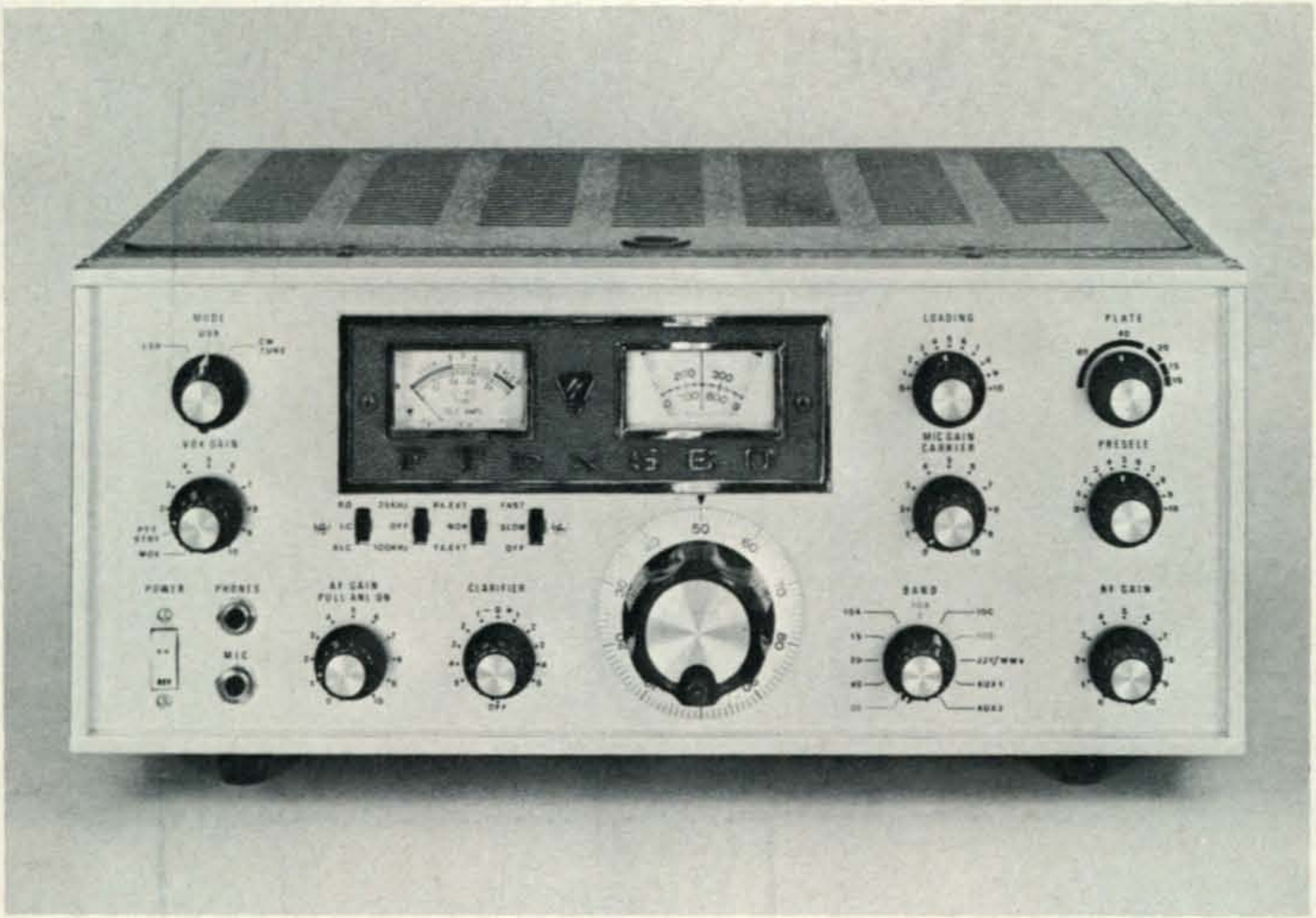

The Yaesu Musen FTdx560 S.S.B./C.W. Transceiver.

CQ Reviews:
The Yaesu Musen FTdx560 Transceiver

BY WILFRED M. SCHERER,* W2AEF

WE'VE come across many pieces of amateur gear of foreign manufacture, both good and poor, but the FTdx560, made in Japan, has been found to be an excellent unit both electronically and mechanically. It not only offers many features found only in the most sophisticated domestic jobs, but it also includes additional features as standard equipment.

The FTdx560 is an s.s.b./c.w. transceiver that functions with a transmitter p.e.p. input of 560 watts for s.s.b. and d.c. input of 500 watts for c.w.

It provides full coverage of the 3.5-28 mc amateur bands and is supplied with all crystals, including those for the full 28 mc band. There also is a 10-10.5 mc range for WWV reception in addition to two auxiliary-band positions where appropriate crystals may be installed and associated circuitry connected to provide transceive operation on any two other 500 kc segments within the 3-30 mc range (except 5.2-5.8 mc).

Each range is covered with an identical linear-tuning rate with frequency calibrations at 1 kc intervals. A high-ratio tuning control is equipped with a spinner-type knob.

*Technical Director, *CQ*.

