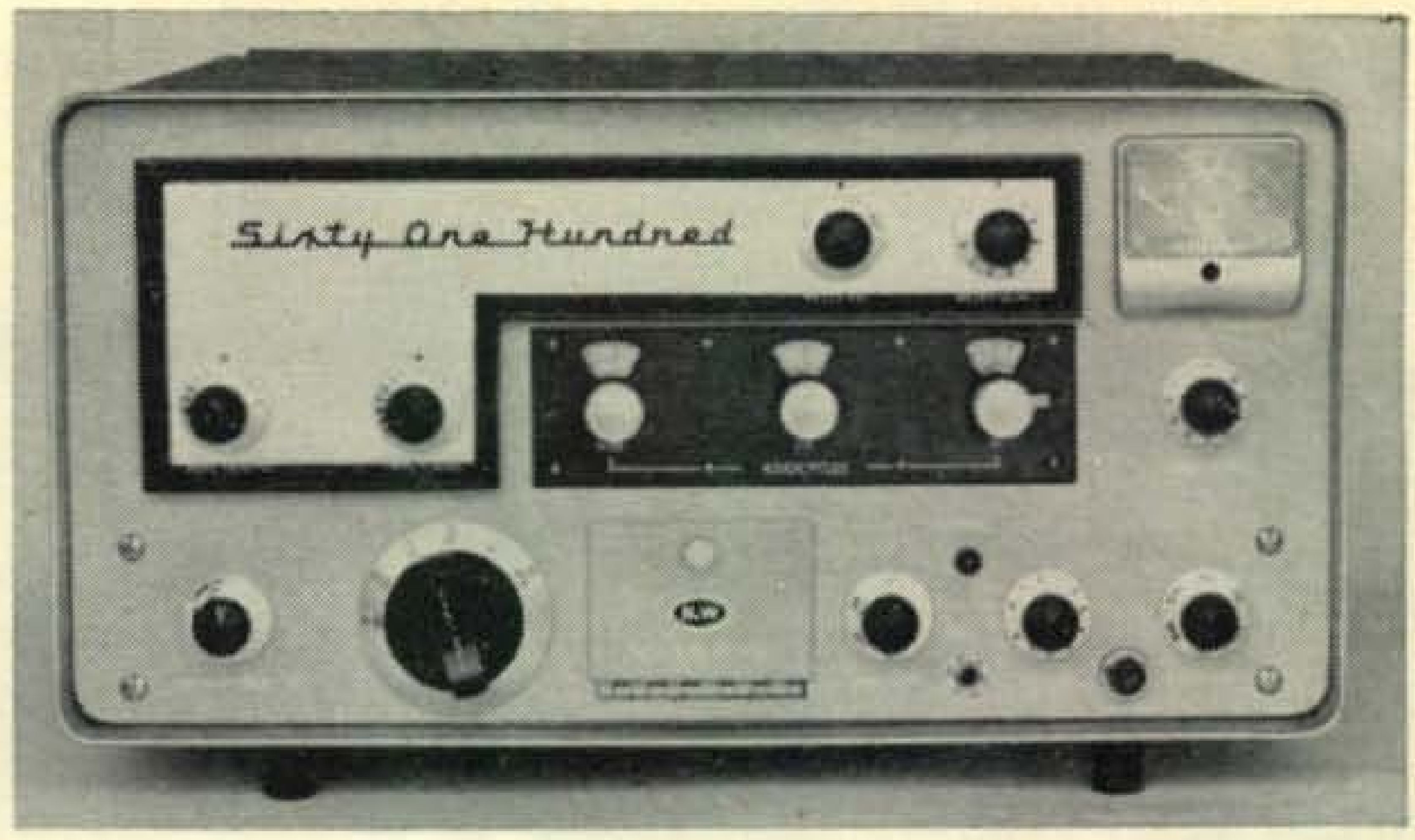


The B&W Model 6100 Transmitter. It is nicely styled with controls conveniently grouped. The three frequency-synthesizer dials are on the black panel in the center. Below these is the door behind which are located the VOX, ALC and CARRIER BALANCE controls. The large knob at the left of the door is the band-selector. The mic and key jacks are at the right with the various function controls.

