacity and insure balance. Step down transformer T_1 may or may not be necessary depending upon the transistor input impedance. The transistor output impedance is also relatively low. For amplifiers in the 5 to 10 watt class, the circuit shown should work perfectly. Transformers T_4 and T_5 are bifilar wound on the larger CF108 core. They will match the transistor to 50-75 ohm load over the bands of interest. For linear operation, the bias, a 1000 ohm resistor and a diode, should be adjusted for an idle current of 8 to 15 milliamperes.

The design parameters were pointed toward simplicity in operation. To provide features that were most desirable, but to eliminate those which might be a source of trouble.

Operation

To place in operation it is only necessary to select the mode and band, resonate a single control and select the frequency. On transmit, it is desirable to trim the resonance control for maximum reading on the built-in s.w.r. bridge. S.s.b. is actuated by a press-to-talk button on the microphone. C.w. instant break-in and side-tone are built-in. Incremental tuning is provided for reception to prevent "leap-frogging" when working other transceivers.

The Argonaut is designed to be powered by a 12 volt lantern battery or an a.c. pack. Battery life is indeterminate as the normal amateur operation is so intermittent. Preliminary tests indicate that several weeks operation of two hours a day can be expected.

[*continued on page 96*]

6M IC Preamp. [*from page 63*]

Results

Signal gain is about 25 db with the 9 volt dual supply. With my receiver, the Lafayette HA-800, the preamplifier is self-limiting. That is, it will not overload, but give 100 μv output (S-9) irrelevant of the changing amplitude of the input signal. This feature is especially desirable when tracking mobiles. ■

CQ Reviews: Standard [*from page 36*]

by. This goes for all brands, not just Standard.

Standard has a good reputation in honoring its warranties. With the better quality control and workmanship indicated by the later production models, the need for warranty work should decrease.

The Standard SR-C826M can be seen at many local amateur dealers. It comes with crystals for four channel combinations, installation hardware, microphone, line filter, and manual for $339.95. Information is available on this Japanese import from Standard Communications Corp., P.O. Box 325, Wilmington, California 90744.

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Argonaut [*from page 62*]

Performance

To mix a metaphor, the proof of the pudding is the on-the-air operation. As may be expected, the performance or QSOs-per-call increases with frequency. When 10 is open, one almost forgets he is using low power. On 15 and 20 it performs well enough to work all continents on phone and c.w. using a TH6DX antenna 50′ high.

As a mobile rig, it surprised us. On 20 meters, K4DCD worked KG6AYL on s.s.b. A little later he worked VK5FM on c.w. Both QSOs were solid and with respectable reports. No installation was necessary, the Argonaut just plugs into a cigar lighter and antenna.

It takes a little more skill and patience to work 40 and 80 meters. With low power, one should pick an uncrowded section of the band, call *good* signals which indicate skip is favorable.

We are hopeful that the Argonaut will expand the horizons of amateur radio. ■

Motorola 80D on 220 mc [*from page 54*]

a satisfactory value. The multiple coils are easily modified. L_6 has one turn shorted, on