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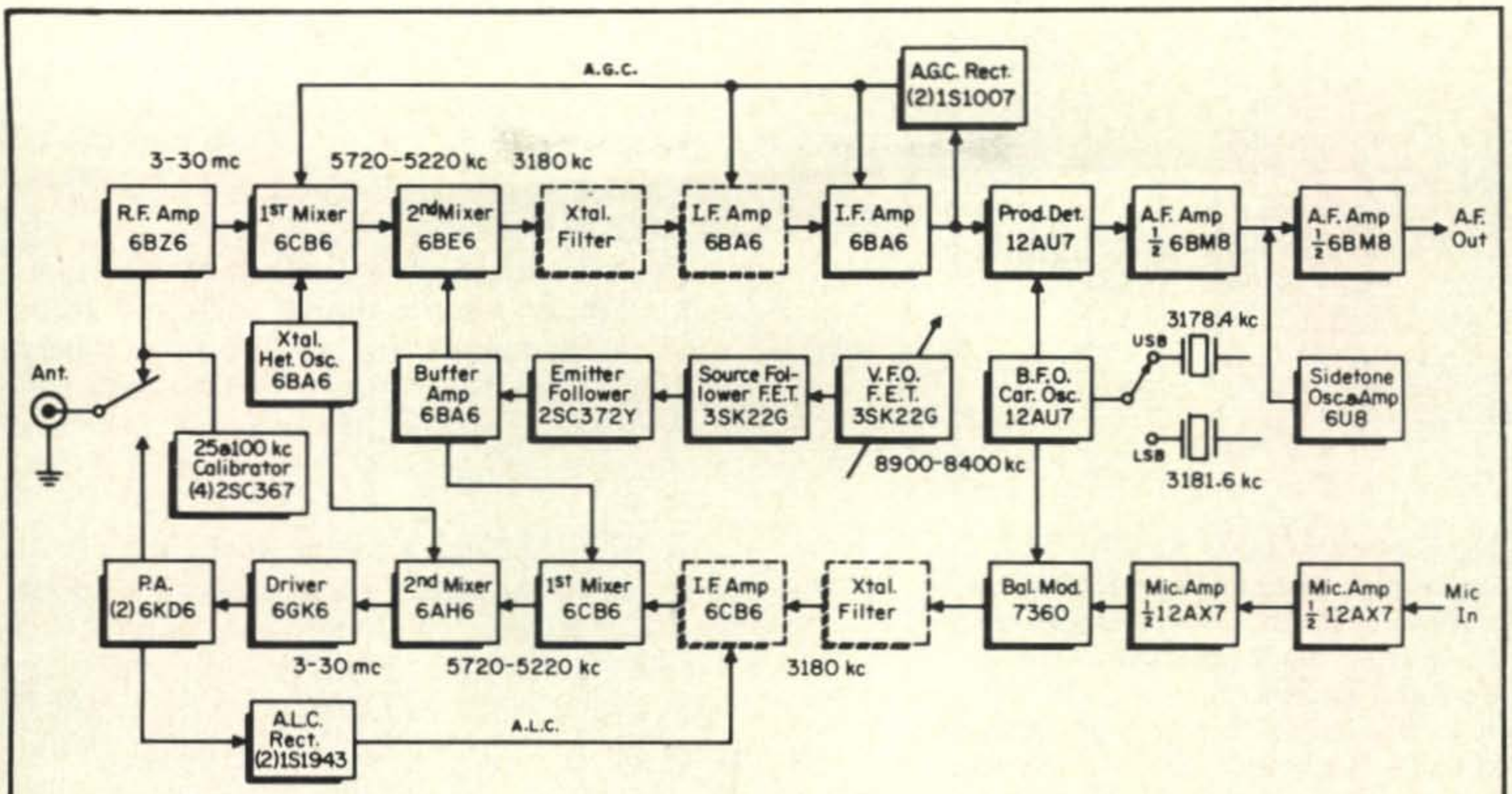

Fig. 1—Block diagram for the FTdx560. Dashed blocks are common to receiver and transmitter. Crystal frequencies and other details are given in the text.

Either u.s.b. or l.s.b. operation may be selected on any range. A "CLARIFIER" control furnishes incremental tuning to allow up to ±5 kc frequency-offset operation on receive

A high order of frequency stability is attained with an f.e.t. v.f.o. Provisions are also included for split-frequency operation using an external v.f.o. accessory, for which front-panel switching is provided. This v.f.o. unit includes four crystal positions, allowing Novice operation also, and at reduced power levels.

The output of a crystal-controlled calibrating setup provides accurate marker signals at the 100 or 25 kc points.

Selectivity or sideband selection is obtained with a 2.3 kc filter having a 1.6:1 shape factor. An optional 600 c.p.s. bandpass filter is available for c.w. operation and is automatically switched in when the transceiver is set for the c.w. mode (as normally supplied, the 2.3 kc filter is used for c.w.).

P.t.t. or built-in v.o.x. operation may be had with the v.o.x gain adjustable from the panel. V.o.x. type break-in or manual operation is used on c.w. for which waveshaping of the keying is provided. There is also a sidetone monitor.

Fast or slow a.g.c. may be selected and a meter may be switched to indicate p.a. cathode current, receiver S-units, a.l.c. level and relative power output. A noise limiter also may be switched in or out.

