The Swan Model 400 S.S.B. Transceiver shown with the Model 420 V.F.O. at the right.

CQ Reviews:

The Swan Model 400 S.S.B. Transceiver

BY WILFRED M. SCHERER,* W2AEF

THE Swan Model 400 is an s.s.b. transceiver that provides full coverage on the amateur bands, 10 through 80 meters, with operation on either upper or lower sideband and with a transmitter input of 400 watts p.e.p. It also operates on c.w. and may be used on a.m., as well, producing a carrier with a single sideband.

A special feature of the Swan 400 setup is the use of two types of transistorized v.f.o.'s built as a separate unit. The Model 420 v.f.o. is designed mainly for fixed-station use and full band coverage, while the Model 406 is a small size unit intended primarily for mobile service on 200 kc segments that include the phone portion of each band (2 segments on 10 meters).

We're especially pleased to find such an arrangement on the market, inasmuch as in almost 10 years of mobile s.s.b. operation with our homebuilt gear, we've found this to be an ideal setup which enables the main part of the equipment to be mounted out of the way without cluttering up the front quarters of the car. It also provides maximum ease of operation, as the small v.f.o. can be mounted near the steering wheel or other convenient point within reach where tuning may be conducted conveniently, safely and comfortably.

Another feature which has been successful in the past with other Swan gear is that unlike other s.s.b. rigs, the Swan 400 incorporates a high i.f. with single conversion on both receive and transmit, instead of the generally used multiple-conversion systems. Spurious responses or birdies can therefore be virtually eliminated and difficulties with cross modulation and overloading may be minimized; while the high i.f. ensures excellent image rejection.

Single conversion necessitates changing the v.f.o. frequency range for each band which in turn requires operation of the v.f.o. at relatively high frequencies where frequency stability ordinarily becomes a problem, but by using tran-

*Technical Director, *CQ*.

