The Davco DR-30 solid-state receiver. It is quite a small package that is neatly styled and arranged.

CQ Reviews:

The Davco DR-30 Receiver

BY WILFRED M. SCHERER,* W2AEF

It is not often that a piece of amateur gear turns up that is new and unique such as the Davco DR-30 receiver. This is an all solid-state dual-conversion job for use with s.s.b. (upper or lower sideband), c.w. and a.m. on the amateur bands 80 through 6 meters, plus WWV. It has three degrees of i.f. selectivity and of a.g.c. release time, a variable-notch filter, noise *blanker*, crystal calibrator, a.f. tone control, pre-selector tuning, the new field-effect transistors for minimum overload and cross modulation, and excellent frequency stability. These and many other features of advanced design both electronically and mechanically make it a lot of receiver packed into a very small package 4″ × 7⅛″ × 6″ (H.W.D.).

Frequency Coverage

Coverage is in 550 kc segments starting at the low-frequency end of each amateur band from 3.5 to 21 mc and of each 500 kc section of the 28 mc band. On 50 mc there is only one range of 50-50.55 mc. An additional band also covers 9.5-10.05 mc for WWV on 10 mc or for 9.5 mc short-wave broadcasts. There are two extra band and crystal switch positions for other optional 550 kc segments.

Technical Details

A block diagram is shown at fig. 1 where the conversion frequencies may be found. Field-Effect Transistors (f.e.t.'s) are used in both the r.f. input stage and the 1st mixer. These transistors are one of the latest advances in solid-state devices; their greatest advantage over conventional transistors being much greater immunity to overload and cross modulation. In addition, they have higher input and output impedances, making it easier to obtain better selectivity for improved image rejection. Furthermore, their low inherent noise ensures a high signal-to-noise ratio for better sensitivity.[1] Circuitry for the f.e.t.'s and other front-end features are shown at fig. 2.

The r.f. input and output "pre-selector" circuits are gang-tuned with a dual-section capacitor. Toroid type r.f. inductors are used, providing high-Q circuits with little or no stray coupling that may introduce instability and they are very small, allowing a considerable saving of space. A single toroid is used in each of the two circuits for all frequencies below 17 mc, with capacitive padding switched in as needed at the lower frequencies. Shunt inductance is added for the higher frequencies.

For 50 mc operation, a special impedance-matching circuit with a separate antenna-input jack for this band is employed. It has a rear-apron trimmer for peaking up operation with the particular v.h.f. antenna in use. Back-to-back diodes, shunted across the r.f. input, protect the r.f. transistor from damage by strong r.f. pickup.

R.F. Gain

An unusual arrangement is that the r.f. gain simply is a continuously-variable attenuator connected at the antenna input to vary the signal levels applied to the r.f. stage. Unlike conventional systems, this allows normal operating voltages and full a.g.c. to be maintained at all times. The "gain" is reduced by *clockwise* rotation of the control instead of the customary counter-clockwise direction. Clockwise rotation *increases* attenuation which in turn *decreases* signal level.

Another unique feature is that the crystal calibrator is connected to the attenuator in a way that the calibrator signal cannot be heard until maximum attenuation is inserted. This allows the calibrator signal to be heard without interference from picked-up signals. Also, if the

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[1] Hyder, H. R., "Understanding Field-Effect Transistors," *CQ*, Aug. '66 p. 38, Sept. '66 p. 51, Oct. '66 p. 36.

