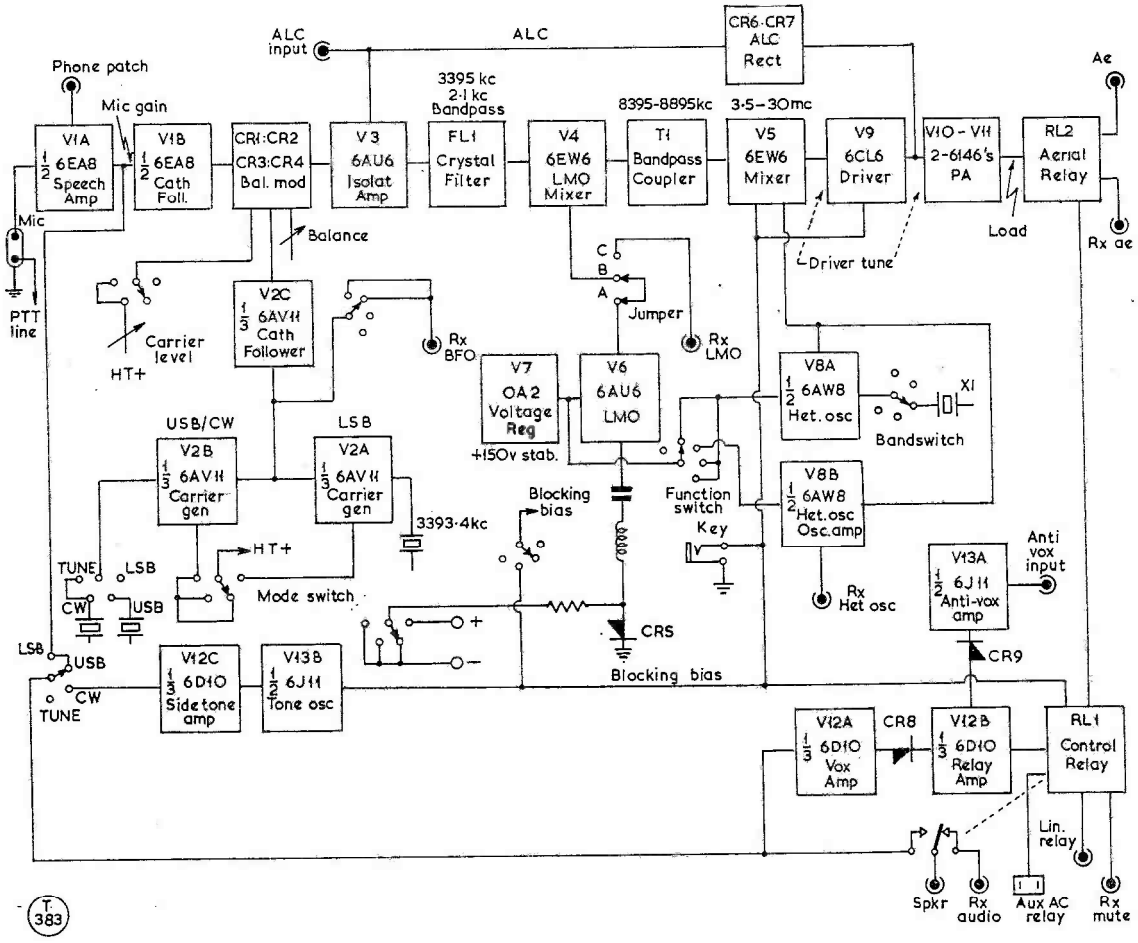


Fig. 1. Complete block diagram of the SB-400 transmitter. Carrier generation is by the crystal oscillators V2A and V2B, at frequencies centred round 3395 kc; after passing through the crystal filter at this frequency, the SSB signal is mixed with the VFO (5-5.5 mc) and passed through a bandpass coupler at 8395-8895 kc, after which the heterodyne mixer (V5) adds the frequency of one of eight crystals for the eight 500-kc wavebands available, taken from the output of the heterodyne oscillator and amplifier (V8A and V8B). Driver and final stages are conventional, with a 6CL6 and a pair of 6146's. The tone oscillator (V13B) keys the Vox circuits and also supplies a 1000-cycle sidetone to the receiver speaker.