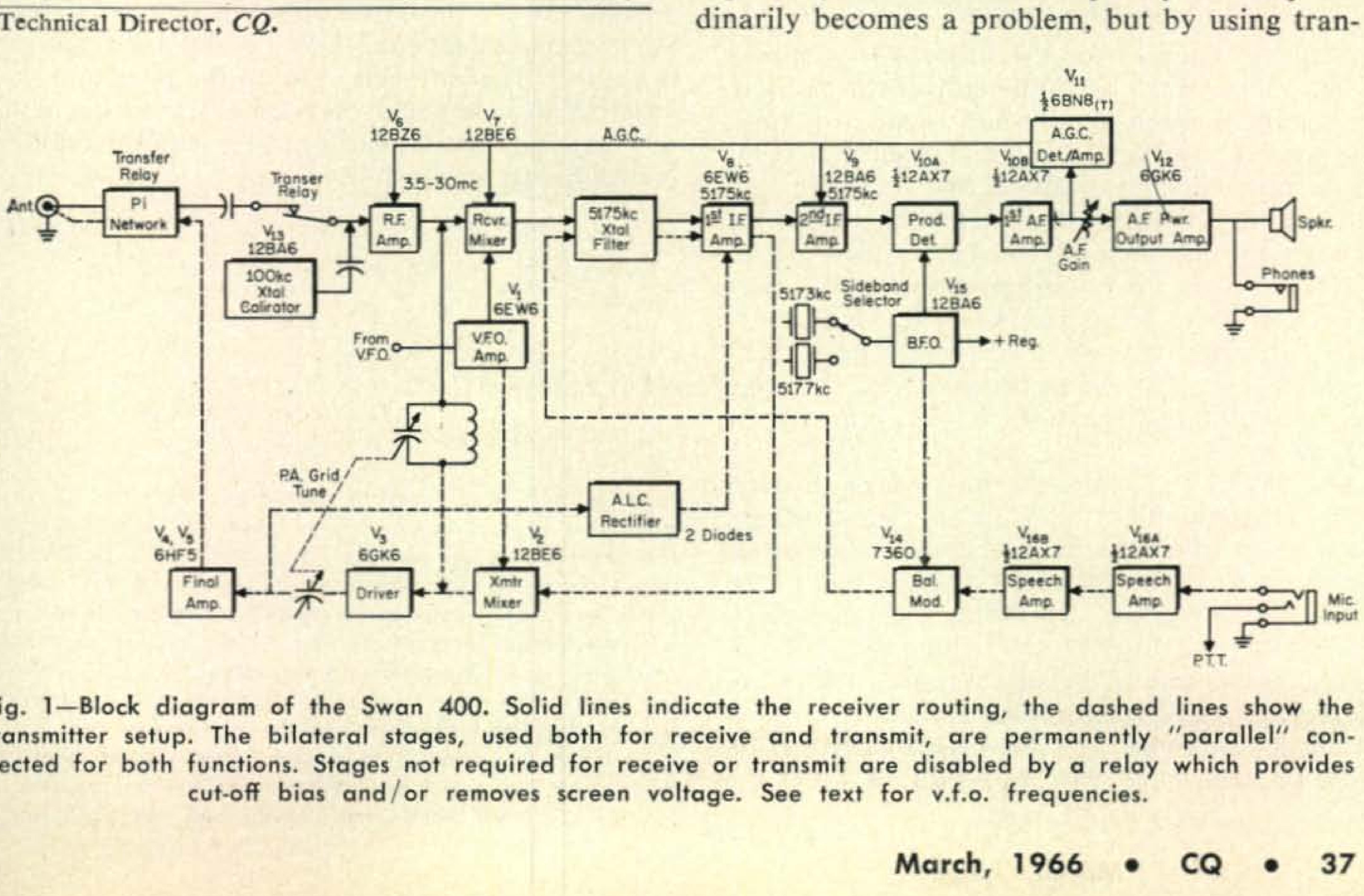
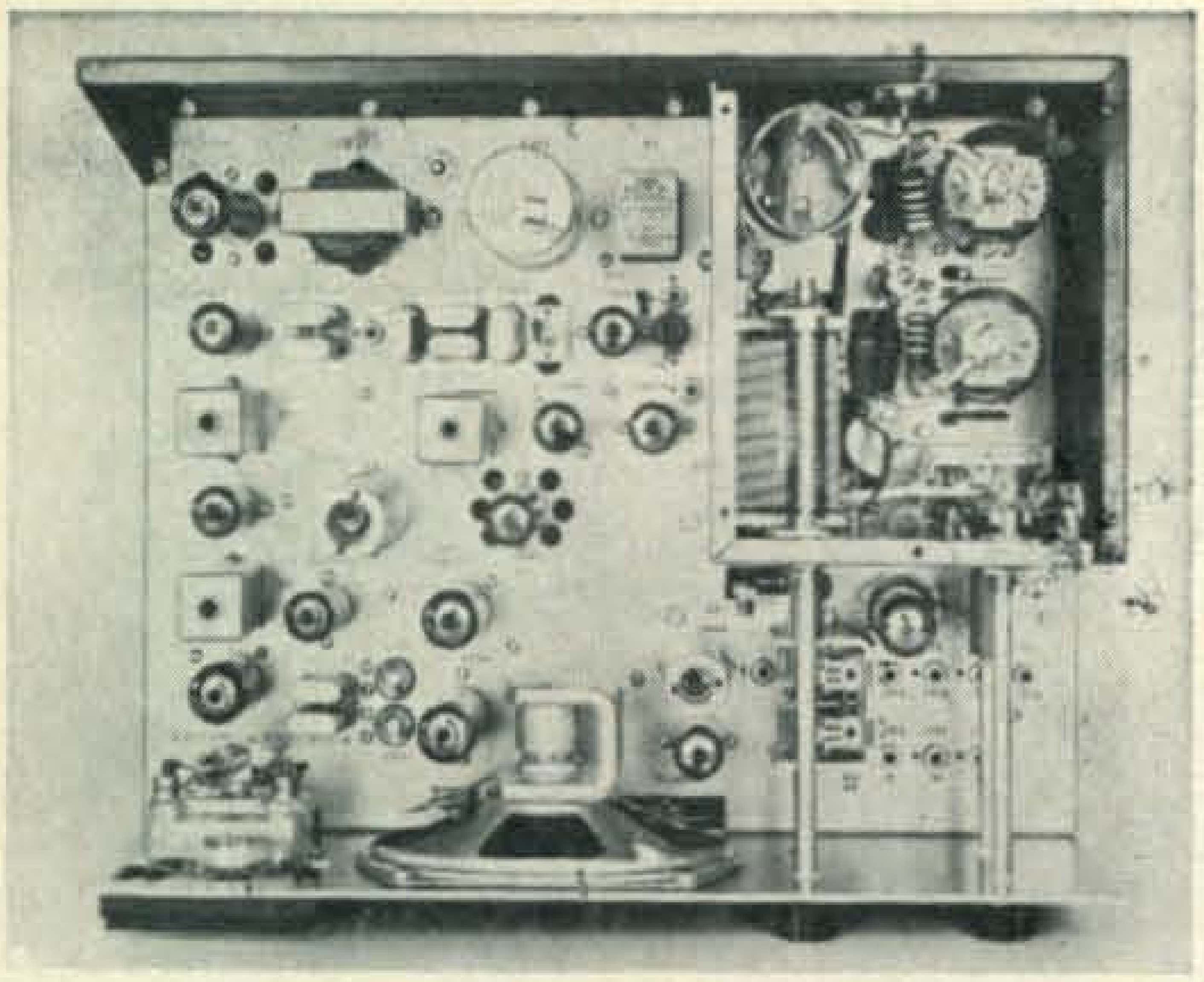