CQ Reviews:

The B&W Model 6100 Transmitter

It is not often that something radically new is introduced on the amateur equipment market, but Barker & Williamson, Inc., have done just that with their outstanding Model 6100 Transmitter which features a frequency synthesizer, a modern development heretofore used only in commercial and military equipment (a few homebuilt affairs have appeared, but these have been few and far between). This arrangement is an entirely crystal controlled device used in place of a v.f.o. for variable frequency control. It insures better stability than ordinarily experienced with free-running oscillators and it facilitates instant frequency changes with an exceptionally high degree of reset accuracy to any frequency within its range. A more detailed description will be given later.

Besides the frequency synthesizer, the Model 6100 has about everything else one might desire in a piece of equipment of this type. First of all, it is an s.s.b., a.m. and c.w. transmitter capable of at least 100 watts peak output on all bands 80 through 10 meters and on many MARS frequencies. It has numerous fine features as will be seen during the ensuing description.

Circuitry

A block diagram is shown in fig. 1. The microphone signal is applied to a two-stage a.f. amplifier consisting of two triode sections of V_1 which is one of the latest type tubes, a 6C10 triple-triode Compactron. The third triode in V_1 is an a.f. cathode follower which feeds a shunt-connected dual-diode balanced modulator no. 1.

A crystal-controlled carrier signal of 3.2 mc, obtained from V_4, also is applied to the balanced modulator where it is balanced out. The result is a double-sideband suppressed carrier signal at 3.2 mc which is fed into a 3.2 mc upper-sideband crystal lattice filter having a bandwidth of 3 kc. This produces a single-sideband signal at 3.2 mc which is amplified by V_5.

Sideband Switching

A second balanced modulator, using 4 diodes, comes next. Here the signal is mixed with a crystal-controlled oscillator signal of either 6 or