THE HEATHKIT SB-400

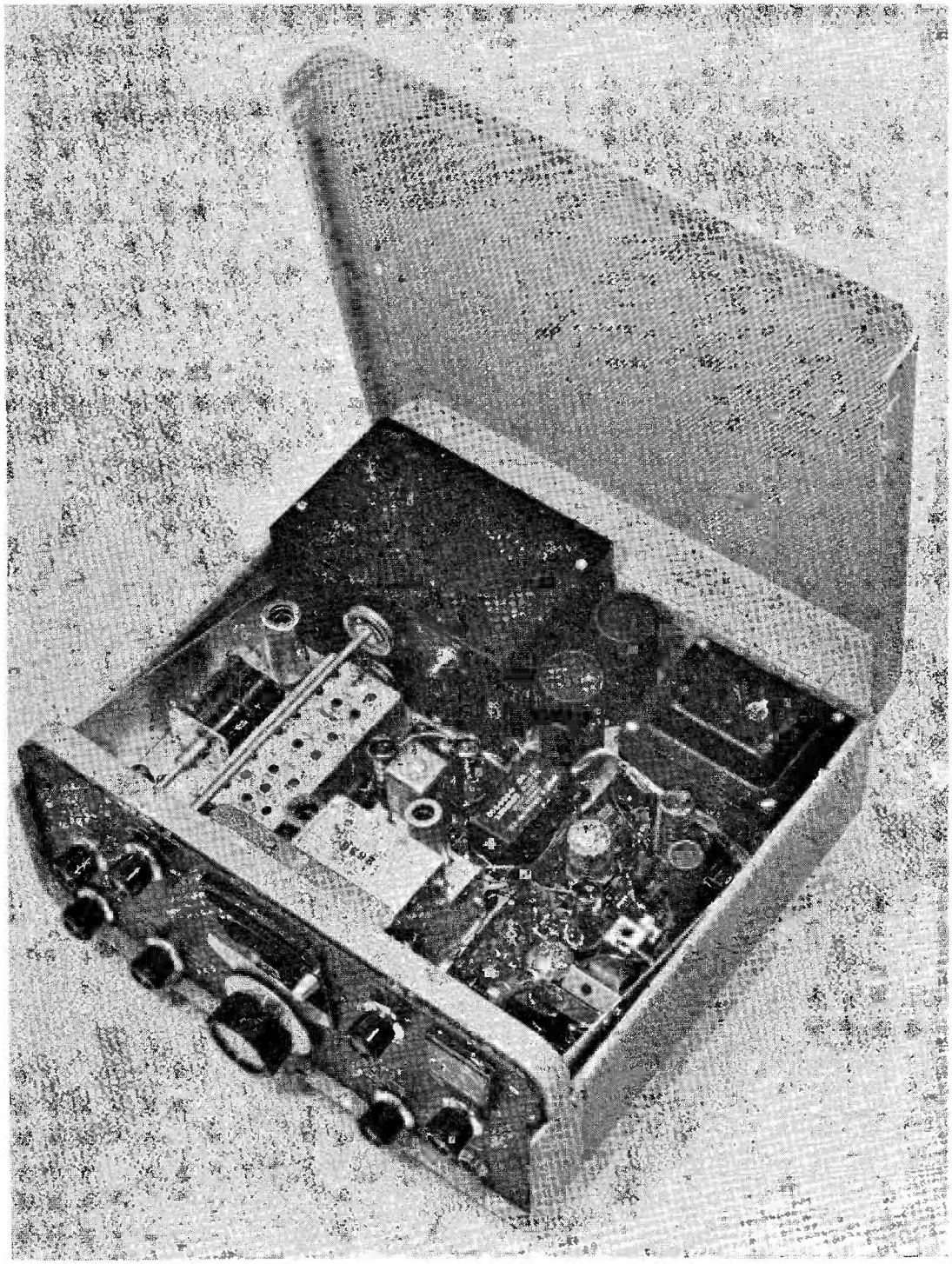
TEST REPORT

COMPACT SIDEBAND TRANSMITTER FOR 10-80 METRES —BUILT FROM THE KIT

THE SB-400 SSB Transmitter kit is quite the most complex of the well-known Heathkit series, but the rewards of some 50 hours of painstaking assembly are considerable. As with all these kits, if one follows the instructions meticulously, the end-product will operate strictly to the maker's specification, and one can be quite confident that any small fault is due to the constructor's own shortcomings.