Fig. 1—Block diagram of the Swan 400. Solid lines indicate the receiver routing, the dashed lines show the transmitter setup. The bilateral stages, used both for receive and transmit, are permanently "parallel" connected for both functions. Stages not required for receive or transmit are disabled by a relay which provides cut-off bias and/or removes screen voltage. See text for v.f.o. frequencies.



Top view of the Swan 400. The final amplifier compartment is shown with the cover removed at the upper right.

sistors instead of vacuum tubes, excellent overall stability is achieved. To obtain a uniform tuning range with accurate calibrations on each band as is usually provided in s.s.b. gear, equal tracking and bandspread must be realized as well as uniform thermal stability. How these requirements are met in the Swan units is described later.

Other features of the Swan 400 include: a 15 mc band for WWV; 320 watts input on c.w.; 125 watts carrier input for single-sideband a.m.; panel meter automatically switched to read S-units or p.a. cathode current; block-grid keying for c.w.; auxiliary contacts on xmt/rcv. relay; Pi-network for 20-300 ohm loads; crystal calibrator; p.t.t. operation (or v.o.x. with plug-in accessory unit); slow a.g.c. on receive; a.l.c. on transmit; built-in loudspeaker. Power supplies are separate, one for 120 v.a.c. operation, the other for 12 v.d.c. mobile use.

Circuitry

A block diagram for the Swan 400 is shown at fig. 1. Inasmuch as single conversion is used, the lineup is quite simple and straightforward. The receiver section has an r.f. stage that feeds the mixer which heterodynes the incoming signals with appropriate v.f.o. frequencies, obtained through the v.f.o. amplifier, to produce an i.f. of 5173 kc. The v.f.o. frequencies at the start of each amateur band are: 8673 kc for 3.5 mc; 12,173 kc for 7 mc; 8827 kc for 21 mc; 22,827 kc for 28 mc. The difference products are used for 3.5 and 7 mc, the sum products for 14, 21 and 28 mc.

The 5173 kc i.f. from the mixer goes through a 2.7 kc bandwidth crystal filter to two i.f. stages and to a product detector where mixing with a 5173 kc crystal-controlled b.f.q. demodulates the s.s.b. signal for the following a.f. amplifiers. Sidebands are changed by switching to a 5177 kc b.f.o. crystal and manually retuning the v.f.o. accordingly. Due to the sum and difference relations given above, the most used sideband on each amateur band will be produced when the 5173 kc b.f.o. crystal is used.

