Front view of the Atlas 210 solid state transceiver. Despite the small size of the unit, all controls are full size and easily manipulated.

CQ Reviews: The Atlas 210 and 215 SSB Transceivers

BY JOHN SCHULTZ,* W2EEY

ANYBODY who happened to see W6QKI at the ARRL Convention in New York City last year operating the Atlas 180 transceiver from a portable battery pack must surely have been impressed. The day of a fully solid-state, portable h.f. rig of reasonable power had arrived. Both the Atlas 180 and the battery pack could be taken under one arm and one would have a completely portable station running 180 watts PEP input on 160, 80, 40, and 20 meters!

Herb Johnson, W6QKI, the President of Atlas Radio, is not new to introducing exciting products to amateur radio. He was one of the founders of Swan Radio and active in developing its product line for many years.

The 180 was the first Atlas product to come on the market and it, as well as the current 210/215 models, borrows heavily from circuitry developed for military/industrial communications applications. Most of the circuitry used was developed by SouthCom International for use in their military transceiver AN/URC-78.

General Specs

Perhaps the first impression one gets about the 210 or 215 is that it is small. As can be seen in the photograph, it is easily held in one hand. The dimensions are 9¼" wide, 3½" high and 9¼" deep overall. The weight is 8 lbs. Contained inside this little package is a complete transceiver of exceptional performance.

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The major specs as Atlas claims them for the 210 and 215 are as follows:

Band Coverage: 210 model: 3700-4050, 7000-7350, 14,000-14,350, 21,100-21,450 and 28,400-29,100 kHz. The 215 deletes 10 meters but adds 1800-2000 kHz. The restricted coverage of some bands is due only to the basic 350 kHz v.f.o. used. Full coverage of 80, 15 and 10 is possible with an external v.f.o. without any other modifications.

Modes of Operation: U.s.b., l.s.b. and c.w.

Power Input/Output: 200 watts PEP or c.w. input and minimum of 80-100 watts PEP or c.w. output on all bands (except 120 watts input on 10 meters for the 210). RTTY and SSTV modes are not specified.

Load Impedance: 50 ohms resistive for rated power output. Infinite v.s.w.r. protection for output transistors.

Carrier and Sideband Suppression: 50-60 db at 1000 Hz.

Harmonic Suppression: 35 db below peak output.

Receiver Sensitivity: 0.3 μv for 10 db signal/noise ratio.

Selectivity: Crystal lattice filter at 5520 kHz i.f., 8 pole.

Image Rejection: 60 db or better.

Audio Output: 2 watts max. into built-in speaker.

Metering: Reads S units on receive, amplifier collector current (0-16 amps) on transmit.

Power Requirements: 12-14 v.d.c. Draws 0.2

to 0.4 amps in receive mode and 16 amps *peak* in transmit mode.

The above specs are not all there is to the 210/215, but are presented mainly to illustrate that the 210/215 claims to be much more than just a compromise type transceiver. Except for band coverage, the 210/215 claims to be as good or better than the 25-60 lb. tube-type transceivers most of us have on our operating tables.

Being completely solid-state, the 210/215 makes use of broadband tuning circuits for both the receiver and transmitter functions. There are no tuning controls except for the v.f.o. In spite of the broadband tuning of the receiver input circuits, a claimed design feature is "exceptional" immunity to overload and cross modulation which matches or exceeds the best tube-type designs. Obviously, Atlas was willing to stand by its claim since the usual "fudge-factor" input attenuator common to solid-state receiver designs is not present.

The 210/215 emphasizes modular design. Not all of the PC boards are plug-in, however, only the main ones which contain active devices, except for the power amplifier stages. The controls visible on the front panel photo are all there are. No hidden controls or switches are on the back panel which contains only the various connectors for microphone, antenna, key and accessory items.

Basic Circuitry

Figure 1 shows a block diagram of the stage arrangement. The heart of the circuitry is the dual use of the i.f. amplifier/mixer chain in both the receive and transmit modes. In the receive mode, the 210/215 performs as a single conversion receiver with an i.f. of 5,520 kHz. The signal is introduced via a set of bandswitched low pass filters to a set of bandswitched 4 pole bandpass receiver input filters and then directly to the first balanced diode mixer *without* r.f. preamplification. The v.f.o. signal, which operates 5520 above the i.f. on 160, 80 and 40 and 5520 kHz below it on other bands, is also injected into the mixer The resultant i.f. signal travels through Q_{101}, a low noise amplifier stage, and thence via the i.f. filter and IC i.f. amplifier to the second balanced diode mixer, injected with the crystal controlled carrier oscillator signal, acts as a product detector. Normal a.f. amplification follows via two IC stages.