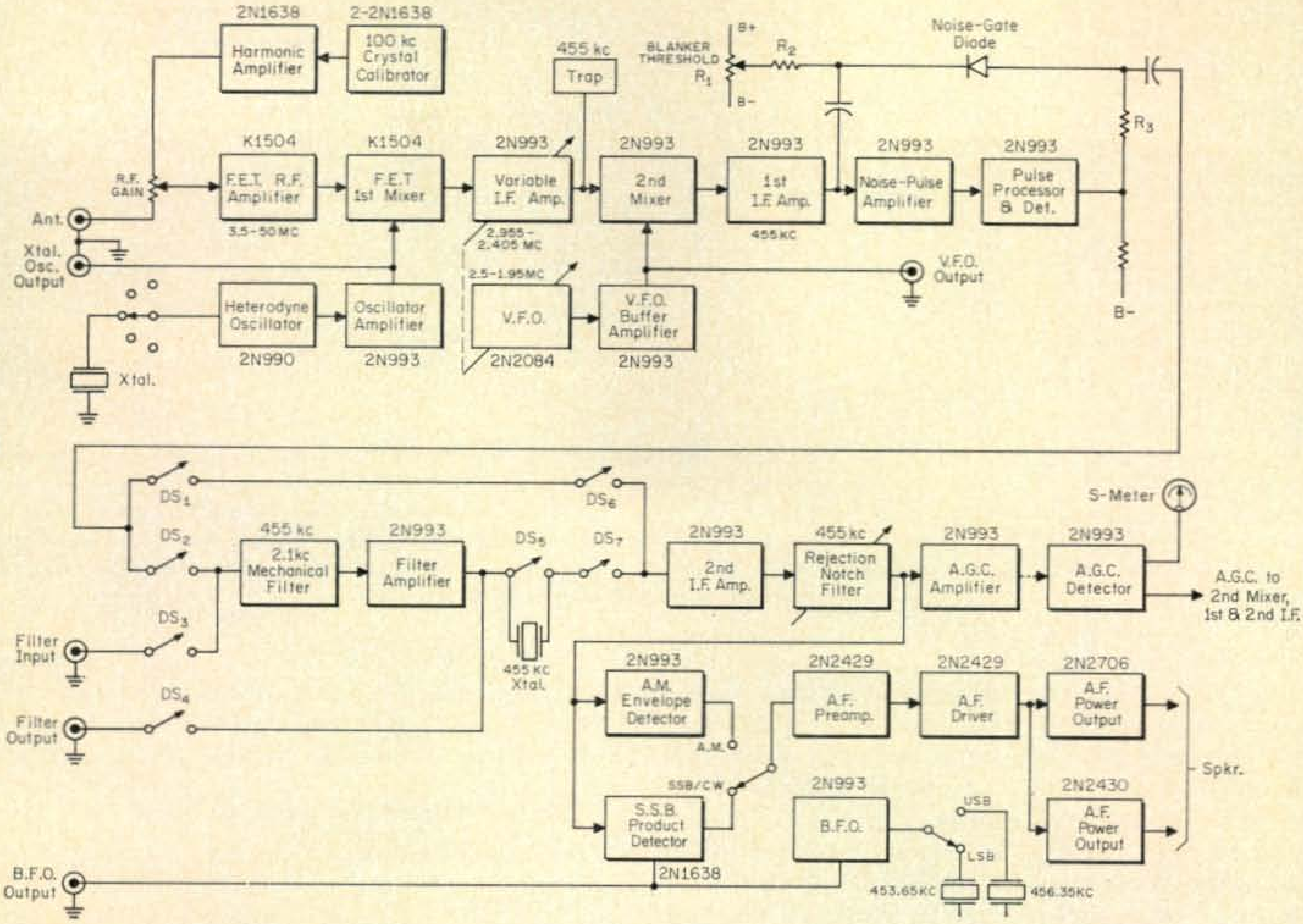


Fig. 1—Block diagram for the DR-30. The heterodyning-crystal frequencies are 2.955 mc *plus* the frequency for the bottom end of each band. DS_{1-7} are diode switches operated by d.c. voltages (see footnote 2). The selector-switch position for 5 kc selectivity closes DS_1 and DS_6. The other diode switches remain open. For 2.1 kc DS_1 and DS_6 open, DS_2, DS_5 and DS_7 close. For .5 kc DS_5 is opened, the others remain as for 2.1 kc. DS_3 and DS_4 can be operated separately to use the mechanical filter with external gear. A ceramic filter resonator is used for the 455 kc trap at the 2nd mixer input. The v.f.o. buffer-amplifier is an untuned affair.

calibrator is left on, it will not cause QRM when the r.f. gain is set for incoming signals.

Variable I.F. and V.F.O.

The 2.405-2.955 mc variable i.f. amplifier is gang tuned with the v.f.o. used for heterodyning at the 2nd mixer. The v.f.o. is operated at a relatively low frequency (1.95-2.5 mc) which, along with the use of a high-Q toroid inductor for the oscillator, a buffer amplifier and zener-regulated voltage, results in excellent frequency stability.