A.g.c. is obtained by rectifying the a.f. output from the first a.f. amplifier and applying the resulting d.c. as a variable control bias to the r.f., the mixer and the 2nd i.f. stage. This arrangement necessitates an a.f. gain control at the input of the audio power amplifier instead of at the 1st a.f. stage. The a.g.c. has a slow time constant to minimize pumping and a.g.c. distortion. The S-meter is connected to the cathode of the 2nd i.f. stage where it indicates the cathode voltage which is inversely proportional to the a.g.c. control voltage; consequently, the meter is zeroed at the right and deflects "backward" with signal.

There are two traps at the input of the r.f. stage. One is tuned to 5175 kc to eliminate i.f. signal feedthrough, the other rejects 13 mc signals that could otherwise produce a 5175 kc i.f. signal by beating against the second harmonic of the v.f.o. on 20 meters. See fig. 2.

Transmitter

The transmitter lineup also is a simple one. A 5173 kc carrier signal from the b.f.o. and the a.f. from the two-stage mic amplifier are applied to a 7360 balanced modulator where a suppressed-carrier double-sideband signal is produced. This signal is then fed to the crystal filter where one sideband is rejected. The s.s.b. signal from the filter goes to the 1st i.f. amplifier and on to the transmitter mixer to which the v.f.o. signals also are applied to produce a frequency in the desired amateur band.

Crystal Filter

In the early model *CQ* received for test the sideband filter had four crystals in a typical high-frequency filter configuration with the addition of a fifth crystal that is shunted across the *L/C* circuit in the filter. This crystal provides a notch near the "normal" carrier frequency of 5173 kc and creates a very steep skirt on this side of the filter. High carrier and sideband suppression can then be obtained while the carrier is positioned close to the passband in order to provide better-than-usual low-frequency a.f. response that makes a more pleasant sounding s.s.b. signal possible.

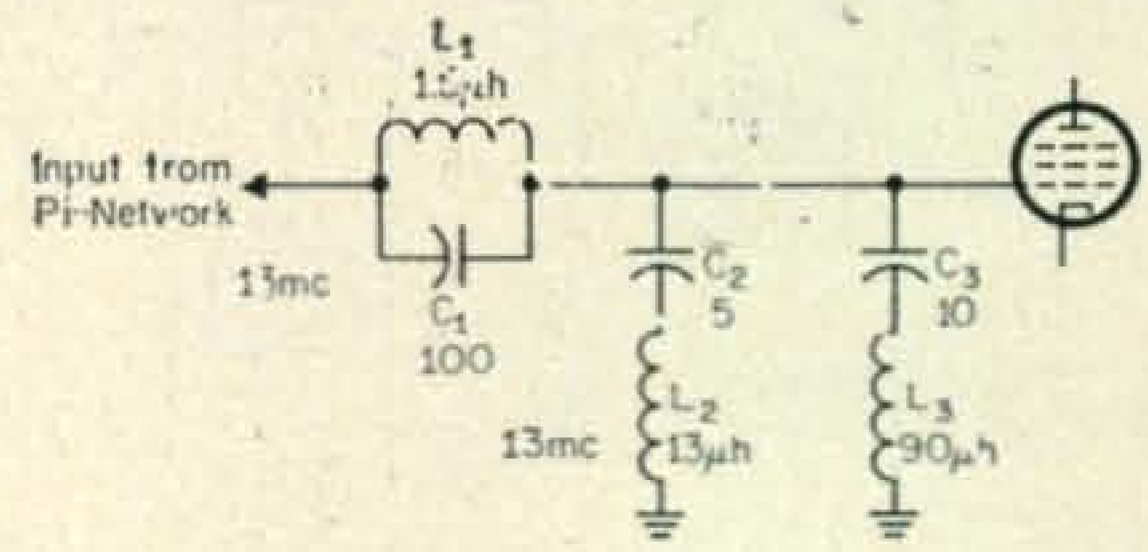


Fig. 2—Input traps used in the Swan 400. The 13 mc trap must have a very high Q in order not to attenuate the desired 14 mc signals. This requires a parallel-tuned circuit (L_1, C_1) connected in series with the tube grid; however, such an arrangement necessitates a low-impedance load at 13 mc which in this case is provided by a 13 mc series-tuned circuit (L_2, C_2) across the tube input. Use of just a shunt-connected series-tuned affair of high Q would present a low reactive impedance at other frequencies which could disastrously cut down the overall gain for desired signals. L_3 and C_3 make up a series-tuned trap for 5175 kc.