In the transmit mode, the first balanced diode mixer serves as the usual diode ring modulator being fed with the transmitter audio and carrier oscillator signals. Sideboard selection is accomplished by the i.f. filter plus use of the desired carrier oscillator frequency for u.s.b. or l.s.b. The second mixer serves as a frequency conversion stage and with injection of the v.f.o. signal and i.f. signal produces a signal output

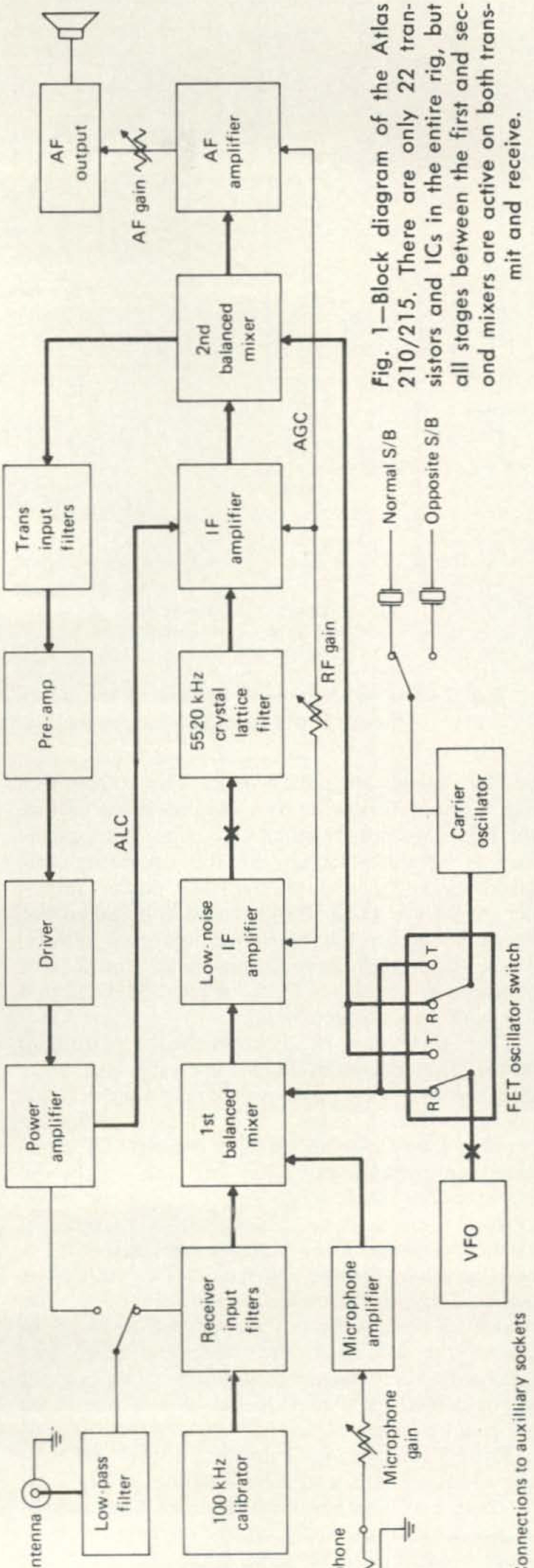


Fig. 1—Block diagram of the Atlas 210/215. There are only 22 transistors and ICs in the entire rig, but all stages between the first and second mixers are active on both transmit and receive.

