CQ Reviews:

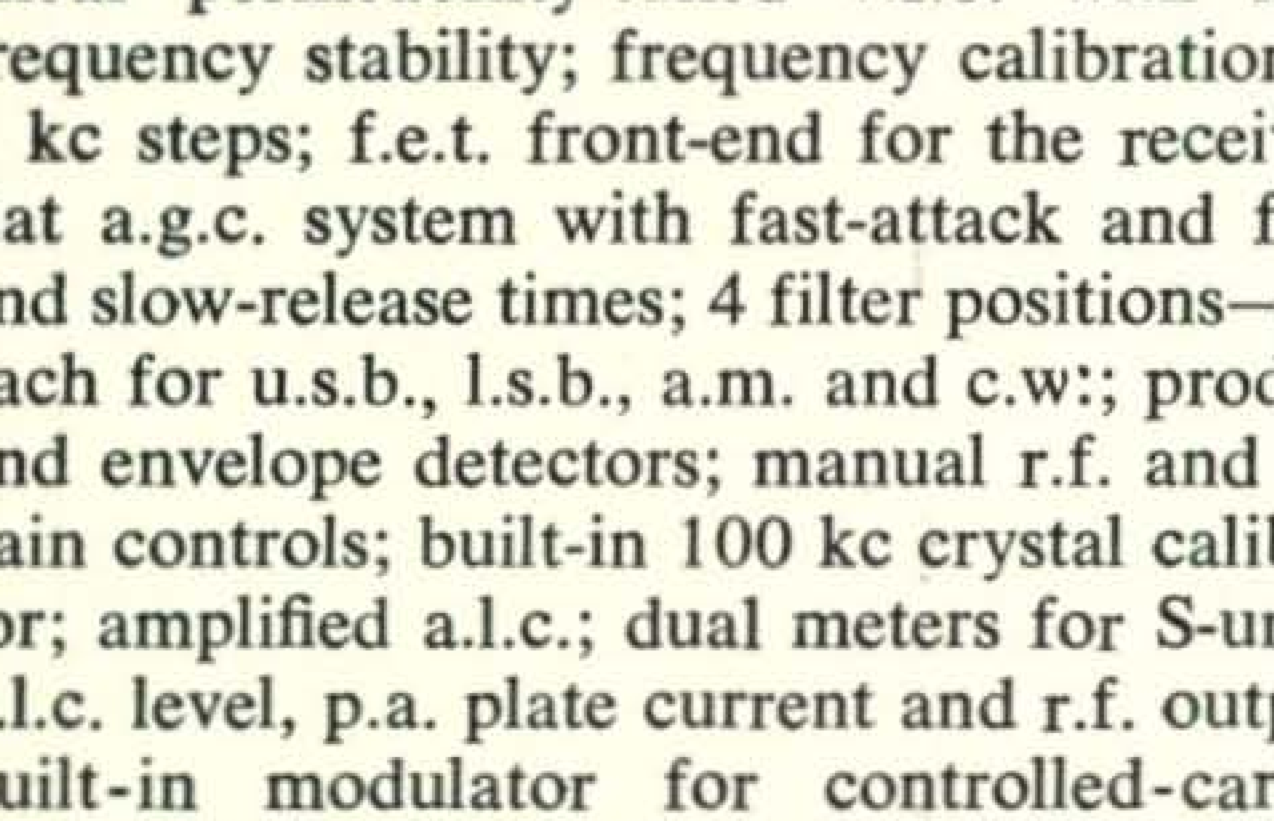
The Drake TR-6 Six-Meter Transceiver

BY WILFRED M. SCHERER,* W2AEF

THE Drake TR-6 is a sophisticated 6-meter transceiver similar in many respects to the popular 10-80 meter Drake TR-4. Complete coverage of the 50 mc band is available plus additional coverage below the band such as may be desired for MARS work. Operation may be had with s.s.b., a.m., c.w. or RTTY (AFSK or RFSK). The transmitter power runs up to 300 watts p.e.p. input on s.s.b. and a.m., 260 watts on c.w. and RTTY.

Among the host of other features are: linear permeability-tuned v.f.o. with high frequency stability; frequency calibration in 1 kc steps; f.e.t. front-end for the receiver; flat a.g.c. system with fast-attack and fast- and slow-release times; 4 filter positions—one each for u.s.b., l.s.b., a.m. and c.w:; product and envelope detectors; manual r.f. and a.f. gain controls; built-in 100 kc crystal calibrator; amplified a.l.c.; dual meters for S-units, a.l.c. level, p.a. plate current and r.f. output; built-in modulator for controlled-carrier screen-grid modulation of p.a. for a.m.; automatic carrier insertion for a.m.; block-grid c.w. keying with waveshaping; sidetone oscillator for c.w. monitoring; transmitter-frequency offset for c.w.; p.t.t. or built-in v.o.x. operation for phone; v.o.x.-type semi break-in for c.w.; RTTY operation with AFSK plus additional jack for permitting RFSK of v.f.o.; provisions for operating 2-meter transverter accessories with front-panel switching furnished. A true noise blanker also is included in the unit.

*Technical Director, *CQ*.



The Drake TR-6 Six-Meter Transceiver.

The transceiver is powered by an external supply of which there are five different models for use with 115/230 v.a.c., 50-400 c.p.s., 12 v.d.c. or 24 v.d.c.

The TR-6 with just about everything in it but the "kitchen sink" is thus a very flexible job capable of providing about every type of operation, whether at a fixed, portable or mobile location, without requiring a lot of outboard accessories. It is ideal for the 6-meter enthusiast who has many friends still operating on a.m., and yet is one that allows new and more reliable contacts to be made using s.s.b. or c.w.

Technical Details

Referring to the block diagram at fig. 1, double conversion is used in the TR-6. On receive the first conversion is made to a 13.9-14.5 mc i.f. and the second is made to a 9 mc i.f. On transmit, the process is in reverse. The carrier is generated at 9 mc with the first conversion made to 13.9-14.5 mc and the second to the r.f.-output frequencies.

The 1st receiver-conversion and the 2nd transmitter-conversion are made by heterodyning with 8 different 36-39.5 mc crystal-controlled frequencies spaced 500 kc apart. The 2nd receiver-conversion and the 1st transmitter-conversion are made by heterodyning with a 4.9-5.5 mc v.f.o. The 50 mc band is thus covered in 8 segments of 600 kc, each with the same tuning rate and an overlap of 100 kc between segments (the TR-6 is supplied with crystals for 49.9-51.0 mc only—crystals for other segments are optional).