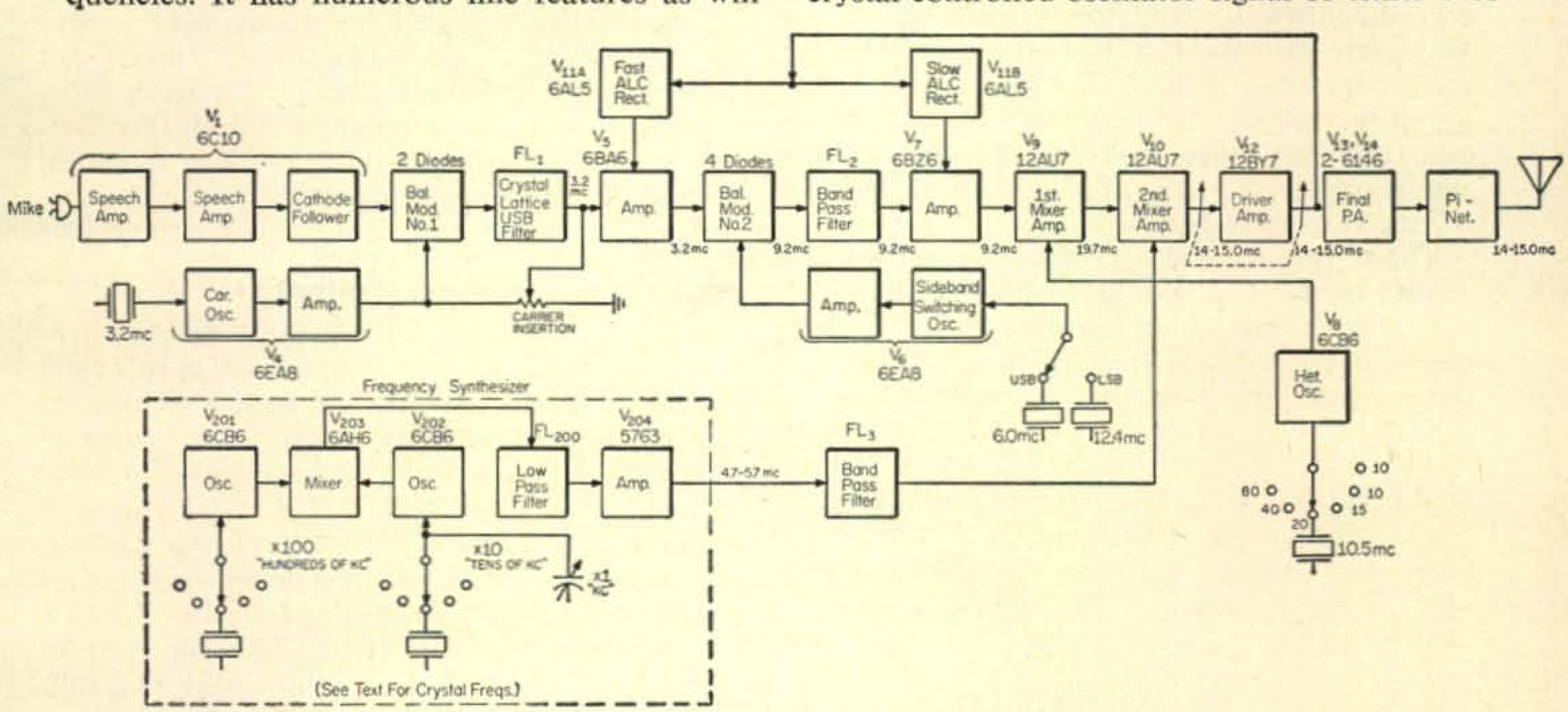
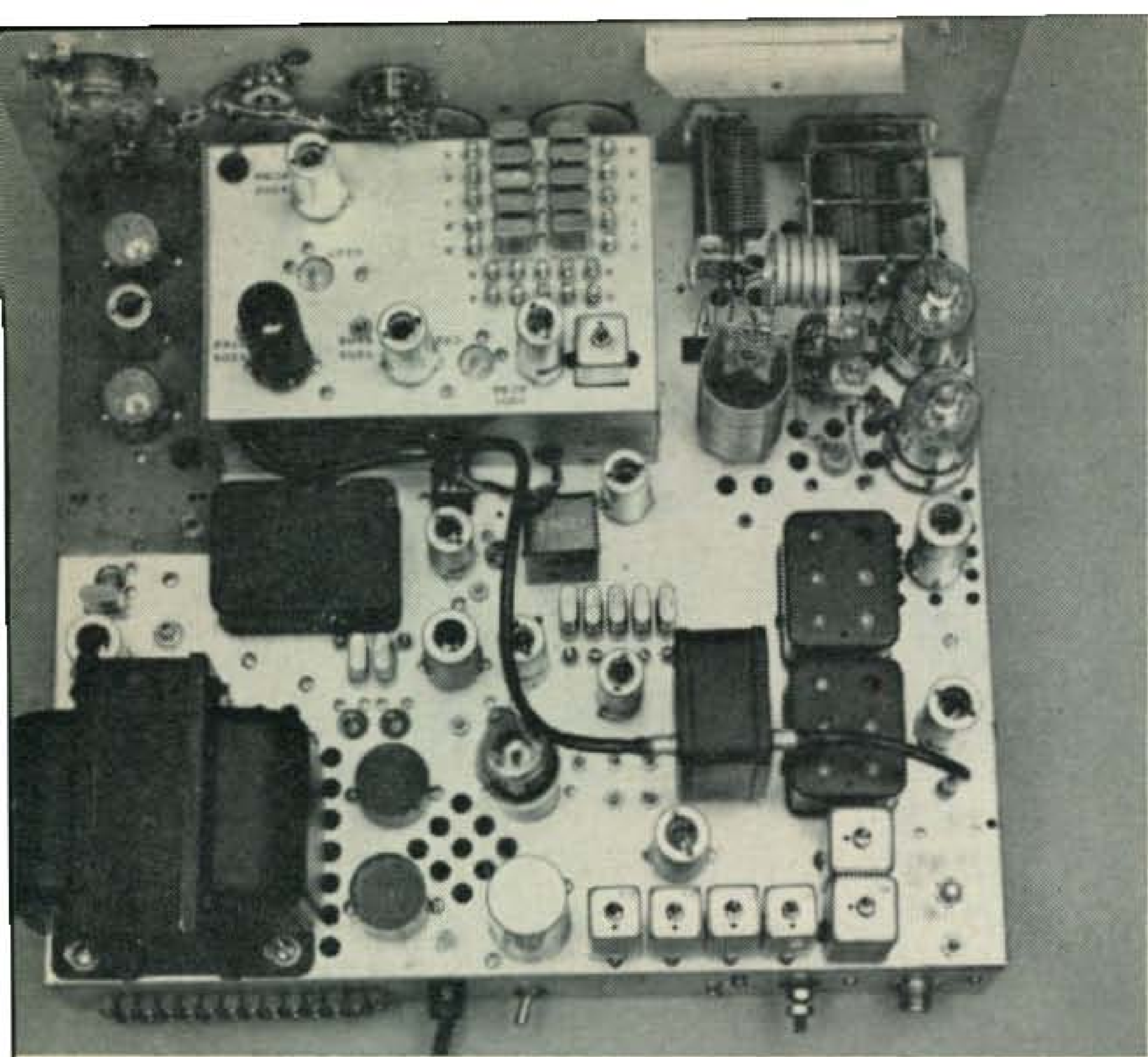