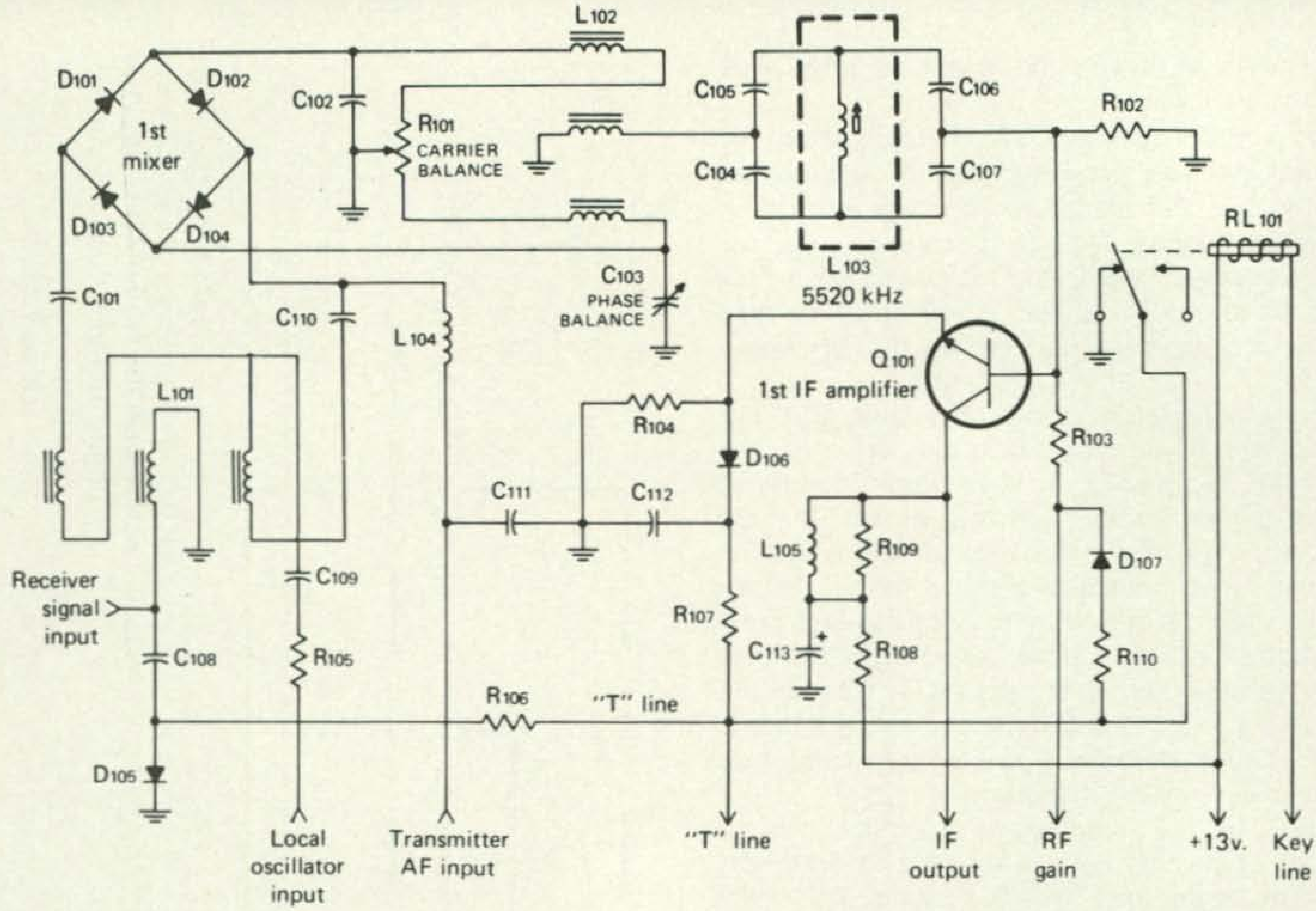


Fig. 2—The most unusual feature of the Atlas 210/215 is the use of a diode balanced mixer, without r.f. pre-amplification, in the receiver, followed by a low-noise i.f. amplifier.

on the desired frequency band. The transmitter input filters following the second mixer select the mixer output. Further s.s.b. signal amplification is straight-through at the operating frequency via Q_{501} through Q_{504}. The power amplifier stages are broad-banded and coupled to the antenna via the bandswitched low pass fiilters. These dual half-wave filters have cutoff frequencies from about ½ to several MHz above the high end of each band.

C.w. operation is accomplished by shifting one of the carrier oscillator crystal's frequency into the i.f. filter passband by capacitive loading. An offset of about 600 Hz is provided to prevent leap-frogging on c.w. contacts. A combined amplified a.g.c./a.l.c. line acts on the IC i.f. amplifier stage Q_{201}. A.g.c. action is audio derived and the a.l.c. action, although not obvious from fig. 1, is actually derived from a built-in s.w.r. bridge. Normal a.l.c. voltage is detected by the forward power pickup of the bridge. Excess reflected power pickup acts to cut-off the i.f. chain thus reducing drive and protecting the power transistors. C.w. keying is performed by the i.f. to cut-off via this same a.g.c./a.l.c. chain.

The "device count" doesn't appear impressive—only 4 IC's and 17 transistors! But, most of them are working *all* the time! The success of the scheme depends mainly on two things—those balanced diode mixers and the switching of the v.f.o. and carrier oscillator signals between the mixers. Both techniques are discussed later in some detail.

Receiver Performance

Input signals from the antenna are first routed through the bandswitched low pass filters which always remain in the antenna line, then via the bandswitched receiver input bandpass filters and finally to the double balanced first mixer (fig. 2).

The first mixer is similar to the second one in the use of 1N4148 diodes and trifilar wound toroid transformers for input and output coupling. Interestingly enough, the diodes are not some super-sophisticated types but silicon types selling at about 30 cents each from G.E. The first mixer output goes to a 5520 kHz i.f. transformer and then to the first amplifying device in the receive chain—a 2N3866. Manual r.f. gain control is applied to this stage via a potentiometer which varies the forward bias. The output of this stage goes first to the 8 pole crystal i.f. filter and then to a conventional MC1350C second i.f. amplifier which has a.g.c. applied. With all the passive components on the input of the receive line one might imagine that the sensitivity would be rather less than spectacular. Atlas claims a minimum sensitivity of 0.3 μv for 10 db signal/noise ratio. The measured results were:

160 — .25 μv	15 — .28 μv
80 — .20 μv	10 — .33 μv
40 — .15 μv	
20 — .15 μv	

One can convert the μv figures for a 20 db signal/noise ratio by multiplying them by approximately 3 times. The 210 or 215 appears as sensitive or more sensitive than most transceivers on the market which do have an r.f. preamplifier stage.