A.f. outputs of 8 and 600 ohms are available. An accessory socket provides voltages and control circuits for operating external gear, together with which are provisions for use of a 6-meter transceiver accessory. There also is a phone-patch input.

The power supply is built-in. This is a special feature not usually found in transceivers. You don't have to horse around an additional unit. It is a solid-state job built with attractive styling and is set up for convenient operation. The size is 6¼" × 15¾" × 13¾" (H.W.D.) and it weighs 40 lbs.

Conversion Scheme

Dual conversion is used throughout in the FTdx560 as shown at the block diagram at fig. 1. On receive the 1st conversion is made to a 5720-5220 kc bandpass i.f., the 2nd to a 3180 kc fixed i.f. On transmit the signal is generated at 3180 kc with the 1st conversion made to the 5720-4220 kc i.f. and the 2nd to the output signal frequency.

A crystal-controlled oscillator is used for the 1st receiver conversion and the 2nd transmitter conversion. The crystal-controlled frequencies are the signal frequency at the low end of each range plus 5720 kc.

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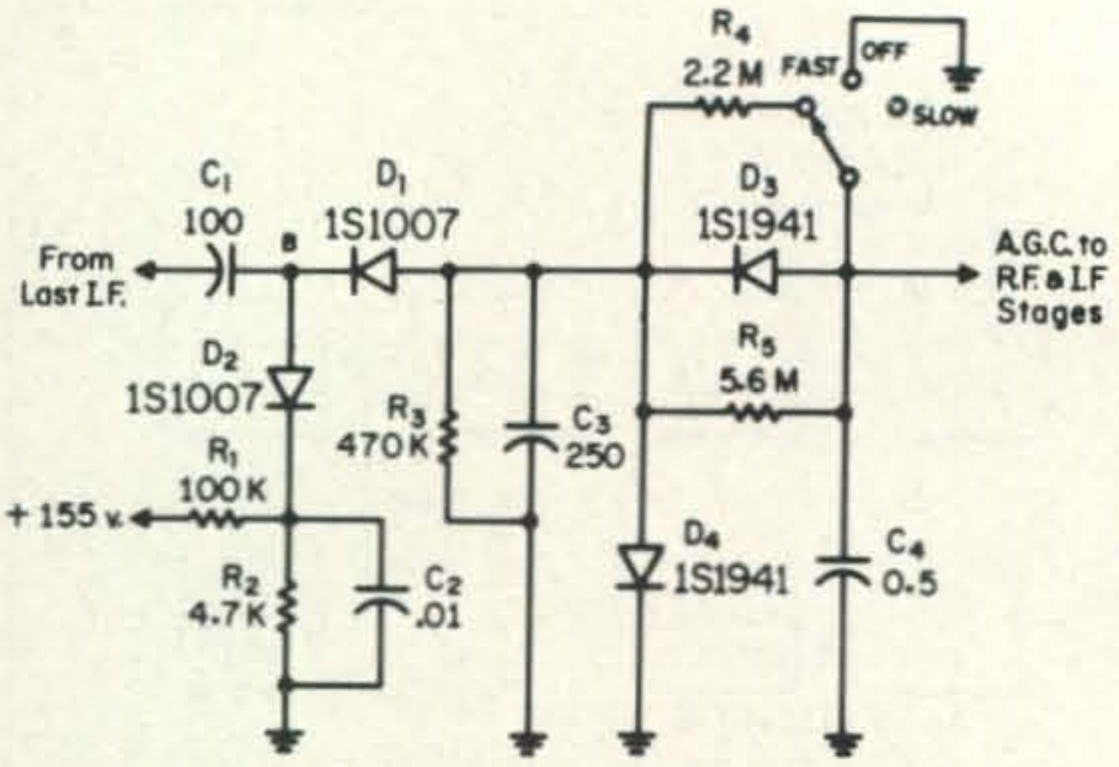

Fig. 2—A.g.c. setup for FTdx560. D_1, D_2 make up a voltage-doubling rectifier. A small fixed positive voltage a *A* reverse-biases D_2 into non-conduction, until the positive value of the voltage at *B* exceeds that at *A*. D_2 thus cannot perform its function for voltage doubling on weak signals. The overall result is delayed a.g.c. On the attack, the negative voltage that appears at D_3 cathode causes D_3 to conduct, allowing C_4 to quickly charge and the a.g.c. voltage to instantly appear on the a.g.c. line. On the release, D_3 is biased into non-conduction by the charge on C_4 which then discharges through R_3 and R_4 or R_5 at a rate depending on whether or not R_4 is engaged. D_4 provides a minimum bias on the a.g.c. line, due to the barrier potential of the diode.

Circuit Details

Preselected-tuning is used at the r.f. stage for the receiver. Separate inductors are used at the input for each band with the antenna individually coupled to each one. This always ensures the same 50-ohm input. A parallel-tuned series-connected trap at the antenna-input line is tuned to 5470 kc to minimize signal-input leakthrough at the 1st i.f.