A conventional split-capacitance Colpitts oscillator circuit is used. The tank inductance consists of the toroid coil which is in series with a slug-tuned coil of much smaller inductance and which is used for trimming the circuit to frequency and for tracking. The r.f. output is taken from the junction of the two inductors which thus provides a low-impedance tap to match the input of the following stage and minimize loading effects on the frequency. The buffer amplifier is an untuned affair that is coupled to the emitter of the mixer.

Noise Blanker

The output of the 1st i.f. goes to a diode switch (noise-gate diode) which is in series with the feed to the succeeding i.f. stage. A forward bias applied to this diode, obtained from the noise-blanker threshold control, allows the diode to conduct and pass the normal i.f. signal on to the next stage. The i.f. also feeds a noise-pulse amplifier which increases the amplitude and accelerates the rise time of the noise pulses. These are then appropriately shaped by the pulse processor where they also are converted to positive-going pulses that reverse-bias the diode gate. The diode then ceases to conduct, interrupting the circuit and silencing the receiver for the duration of each pulse.

No deteriorating pulse-lengthening occurs before the noise blanker functions, because it is installed ahead of the highly selective i.f. filters rather than after them in which case the effectiveness of the blanker would be reduced. Elimination of noise pulses at the i.f. level prevents their activating the a.g.c. and desensitizing the receiver.

I.F. Selectivity

Three degrees of i.f. selectivity are provided: 0.5, 2.1 and 5 kc. The 5 kc step is obtained using three interstage transformers and ceramic filters in the i.f.'s. These filters are very high-Q ceramic resonators used as emitter bypasses that steepen the skirts of the response curve. For 2.1 kc bandwidth a Collins mechanical filter is *added* along with the filter amplifier. For 0.5 kc a single crystal