For example: on receive the 1st conversion to a 13.9-14.5 mc i.f. is obtained using a 36 mc heterodyning crystal for the 49.9-50.5 mc

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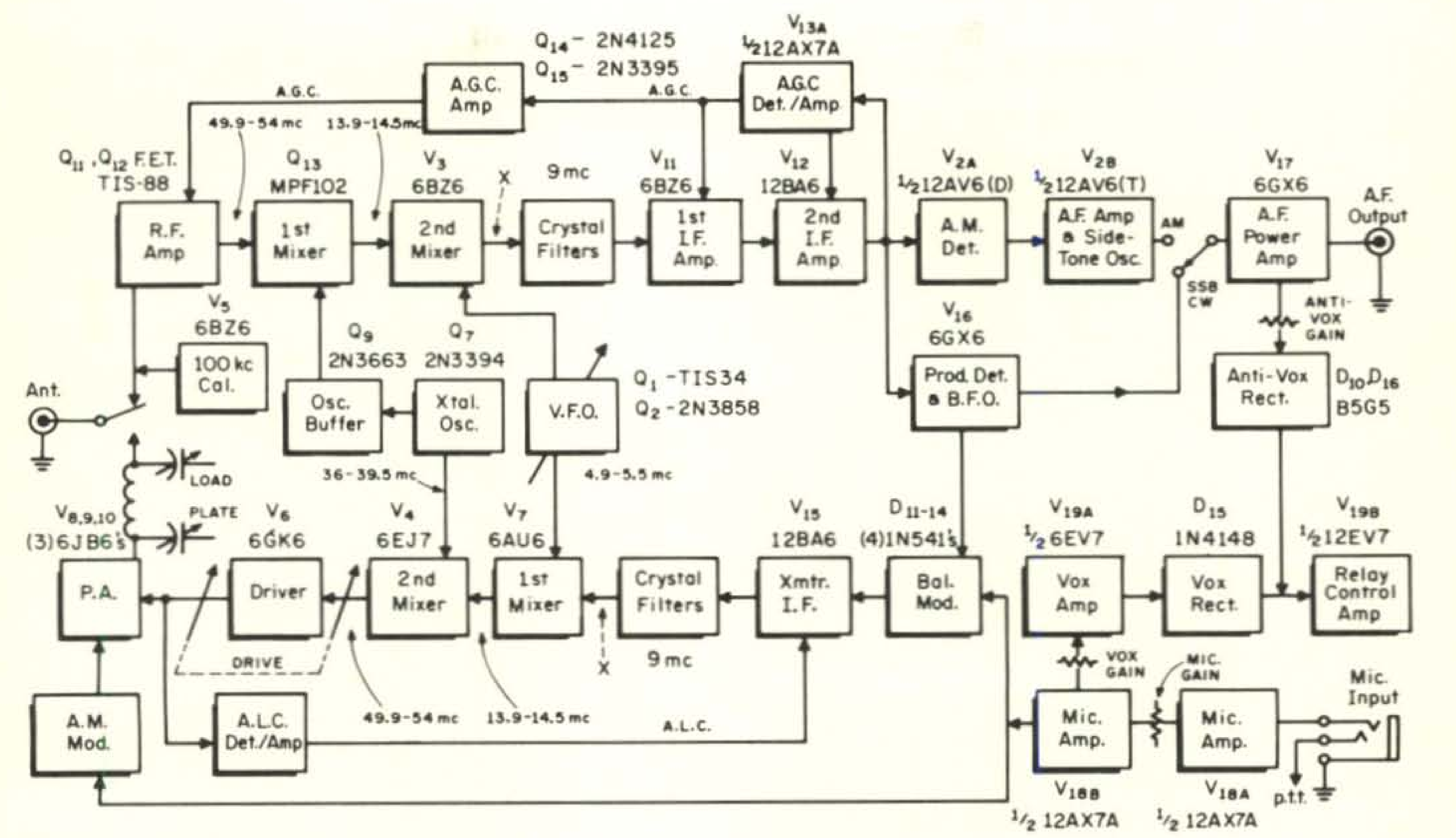

Fig. 1—Block diagram for the Drake TR-6 Transceiver. The filter is common to both receiver and transmitter. See text for details. The blanker is inserted at points marked "X".

segment (49.9−36 mc = 13.9 mc and 50.5−36 mc = 14.5 mc). Similarly a 36.5 mc crystal is used for 50.4-51.0 mc (50.4−36.5 mc = 13.9 mc and 51.0−36.5 mc = 14.5 mc), and so on for the other segments. The 2nd conversion to a 9 mc i.f. is the 1st i.f. *minus* the v.f.o. frequency (13.9−4.9 mc = 9 mc and 14.5−5.5 mc = 9 mc).

On transmit the mixing frequencies are additive, so we have 9+4.9 mc = 13.9 mc and 9+5.5 mc = 14.5 mc for the 1st i.f. Then, 13.9+36 mc = 49.9 mc and 14.5+36 mc = 50.5 mc, etc., for the output frequencies.

Circuitry

The TR-6 is a hybrid affair using 19 vacuum tubes, 15 transistors and 14 diodes.

Of special interest in the receiver section is the 50 mc front-end converter which employs 3 f.e.t.'s to provide excellent performance. As shown at fig. 2, two TIS88 f.e.t.'s are used for the r.f. stage in a cascode type circuit. The mixer is an MPF 105 f.e.t. with the heterodyning-oscillator signal injected at the source through a buffer stage using a 2N-3663 bipolar transistor as an emitter follower. Two traps at the converter input minimize spurious responses from TV stations.

A problem involved with f.e.t.'s is that of obtaining good a.g.c. performance. This is accomplished in the TR-6 using a vacuum-tube a.g.c. detector/amplifier plus a two-stage d.c. amplifier using bipolar transistors. The a.g.c. setup also is shown at fig. 2.

The 13.9-14.5 mc i.f. from the converter mixer goes through a 13.9-14.5 mc double-tuned bandpass-coupling circuit to the grid of a 6BZ6 mixer where the v.f.o. signals are injected at the tube cathode.

Upper-or lower-sideband operation is selected by switching in different 2.4 kc bandpass crystal-lattice filters after this mixer. Two additional filters also may be switched in. One has a bandpass of 300 c.p.s. for c.w., the other a 5 kc bandpass for a.m. Only the u.s.b. filter is supplied with the transceiver. The others are optional accessories.