This also causes the filter to be unsymmetrcial with a more gradual slope found on the opposite skirt. Thus, when sidebands are switched with the b.f.o. carrier at 5177 kc on the sloping side of the filter, the suppression is somewhat less; nevertheless, it is within acceptable limits.

In this connection, the 5173 kc carrier and the steep-skirted side of the filter are used for normal operation, so that the improved suppression and a.f. quality obtained thereby may always be realized when transmitting the customary sideband for the particular amateur band; that is, l.s.b. on 40 and 75, u.s.b. on 10, 15 and 20 meters. The poorer side of the filter is used only for the seldom-used sideband.

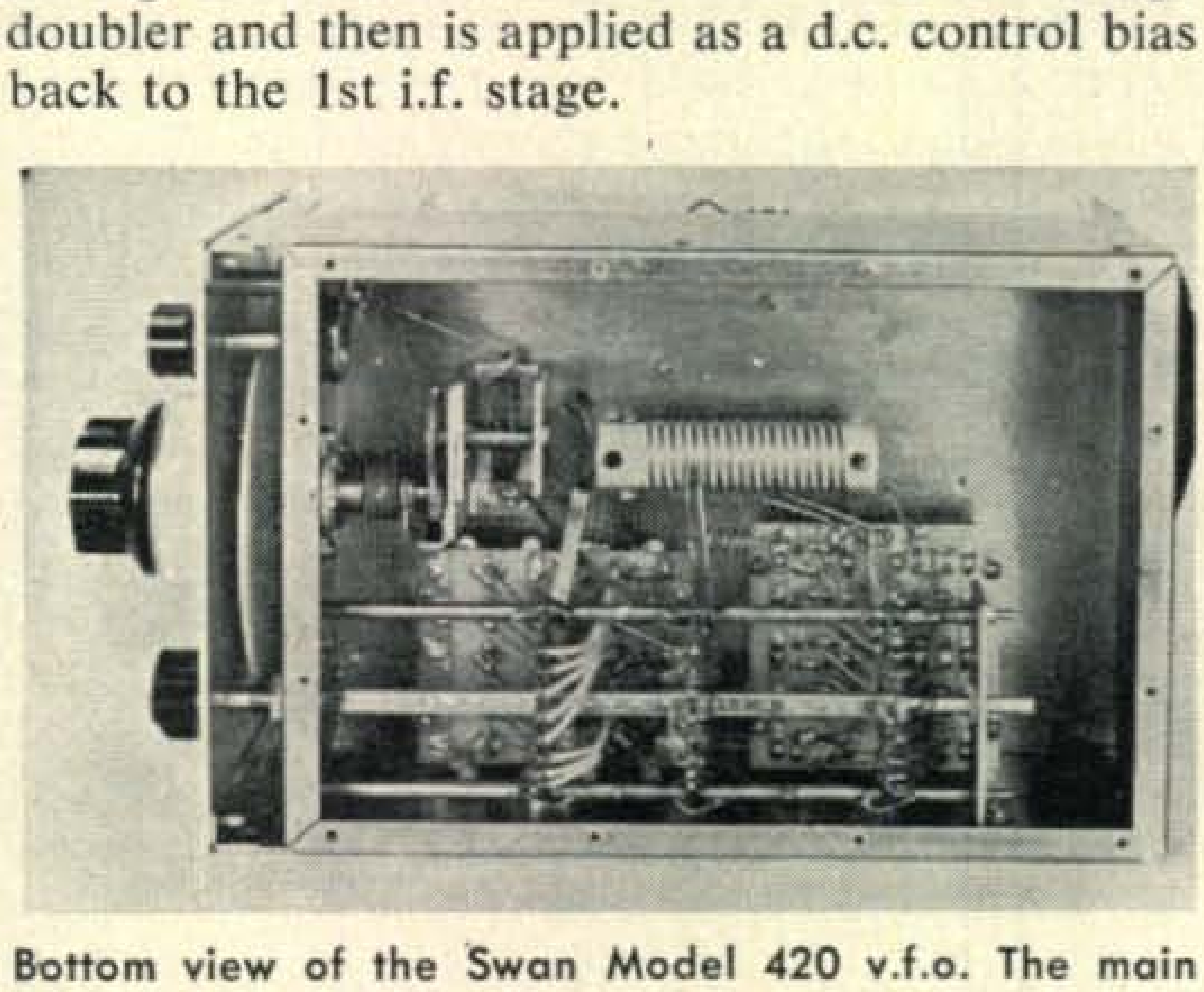
A 2.7 kc six-pole lattice filter is being installed in current production models of the 400. The filter response is symmetrical with a shape factor of 1.7. Suppression is further improved and is alike for either sideband.