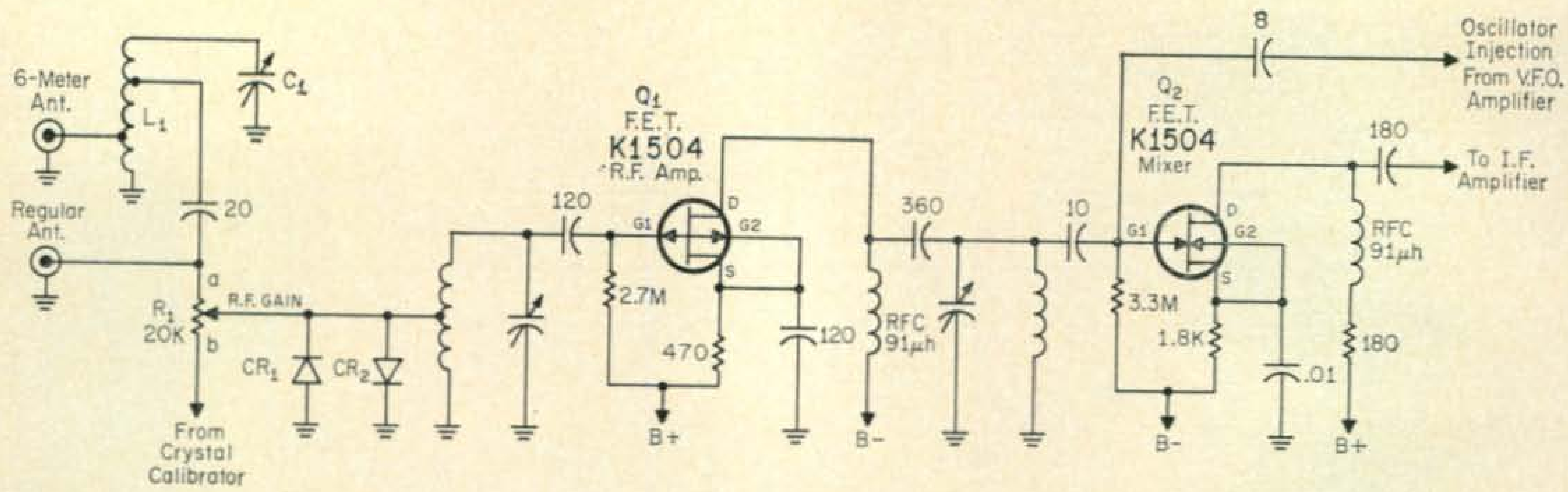
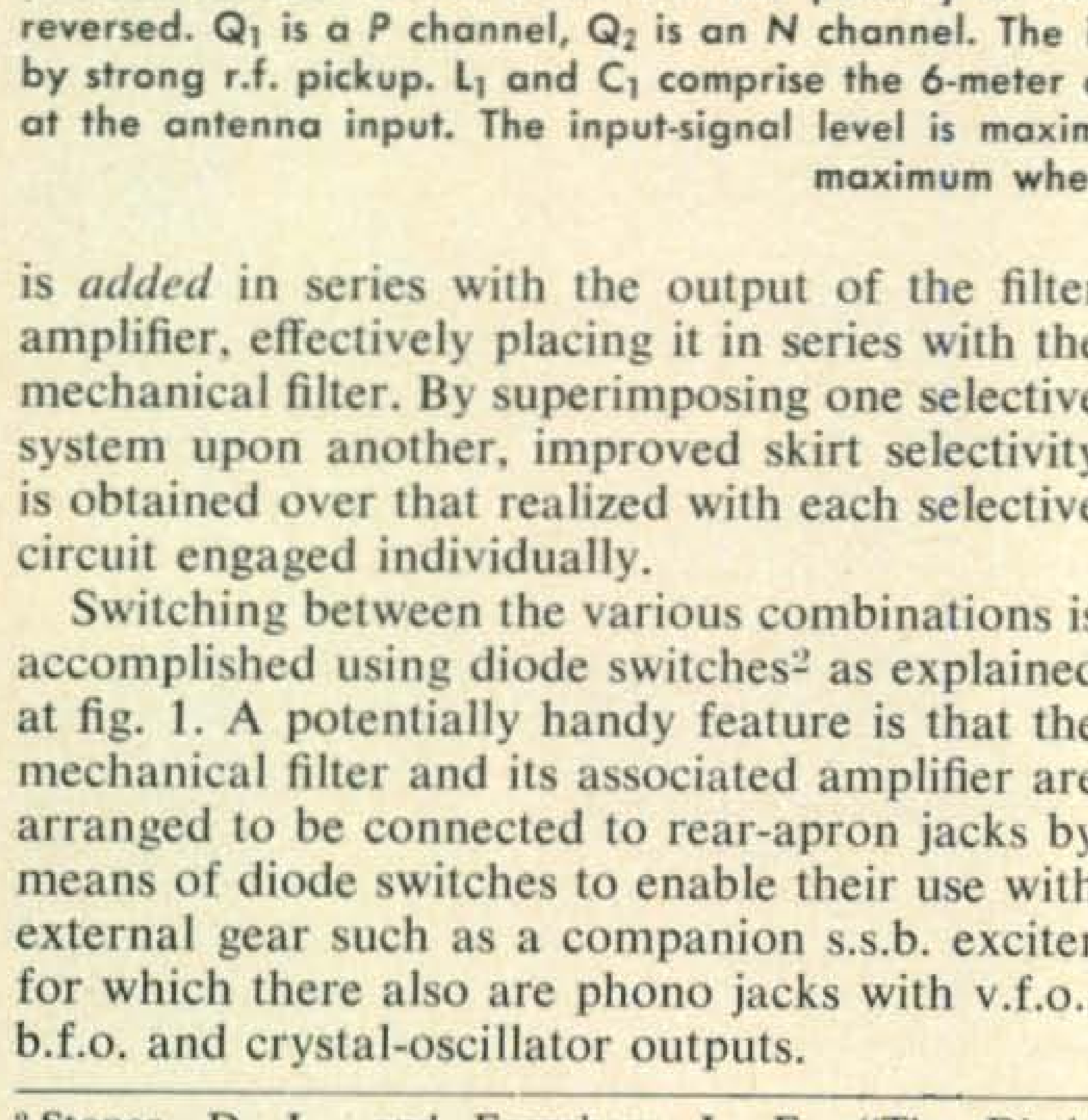


Fig. 2—Basic circuitry for field-effect transistors as used in the Davco DR-30. Both transistors are channel junction tetrode f.e.t.'s. Note that the polarity at the *source* (S) and *drain* (D) terminals of the two f.e.t.'s is reversed. Q_1 is a *P* channel, Q_2 is an *N* channel. The input transistor is protected with D_1 and D_2 from damage by strong r.f. pickup. L_1 and C_1 comprise the 6-meter antenna-matching affair. The R.F. GAIN, R_1, is an attenuator at the antenna input. The input-signal level is maximum when the arm is at *a*, the crystal-calibrator signal is maximum when the arm is at *b*.

is *added* in series with the output of the filter amplifier, effectively placing it in series with the mechanical filter. By superimposing one selective system upon another, improved skirt selectivity is obtained over that realized with each selective circuit engaged individually.