The general impression that one gets when operating the 210 or 215 in receive is how similar the bands sound as to when using a direct conversion receiver. The main impression is the remarkable lack of signal "garbage" and clutter generated usually by front end overload and poor image rejection. Signals seem to pop out of a quiet background.

The 8 pole filter is extremely effective. Numbers and measurement figures on such things as front-end overload and filter bandwidth are certainly interesting, and if everyone were consistent in measurement, useful for comparison purposes. But, they can also rapidly loose meaning when trying to describe actual operating experiences. The 210/215 was tried extensively in the Saturday/Sunday morning mayhem which exists on the phone bands on the East coast. Probably no receiver in this world will ever be able to offer enough selectivity, sensitivity and overload protection to separate all the DX from the locals and unscramble all the W's from each other. But, the 210/215 performed as well as an expensive communications receiver using mechanical filters and costing several times the price of a 210 or 215.

For c.w. reception under extreme QRM, additional selectivity is undoubtedly desirable. Atlas at the moment does not provide a c.w. filter. However, they did bring the leads from the installed s.s.b. filter to an accessory socket on the rear of the 210/215. So, one could break the i.f. chain at this point and insert additional selectivity. A 2 pole crystal filter with 100-200 Hz bandwidth can be worked in series with the s.s.b. filter. This should provide excellent c.w. selectivity at low cost.

The audio derived a.g.c. used works very well. A signal input range of from 5 μv to 3 volts produces only a 4 db change in the audio output level. The only thing in the audio chain that might deserve a bit of criticism is the built-in 3" speaker. On the units tested, it had a slightly tinny ring to it. There is a provision for the plug-in of an external speaker. The 2 watts of audio output is more than sufficient, even for mobile use.

The "feel" of the tuning on a transceiver is another one of those things which defies definition by a set of numbers but yet determines very much over a period of time whether one is going to enjoy using the unit. The feel of the tuning on the 210/215 is very good. Smooth and with no backlash. The tuning rate on all bands is 15 kHz/revolution except on 160 where it is about 9 kHz and on 10 where it is 30 kHz/rev.

For c.w. and with a sharp c.w. i.f. filter installed, the tuning rate would be excellent. The main dial is calibrated every 5 kHz. With the slow tuning rate one can easily count down to 1 kHz and spaced markers on the main tuning knob make the job easier.

A 100 kHz calibrator is built-in and produces strong markers. Why 50 cents or so more wasn't spent to include an IC divider to obtain markers every 25 kHz is not clear. It is a simple thing, of course, to add such a divider to the calibrator if desired.

Transmitter Performance

The same i.f. chain used in the receive mode is used to develop the s.s.b. signal. The basic d.s.b. signal is generated in the first low-noise, diode, balanced mixer at either 5520 kHz or 5523.3 kHz, depending on the sideband chosen. U.s.b. is automatically produced on 20, 15 and 10 meters and l.s.b. on 40, 80 and 160. A front panel switch allows for opposite sideband selection when desired. The "switching around" of the first mixer to function either as the receiver input mixer in the receive mode or as the d.s.b. balanced modulator in the transmit mode is accomplished in a simple but ingenuous fashion. Referring to fig. 2 which shows the first mixer in detail, it can be seen how the switching of inputs is accomplished. In the receive mode, the "T" line going to R_{106} is at zero volts. Diode switch D_{105} is open and allows receiver input signal to go to L_{101}. The local oscillator (v.f.o.) signal is routed to L_{101} via C_{109} and R_{105}. The transmitter a.f. input coupled via r.f. choke L_{104} has been grounded via a diode switch similar to D_{105} on another PC board. On transmit, the "T" line is at +13 volts and diode switch D_{105} shorts out the receive input signal. The local oscillator input becomes the carrier oscillator input (via another switching arrangement described later). The transmitter a.f. input is fed to the diode modulator from the microphone amplifier. A similar type of switching arrangement converts the second mixer to either a product detector on receive or mixer for the purpose of translating the 5520 kHz s.s.b. signal to the desired output band on transmit.

The v.f.o. is a three stage affair with two buffer stages. Its frequency range is switched depending upon the band in use. Stability is excellent, being in the order of 100 Hz per hour after warmup.

The 8-pole crystal filter following Q_{101} performs the single side-band selection. Atlas makes a definite point of the fact that they chose a filter with a 6 db bandwidth of 2.7 kHz to handle an audio response of 300 to 3000 Hz rather than a 2.4 or 2.1 kHz wide filter. They point out that "it has been convincingly proven that transmission and reception of the audio frequencies between 2400 and 3000 Hz provides a substantial improvement in real signal readability." There might be some argument on this point. All that can be said here is that reports of excellent audio quality and signal punch were received. Atlas recommends the use of a quality microphone with a smooth response from 300 to 3000 Hz, one example of which might be the Shure 404 C.

