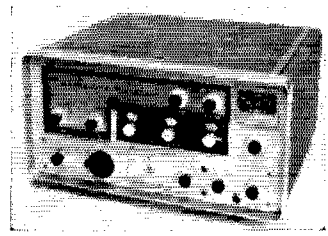
• Recent Equipment —

B & W 6100 Transmitter



THE B & W 6100 is a single-sideband, a.m. (carrier and one sideband), and grid-blocked-keyed c.w. transmitter rated at 180 watts peak envelope power on s.s.b. and c.w., and 90 watts on a.m. The operator has a choice of voice-operated break-in, push-to-talk or manual operation. For frequency control the 6100 uses a frequency synthesizer — a tongue-twisting word, but one you'll be reading quite often in this article since the frequency synthesizer is the big feature of the transmitter.

Except for the synthesizer, the 6100 is more or less conventional in its block diagram, shown in Fig. 1, although it has an unusual circuit in the mixer sections and an effective a.l.c. system, all of which will be discussed later in this write-up.

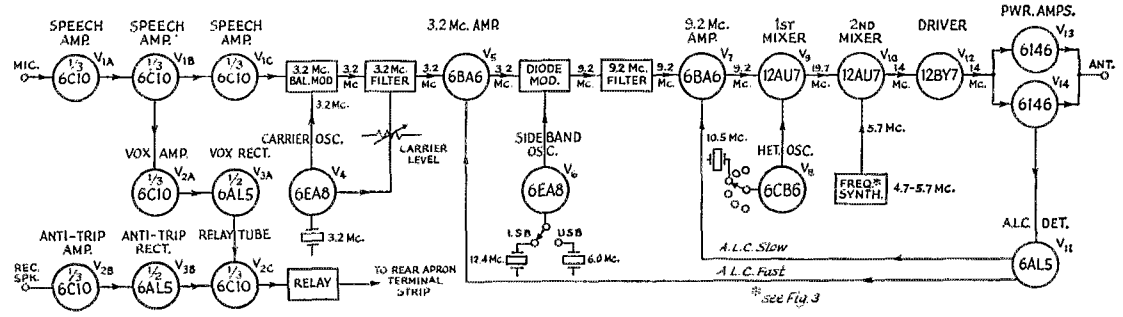
The speech section of the transmitter takes up very little space on the chassis because a 6C10 compactron is used for the speech amplifiers. Referring to the block diagram in Fig. 1, output from the microphone is amplified in the three stages of speech and fed to a semiconductor diode balanced modulator. Also arriving at the modulator is 3.2-Mc. r.f. from the carrier oscillator, V_4. Output from the balanced modulator is a double-sideband, suppressed-carrier signal which, when passed through the 3.2-Mc. crystal lattice filter, has the lower sideband lopped off, leaving an upper-sideband signal with a nominal carrier frequency of 3.2 Mc. The crystal-filter bandwidth at the 3-db. points is 3 kc. The rated sideband suppression for the transmitter is 50 db. below the peak output on s.s.b.

Output from the crystal filter is amplified by V_5 and then fed into the diode modulator. Here the signal is mixed with either 12.4-Mc. or 6.0-Mc. energy from the sideband oscillator, V_6. If the 6-Mc. crystal is selected, the signal is added to the 3.2-Mc. signal, resulting in a 9.2-Mc. u.s.b. signal. The 12.4-Mc. crystal oscillator signal and the 3.2-Mc. signal result in a 9.2-Mc. l.s.b. signal.

Diode modulator output is passed through an *LC* filter, then amplified in V_7 and fed into the first mixer, V_9. Injection for this mixer is furnished by the crystal-controlled heterodyne oscillator, V_8. A series of five crystals are used in the oscillator and are selected by the front panel BAND SELECTOR switch. On 80 meters, the mixer operates as a straight-through amplifier and the heterodyne oscillator is inoperative. The mixer circuit used at V_9 is interesting and is shown in Fig. 2. This type of mixer, using a cascode configuration, is reported to have better stability than the more conventional type and, in addition, exhibits some conversion gain. Input to the mixer at the grid is high impedance, and is low impedance at the cathode input.