Switching between the various combinations is accomplished using diode switches[2] as explained at fig. 1. A potentially handy feature is that the mechanical filter and its associated amplifier are arranged to be connected to rear-apron jacks by means of diode switches to enable their use with external gear such as a companion s.s.b. exciter for which there also are phono jacks with v.f.o., b.f.o. and crystal-oscillator outputs.

[2] Stoner, D. L., and Earnshaw, L. E., "The Diode Switch," *CQ*, Feb. '61 p. 36.



Top view of the DR-30 showing the gearing mechanism for tuning and bandsetting. A string drive is used only for moving the pointer along the slide-rule scale. The heterodyning oscillator and crystals are mounted near the front end of the bandswitch (left). The v.f.o. and calibrator compartments are at the right. The v.f.o. toroid cannot be seen.

The variable-notch filter is a passive type that provides high attenuation at the notch frequency in the i.f. passband. The notch depth is adjusted by a trimmer control at the rear of the set.

Automatic Gain Control

The a.g.c. detector, preceded by a buffer amplifier that prevents i.f. loading, operates with bootstrap circuitry having a fast attack and three selectable degrees of release time: .015 sec. for a.m., 0.2 sec. for c.w. or 0.8 sec. for s.s.b.

Detector and A.F. System

The envelope detector for a.m. or the product detector for s.s.b. and c.w. can be switched in as desired with any one of the selectivity positions. The sideband switch changes the b.f.o. crystals and compensates the v.f.o. frequency at the same time. Retuning is not required.

The two a.f. power-output transistors operate with transformer-less output circuitry and will accommodate speaker impedances of 8-45 ohms. Where headphones are to be used, they should be magnetic types of 600 ohms or less. There is no phone jack, by the way. Power output is rated at 0.6 watts with 5% distortion.

High-frequency roll-off can be had with a tone-control switch that is a 3-position toggle type. The third position is wired to the power plug for controlling accessory gear such as transmitter relay, etc.

Power Supply

The DR-30 operates directly from a 12-15 v.d.c. source, either positive or negative ground. A three position toggle switch at the rear of the unit allows the case to be grounded to either side of the power source, or it may be left floating. A diode connected in series with the supply line will cease to conduct if the battery polarity is incorrect, thus protecting the transistors and components from accidental damage. Current drain for the receiver is 300 ma with the panel lights turned on, but they may be switched off to cut the current drain to 150 ma. Provisions are included for muting the receiver.

Construction

The mechanical construction of the DR-30 is a marvel to behold. The main body of the unit consists of a rigid solid-aluminum extrusion which is divided into a number of separate compartments that have milled slots to accept glass-epoxy printed-circuit boards on which the various sections of the set are assembled. As each board is slid in, it engages a slip-on terminal-connector block. On some boards a few extra connections are soldered to easily accessible terminal pins on top of the board. All interconnecting wiring is Teflon insulated, so there is no danger of melting or ruining insulation when leads are soldered or unsoldered. The whole arrangement facilitates maintenance and servicing.

Parts that require physical stability are attached to the main body and the tuning-capacitor drive mechanism is installed in a heavy-aluminum milled assembly with ball bearings for the drive shafts. Spring-loaded split-gears, for "backlash-free" tuning, are used to obtain the desired tuning ratio. The panels are stainless steel. The power plug is a Jones type. Phono jacks are used for other connections.

Calibration

The frequency is read from a 4½" slide-rule dial that is calibrated (slightly non-linearly) in 5 kc steps spaced at an average a bit less than 1/16." There are two scales, one calibrated from 0 to .55 mc, the other .5-1.05 mc. When the bandswitch is rotated, a red or white number appears at the left of the scale to indicate the megacycle range to which the scale calibration must be added for the particular range. When the megacycles are shown in red, you add the red dial markings for the frequency readout. The black scale readings are added when the mc numerals are white. Calibration may be set with a screwdriver-adjust control accessible through a hole in the panel.