The second mixer converts the 5520 kHz s.s.b. signal to the output band frequency. It might be interesting to see at this point how the v.f.o. and carrier oscillator signals are switched back and forth to either the first or second mixer.

The diagram of the "switch" is shown in fig. 3. Essentially, it is a solid-state equivalent of a d.p.d.t. switch using FET's as the switching elements. The transmitter "key line" is at +13 volts on receive and at 0 volts on transmit. The opposite is true for the "T" line shown. On receive, Q_{304} and Q_{305} are pinched off by about +10 volts. Q_{303} and Q_{306} are conducting with only about +0.7 volts on their gates. Thus the v.f.o. signal flows to mixer #1 and the carrier oscillator signal to mixer #2. On transmit, the opposite happens with Q_{303} and Q_{306} pinched off, etc. It's a handy circuit to remember for use as a solid-state low-level switch.

Following translation to the output frequency, the real power buildup comes in the stages contained in a separate power amplifier module (really a large heat sink enclosure) mounted on the rear of the transceiver. The r.f. buildup is via a 40446 as a preamplifier, a 2N5490 as driver and two 2N6459's as finals. All stages are coupled by broad-band transformers. The nominal 12 volt input power line to the transceiver is permanently connected to the latter two stages. Only the low-level 12 volt circuits are affected by the front-panel on-off switch. A bias switching transistor associated with the driver and final stages assures that they draw no significant current unless the low-level 12 volt circuits are activated. The final stage is rated as 200 watts input (except on 10) on s.s.b. and c.w. and a minimum output of 80 watts. Measurements made showed the following for output at 13.6 v.d.c.:[1]

160 — 93 watts	15 — 90 watts
80 — 102 watts	10 — 42 watts
40 — 90 watts	
20 — 84 watts	

RTTY and SSTV modes were not tested but it would appear that the 210 or 215 could run at a reduced power input of around 100 on these modes.

Those who have seen solid-state 2 watt transmitters completely ruin nearby TV reception because of their high harmonic collector currents and output, may wonder what 200 watts of solid-state can do. Not much in this case. Through the shielding provided by the completely enclosed power amplifier module and the use of bandswitched low-pass filters harmonic radiation is 35 db down from peak output. This is sufficient for mobile use but for home use in fringe area more harmonic attenuation will probably be necessary, the same as with almost any transceiver on the market today.

A far more significant item to watch when using the 210/215 (or any new solid-state, broad-band transmitter) is that of having an *exact* antenna/transmission line match to the output of the transmitter. A tube type rig with an adjustable pi-network output can match a small but definite range of impedances. However, with a broadband, solid-state rig there is no adjustable pi-network and fig. 4 shows what happens to the output power of a rig such as the 210/215.

Most mobile antennas on the market today do not provide a non-reactive load of 50 ohms at their resonant frequency. They may provide a "nominal" 50 ohm load but that won't do for solid-state rigs. Therefore, when using a rig such as the 210/215 for mobile applications, it must be matched far more closely to the antenna used. Atlas markets a toroid, broadband matching transformer (the MT-1) which converts from 50 ohms to selectable impedances of 13, 18 or 23 ohms. These impedances are closer to the "real" ones presented by most center loaded mobile antennas. The taps may have to be changed when bands are switched.