Fig. 1—Block diagram of the B&W 6100 transmitter. Vox circuits are not shown for simplicity. Heterodyne oscillator V_8 shows output for 20 meters only. Crystal frequencies used for other bands are shown in the text.



Top chassis view of the B&W Model 6100 Transmitter. The heart of it, a frequency synthesizer is a separate plug-in module seen next to the panel. The ten 100 kc step crystals, surrounded with their associated trimmers, are on top of the unit. The other crystals are inside of the module. A perforated metal cage, which is normally secured to the bracket on the panel, has been removed to obtain a view of the p.a. at the upper right. Note the silver-plated ribbon-type 10-meter high efficiency tank coil to the left of the 6146's. The vox and speech amplifier stages are at the left of the synthesizer. At the lower left is a husky power transformer, between which and the synthesizer is the sideband filter. The output cable from the synthesizer is connected to bandpass filter FL_3

12.4 mc, derived from V_6, to produce either an upper or lower sideband signal at a frequency of 9.2 mc.

Switching sidebands at this point has two advantages. One is that only one frequency has to be shifted, rather than two as needed with some systems. The other is that the 3.2 mc carrier can be fixed at the best side of the filter where its skirt can be made steeper for a given cost, thus providing a high degree of unwanted-sideband suppression and better low-frequency a.f. response for producing a more pleasant-sounding voice signal.

The output of the balanced modulator no. 2 is passed through a 9.2 mc band-pass filter which eliminates the possibility of spurious responses, notably the 3rd harmonic of the 3.2 mc s.s.b. signal. A second amplifier, V_7, is then used prior to feeding the signal to the first mixer/amplifier V_9. For 80-meter use this stage operates as a straight-through amplifier on 9.2 mc. For the other bands it combines signals from crystal-controlled oscillator V_8, of 3.5 mc for 40 meters, 10.5 mc for 20, 17.5 mc for 15, 24.5 mc for the lower half of 10 and 25.5 mc for the upper half of 10. The resulting output frequencies from this stage then are: 9.2 mc and the sum-mixtures 12.7, 19.7, 26.7, 33.7 and 34.7 mc for the respective bands.