Each complete rotation of the tuning knob covers an average of 20 kc. The knob is marked off in ten steps, representing about 2 kc. The knob divisions are not identified numerically, so you have to mentally note by how many marks the knob has been rotated for resetting back to a given frequency. An adjustable dial drag and lock is provided.

Performance

Although the sensitivity of the Davco DR-30 is rated at 1 μv for 10 db s./n., each receiver is supplied with an individual specification sheet giving the s.s.b.-c.w. sensitivity on each band for the particular unit. The average of the figures for two models on hand was .18 μv for 10 db s./n. on all bands, except on 50 mc the average was .42 μv. Our own measurements were virtually identical to the figures supplied by the manufacturer.

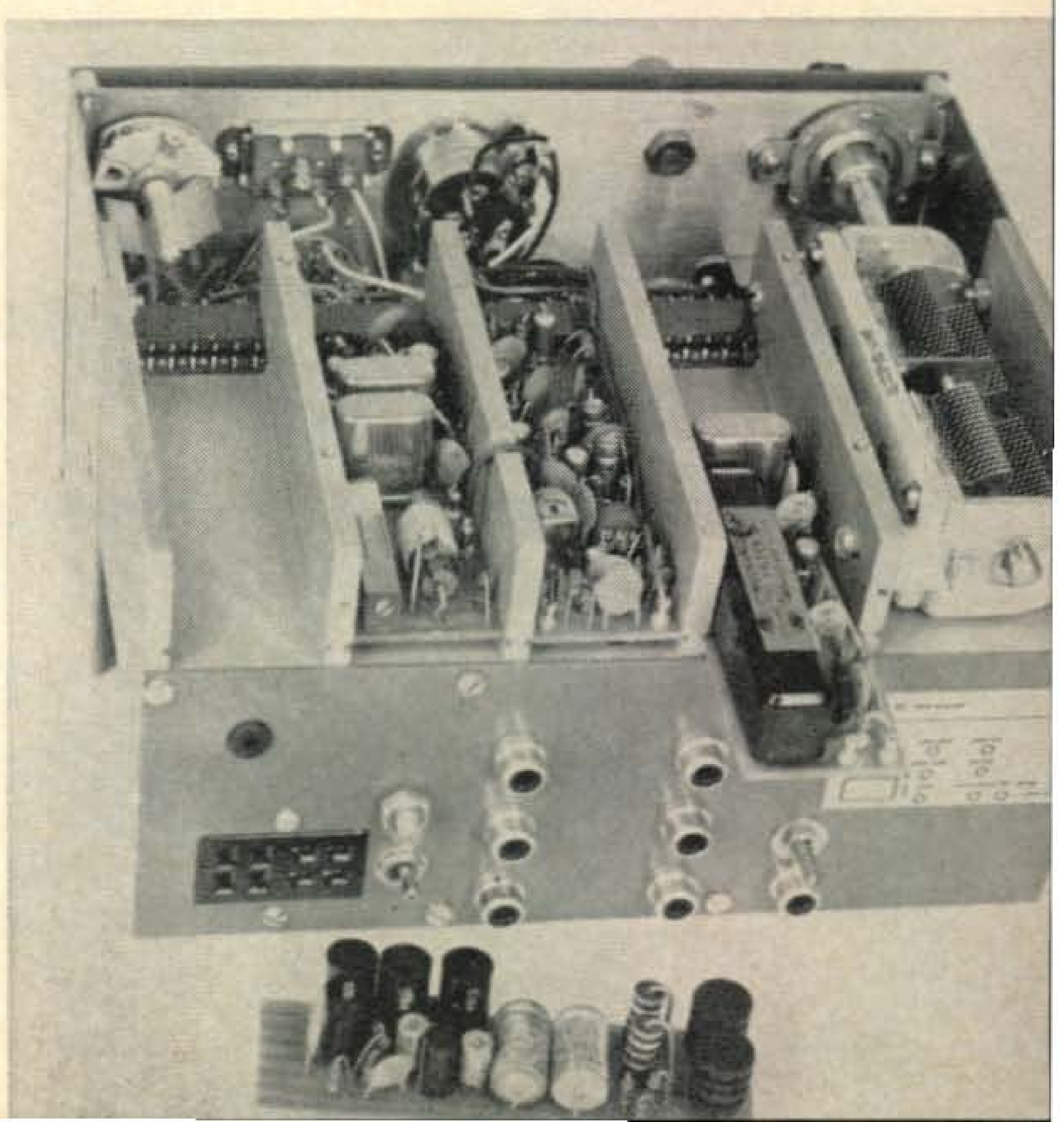
The maximum variation in gain between the bands was 4 db. At about 100 kc below the top end of each band a "suckout" was noted that resulted in a signal-level loss of near 6 db; however, there was no deterioration of sensitivity or signal-to-noise ratio.