Output from the first mixer falls somewhere between 9.2 Mc. and 34.7 Mc., depending upon the frequency of operation. In the 14.0-Mc. example in Fig. 1, the heterodyne oscillator V_8 operates at 10.5 Mc., which, when mixed with the 9.2-Mc. signal, gives 19.7 Mc. at the grid of the second mixer, V_{10}. The second mixer incorporates much the same type cascode circuit shown in Fig. 2. In this mixer, injection comes from the frequency synthesizer, which is in the 4.7- to 5.7-Mc. range. This gives an output from the second mixer on the desired amateur frequency, which is then amplified in the 12BY7 driver and 6146 amplifiers. In the c.w. mode, grid-block key-

Fig. 1—Block diagram of the B & W 6100 transmitter. Frequency examples are for 14-Mc. operation.



ing is used in the second mixer and driver stages.

Protection against overdriving the final amplifiers is provided by a double-action automatic load control (a.l.c.) circuit which involves the a.l.c. detector, V_{11}, the 3.2-Mc. amplifier, V_5, and the 9.2-Mc. amplifier, V_7. R.f., taken from the 6146 grids, is detected in the a.l.c. detector, V_{11}. The detected signal is compared to a d.c. bias which is adjustable by way of a control, the a.l.c. threshold (ALC THR), located behind a door on the front panel. The detector conducts only when the a.l.c. bias voltage is exceeded. The 6AL5 a.l.c. detector, V_{11}, is a dual diode. Each section of the diode has a separate load of a different time constant; "slow" (1.5-second) t.c., and "fast," (0.03 second) t.c. The two time-constant buses return to the grid circuits of earlier amplifier stages (V_5 and V_7) where their gain is controlled so as not to overdrive the 6146 grids. The above time constants were chosen to control gain between words (1.5 sec.) and to control gain through variation of syllables (0.03 sec.).

A tunable, band-switched pi network in the final amplifier plate circuit is designed for nonreactive loads between 30 and 100 ohms. Provisions are made for metering the relative r.f. voltage appearing across the output of the transmitter. In addition to reading relative output, the meter can be switched to read plate current (actually cathode current) and a.l.c. In the latter case, the meter indicates the approximate amount of a.l.c. compression by measuring the unbalance in a bridge circuit which includes a constant voltage source and the screen circuit of the 9.2-Mc. amplifier, V_7.

Audio VOX and anti-trip circuits in the 6100 are conventional and control the bias on a relay tube and relay which does the necessary switching between transmit and standby. Panel controls are provided to give variable VOX hold-in time, VOX sensitivity, and anti-trip sensitivity. A 6C10 compactron is used for most of the VOX and anti-trip circuitry.

The 6100 runs relatively cool when compared to transmitters using vacuum-tube power supplies. B & W has eliminated nearly 50 watts of heat dissipation inside the cabinet by using silicon

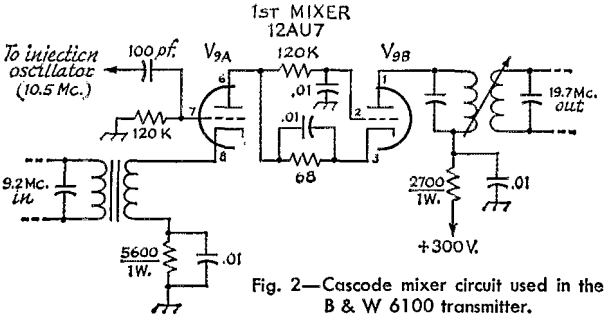


Fig. 2—Cascade mixer circuit used in the B & W 6100 transmitter.

rectifiers in the 700-volt high-voltage, 300-volt low-voltage and −100-volt bias supplies. A tapped power-transformer primary permits the use of the transmitter over three ranges of line voltage, 110–118 volts, over 118 volts, and below 105 volts. Either of the first two ranges can be selected by a rear-apron toggle switch. For operation on line voltages down to 105 volts, the cabinet bottom plate can be removed and a simple wiring change will tap the transformer primary even lower.