These frequencies are now applied to the second mixer, V_{10}, together with frequencies in the 4.7 to 5.7 mc range from the frequency synthesizer. Output which is produced from this stage covers the respective amateur bands as follows:

Band	*Signal from V_9 (mc)*		*Signal from Synthesizer (mc)*		*Mixer output (mc)*
80	9.2	minus	5.7-4.7	=	3.5- 4.5
40	12.7	minus	5.7-4.7	=	7.5- 8.0
20	19.7	minus	5.7-4.7	=	14.0-15.0
15	26.7	minus	5.7-4.7	=	21.0-22.0
10	33.7	minus	5.7-4.7	=	28.0-29.0
10	34.7	minus	5.7-4.7	=	29.0-30.0

Driver and Final

A 12BY7 driver/amplifier, V_{12}, which uses high-Q circuits gang-tuned together with those of the preceding mixer, pushes a pair of 6146's, V_{13} & V_{14}, to a p.e.p. input of 180 watts. The 6146's are a specially selected type to ensure high output, good linearity and long life. The output circuit consists of a variable pi-network for matching to resistive loads of from 30 to 100 ohms. Particular attention has been paid to this circuit to maintain proper tube-load impedance and high efficiency, as is evidenced by the fact that uniform output is obtained on all bands with no drop-off at the higher frequencies. An r.f. choke across the output terminals provides a d.c. path directly to ground in the event the d.c. blocking capacitor should break down, thereby eliminating a potential shock hazard.

Capacitance-bridge type neutralization is used in the final. The 12BY7 is likewise neutralized. An interesting feature, in this respect, is that a separate neutralizing capacitor for each band is selected with the bandswitch. Stabilization of a 12BY7 usually is quite critical, but this arrangement handles it nicely by maintaining proper neutralization on each band which might not otherwise be obtained due to changing stray reactances as the tube is bandswitched. "Neutralizing" jumpers are provided in both stages to disable their B-plus supply lines during neutralizing adjustments.

Frequency Synthesizer

Now let us take a look at the frequency synthesizer which is not as complicated as its exotic name suggests. The basic principle is one of hetrodyning a fixed crystal against another crystal whose frequency can be varied over a small range. Referring to fig. 1, V_{201} and V_{202} are separate crystal oscillators, each having a switch to select any one of ten crystals which for V_{201} are fixed at 100 kc intervals from 24.7 to 25.7 mc. Those for V_{202} are spaced 10 kc apart from 20.01 to 20.1 mc. Each of these may be "rubbered," or shifted downward 10 kc by means of a variable capacitor. The output of the oscillators is combined in a mixer, V_{203}, to produce difference-frequencies anywhere from 4.7 to 5.7 mc, depending on the crystal combinations and the variable shift of the 20 mc crystals. Temperature-matched crystals are used to maintain a constant difference-frequency at the mixer output as the equipment temperature varies. The output of the mixer is fed through a three-section low-pass filter, FL_{200}, to eliminate spurious responses, and is then amplified by V_{204} before being applied to the transmitter mixer, V_{10}, through a band-pass filter, FL_3.

A.M. Operation

When a.m. is used, a 3.2 mc carrier from V_4 is reinserted after the sideband filter by means of a variable carrier-level control, thus producing a single-sideband a.m. signal. The control is equipped with a warning light which goes on when carrier is inserted. In the event carrier is inadvertently left on when s.s.b. operation is contemplated, the light brings this situation to the operator's attention. The a.m. carrier input is 45 watts with 180 watts p.e.p.

C.W. Operation

For c.w., carrier is inserted with the carrier-level control for a d.c. input of 180 watts to the final. Grid-bias keying is used on the 2nd mixer and the driver stage. Break-in operation is possible. Key jack is located on the panel.