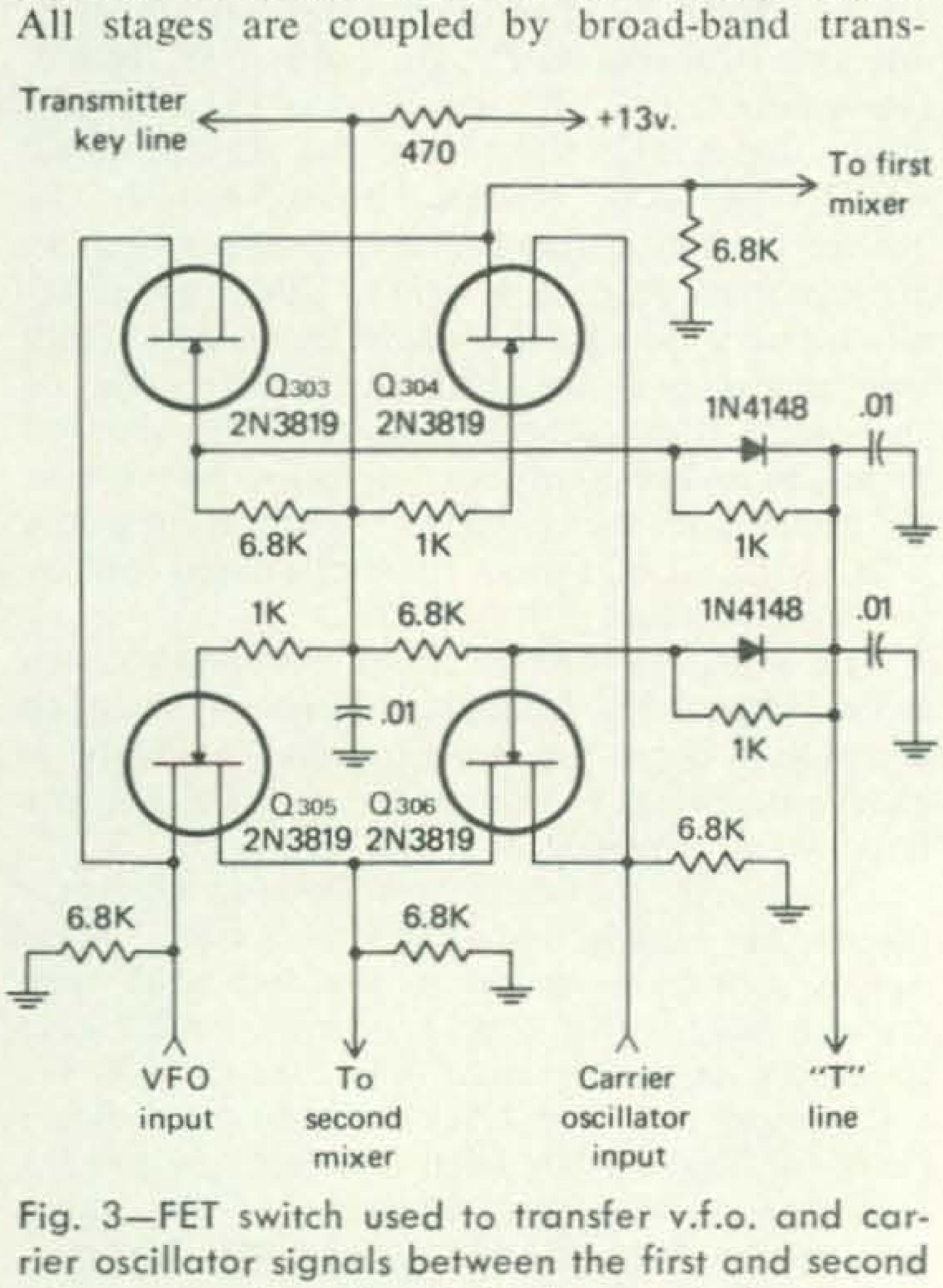


Fig. 3—FET switch used to transfer v.f.o. and carrier oscillator signals between the first and second mixers. Functionally, it is the equivalent of a d.p.d.t. relay.

[1] Values shown are worst-case figures for two units tested where both units cover the same band. Same as for receiver sensitivity.

S.W.R.	Nominal Power Output (*Watts*)
1.0	100
1.1	98
1.2	95
1.3	90
1.5	80
2.0	50
3.0	20

Fig. 4—Output power vs. s.w.r. for the Atlas 210/215 transceiver. Note the particularly sharp decrease in output power when s.w.r. rises above 1.5:1. This characteristic is common to broadband solid-state transceivers using high-s.w.r. protective circuitry.

For home station operation, the amateur using a simple dipole or beam will almost certainly require a matching network between the barefoot 210/215 and his antenna on 20, 40 or 80 meters to achieve maximum power output over the entire band. Working into a linear generally will present no problem if it has the usual input broadband Pi or L network, although these networks may have to be optimized for 50 ohms instead of the usual sloppy tolerances which tube-type transceivers can accommodate.

Excessive s.w.r. protection and a.l.c. operation in the 210/215 is provided by a built-in reflectometer or s.w.r. bridge using a toroidial transformer as the pickup element on the transmitter output line. Voltage pickup proportional to the reflected power level is used to reduce r.f. drive via the a.g.c./a.l.c. loop. Several tests confirmed the effectiveness of this circuit involving no-load conditions.

Tune-up is normally accomplished in the c.w. mode and in this mode the front-panel microphone gain control is automatically switched to function as a carrier level insertion control. The a.l.c. control is brought out as a front panel control as a dual potentiometer arrangement with the microphone gain potentiometer. This arrangement allows an optimum setting of the a.l.c. level to be achieved for each band.

S.s.b. signal reports confirmed clean and articulate modulation. Higher order distortion products are at least 30-35 db down. C.w. keying, which is accomplished by means of cut-off of the i.f. chain, shows no sign of clicks. No c.w. monitor is built in although one can be easily added.