Two 9 mc i.f. stages are employed. The product detector is a 6GX6 which also functions as a crystal-controlled b.f.o. The a.f. output from the product detector is high enough to be fed directly to the a.f.-output stage without the need for an additional a.f. amplifier.

Only one 9 mc crystal is needed for the b.f.o., inasmuch as sidebands are changed by switching filters. The v.f.o., therefore, does not have to be retuned in either case.

A.m. detection is obtained with the duo-

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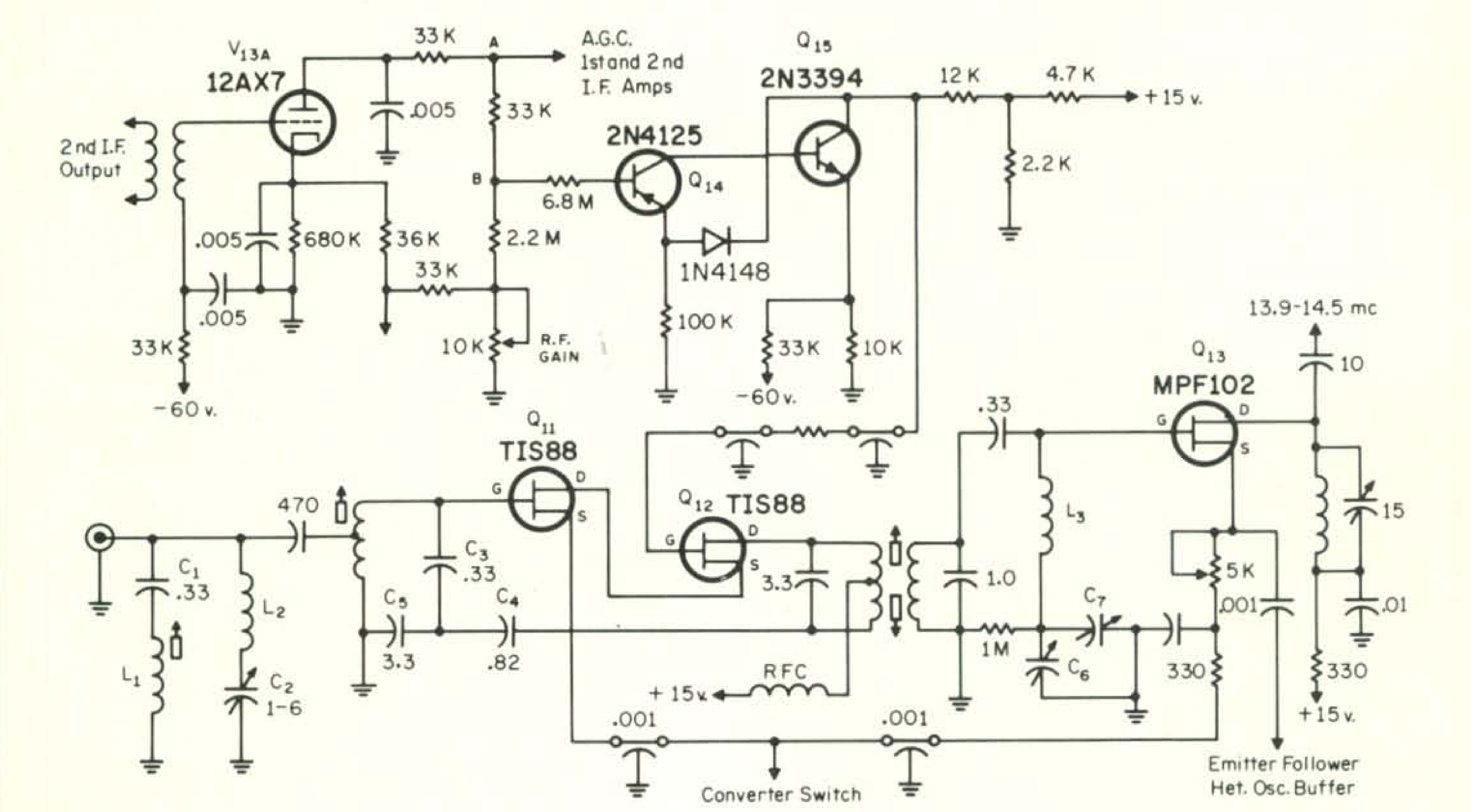

Fig. 2—R.F. Front-end converter and a.g.c. system used in the TR-6. The r.f. amplifier employs a cascode type circuit using two f.e.t.'s. C_3-C_4 are gimmick type capacitors which with C_5 neutralize the setup. C_1-L_1 and C_2-L_2 are 55.25 and 55.75 mc traps for minimizing spurious TV-signal responses. C_6-C_7 and L_3 make up a 14 mc trap which also peaks up the 50 mc signals. Operating voltage is obtained from the cathode of the a.f. power-output tube.

A.G.C. voltage is applied to the gate of Q_{12} which has an initial bias of about plus 5 volts. The r.f. signals applied to the a.g.c. detector/amplifier, V_{13A}, cause point A to go negative and thus reduce the gain of the i.f. stages. A negative voltage also developed at point B goes to a d.c. amplifier, Q_{14}-Q_{15}, where with a strong signal the negative voltage applied to the gate of Q_{12} (from Q_{15}) swings far enough to cause the gate bias to go from plus 5 volts, through zero and over to a negative voltage, a requisite for wide a.g.c. range with the f.e.t.'s. On transmit a transistor functions as a switch to disable the converter with a bias applied to the source of Q_{11}-Q_{13}.

diode section of a 12AV6, the triode section of which serves as an a.f. amplifier for a.m. preceding the a.f.-output stage. During c.w. operation, the circuitry of the 12AV6 triode is automatically switched around to allow it to function as a phase-shift a.f. oscillator to provide a sidetone for monitoring c.w. keying.

V.F.O.

The v.f.o. employs a TIS34 f.e.t. and uses permeability tuning; that is, instead of changing the frequency with a variable capacitor, the tuning is accomplished by moving a powered-iron core in or out of the tank inductor. This varies the inductance and thus tunes the v.f.o. The inductor turns are spaced to provide a linear tuning rate as the core is moved.