The Frequency Synthesizer

As mentioned earlier, the big feature of the B & W 6100 transmitter is its frequency synthesizer for frequency control. Whether called frequency synthesizer, VXO[1], or simply a mixer with crystal-controlled inputs, this type of all-crystal frequency control (there are no free-running oscillators in the entire transmitter) for amateur work is unique in the 6100 as far as commercial equipment for amateurs is concerned. Synthesizers have been used for some time in military equipment where "channel-type" operation is necessary. B & W uses the same general idea except that they provide for continuous variation of the frequency by "pulling" one of the crystal-controlled oscillators. A look at the block diagram in Fig. 3 will show how the system works. The output of V_{201}, which has a series of 10 crystals at 100-kc. intervals in the 24.7 to 25.7 Mc. range, is mixed with the output of V_{202}, whose crystals are spaced 10 kc. apart in the 20.1- to 20.01-Mc. range. These crystals can be pulled downward in frequency as much as 11 kc. by capacitor C_1. The output of the subtractive mixer, V_{203}, is the difference between the two crystal-oscillator frequencies, and falls between 4.7 and 5.7 Mc. Filters following the mixers reject unwanted spurious frequencies (spurious mixture signals from the transmitter are rated at −50 db.), and an amplifier, V_{204}, boosts the mixer output to a useful value before it is injected into the second mixer.

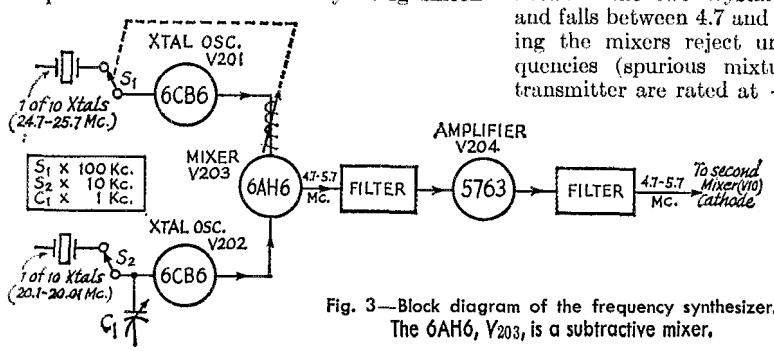
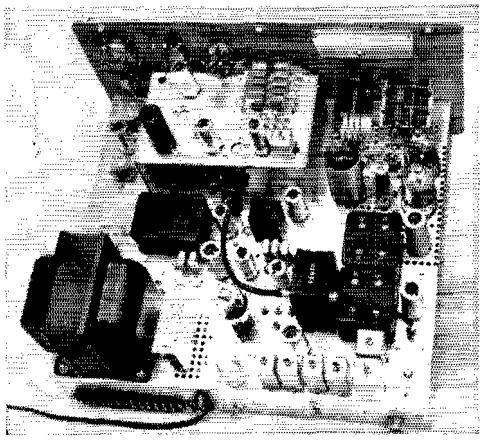


Fig. 3—Block diagram of the frequency synthesizer. The 6AH6, V_{203}, is a subtractive mixer.

[1] Shall, "VXO — A Variable Crystal Oscillator," *QST*, Jan., 1958.



This view of the B & W 6100 transmitter shows the frequency synthesizer chassis at the top just behind the front panel. The final amplifier stage is just to the right of the synthesizer deck and the power transformer at the lower left of the photograph. Rear apron connections include (from right to left): r.f. output connector (SO-239), line voltage toggle switch (for 125 or 115 volt operation), line fuse (top) and line cord, and 12-terminal barrier strip. The barrier strip is used for push-to-talk, external relay control, bias for external amplifier or receiver muting, and anti-trip connection to receiver.