The bandswitch for the preselector tuned circuits at the input and output of the r.f. stage has two unwired auxiliary positions. When an auxiliary range is to be set up, the desired positions may be connected to any of the existing preselector inductor/capacitor combinations that will resonate on the desired auxiliary-frequency range. This would be limited in most cases to a range adjacent to one of the amateur bands, such as for MARS work, since the preselector circuits have a limited range in themselves. For other cases, additional suitable *L/C* combinations may be installed, for which mounting brackets are already in place for securing the slug-tuned inductors that would be involved.

The bandswitch at the crystal-controlled oscillator is a similar setup where two spare crystal sockets are wired to the extra switch contacts. Other spare switch contacts are already wired with the trimmers that would be needed in conjunction with existing circuitry.

To further improve i.f.-signal rejection, there are two series-tuned 5470 mc traps each shunted across the mixer output. These may be individually tuned to the same frequency or stagger-tuned if necessary for more uniform rejection over the whole i.f. passband.

A 5720-5220 kc bandpass-coupled circuit with toroid inductors is used between the 1st and 2nd mixers. The 3180 kc s.s.b. filter is a 6-pole crystal-lattice job. An additional filter with a 600 c.p.s. bandpass may be installed for c.w. use. The filters are switched in or out of the circuit by means of diode switches both at the input and output of each filter. This enables the insertion of either filter to be made with a d.c. control circuit to simplify switching at the panel. Stray coupling around the filters also is minimized, resulting in good isolation for avoiding spurious responses outside of the passband.

One half of a dual triode functions as the product detector, while the other half is a cathode-follower for matching the b.f.o. output by means of cathode coupling to the product detector. The b.f.o., or carrier oscillator, is a dual triode, each section of which functions as a crystal oscillator. One oscillator operates with a 3178.5 kc crystal for u.s.b. use, the other with a 3181.5 kc one for l.s.b. Sidebands are changed by switching between either of the two oscillators. This is done by opening and closing the cathode return of the triodes accordingly. The v.f.o. frequency is not conjunctively shifted, so it must be retuned by 3 kc when sidebands are changed.

The r.f. gain controls the cathode bias of the r.f. and i.f. stages.

A.g.c. is obtained from a voltage-doubling rectifier at the i.f. output, using a small d.c. voltage to provide a delay on weak signals and charging diodes to ensure a fast attack. The setup is shown at fig. 2.

The crystal-controlled heterodyning oscillator is a pentode with a Pierce type circuit for the crystals used between the grid and screen. For 3.5 and 7 mc operation, the plate is tuned to the crystal frequency. For 14, 21 and 28 mc use the crystal frequency is tripled at the tube plate. The crystal frequencies for these bands thus are one-third that re-

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quired for the heterodyning frequency.

Output from the oscillator is obtained from a link winding on the plate inductors which is in series with the cathode return of the receiver mixer. The oscillator signal required for the transmitter is obtained by capacitive coupling between the oscillator plate and mixer grid.

The noise limiter is an a.f. type and precedes the 1st a.f. amplifier. It is a simple affair as shown at fig. 3.

V.F.O.

The v.f.o. employs an f.e.t. in a series-tuned Colpitts-type circuit. Output is obtained from the source of the f.e.t. and is applied to the gate of another f.e.t. that functions as a source-follower buffer amplifier coupled o the base of a bipolar-transistor amplifier. Output from its emitter goes to a pentode buffer amplifier that has a 8400-8900 kc band-pass-coupled output to the grids of the 2nd mixers. This amplifier also serves as a buffer for an external v.f.o. A high degree of isolation is provided by the various stages after the oscillator proper, thus ensuring excellent overall stability with changes in loading.

Temperature compensation of the v.f.o. is precisely adjustable by a differential capacitor that can be set to provide the optimum ratio of compensation between a zero-temperature and a negative-temperature coefficient capacitor.