The f.e.t. is tapped across only a portion of the tank in order to improve stability. A 2N-3858 bipolar transistor is used as a grounded-emitter amplifier for the v.f.o. The oscillator signal is capacity-coupled from a tap on the oscillator tank to the base of the amplifier. A Pi-network at the amplifier's collector functions as a low-pass filter to eliminate spurious responses from the v.f.o. It also provides a match to the receiver mixer.

A terminal on the v.f.o. assembly is provided for making it possible to use RFSK in conjunction with external components. Special instructions for this are required from the factory.

The 9 mc tuned circuit for the receiver mixer also is the tuned circuit for the grid of transmitter mixer. For transmit, the v.f.o. signal is injected to the transmitter mixer through a capacitive divider which is part of the 9 mc tuned circuit.

Transmitter

The a.f.-input circuits for the transmitter are quite straight-forward. The balanced

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modulator is a four-diode ring type. A unique feature here is that the carrier-balanced potentiometer is operated by a 10:1 planetary-driven control that provides vernier action. This allows a precise adjustment to be easily made.

As in the receiver section, a 13.9-14.5 mc bandpass-coupling circuit is used between the two transmitter mixers.

The p.a., which employs three 6JB6's in parallel, has a Pi-network tank with adjustable loading for 50-ohm loads having a miximum s.w.r. of 2:1. The transmitter-i.f., driver and p.a. stages are each individually neutralized.

C.W.

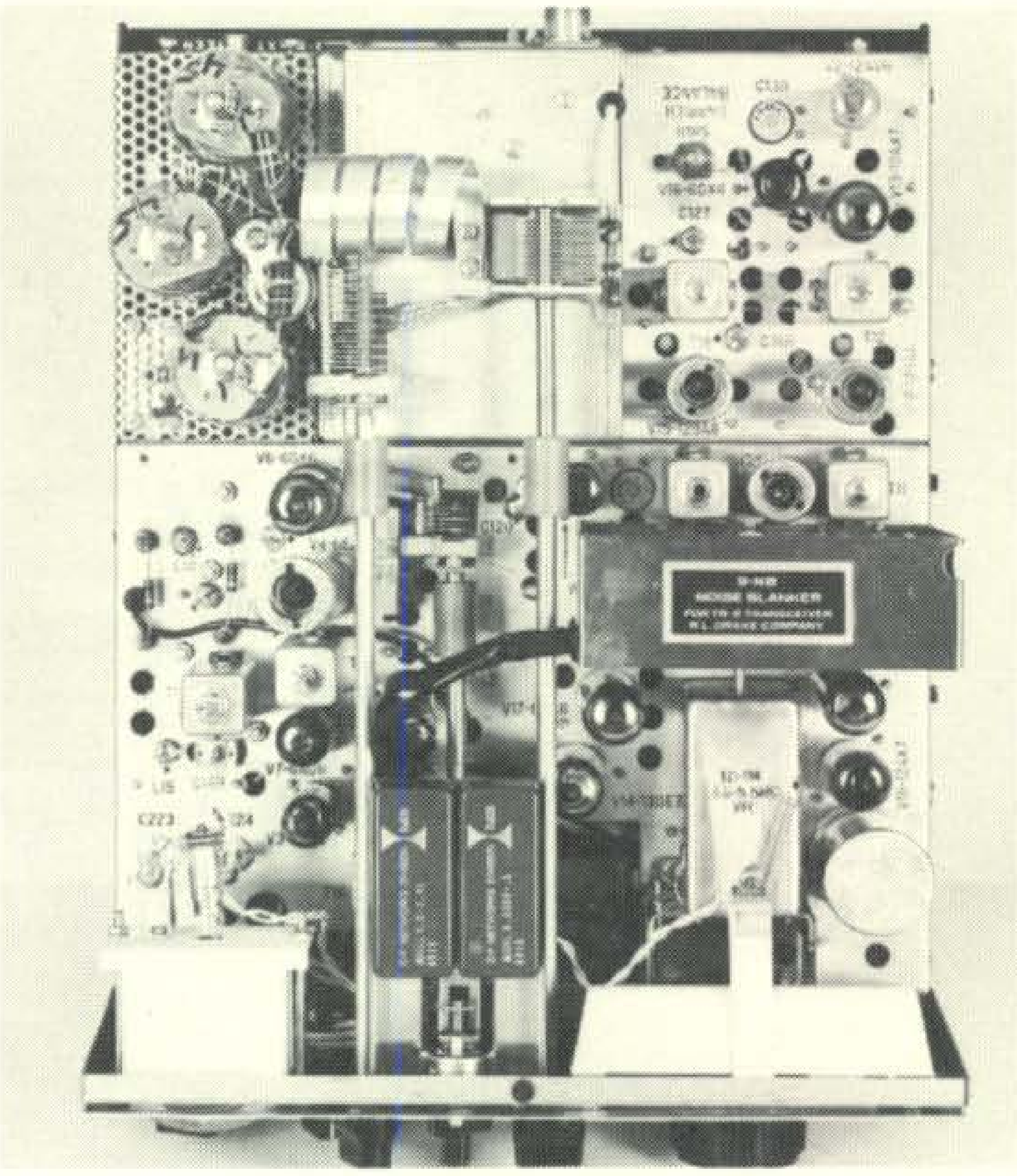
For c.w. and tuneup the s.s.b. modulator is unbalanced by means of a d.c. bias which can be varied by a panel control to provide whatever relative amount of unbalance is required to produce the desired carried level. At the same time a resistor is automatically switched in the p.a. screen-supply line to hold the power level within safe limits during key-down conditions.

In addition, a relay alters the capacitance in the crystal circuit for the 9 mc carrier oscillator, shifting the crystal frequency about 1 kc to place the carrier within the passband of the crystal filter. The relay is actuated by the screen current drawn by the transmitter i.f. amplifier and it therefore shifts the carrier frequency only when the amplifier is activated on transmit. The v.f.o. frequency thus goes back to normal on receive and the setup thereby provides a 1 kc transmitter-frequency offset during c.w. operation.

Grid-block keying is used at the 1st transmitter mixer with waveshaping for minimizing key clicks. The sidetone oscillator also is keyed this way and the a.f. signal therefrom triggers the v.o.x. system to activate the transmitter whenever the key is depressed. The v.o.x. setup is quite conventional. The sidetone level, heard on the speaker or headphones, varies according to the setting of the receiver a.f.-gain control, but any desired ratio between the receiver-signal level and that of the sidetone may be set up by a separate sidetone-level control on the rear of the chassis.

A.M.