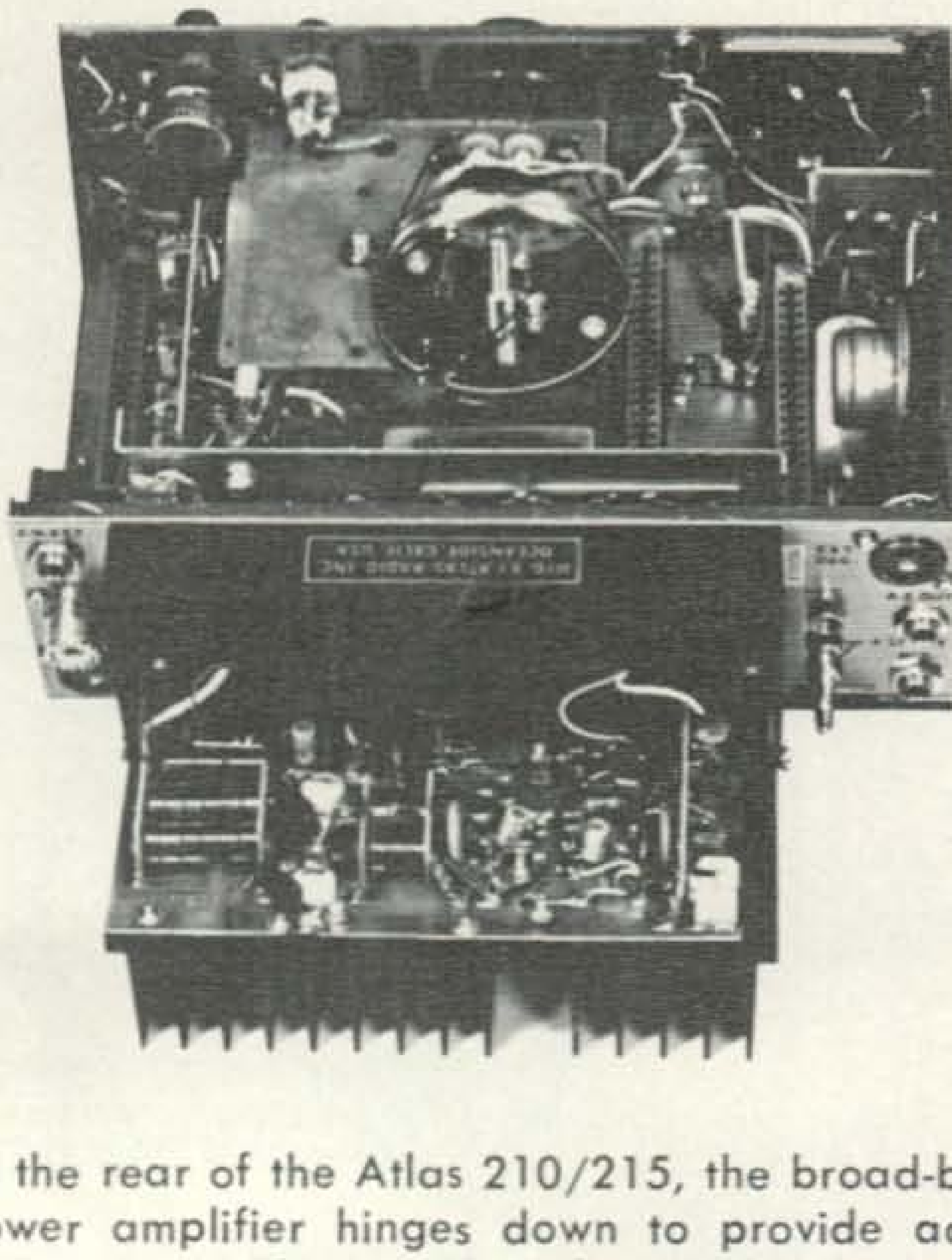
Switching between receive and transmit modes on s.s.b. is conventional. Either a PTT button on a microphone, or the front panel function switch can be used. Unfortunately, things are not so simple of c.w. Using the same front panel switch one would have to go from REC through TRANS and to CW and then back each time the receive/transmit function is performed. This arrangement is certainly not acceptable for a lot of c.w. activity. Fortunately, all the lines which have to be switched are terminated also as points on the accessory sockets on the rear of the transceiver. Semi-break-in, for instance, could be achieved by an external keyer which activated a time delay circuit and relay which accomplished the necessary switching or one could run a line to a miniature d.p.d.t. toggle switch set next to or on the base of the key to use for manual receive/transmit switching.

Frequent reference has been made to the various sockets on the rear of the 210/215. Specifically, there are sockets for r.f. output, external speaker/headphones, microphone, c.w. key, external oscillator and another simply marked "accessory socket." It accesses linear amplifier switching, a.l.c. input from a linear, provision for c.w. filter insertion in the i.f. chain and just about every operating voltage and switching function.

Wiring and Construction

The construction and wiring can be rated as excellent. The wiring was examined carefully and no trace of poor workmanship could be found. The plug-in boards are held tightly in place by brackets or other support means. A nice feature about all of the controls, switches and sockets is that they are screw mounted instead of riveted. Therefore even if something

[*continued on page 65*]



At the rear of the Atlas 210/215, the broad-band power amplifier hinges down to provide access to PA wiring. The toroid-stack-cores for the broadband transformers are visable towards the left. Missing from this view are the plug-in PC boards and the drum dial which sits above the dial cord pulley at the top center.

detector was now at hand for s.s.b. reception. And, most important, the cost of building such a hand-crafted receiver had sky-rocketed, and it seemed impractical, or rash, to continue with the project. Regretfully, it was shelved.