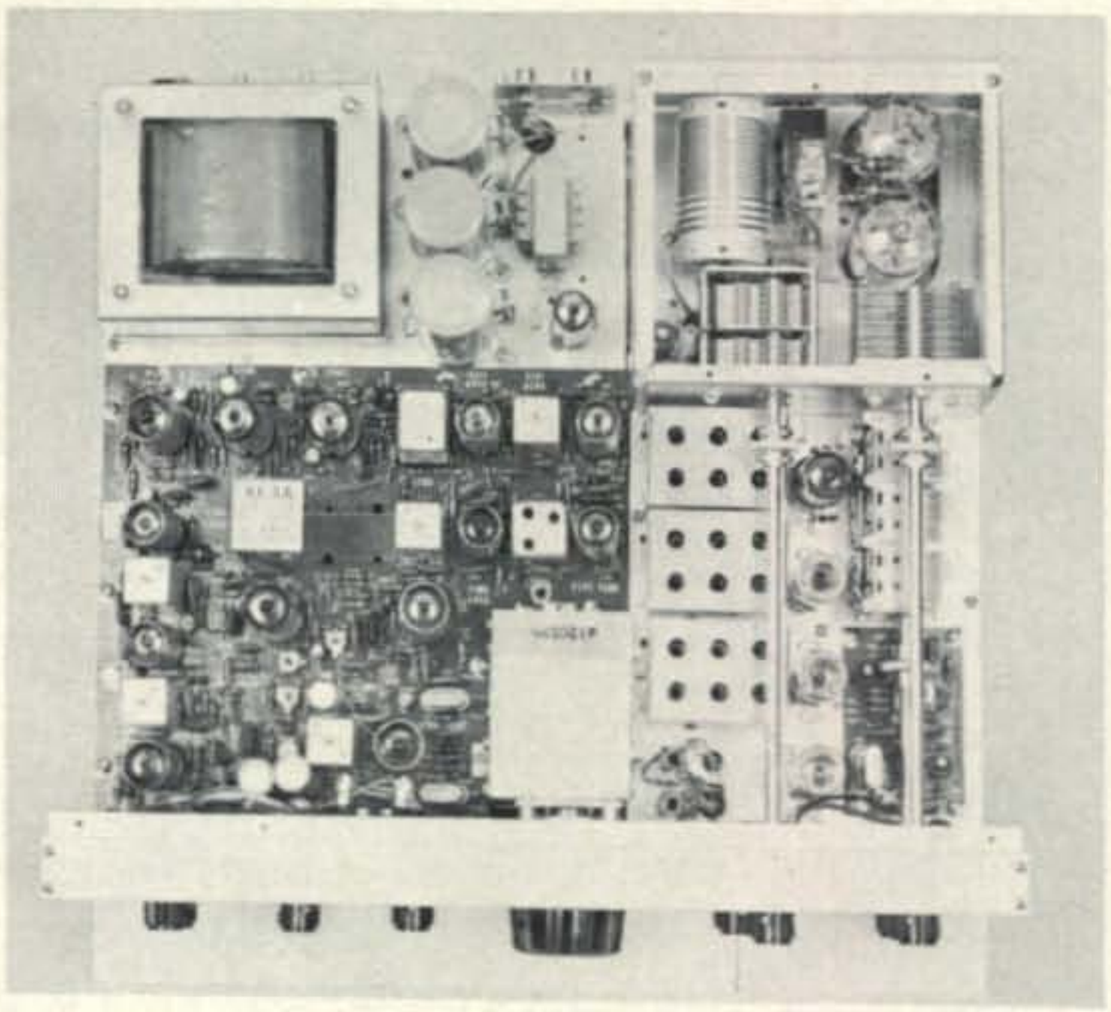
Incremental tuning is provided by a variable-capacitance diode that is added to the oscillator tuned circuit and controlled during receive by a d.c. voltage adjustable at the panel. On transmit it is automatically disengaged by the control relay.

Calibrator

The calibrator is a transistorized 100 kc job with a succeeding 25 kc multivibrator followed by an amplifier. Either the 100 kc or the 25 kc signals may be selected by a panel switch.

Transmitter

Two stages of speech amplification are used ahead of the balanced modulator which utilizes a 7360 sheet-beam deflection tube with typical circuitry. A stable carrier balance is maintained through the use of a regulated operating potential for the 7360. Pentodes are used for both mixers with signal and oscillator injection made at the control grids.



Top view of the FTdx560. The p.a. is in the enclosure (with cover removed) at upped right. R.F. inductors are in the shielded boxes with holes on top along right section. The v.f.o. is in the box at front center.

The 6GK6 driver is stabilized with neutralization and parasitic suppressors at the grid and plate. The tuned circuits at the input are the same ones used for the preselector at the plate of the receiver r.f. stage. The circuits at the driver output are ganged with the receiver preselector tuning. The receiver and transmitter r.f. drive circuits are thus simultaneously peaked with one control.

The p.a. has two 6KD6 TV sweep-type tubes which have greater power-handling capabilities than many other similar types. Grid and plate parasitic suppressors plus capacitance-bridge neutralization provide stable operation. This is enhanced by different capacitors switched in one leg of the bridge network for each band to ensure optimum neutralization in each case.

A Pi-network output is designed for operation into essentially non-reactive loads of 25-100 ohms presenting an s.w.r. within 2:1. This is done by various size fixed capacitors switched in for loading on each band, together with a variable loading capacitor. An unusual feature here is that different value fixed capacitors also are switched across the plate-tune capacitor in order to maintain the proper Q and optimum impedance matching to the tube plates on all bands.

As at the receiver r.f. circuits, there are two spare positions at the bandswitch for the driver output and the p.a. tank. These may be wired to the necessary components or to

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taps on the p.a. tank for operation on the auxiliary ranges. In this respect the p.a. tank inductor is wound on a grooved ceramic form that has a recess along its length to allow any turn to be easily accessible for tapping.

In order to prevent accidental transmission on the WWV range, no connections are made to the above switches at this position.

A conventional a.l.c. system is incorporated in the FTdx560.

V.O.X.

The v.o.x. setup, not indicated at fig. 1, is conventional, except for an adjustable control that allows the bias on the relay tube to be set for optimum pull-in of the relay. It is of particular value for operation with c.w. and in cases where changes in tube characteristics may impair good v.o.x. operation, a situation often experienced with usual systems.

Another feature of the v.o.x. is that the v.o.x. gain control is located on the panel. It is equipped with a switch that at the OFF position activates the transmitter for tuneup or manual c.w. operation. When the control is first advanced, the switch operates and sets up the transmitter for p.t.t. operation. When the control is further advanced, v.o.x. operaion is available simply due to the fact that sufficient gain is now provided from the speech amplifier to operate the v.o.x. The other normal v.o.x. controls are finger-adjust types on the rear of the set.