On a.m. the s.s.b. modulator is unbalanced with a fixed d.c. bias to provide an initial carrier for operation with a conventional



Top view of the TR-6. A perforated-metal enclosure has been removed from the p.a. (at upper left) to show its components. The tank inductor is made of silver-plated 1/2"-wide strap. The filters are at the lower center of the set. The v.f.o. is in the oblong can seen vertically at the lower right. At a right angle behind it is the noise blanker module.

controlled-carrier screen-modulation system at the p.a. This is done with a separate modulator consisting of the two triodes in a 13DE7. Double-sideband a.m. is thus obtained with high percentages of modulation at all speech levels, thus ensuring an a.m. signal with a good punch without the compromise otherwise incurred with an s.s.b. a.m. signal as usually provided with s.s.b. exciters.

A.L.C.

A.l.c. voltage is obtained in the usual manner by rectifying the a.f. component that appears, during modulation, as a voltage drop across a grid-return resistor in the p.a. that is produced when grid current starts to flow at the onset of overdrive. An a.l.c. detector/amplifier setup, with a triode (1/2 12AX7), as similarly used for the receiver a.g.c., ensures fast a.l.c. pickup, before any significant overdrive takes place. The a.l.c. voltage controls the gain of the transmitter i.f. amplifier. The a.l.c. does not function with a.m.

Physical Details

The TR-6 is styled and constructed in the same way as the TR-4 transceiver and the

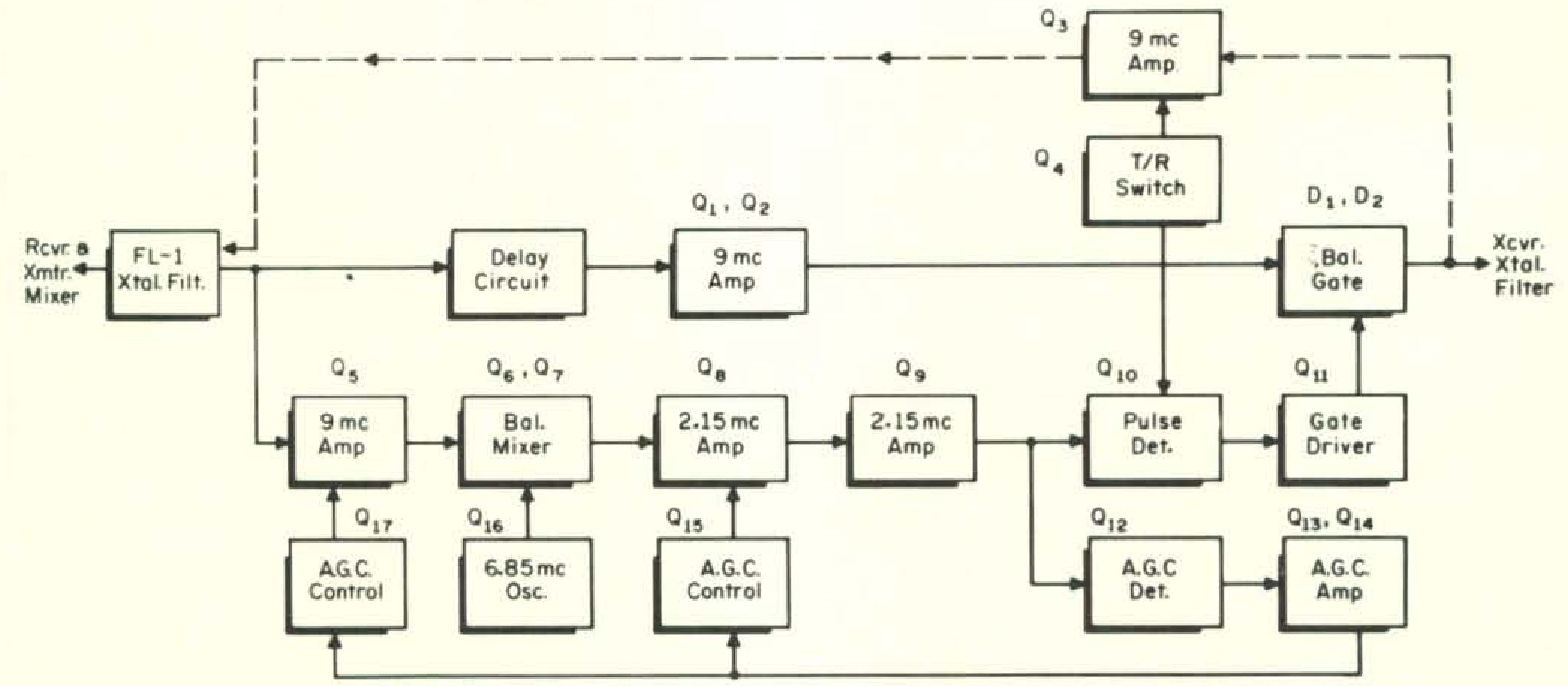


Fig. 3—Block diagram for the Drake Noise Blanker. Both the receive and transmit 9 mc signals go through the unit. The transmit path is indicated by the dashed lines. Other details are given in the text.

other models in the Drake line of gear.

The two edgewise-type meters indicate p.a. plate current on one and receiver S-units or a.l.c. level on the second. Relative r.f. output may be read at the plate meter by pushing in a button which also operates a control to adjust the meter sensitivity for these readings

The v.f.o. is operated by a high-ratio drive mechanism with 25 kc covered by one revolution of the tuning knob. A skirt on this knob is calibrated in 1 kc increments of 0-25 spaced 1/4" apart, making easy readability down to a few hundred cycles. The skirt may be slipped on the shaft to allow precise indexing against signals from the built-in 100 kc calibrator. A larger dial behind a window has reference points for each 25 kc interval on two scales. One scale is calibrated .000-0.5 mc, the other 0.4-1.000 mc. The frequency readout is the sum of the bandswitch setting (in mc), the mc-dial reading and the kc indicated at the tuning-knob skirt A switch at the rear of the set changes the glow of the panel lamps between dim and bright.

A panel switch selects any filter, regardless of the mode of operation. An a.g.c. switch cuts the noise blanker (described later) in or out and provides slow or fast a.g.c. in either case.

On the right side of the transceiver are jacks for headphones, microphone and key; Knurled screw-driver-adjust controls for v.o.x. gain/c.w. release, anti-v.o.x. gain and S-meter zero. There is no separate control for setting the v.o.x. delay with s.s.b. The release time is dependent on the v.o.x.-gain setting; however, for c.w. this control is used for the c.w.-release time.