Cross Modulation

Measurements of overload and cross modulation were made on a comparative basis against other transistorized and vacuum tube gear. The performance in this area was well up to expectations due to the attributes of the f.e.t. devices used in the front-end. Absolute values are not given, as we've yet to find a standard method or rating in this respect set forth by amateur-equipment manufacturers.

From an on-the-air operating standpoint an acid test here in the New York area is the effects caused by NSS on 4005 kc with the receiver tuned in the 3990-4000 kc region while using a 75-meter antenna, a test which the DR-30 withstood very well; except when the noise blanker was engaged to a large degree, desensitization and spurious signals were experienced. This evidently occurred because the blanker is installed ahead of the i.f. selectivity and thus is susceptible to triggering by pulses from strong nearby signals that would otherwise be attenuated by the i.f. filters.

[*Continued on page 94*]



Bottom view of the DR-30. The individual circuit boards slide into slots at the side of each compartment and engage slip-on terminal-connector blocks at the far end of the channel. The a.f. board, lying in the foreground, has been removed from the left partition. The section with the mechanical filter is shown partly inserted near the right. The installed board at left of center contains the b.f.o., product detector and the notch-depth control which is the "Trimpot" at the rear. The center board holds the 2nd i.f., a.g.c. and a.m. detectors. Four other boards are accessible when the panel with the connectors is removed.

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ing, ask for the APT alert messages which local offices receive on the teleprinter network at 1900 GMT daily from the National Environmental Satellite Center in Washington, D.C. The TBUS-1 messages received on the net contain orbital information for ESSA weather satellites, while TBUS-2 messages contain data for the NIMBUS satellites. Orbital information is given in the form of predicted equator crossings in longitude and time. From this it should be relatively simple to predict overhead passes at any location. Additional information concerning weather satellites and APT transmissions can be obtained from Mr. David Holmes, National Environmental Satellite Center, Environmental Science Service Administration (ESSA), Washington, D.C., 20233.

As of early November, the following are orbital and frequency data for the ESSA-2 and NIMBUS-2 weather satellites.

	Period (Mins.)	*Incli-nation* (Degs.)	*Freq.* (Mc.)
ESSA-2	113.5	101	136.770 Tracking & Telemetry, On Command 137.500 APT
NIMBUS-2	108.1	100.3	136.5 Continuous Beacon 136.95 Tracking & Telemetry, On Command 136.95 APT

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Image and I.F. Rejection

Images are rated at down 60 db below 22 mc and 35 db in the 22-54 mc range. Primary image rejection was found to be 50 db at the center of the 3.5 and 21 mc bands, 40 db on 50 mc and 45 db on the other bands. I.f. rejection at 2900 and 2500 kc was 45 and 55 db respectively on 3.5 mc, 55 db at both points with the other bands.

Selectivity

At the 2.1 kc selectivity position the bandwidth measured 1.8 kc at the 6 db points, 2.4 kc at 20 db and 2.9 kc at 40 db. The narrower bandwidth and steeper skirts than usual are evidently due to the super-imposed selectivity added by the ceramic filter resonators in the i.f. strip. Although the b.f.o. frequency is well-down on the skirt, resulting in unwanted-sideband suppression of 60 db at 500 c.p.s., the a.f. response with s.s.b. is pleasant sounding without the harshness one might expect.

The 0.5 kc step used for c.w. peaked at 1300 c.p.s. with a very steep skirt on the zero-beat side when the USB position is used. Bandwidth was 200 c.p.s. at 6 db, 1 kc at 20 db and 1.5 kc at 40 db. No loss of level was found at the peak frequency.

The 5 kc position had a 4.8 kc width at 6 db, 12 kc at 20 db. The resulting response produced good a.f. quality with a.m.