C.W. Operation

Grid-block keying is used for c.w. at the 2nd transmitter mixer. Waveshaping for minimizing key clicks is done with a 1 henry and a 0.5 mf combination in the keying line.

The necessary carrier is obtained by unbalancing the modulator at one of the 7360 deflection plates. This is done with the mode switch that also inserts a control by which the degree of unbalance may be adjusted to provide the desired carrier level. The switch also disables the speech amplifier and sets up the sidetone oscillator which is a phase shift type with an 800 c.p.s. tone. It is followed by a triode amplifier (with an internally adjustable gain control) coupled to the receiver output amplifier. The grid-block keying also is applied to the tone oscillator and the relay-control tube. The control tube is not keyed by the tone, as sometimes is the case, which together with a fast-charge diode, results in quick relay pickup. The diode also ensures instantaneous v.o.x. action with voice operation.

In order to place the carrier within the filter passband, the frequency of the u.s.b. crystal (the one used for c.w. work and tune-up) is shifted accordingly by switching a capacitor across the crystal. This is handled by a transistor switch arranged in a fast-acting switching network that during receive on key-up returns the frequency to normal.

Power Supply

The built-in power supply is a solid-state affair using full-wave bridge rectification at two individual h.v. secondaries of the power transformer to provide potentials of 315 and 800 volts. There also is a bias supply. A VR tube used to provide a regulated potential of 105 volts is used for the balanced modulator, the crystal oscillators and the screen grids of several intermediate stages.

Zener diodes are often used in modern equipment to provide a regulated low voltage for operating transistors; however, their stability for use in connection with a solid-state v.f.o. often leaves something to be desired for maintaining optimum frequency stability with supply- or line-voltage variations, such as may occur with s.s.b. operation, resulting in incidental frequency modulation. In the FTdx560, extremely good voltage regulation for the v.f.o. is had by using an electronic voltage regulator consisting of two transistors with zener reference diodes. Its operating voltage is obtained from a stiff source derived from an individual low-voltage winding on the power transformer.

Two primary windings on the transformer may be connected in parallel or in series for 117 or 234 volt operation respectively. These are also tapped for use with slightly lower voltages.

There are no provisions for mobile operation with an external 12 v.d.c. supply. Although this could be set up, it would require rewiring of the tube heaters which are now connected in parallel for 6.3 volt operation.

Construction

The FTdx560 is neatly built on a heavy-gauge chassis together with a rugged panel with a die-cast escutcheon for the meter and main-dial windows. Much of the assembly is made on one large printed-circuit board. All components appear to be of top quality.

The r.f. inductors for the receiver and the

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low-power transmitter stages are completely and individually shielded. The p.a. is installed in a separate enclosure. The v.f.o., including its tuning capacitor, is likewise enclosed in an individual shielded compartment. Access holes thereat are covered with a removable metallic-coated tape which thus provides *complete* shielding and eliminates the flow of air through the v.f.o., thereby improving stability under various environmental changes.

The v.f.o. is operated by a high-ratio drive covering 15 kc with one revolution of the knob. Spring-loaded split gears are utilized for maintaining an accurate calibration and eliminating backlash. There are two scales on the main dial. These have reference calibrations at the 25 kc increments with the major 100 kc points identified on a black 0-500 kc scale and a red 500-1000 kc scale. A dial at the tuning knob shaft is calibrated in 1 kc steps of 0-100 about 1/8" apart. This dial may be manually slipped on the shaft for precise calibration indexing. The frequency readout is the sum of the reading on the two dials plus the frequency representative of the range at the bandswitch setting the band identification is color-coded for correlation with the main-dial scale).

An SO-239 coax connector is used for the antenna; phono jacks are used for other functions. The mic jack accepts a standard 3-circuit phone plug, while jacks for headphones and the c.w. key accept a standard two-circuit phone plug. These are supplied with the unit.

Performance

The FTdx560 is handy to operate and on-the-air performance leaves little to be desired. The a.f. quality on both transmit and receive was found to be pleasant with clean sounding signals, although in some cases with very strong signals a slight reduction in the r.f. gain was needed on receive to maintain the cleanest signal.[1] The noise limiter was quite effective, although a bit of distortion on an s.s.b. signal was sometimes experienced. However, the intelligibility was not impared, especially in view of the extent to which the signal might not otherwise have been readable in the presence of heavy impulse noise.

The v.o.x. system functioned smoothly and quietely—a relief from some of the clattering setups we've experienced.