Provisions also are made for operating 2-meter receiving and transmitting converters (having a 13.9-14.5 mc i.f.) in conjunction with the TR-6. A remote v.f.o. accessory also may be used for split-frequency operation. There also are jacks on the rear that provide for muting an external receiver. Speaker and external-relay control connections are made through the power-cable plug.

Performance

Measurements on the TR-6 produced the following results:

Receiver Sensitivity: For 10 db S+N/N-0.1 μv on s.s.b. with 2.4 kc filter; 1 μv on a.m. (30% modulation at 400 c.p.s.) with 6 kc filter and less than 0.1 μv on c.w. with 300 c.p.s. filter. Selectivity: 2.3 kc at 6 db and 6.2 kc at 50 db with s.s.b. filter; 6 kc at 6 db and 12 kc at 50 db with a.m. filter; 450 c.p.s. at 6 db and 5 kc at 50 db with c.w. filter.

Image Rejection: 83 db (primary), 100 db (secondary). I.F. Signal Rejection: 78 db at 14 mc and over 100 db at 9 mc. Internal Tweets or Spurious: Equivalent to 1 μv or less r.f.-input signal found at 49.999, 50.399 and 50.999 mc (on two lower segments—other segments not checked, since crystals for them were not supplied).

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A.G.C. CHARACTERISTIC: 12 db a.f. output change with r.f. input variation of 0.1-1.0 μv (20 db) and only 2 db a.f. change with input signals of 1-100,000 μv (100 db). Blocking was not evidenced at this maximum input. Slow-release of 1 sec. from S-9 or greater signal. Fast release and fast attack not checked (rated at 200 milliseconds and 100 microseconds respectively). S-Meter: S9 reading with 35 μv signal.

TRANSMITTER OUTPUT: 150 watts d.c. (c.w.); 200 watts p.e.p. on s.s.b. and 150 watts p.e.p. on a.m. with controlled carrier. 3rd-Order DISTORTION: 31 db below maximum peak output with two-tone test on s.s.b. UNWANTED SIDEBAND SUPPRESSION: 40 db at 1 kc CARRIER SUPPRESSION: 52 db. A.L.C.: No evidence of r.f.-output flattopping with maximum a.l.c. levels. Since there is no a.l.c. for a.m., flattopping can easily take place with this mode. This can be avoided by maintaining speech levels that keep the plate meter peaks within the specified range.

FREQUENCY STABILITY: Starting cold from a 66° F. ambient, drift during first 15 minutes was 310 c.p.s., 500 c.p.s. the next hour and 100 c.p.s. or less per hour thereafter. With ±10% line-voltage variation, the frequency shifted ±5 c.p.s. No evidence of frequency twittering or microphonics was found when the unit was subject to banging by hand. DIAL CALIBRATION: Within 0.5 kc at 10 kc points when indexed at nearest 100 kc interval.

The TR-6 handles well and is easy to operate. The a.f. quality on either s.s.b. or a.m. is excellent both on receive and transmit. C.w. keying is clean, but a little on the soft side. C.w. break-in is of the usual v.o.x. type with break-in during pauses. Plenty of mic gain is available for either modulating the transmitter or tripping the v.o.x. which works smoothly. As noted from the measurements, the receiver sensitivity is fine. The a.g.c. action is pleasing without impact popping or signal pumping.

The size of the TR-6 is 5 7/16" × 10¾" × 14¼" (H.W.D.) and it weighs 15¾ lbs.

Noise Blanker

It had been intended to review the Drake Noise Blanker as a separate entity, inasmuch as it has been available only as an accessory. It has just been learned that the TR-6 is now supplied with the blanker installed, so a description of this unit is included at this point in the TR-6 review.

The Model 9-NB Noise Blanker is an elaborate solid-state job designed for use at a 9 mc i.f. with the TR-6. There also is the Model 34-NB available for factory installation in the Drake TR-3 and TR-4 Transceivers.

The advantage of a true noise blanker, such as Drake's, over conventional noise limiters or clippers is that the noise is cut out at a point in the receiver before any selectivity is introduced that would lengthen the noise pulses and thus minimize the effectiveness of noise silencing. Furthermore, the noise pulses are virtually eliminated or are considerably attenuated below the desired signal, rather than simply being brought down to the signal level. No distortion of the desired signal is caused by the blanking action.

Before proceeding with the details on the Drake blanker, let it be said that it does a superb job of impulse-noise elimination. The unit installed in our TR-6 provided at least 50 db attenuation of impulse-noise peaks. With noise pulses peaking over S9, switching the blanker on dropped them to less than 1 μv and they did not even budge the S-meter. Under these severe noise conditions not only was the a.g.c. prevented from being captured by the noise pulses, but c.w., s.s.b. and a.m. signals in the low-microvolt region were perfectly readable. Without the blanker in operation, many of these signals were not even heard through the noise. No distortion of the signals was noted, nor was there an over-all