When this kit, submitted for test, had been completely assembled and was put through the preliminary pre-operating checks, two such faults were discovered and quickly righted. One was an accidental short-circuit between a piece of bare wire and a metal cover; the other was a misplacing of one lead. These having been rectified, it was not long before the transmitter was operating on all bands, all modes, without the slightest sign of trouble.

The SB-400 packs a lot of transmitter into a very small space—15in. wide, 13⅜in. deep and 6⅝in. high, and weighing only 26lbs. Its output, from a pair of 6146's, is 100 watts (80 watts on 28 mc) from



The popular "wrap-around" styling is much improved by a neatly-designed hinged lid, which makes it unnecessary to slide the transmitter out of its cabinet for small adjustments of trimmers and other controls. The 6CL6 driver is on the left, between the driver tuning condenser and the PA box. Trimmers for all the tuned circuits are in the box below the PA tuning condenser spindle.

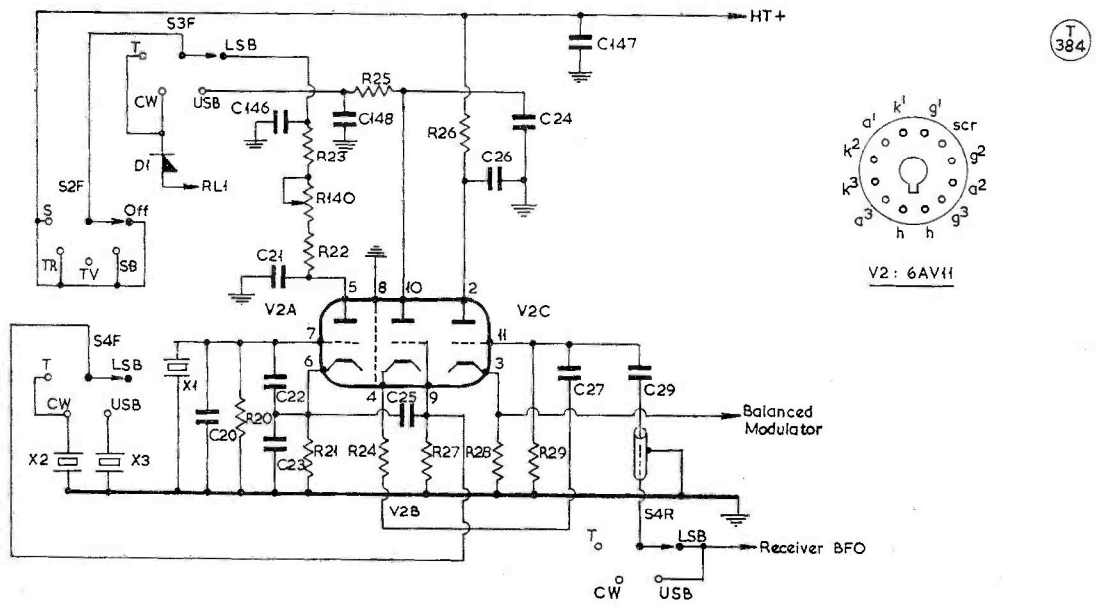


Fig. 2. A triple-troide (6AV11) is used for carrier generation, one section for LSB, one for USB and CW, and the third as a cathode follower. Three separate crystals are used, and the anode circuit of V2A includes a sideband amplitude balance control. All the components for this stage, and several others, are on a printed circuit board and very compactly mounted.

an input of 150 watts on CW or 180 watts p.e.p. on SSB.

Circuit Line-Up

The circuitry, while being more or less conventional-SSB, has some pleasing features not found in other comparable transmitters. The carrier is generated in the region of 3395 kc, with crystals centred on this frequency for upper or lower sideband; this meets the audio in a balanced modulator and passes through a sealed crystal filter, after which it is mixed with the VFO output (5-5·5 mc) and passed through a bandpass coupler covering 8395 to 8895 kc. Thereafter it is heterodyned by a series of crystals, all on the HF side of this frequency, to operate the driver stage and the final on eight bands (the 28 mc band is divided into four slices of 500 kc each).

The VFO, which the makers call the LMO (linear master oscillator) is an extremely stable unit controlled by an excellent drive mechanism, the dial of which is calibrated in divisions of 1 kc—and very accurate it is. The tuning can, in fact, be set to an accuracy of 200 cycles on all bands, and this is combined with a 4 : 1 reduction on the main tuning knob.