L'envoi

Jim Millen has been in the "wireless" business for 50 years. The Millen Company continues, although all of the pre-war competitors of years ago have long since disappeared. *No large communications company that made amateur communication receivers pre-war is in the business today!* James Millen ran his first advertisement in 1922 in *Radio News*. Today—over fifty years later—if you look in the advertising pages of *CQ*, you will see an advertisement for his present company! *CQ*, and the author of this article, salute a great radio amateur and pioneer, Jim Millen, and his famous HRO receiver, the first *modern* communication receiver! ■

Announcements [*from page 8*]

They will operate on 40 meters, phone and cw; 20 meters, phone and cw; and 2 meter FM. The Novice Bands will be kept active on 40. Shows and exhibits will be all day in Van Cortland Park in The Bronx.

● **Trenton, Tennessee** – The Annual Humboldt ARC Hamfest is Sunday, May 18th at Shady Acres City Park, Trenton, TN. For information, contact: Hugh Wardlaw, WB4SLI, 2678 Cole Dr., Humboldt TN 38343. ● **Knoxville, Tennessee** – The Radio Amateur Club of Knoxville is pleased to announce that it's annual Greater Knoxville Hamfest will be held on May 24th and 25th 1975. Activities will be located in the Jacobs Building at Chilhowee Park, Knoxville. More information for SASE from WA4 BTK, 1316 Kirby Road., Knoxville, TN 37919. ● **Rochester, New York** – The FCC will conduct amateur radio examinations at the Western New York Hamfest, in Rochester, NY, on Saturday, May 31st for General and higher class licenses. Examinations requiring a code test (13 or 20 wpm) will begin at 10 am. Those not requiring a code test (advanced class) will begin at 1 pm. Applications should be submitted with the $4.00 filing fee no later than May 23rd to the FCC, Room 1005 Customhouse, Second and Chestnut Sts., Philadelphia, PA 19106. ● **Burlington, Kentucky** – The Kentucky HAM-O-RAMA will take place Sunday, June 1, at the Boone County Fairgrounds, Burlington, Kentucky. Located 10 miles south of Cincinnati, Ohio near I-75. Advance tickets, $1.50, for information, contact: WA8OGS, 6381 Mullen Road, Cincinnati, OH 45239. ● **Oglesby, Illinois** – The Starved Rock Radio Club's annual Hamfest is June 1st at the Bureau County Fairgrounds in Princeton. A long SASE is required for information an/or advance registration. Write, G.E. Keith W9MKS/W9QLZ, RFD no. 1, Box 171, Oglesby, IL 61348. (815) 667-4614. ● **Winfield, PA** – The Twelvth Annual Penn-Central Hamfest will be held by the Williamsport and Milton clubs on Sunday, June 1st, 1975 at the Union Township Volunteer Fire Co. grounds on route 15 in Winfield, PA. For more information, write, West Branch Amateur Radio Association, c/o Allan Owen, WA3OWT, 2901 Highland, Ave., Montoursville, PA 17754.

CQ Reviews Atlas [*from page 27*]

should give out eventually, a simple repair or replacement effort is all that is needed.

Instruction Manual

The instruction manual starts off well enough with some general circuit description, hints for mobile installation and then the basic schematics, but PC board layouts and complete parts numbering for replacement purposes are lacking.

Accessory Items

Desk mounted consoles which include a built-in a.c. power supply and two types of mobile mounts are available (one a completely plug-in affair and the other a support bracket with manual plug-in of external cables).

The MT-1 mobile whip matching transformer is also available. Other accessories still to be produced are an accessory v.f.o., a semi-break in keyer/monitor unit and possibly a c.w. filter.

Summary

The 210 or 215 is not a transceiver loaded with frills but its basic performance is very good to outstanding. It is definitely s.s.b oriented for the mobile amateur but there is no reason why it could not be adapted to become the heart of a home station also for both s.s.b. and c.w. For portable operation with a nic-cad battery pack it opens up possibilities for portable operation about which one can only speculate. The frills that are missing can be added if one is a bit handy with circuit work.

For instance, one could easily enough put in digital frequency readout via a preprogrammed counter since only one frequency conversion is involved. Plenty of room exists if the dial drum is removed. The disadvantage is that a TTL counter will draw much more current than the receiver alone and this may restrict the versatility of the transceiver for portable use. A c.w. monitor and VOX are easy to install or can be used as external accessories. The restricted coverage on some bands can be shifted to cover desired portions of a band by retuning the internal v.f.o. Full coverage of any band can be achieved by an external v.f.o. since only the range of the internal v.f.o. (350 kHz on most bands) restricts individual band coverage. The broad-band receiver/transmitter circuits fully cover each band.

The Atlas Models 210 and 215 are available from dealers throughout the USA, and are manufactured domestically by Atlas Radio Inc., 490 Via Del Norte, Oceanside, CA 92054. Either model costs $599. Power supply console for 117 volt operation is $129. —*W2EEY*