Output Amplifier

The mixer feeds a driver stage for the final amplifier which has two 6HF5 pentodes in parallel operating class AB_1 and which may be driven to at least 400 watts p.e.p. input. The output circuit is a conventional Pi-network with coarse and fine loading provisions for matching to impedances of 20-300 ohms. The amplifier is neutralized by the standard capacitance-bridge method, except individual fixed capacitors are switched in at the by-pass leg of the bridge to maintain optimum neutralization on each band.

The Pi-network also serves as the tuned input for the receiver r.f. stage which is disconnected from the circuit by a relay during transmit. The same tuned circuits that are used between the r.f. stage and the receiver mixer also are used between the transmitter mixer and driver. These stages are thus simultaneously tuned when peaking is made on either transmit or receive.

A.l.c. for the transmitter is a standard system whereby an a.f. voltage, produced in the final grid circuit as soon as excess drive is applied during modulation, is rectified with a voltage doubler and then is applied as a d.c. control bias back to the 1st i.f. stage.



Bottom view of the Swan Model 420 v.f.o. The main inductor is wound on a ceramic form at the center. Capacitance and inductance trimmers are on printed-circuits boards under the bandswitch. The transistors and associated circuitry are on a board on top of the chassis.

For tuneup, a carrier is obtained by unbalancing the modulator and by shifting the frequency of the carrier crystal several hundred cycles within the filter passband. The latter is accomplished by switching capacitors across the crystal to "rubber" it. A similar arrangement is employed with c.w. operation for which grid-block keying is provided. During transmit the meter circuits automatically change over to read cathode current of the final.

The v.o.x. accessory module is a transistorized affair which plugs into an octal socket on the left of the rear apron on the transceiver in such a manner that positions the v.o.x. level, delay and anti-trip controls so that they are accessible from the side. Power supply requirements for the 400 are: 12 v.a.c. or d.c. @ 5a., 12 v.d.c. @ 250 ma, −110 v.d.c. @ 100 ma, 225 v.d.c. @ 150 ma and 800 v.d.c. @ 500 ma. These voltages are available from the Model 117-XC a.c. power supply or from the Model 14-117 d.c. unit.

The V.F.O.s

Besides utilizing transistors for stability, the v.f.o. is contained in a separate cabinet to eliminate wide temperature excursions and frequency drift that might otherwise occur from heat generated by tubes or other components in the main unit. Circuitry for the v.f.o. is shown at fig. 3. Two type 2N706 silicon transistors are used. One functions as the oscillator in a grounded-base Colpitts circuit, while the other is an emitter-follower output stage that matches to a low-impedance cable which connects the v.f.o. to the main unit. A Zener diode in the latter provides regulated voltage for the v.f.o.

There are two hairlines on the dial fiducial. One is used for upper sideband, the other for lower sideband. These are needed, because when sidebands are switched, the b.f.o. carrier crystals are changed accordingly, but the v.f.o. frequency is not. This requires a different calibration point to which the v.f.o. must be retuned by about 4 kc. The dial-drive mechanism is a two-speed affair that provides fast tuning with an inner knob or slow tuning with an outer knob. One revolution of the latter covers only 7 kc.

A panel-controlled trimmer, connected across the main tuning capacitor, is furnished as a dial-set for calibration purposes. The r.f. gain for the receiver also is located on the v.f.o. panel.