No adverse key clicks were observed on c.w. The keying was clean, but somewhat on

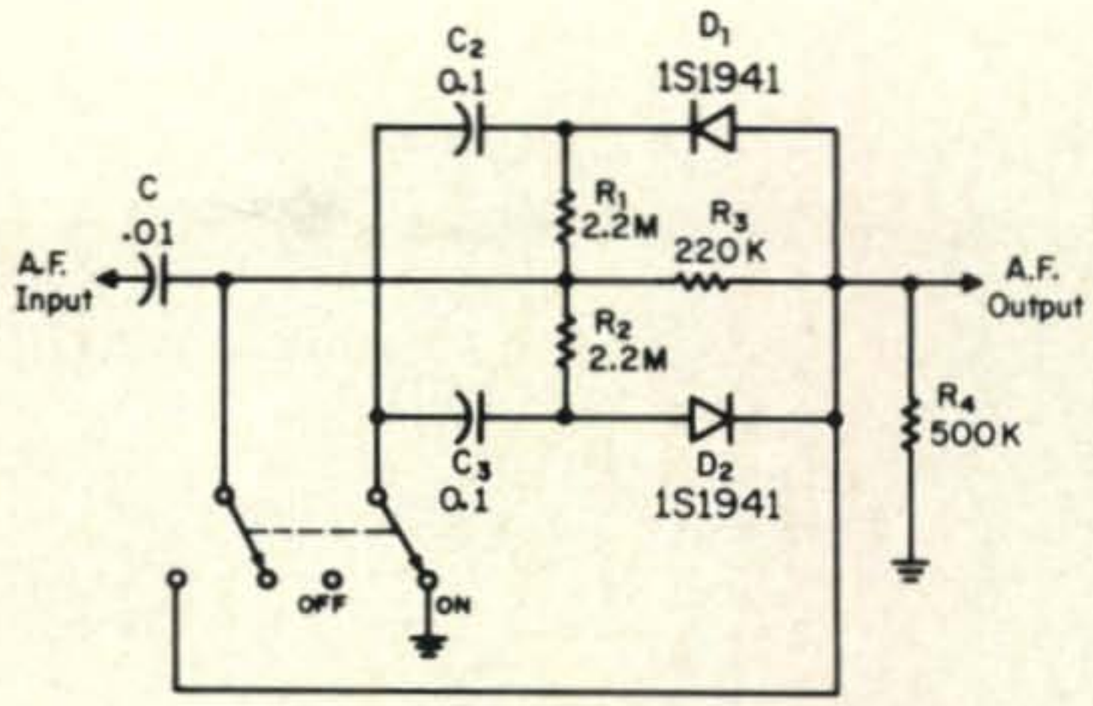

Fig. 3—Circuitry for the simple a.f. type noise limiter used in the FTdx560.

the "soft" side due to a slow rise time, making characters (particularly dots) noticeably shortened with the overall effect of a lisping and lilting signal.[1]

The v.o.x. type break-in could be set as fast, if not more so, as with other similar systems. No shortening of characters was due to hesitancy in the v.o.x. keying setup. Semi-break-in, of course, may be set up using the v.o.x. delay. The sidetone monitor keyed cleanly with a pleasant and stable tone and without chirping. The unit on hand did not include the c.w. filter, so performance in this respect could not be evaluated.

As noted earlier, switching sidebands requires retuning the v.f.o.; however this can be done without retuning (during receive only) by intelligent use of the incremental tuning (clarifier). In any case, retuning the v.f.o. exactly 3 kc is a simple expedient.

One thing that requires getting use to, is that the meter works backwards on a.l.c. and S-units. Also, the p.a. cathode-current position is identified in an unfamiliar way as *IC*, which it really denotes.

The a.g.c. works smoothly without pumping effects, but as will be seen from the measurements, there is little difference between the fast and slow positions. A.l.c. also works well with only a slight rounding off of r.f. peaks at maximum compression.

Fine performance also is indicated by the results of the following lab measurements (figures in parenthesis denote the rating where given in the manual):

RECEIVER SENSITIVITY (0.5 μv for 20 db S+N/N, at 14 mc): 0.2 μv or less for 10 db S+N/N on all bands, except 3.5 mc, 0.3 μv; BAND-TO-BAND GAIN: Within 3 db referred to