All of the crystals used in the frequency synthesizer have been selected for uniform temperature characteristics so that they will all react the same way to a temperature change.

Fig. 4 shows the frequency synthesizer control area on the front panel of the 6100. Frequency coverage is in six bands: 3.5 to 4.1 Mc., 7.0 to 8.0 Mc., 14 to 15 Mc., 21 to 22 Mc., 28 to 29 Mc., and 29 to 30 Mc. Frequency is controlled by a band switch and three digital dials for hundreds, tens and units of kilocycles. The $\times 100$ knob is the crystal switch, S_1, shown in Fig. 3. The $\times 10$ knob is S_2, and the $\times 1$ knob is variable capacitor C_1. If the BAND SELector is set for 14-Mc. operation and a frequency of 14.052 Mc. is desired, the kilocycles panel would appear as shown in Fig. 4. To change frequency a few kc., as for zero beating, the $\times 1$ knob can be turned in either direction for a smooth slide-in on frequency. This knob covers 11 kc. through 180 degrees of rotation. For greater frequency excursions, the $\times 10$ or $\times 100$ knobs are used. The BAND SELector is marked in frequency except on the 3.5-Mc. band where it is marked 80 meters and is printed in red. On this band a special red scale is used on the $\times 100$ dial which is calibrated directly in frequency, i.e.: 37, 38, etc.

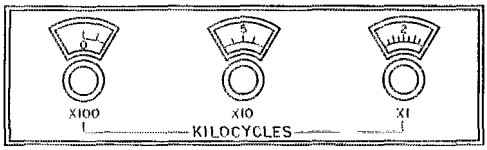
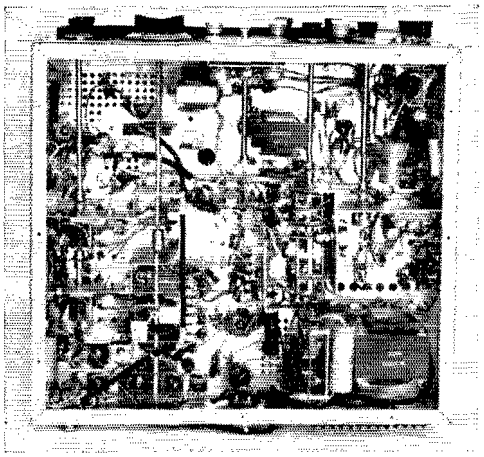


Fig. 4—The frequency control panel on the 6100 transmitter, shown set for a frequency of 14.052 Mc.

Dial accuracy is rated as plus or minus 1 kc. on any band and can be reset plus or minus 100 cycles. The stability of the system is impressive, too. It is rated at not greater than 100 cycles of drift during the first 15 minutes of operation (at normal room temperature), and within 25 cycles during any hour of operation thereafter.

B&W 6100 Transmitter

Height: 9½ inches
Width: 18¾ inches
Depth: 16 inches
Weight: 60 pounds
Power requirements: 105–125 volts, 50/60 cycles, 425 watts.
Price class: $875.00
Manufacturer: Barker & Williamson, Inc., Bristol, Pennsylvania



Bottom view of the B & W 6100 transmitter. Although not all of them are visible in this photograph, there are several compartments which isolate the various circuits in the transmitter. The power supply area is at the lower right.

A rear-apron barrier strip is provided on the 6100 transmitter for connecting all the outboard devices and accessories that are with us today: a negative 100 volts for receiver muting or amplifier biasing, three sets of relay contacts (one s.p.s.t. to ground, two s.p.d.t.), anti-trip connections (to the shack receiver), a push-to-talk connection, and a low-impedance (600 ohms) connection to the input of the audio stages of the transmitter.

For those interested in f.s.k., a diode f.s.k. kit is available that provides constant shift on all bands. The kit, or information on the circuit for do-it-yourselfers, is available from B & W.

—*E. I. C.*

put from the microphone [illegible]