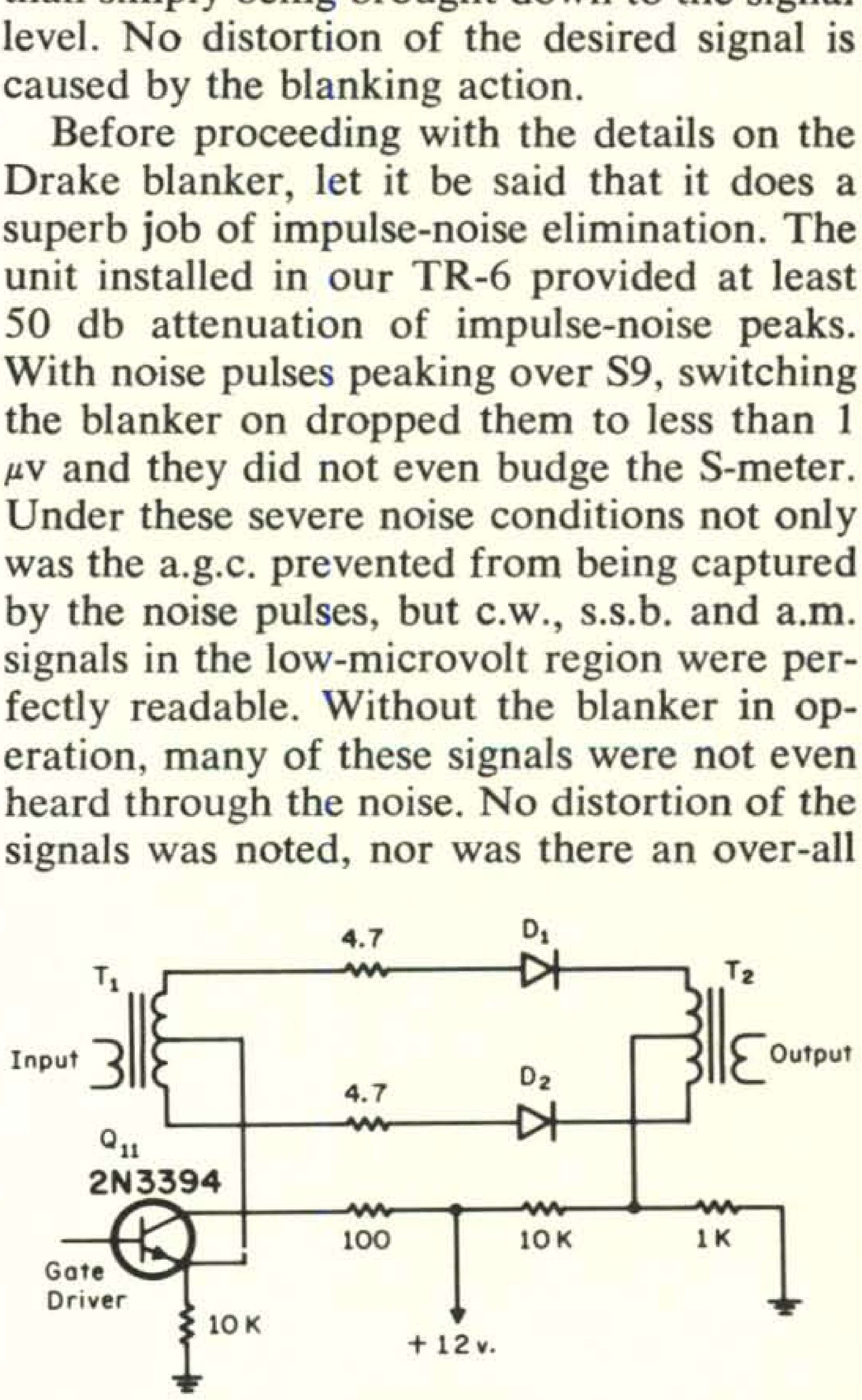

Fig. 4—Balanced gate used in the Drake Noise Blanker. T_1 and T_2 are toroid transformers. The voltage at the emitter of the gate driver also appears at the anodes of the diodes. This voltage is slightly more positive than that at the diode cathodes. It therefore forward-biases the diodes into conduction, allowing the signal to pass from T_1 to T_2. During a gating pulse, the emitter of the gate driver goes less positive (negative going) than that at the diode cathodes. This reverse-biases the diodes into non-conduction, opening both sides of the circuit between the transformers for the duration of the noise pulse. Since this action is balanced, switching noise is not introduced.

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loss in signal level as is otherwise often experienced with such devices.

Principal of Operation

The Drake blanker employs 16 transistors (2 f.e.t.'s) and 4 diodes. Referring to the block diagram at fig. 3, the blanker is installed in the 9 mc line between the receiver and transmitter mixers and the crystal filter of the transceiver.

On receive, the 9 mc output from the receiver mixer goes through a crystal filter, (FL_1), which has a 10 kc bandpass with moderately steep skirts. The filter bandwidth and shape factor are such that they do not cause any detrimental lengthening of noise pulses, yet the filter characteristics are sufficient to prevent strong adjacent signals from overloading the pulse detector in the unit.

The 9 mc signal plus any noise pulses then goes through a delay network, a broadband 9 mc amplifier and to a balanced gate. The 9 mc signal and the noise pulses also go to a noise processor where only the noise pulses are extracted and shaped to produce a d.c. pulse that triggers the gate with each pulse and thus interrupts the signal for the pulse duration. This effectively punches a hole in the signal (which due to its short duration, goes unnoticed) and thus eliminates the original noise signal. The noiseless signal then goes to the crystal filter and the 9 mc i.f. amplifiers of the receiver.

Other Details

At the noise processor, the signal plus noise goes through a tuned 9 mc amplifier (Q_5) and to a balanced mixer (f.e.t.'s Q_6 & Q_7 where the signals are heterodyned with the signal from a 6.85 mc crystal-controlled oscillator (Q_{16}) to produce a 2.15 mc i.f. Feedthrough of the oscillator signal is minimized by the mixer balance.

The 2.15 mc signal is amplified by Q_8 & Q_9 and is fed to the a.g.c. and pulse detectors (Q_{12} and Q_{10} respectively). The time constants of the a.g.c. system are such that only the desired signal is held down, allowing the noise pulses to be accentuated or differentiated for the pulse detector. The detected pulses go to the gate-driver which is a direct-coupled emitter follower that causes a negative-going signal to reverse bias two diodes in the gate and thus open the circuit with each pulse. Switching noise is not introduced, because the gate is a balanced affair that function like a balanced modulator. See fig. 4.