The extreme compactness of the transmitter is largely made possible by the use of two printed-circuit boards which take the components and valves for some fourteen stages in all. Three "Compactron" multi-unit valves are used. There is a 6AV11 (triple-triode) serving as LSB generator, USB and CW generator and cathode follower; a 6D10 (also a triple-triode) as Vox Amplifier, Sidetone Amplifier and Relay Amplifier; and a 6J11 (double-pentode) as Anti-Vox Amplifier and Tone Oscillator.

The latter is a 1,000-cycle oscillator, used only when the Mode Switch is in the CW position. It keys the Vox amplifier and also supplies a monitoring tone to the receiver loudspeaker, if desired; full break-in with a nicely-adjustable delay is available, so that one does not have to endure the more usual clacking relays. This is easily set to break only between words, or even longer pauses if required.

The balanced modulator involves four crystal diodes and there are two controls for producing a really effective carrier *null*. The makers claim "55 dB down" for the carrier, and measurements suggest that

Table of Values

Fig. 2. Carrier Generator circuit in the SB-400

C20	= 7.5 μμF	R25	= 6,800 ohms
C21, C24,		R26, R28	= 1,000 ohms
C29	= .001 μF	R140	= 5,000 ohms, SB amplitude balance
C22, C25	= 30 μμF		
C23, C27	= 50 μμF		
C26	= .005 μF	X1	= 3393.4 kc (LSB)
C146,		X2	= 3395.4 kc (CW)
C148	= .02 μF	X3	= 3396.4 kc (USB)
C147	= 20 μF	V2A-C	= 6AV11 triple triode
R20, R27,			
R29	= 47 000 ohms	V2A	= LSB carrier generator
R21	= 2,700 ohms		
R22	= 10 ohms	V2B	= USB/CW carrier generator
R23	= 470 ohms		
R24	= 2,000 ohms	V2C	= Cathode follower

NOTE: Circuit-element nomenclature as in Heathkit SB-400 Manual.

this figure is by no means an overestimate.

The LMO itself, which is preassembled, prealigned and sealed, is one of the most "solid" yet encountered. No change in note results when the transmitter is pounded vigorously, or any part of the LMO box tapped quite sharply with the handle of a screwdriver. The LMO frequency is shifted when sidebands are switched, and this is done by a change in bias on a varicap diode. The frequency is shifted by some 2·5 kc, to keep it within the passband. Incidentally, some of the RTTY enthusiasts in the U.S.A. have discovered that it is an easy matter to alter the bias voltage so that the standard frequency-shift of 850 kc for RTTY purposes may be produced. Instead of switching, as at present, from approximately 43v. positive to 43v. negative, a change of some 6v., applied from an external source, will give the required frequency-shift for radio T/P operation.