VOX

Two tubes, a 6C10 Compactron and a 6AL5, make voice-control operation possible with a conventional vox circuit. This includes an anti-trip circuit which prevents loudspeaker signals from actuating the transmitter. All controls for the vox system are accessible from the front panel. Push-to-talk operation also is available.

A.L.C.

The automatic-level control (a.l.c.) system in the Model 6100 is quite unique. An a.l.c. dual-diode detector, V_{11}, is connected to the grid of the final amplifier and conducts only when the r.f. drive exceeds a preset a.l.c. bias potential determined by the a.l.c. threshold control. The detector diodes are connected to separate loads, each of which has a different time constant. Bias potential developed at the slower one (1.5 sec. constant) is applied to V_7 where the gain is held between words, while bias from the faster one (0.03 sec.) is applied to V_5 where the gain follows the rapid variations of each syllable. Thus excellent a.l.c. linearity is maintained and the overall gain is smoothly controlled to limit excitation at the 6146 grids to the pre-set value. The a.l.c. takes hold *before* overloading of the final tubes commences and thus prevents flat topping and resulting distortion.

An innovation with this a.l.c. system is that it allows the final output to be limited to any desired value between 10 and 100 watts, thereby furnishing a convenient means for reducing power during local rag chews, or for use with a linear requiring low drive and to prevent overdriving the linear. The a.l.c. threshold control is accessible for screw-driver adjustment from the front panel and the degree of a.l.c. compression is indicated in db on the panel meter.

Frequency Spotting

A CALIBRATE position is provided to enable the operator to "zero-in" on a received signal without putting a signal on the air with the transmitter. A panel control allows the calibrating level to be adjusted to prevent overloading the receiver and to provide the optimum level for the best beat.

Metering

Besides indicating a.l.c. compression, the panel meter may be switched to read relative output power. This is useful for tune-up to maximum output, for nulling out the carrier and for output monitoring. A sensitivity control is included to set the meter reading to any desired reference point. The meter also may be switched to read total cathode current of the final. There are three separate meter scales, one for each function.