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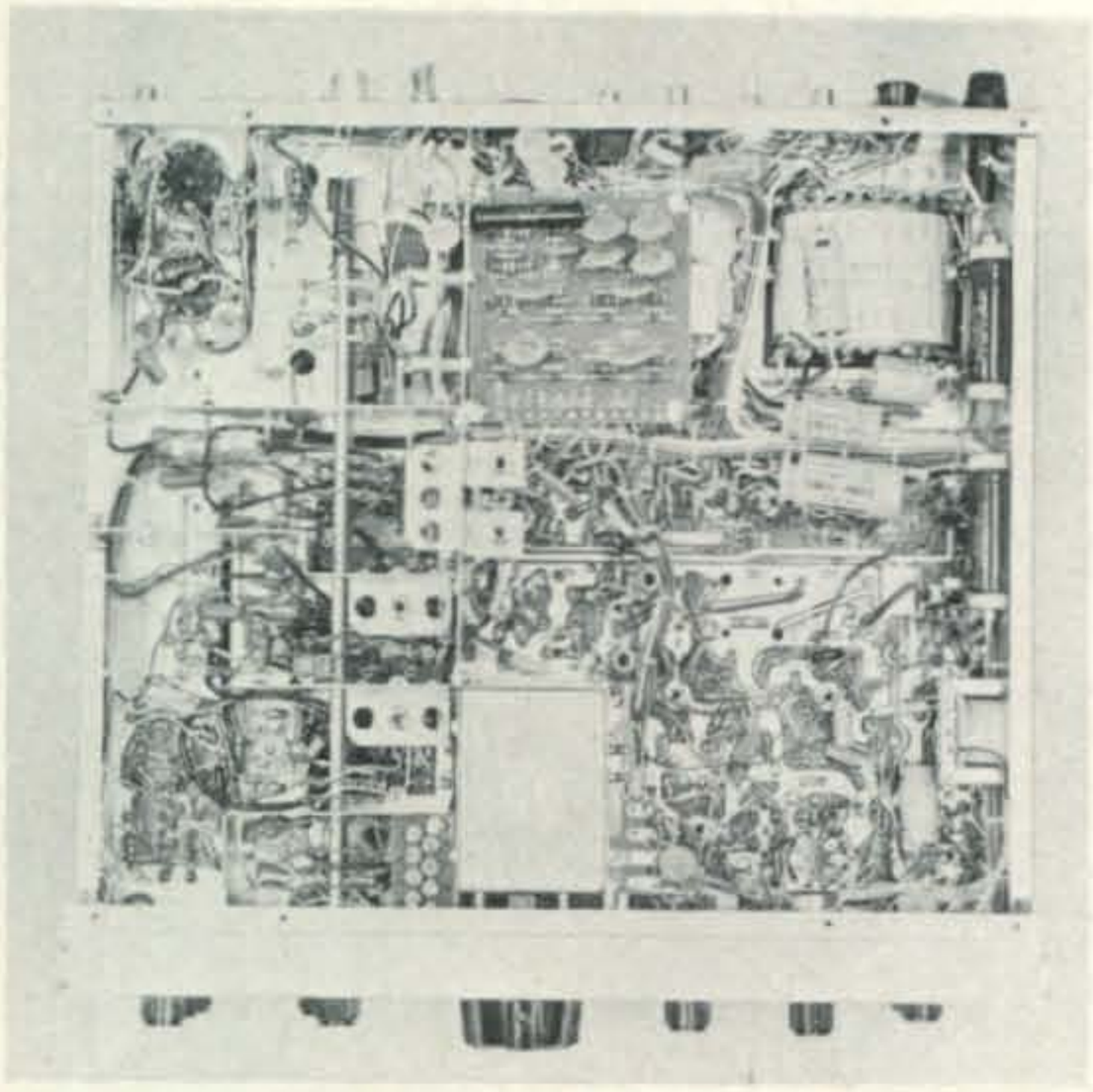

Bottom View of the FTdx560. The r.f. section is at the left. The brackets with empty holes installed on the shield partitions are for mounting auxiliary-range inductors. The silicon rectifiers with capacitor transient suppressors are on the board at top center.

28 mc, except +6 db on 7 mc; SELECTIVITY (2.3 kc at 6 db and 3.7 kc at 60 db): Same as rating with unwanted-sideband suppression at 1 kc 56 db down with u.s.b. position and 50 db with l.s.b., 5720-5220 KC I.F. SIGNAL REJECTION (50 db): 62 db on 3.5 mc band to 68 db on 28 mc; 3180 KC REJECTION: 84 db on 3.5 mc, over 90 db otherwise; IMAGE REJECTION (50 db): 74 db on 3.5 mc band to 90 db on 28 mc; INTERNAL SPURIOUS RESPONSES: Two found equivalent to 1 μv signal input, four others at less than 0.5 μv; A.G.C.: 10 db a.f. output change with r.f. input change of 10 db (1-3 μv), 7 db output change with input change of 80 db (3-30,000 μv), fast release 0.5 sec., slow release 1 sec.

TRANSMITTER POWER OUTPUT (input rated at 500 watts c.w., 560 watts p.e.p.): 260 watts output c.w. and tuneup, 300 wats p.e.p. on all bands; UNWANTED SIDEBAND SUPRESSION (50 db or more at 1 kc): Same as receiver measurement: CARRIER SUPPRESSION (better than 40 db): at least 50 db. DISTORTION PRODUCTS (better than −25 db): within the rating.

FREQUENCY STABILITY (100 c.p.s. for any 30-minute period after warmup): Average for all bands—300 c.p.s. drift during first 30 minutes from cold start at 72°F. ambient, 200 c.p.s. or less per hour thereafter. With ±10% line-voltage variations, ±15 c.p.s. slow change, attributable to crystal oscillators, not the v.f.o. No adverse effects on frequency when cabinet banged by hand. CALIBRATION LINEARITY: Within 0.5 kc when indexed at nearest 25 kc point.

The FTdb560 is priced at $449.95. The optional c.w. filter, factory installed or as a kit, is priced at $39.95. Where auxiliary ranges are to be set up, factory installation is recommended at the time of order. On the other hand, instructions are available for installation by the customer.

A matching speaker-console, Model SP-560, is priced at $19.95. The Model FV400S external v.f.o. is $99.95 and the Model FTV-560 6-meter Transceiver is $139.95. These are products of Yaesu Musen Co., Ltd, Tokyo, Japan. Further information may be obtained from the exclusive supplier for the USA: Spectronics, Box 338, Lakewood, California 90714. An important consideration is the availability of spare parts, a full line of which is carried at the supplier's headquarters and at their Eastern outlet. A one year guarantee is included with the FTdx560. —*W2AEF*

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