The output from the v.f.o. is quite low, so a vacuum-tube amplifier is incorporated in the main unit to bring the level up as needed. The coax line between the two units is fed directly to the tube grid which is heavily swamped with a 75-ohm resistor. The amplifier is thereby completely stabilized and r.f. feedback or reactive effects from this stage, that might otherwise affect the v.f.o. frequency, are eliminated. This is further aided by coupling the emitter-follower lightly to the emitter of the v.f.o. The 75-ohm resistor also provides a matching termination for the coax line.

The setup for the Model 406 mobile v.f.o. is

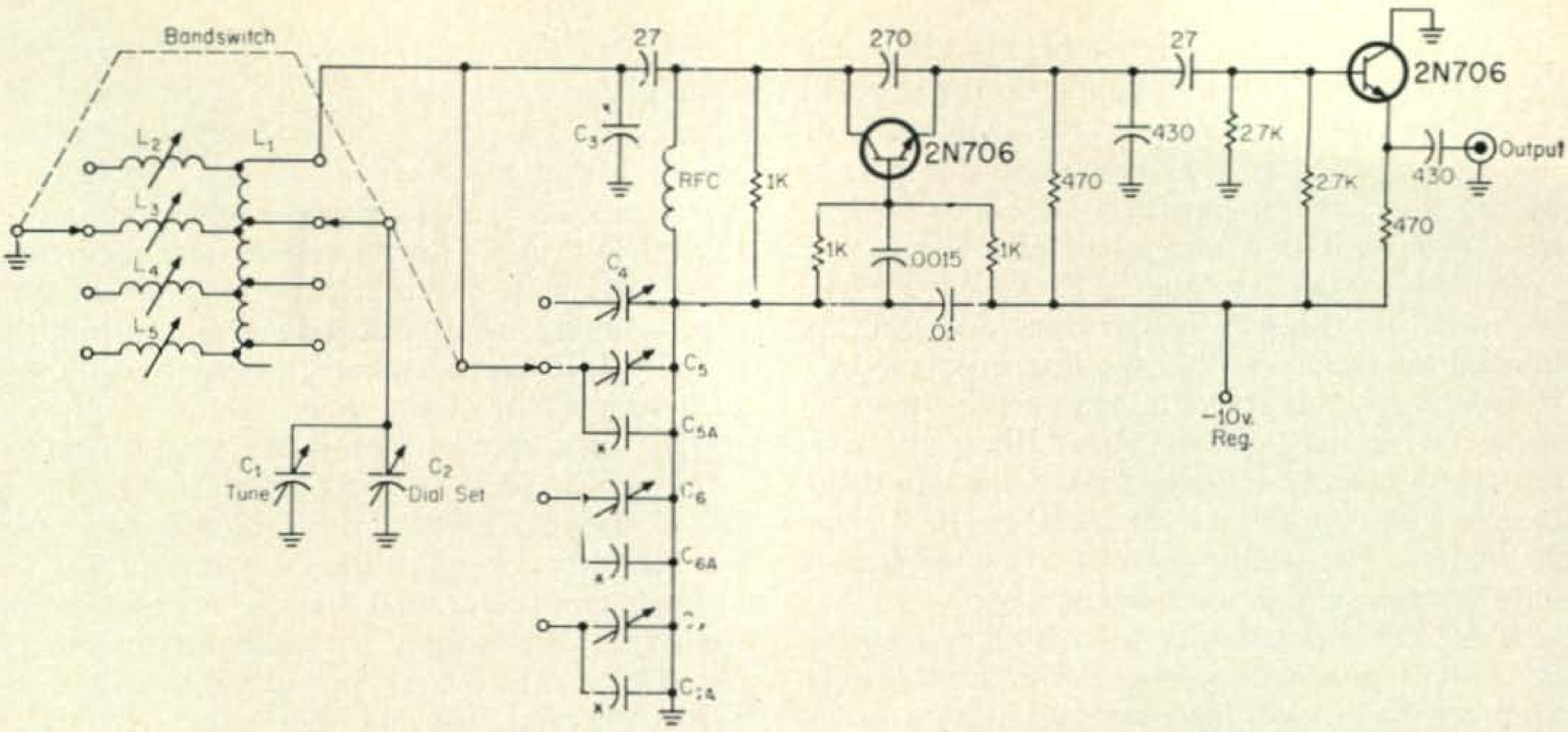


Fig. 3—Basic circuitry for the Swan Model 420 v.f.o. 20 different 200 kc ranges are selected by the bandswitch which chooses the proper tap on the main coil (L_1) and selects trimmers for *both* capacitance and inductance which makes it possible to obtain exact tracking with a single scale on the dial. Separate temperature-compensating capacitors (marked with an asterisk) are switched in to optimize stability on each range. Only 4 positions are shown for the sake of clarity.

like that of the Model 420, except for the limited band segments, the lack of a dial-set and its smaller size.

Performance

Performance-wise, the Swan 400 behaved in this fashion: Receiver sensitivity, 0.2 μv or better for 10 db S/N ratio (rated at 0.5 μv); i.f. signal rejection (5175 kc), −55 db on 3.5 mc band, 70-80 db on all other bands; image rejection −65 db average; sideband suppression at 1 kc, 50 db on normally-used sideband position, −40 db for the other sideband position; carrier suppression, better than 50 db.

Using the Model 420 v.f.o. (we did not have the Model 406 on hand) the frequency stability on all bands, except 28 mc, was 100 c.p.s. drift for the first 5 minutes (starting with normal room ambient), settling down to less than 25 c.p.s. per hour thereafter. On 28 mc the v.f.o. drift was 300 c.p.s. every 10 minutes for the first hour, after which the rate was considerably slower. It is understood that this is being improved by the manufacturer. The v.f.o. tuning was exceptionally smooth and the 2 kc dial calibrations, which are spaced a little over ⅛" apart, made it possible to read the frequency to 1 kc. Reset accuracy and linear tracking was as good as the dial could be read.