The rejection-notch depth was at least 50 db with a very sharp null, but with some loss of a.f. level in the remaining useful passband as often found.

Spurious Responses

Internal in-band tweets are rated at 1 μv equivalent. Those that were found were within the rating, except a 2 μv signal just out of the 75-meter phone band at 4001 kc. Also, 2 μv tweets between .21-.23 mc (or .71-.73 mc) on the scale with all bands, apparently caused by the 6th harmonic of the b.f.o. picked up by the variable i.f. Because of the excellent s./n. ratio of the set, any tweet above about 0.5 μv sounds like a larger signal. On the other hand, if you're in a noisy location or listening on a crowded band, these tweets will go unnoticed.

A.G.C. performance was 12 db a.f. output rise with 80 db input-signal increase (1-10,000 μv). The choice of the three different release times appeared to be quite suitable for the various modes of operation.

Noise Blanker

The noise blanker is extremely effective, even in the presence of heavy power-line noise in which case signals as low as 1 μv were readable. No noticeable distortion was experienced with it and although it is designed specifically for s.s.b. and c.w., it was found useful with a.m. too but with some distortion.

As pointed out previously, full use of the blanker can in effect deteriorate the selectivity (as far as desensitization goes), so in many cases it will be best not to advance the blanker control further than needed for a particular situation. Also, there is a noticeable loss in i.f. gain when the blanker is full on.

Frequency Stability

The stability was found within the ratings of negligible drift during warmup, less than 100 c.p.s. per hour and 25 c.p.s. with 20% power-supply variation. Warmup drift for first 30 minutes from normal ambients averaged close to the hourly rate. Drop tests indicated excellent electrical and mechanical stability. Shaking the unit forward and backward produced a slight frequency shimmy, making us a bit apprehensive about performance in mobile service; however, road tests indicated no adverse effects.

Miscellaneous Notes

Care must be taken to see that the case-grounding switch is set to connect the case to the *grounded* side of the 12-volt supply in mobile installations. Switching it to the hot side will produce a short across the line when grounded antenna cabe is connected or if the case is fastened to metal parts of the car. The switch should be pushed *down* for *negative* ground, *up* for *positive*. The case floats in the center position. Once set, it might be well to secure the switch lever with masking tape to prevent accidental changeover.

The power-cable plug is a male with exposed pins, so if it is handled while connected to a live source, be sure not to accidentally short or ground the pins by contact with metal elements.

The r.f. gain-control knob works the standby-operate switch. It must be pulled *out* for operate, pushed *in* for standby. If the set fails to function, check to see if the knob has been pushed in inadvertently while the receiver was handled.

Although the DR-30 is a very small package, it handles nicely once you're accustomed to it and if you're not "all thumbs." It is quite a sophisticated job in spite of its little size which, by the way, is just about right to fit in your Christmas stocking.

The DR-30 is priced at $389.50 with all crystals and mating connectors. An inexpensive accessory a.c. power supply/speaker is also available. The DR-30 is manufactured and sold by Davco Electronics, Inc., P.O. Box 2677, 2024 South Monroe Street, Tallahassee, Florida, 32304. —*W2AEF*

Coax Switching [*from page 54*]

Another innovation which I later introduced is an r.f. pick up probe for my keying monitor. You may not need this feature if you work phone exclusively or have a keying monitor which does not depend on sampling the radiated r.f. My monitor is a Viking Signal Sentry which does require a bit of r.f. I procured this by connecting a small coil (4 turns) wound on a ¾" ceramic form, in series with the r.f. ammeter. Over this I wound two turns, leaving one end unconnected and wiring the opposite end to a phono jack in the side of the housing between two of the coax chassis connectors. This arrangement appears in the schematic as L_1 and L_2.

A simple s.p.s.t. toggle switch between the other two coax connectors serves to switch a small resistance wire shunt across the meter should I ever increase power to a point sufficient to run the meter off scale.

Installation

All of the foregoing equipment is mounted on my shack walls. The transmitter/antenna switching panel and the antenna selector cabinet are mounted adjacent to the transmitter group and the receiver/antenna switching panel just above the receiver positions. I've finally achieved the complete flexibility and convenience I had long been aiming at in choice of antennas versus transmitters/receivers and it has added immensely to my operating pleasure and convenience. I'm sure that you'll find it so for you, should you choose to adopt the scheme either partially or in its entirety. ■