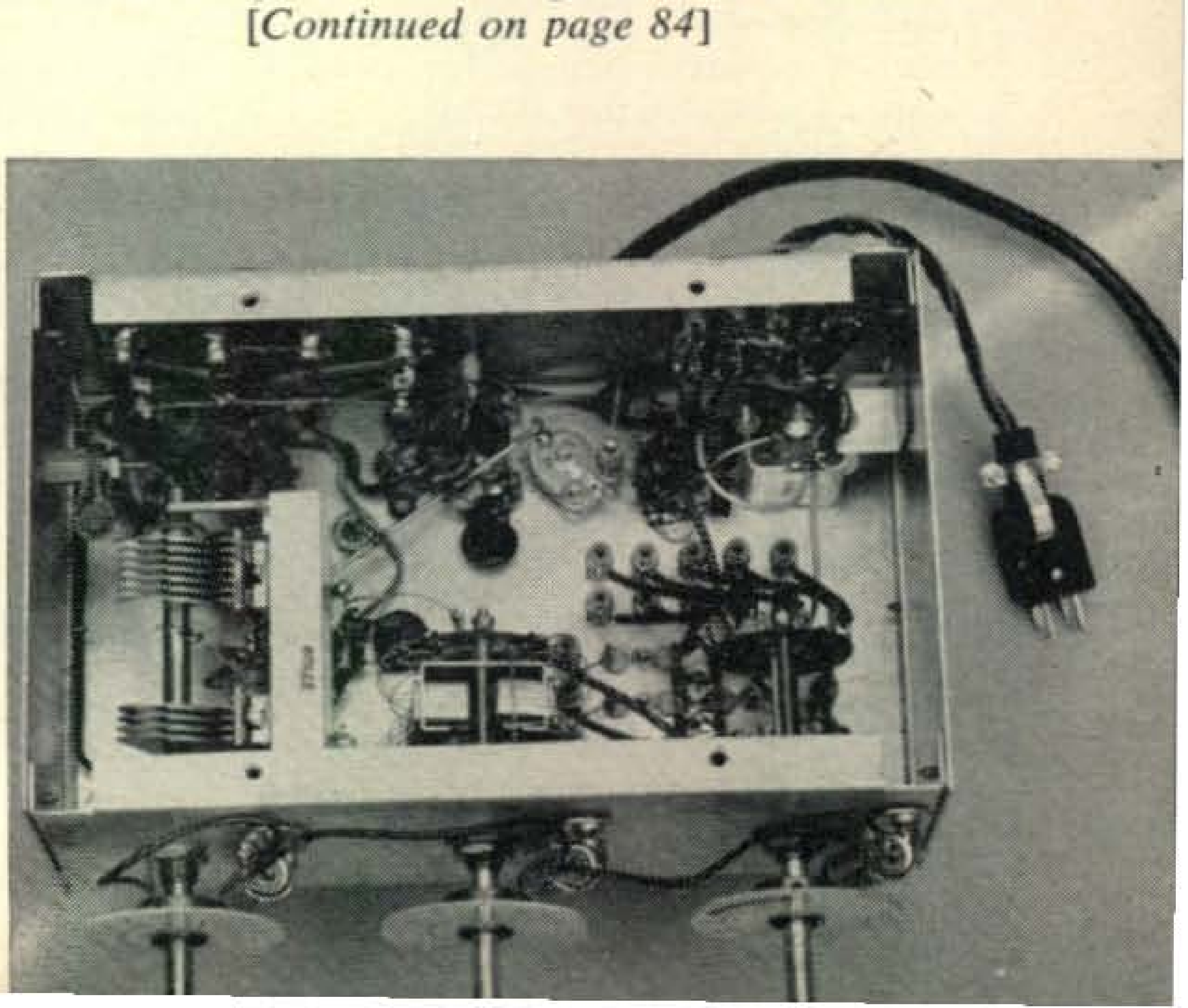
Phone Patch

The Model 6100 is equipped with a separate low-impedance phone-patch input which is available at a terminal strip on the rear apron. High-impedance patch may be used through the microphone input. Vox may be used with either input.

Auxiliary Terminals

Other rear terminals provide up to −100 volts for receiver disabling, anti-trip circuit to receiver output, external push-to-talk control

[*Continued on page 84*]



Underside view of the frequency-synthesizer module for the Model 6100. It is easily taken out without necessitating removal of the dials, nor is the calibration altered. At the left is the variable capacitor for "rubbering" each 20 mc crystal over a continuous range of 10 kc. Its dial (×1) is calibrated in one-half kc steps. The ×10 switch is at the center with the ten 20 mc crystals mounted on it. At the right is the ×1000 switch behind which are some of the piston-type trimmers for its 25 mc crystals.

B&W 6100 [*from page 51*]

and relay contacts which provide a normally-closed ground contact for use with a receiver's standby circuit. Other relay contacts provide a d.p.d.t. arrangement, normally closed on one side.

Power Supply

Three power supplies operate from a common secondary on the power transformer. All told, thirteen silicon rectifiers are employed. Their use saves space, provides good regulation and eliminates about 50 watts of heat which might otherwise be generated. Each one is shunted with a separate .001 mf capacitor for surge protection. The supplies furnish +750 volts for the final, +300 volts for the low-power stages and −100 volts for bias needs. A rear-apron switch is used to accommodate high or low power-line potentials.