One difficulty encountered was that on some bands it was not possible to set the dial calibrations right to the 100 kc markers of the crystal calibrator. No doubt, this could have been corrected with realignment on the ranges concerned. Mechanical stability was quite good, requiring a heavy bang on the cabinet to make the v.f.o. frequency twitter.

A.g.c. action was very smooth. The receiver frequency response produced nice sounding audio output; however, with the r.f. gain set for signal levels a little above the a.g.c. threshold, some dynamic distortion at low audio frequencies was evidenced, but since we're usually super critical, chances are that this would go un-noticed by most amateur operators. At any rate, if it should be bothersome, you can crank down the r.f. gain and bring up the a.f. gain accordingly to obtain really clean a.f. quality (this is the way we personally prefer operation anyway, especially since we've run into similar situations with a number of other receivers).

The transceiver handles nicely, but one thing you have to remember is that when bands are changed, you have to reset a bandswitch on *both* the transceiver and the v.f.o. You also have become accustomed to the backward reading S-meter.

The transmitter tunes up easily to 325 watts "d.c." input that produces 200 watts output for an efficiency of a little over 60%. With s.s.b. voice modulation the input is a good 400 watts p.e.p. with 250 watts out. Two-tone test patterns indicate good linearity and a.l.c. control is excellent with no evidence of flattopping, even with the mic gain cranked up; however, excess mic gain or abuse of a.l.c. is not recommended, because deterioration of the signal can set in as with any such limiting device. On-the-air reports indicated a good quality s.s.b. signal. C.w. also was reported to be good; however, you can't work break-in with c.w., as the set must be manually switched for transmitting in this mode.

The Swan 400 is cleanly laid out both externally and internally. The panel meter is a good size for easy readability and the control knobs are well designed. The key jack is conveniently located on the front panel instead of at the rear. The v.f.o. dial is exceptionally well lit up and readable, while the tuning is as smooth as velvet.

The Swan Model 400 S.S.B. Transceiver is priced at $395. Prices for the other units are: Model 420 v.f.o., $120; Model 406 v.f.o., $75; Model 117-XB a.c. power supply, $75; Model 14-117 d.c. power supply, $120; Model VX-1 v.o.x. accessory, $35.—*W2AEF*