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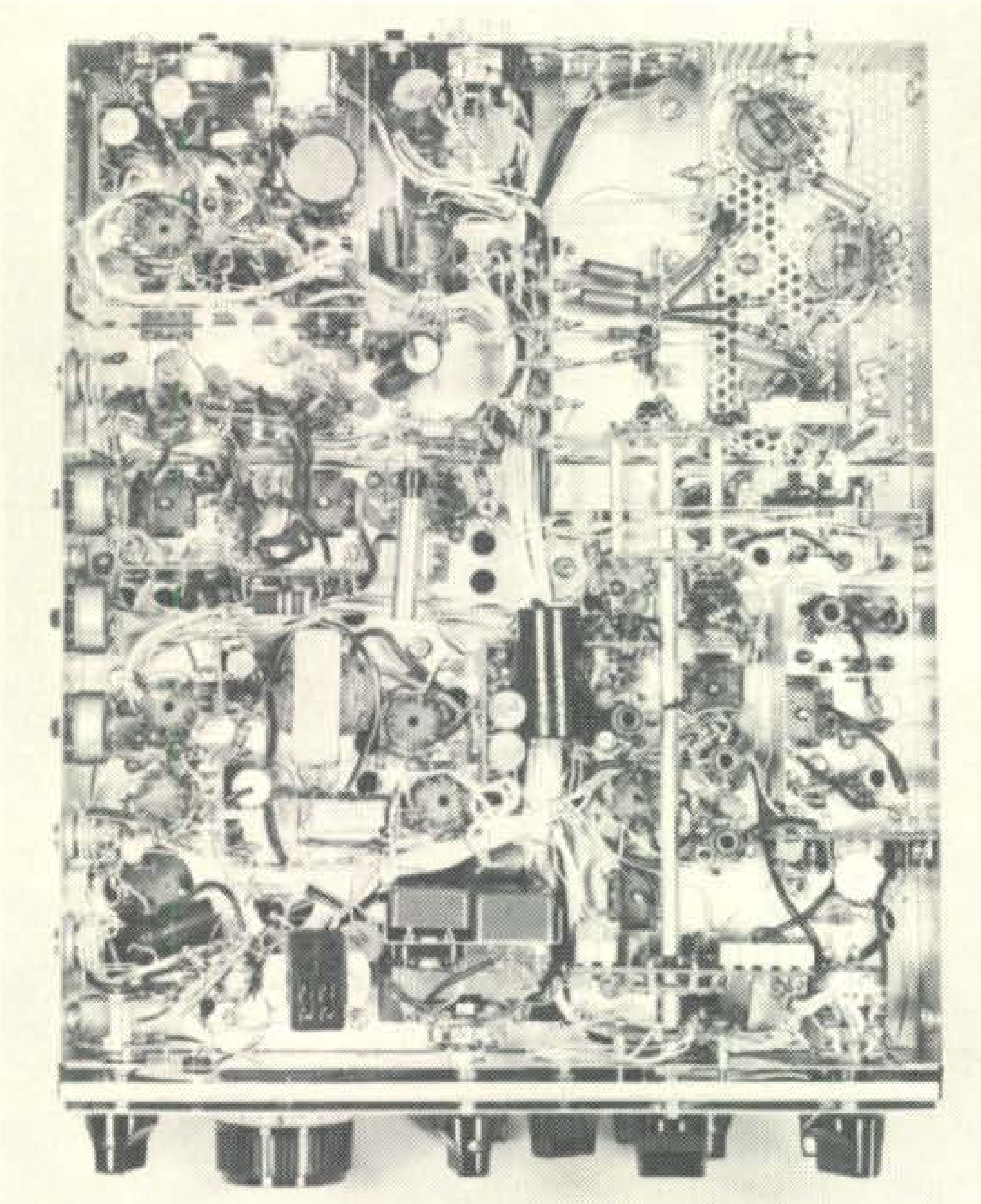

Bottom view of the TR-6. The solid-state sections are built on various small circuit boards mounted vertically below the chassis.

The conversion to the lower i.f. in the pulse processor minimizes the possibility of gate-triggering effects by undesired signals, eliminates 9 mc leakthrough around the blanker and provides a high gain for better gating action.

The delay circuit in the 9 mc desired-signal path is made up of two toroid transformers capacitively tuned and coupled. The delay makes up for that introduced in the pulse-processing section. This delay-compensation, in effect, properly synchronizes the noise-gating action with the noise pulse on the desired-signal path, so that both occur at the same insant for maximum overall effectiveness.

The gain of the desired-signal path is such that there is no change in the overall operating level of the receiver when the blanker is switched in or out.

On transmit, the signal path is from the transceiver crystal filter, through the 9 mc amplifier, (Q_3), the blanker filter (FL_1) and on to the transmitter mixer. Q_4 is a T/R switch that disables Q_3 during receive.

The Drake TR-6 Six-Meter Transceiver is priced at $650 with Noise Blanker installed, u.s.b. filter and crystals for 49.9-51.0 mc coverage. The AC-4 power supply for operation from 115/230 v.a.c., 50-400 c.p.s. is

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Letters *[from page 8]*

The horizontal resolution is at least 100 elements. The pictures are definitely not of low resolution as can be seen from the photographs shown in MacDonald (1964), Miller (1969) and Taggart (1969). Further, it is my opinion after four years of SSTV operations that the 8-second frame period is quite satisfactory. For the P7 cathode ray tubes employed, the top of any given scan has almost faded by the time a new frame is to begin, and the effect of a picture "wiping" on the face of the CRT detracts little from the system capability. Finally, the material we've transmitted not only included slides, call letters and pictures of the operator, but also included pictures of stations and equipment and schematic diagrams.

That the above discussion be construed as a put-down of Dr. Ingerson's ideas would be erroneous. My intent is to remind the interested amateur that even using the simplest bandwidth-compression techniques, it is possible to construct and operate a versatile slow-scan television system suitable for use in the h.f. bands. Much of the present system's acceptance and success is due, of course, to the availability of that inexpensive storage device, the long-persistence CRT.

I sincerely hope that the amateur community will explore the suggestions put forth by Dr. Ingerson, as it is quite possible for the amateur to make real contributions in the field of video communications. One has only to look at the work done in memory cathode ray tubes (MacDonald, 1960), pseudo-random scan TV systems (Deutsch and Simpson, 1968), scan-conversion systems (sampling cameras, Miller, 1969) and color SSTV (Taggart, *et al,* 1969) to realize that video communications present a most fertile field for investigation.

Theodore J. Cohen, W4UMF
Alexandria, Va.

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priced at $99.95. The Model 34-NB Noise Blanker is available as a factory installation in the Drake TR-3 and TR-4 10-80 meter transceivers at a cost of $129. This includes complete realignment of the transceiver. The manufacturer is R. L. Drake Company, Miamisburg, Ohio 45342. *—W2AEF*

DX *[from page 75]*

FB8WW—c/o K2MGE, 14 Bernice Drive, Freehild, N.J. 07728.
FY7YR—Via VE3BYN.
GC5AGA—c/o K4IL.
GD3TXF—To G3TXF, Holt Cottage, Kingston Hill, Surrey, England.
HB9AKJ—c/o WA3HUU, 384 Union St., Uniontown, Pa.
HP9FC/MM—Via VE1ASU, P.O. Box 51, St. John, N.B., Canada.
HQ2GK—To VE1ASJ.
HR1KAS—c/o VE1ASJ.
HR2GK—Via VE1ASJ.
IT1ALO—P.O. Box 20, Messina, Sicily.
JX2BH—NOT via VE1ASJ, send to Norwegian Bureau.

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