Panel Controls

Panel controls include FINAL TUNE and LOADING, METER SWITCH, METER SENSITIVITY, DRIVER TUNE, BANDSWITCH, CARRIER LEVEL, EMISSION switch for L.S.B, USB, AM/TUNE or CW and OPERATION switch for OFF, STANDBY, MANUAL, CALIBRATE, VOX and PTT. Also included is a small hinged door behind which are recessed the following controls: METER ZERO, ANTI-TRIP, VOX SENSITIVITY, VOX DELAY, CALIBRATE LEVEL, CARRIER BALANCE and ALC THRESHOLD. This arrangement makes the controls readily available, yet protects them from accidental misadjustment. There are three dials for the frequency synthesizer.

Operation and Performance

The Model 6100 is set to frequency by means of the frequency-synthesizer dials and the band-selector switch. The first synthesizer dial varies the frequency in 100 kc steps, the second in 10 kc steps and the third tunes continuously throughout a 10 kc range which is calibrated in one-half kc increments and is readable to less than 200 cycles. The third dial has an adjustable hair-line fiducial for aligning any band against a calibrator. The frequency read-out is obtained from the sum of the dial settings and the position of the band selector.

When the frequency is tuned to zero-beat with another signal, the operation is somewhat different than one is accustomed to when a conventional v.f.o. is used. Instead of having one dial to twist to cover an entire band, there are three dials to turn before the beat can be located. This is not as involved as it may at first appear. If the receiver is well calibrated, chances are that after the $\times100$ and $\times10$ synthesizer dials are set accordingly, rotation of only the $\times1$ dial (this has a slight overlap at each end) will rapidly locate the beat. If the receiver is only approximately calibrated, it most likely will be close enough to indicate the 100 kc segment of a band concerned, for which the $\times100$ dial can be set and the $\times10$ one then switched step-by-step from 0 to 10 at the same time the $\times1$ dial is being rotated over its full range until the signal is heard. A little practice in this regard will enable the operator to quickly tune to frequency without difficulty.

Tune-up procedure is quite conventional. With the operate switch set for manual, carrier is inserted and the DRIVER TUNE, FINAL TUNING and LOADING are all adjusted for maximum output as indicated on the meter. The operation and emission controls are then set for the desired function.

The manufacturer's specifications for frequency stability are: Less than 100 cycles drift during first 15 minutes from normal room temperature. During any hour thereafter it is less than ±25 c.p.s. Results with the unit indicated performance within bounds. P.e.p. output is conservatively rated as 100 watts. It was found possible to actually obtain 115 watts on all bands (with a power-line potential of 117 volts) with good linearity.

Distortion products are rated 40 db below peak (140 watts input) with voice input and a.l.c. in use. Carrier suppression, sideband suppression and spurious-mixture signals, at least 50 db down.

The a.f. response (350 to 3300 c.p.s. at 3 db points) was found to produce a most natural and intelligible sounding signal. On-the-air checks all reported outstanding a.f. quality. The a.l.c. works like a charm. Use of 3 to 5 db of compression effectively raises the average power level with no sign of flat topping or other distortion. Pumping action, as found with some systems, was not exhibited.

The vox functions very smoothly and there is no annoying audible clatter from the vox relay. With c.w., the keying characteristics are really beautiful and break-in operation is good.

The transmitter is solidly built using high-quality components of more than adequate power rating. A continuous carrier output of 120 watts was fed into a dummy load for over an hour with no sign of excessive heating of components nor did the power output drop off. Our only criticism of the unit is that an antenna-changeover system was not included.

The Model 6100 is mounted in a tilted-up table-top cabinet with dimensions of $18\frac{3}{8}'' \times 9\frac{1}{2}'' \times 16''$ and it weighs 60 lbs. It is nicely laid out in a neat design having a silver-colored panel with black trim and black knobs with silver colored skirts. The price tag of $875 is higher than the general run of gear, but it is well justified for equipment of this quality and with such outstanding features. The Model 6100 Transmitter is manufactured by Barker & Williamson, Inc., Bristol, Pa.—*W2AEF*