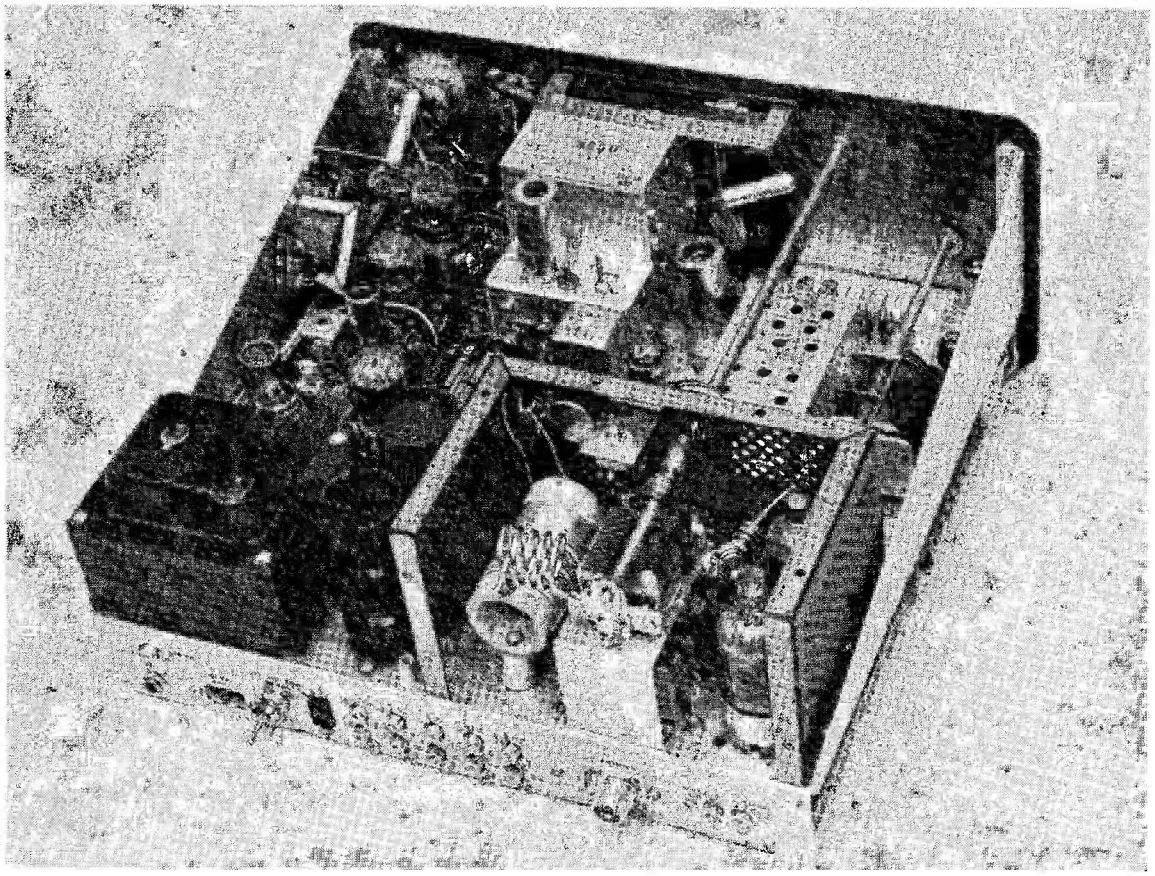
Controls

The Function Switch has five positions—Off, Standby, Transceive, Transmit and Spot (the latter for netting). The Mode Switch gives LSB, USB, CW and Tune (the latter being merely CW with the key shorted). And the Meter Switch gives readings, all on the one meter, for PA Grid, PA Anode Current, ALC, HT volts and Relative Output (RF).

Apart from these there is the 8-position bandswitch; a control marked "Level," which is two ganged but electrically separate potentiometers controlling the RF drive and the Audio Gain; Driver Tuning; PA Tuning and Loading (two concentric knobs, and very convenient) and, of course, the main tuning dial on the LMO, which gives 5 feet of bandspread for the 500 kc coverage on each range. It is directly calibrated, with 0-100 kc for each of its five revolutions, and also has a sliding pointer which merely counts the revolutions and displays them on a horizontal scale.

Operation as Transceiver

The SB-400 is designed for use either as a straight transmitter or as a transceiver in conjunction with the SB-300 receiver. The latter has an identical LMO, and rearrangement of plugs makes it possible to use this for controlling the transmitter. Automatic com-



Just in front of the power supply is the printed-circuit board with all components for the carrier generator and following circuits. The LMO is in the sealed box behind the centre of the front panel, and the eight crystals for the various bands may be seen at the right, between the trimmers and the front panel. The PA compartment, in the foreground, is normally completely boxed in.

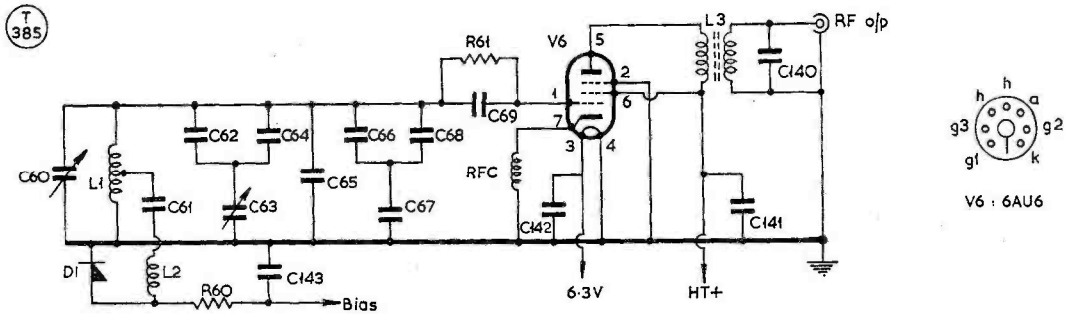


Fig. 3. The extremely stable VFO has a linear calibration over its entire range of 500 kc (5-5.5 mc). By the extensive use of negative temperature-coefficient condensers, balanced against positive types, the frequency is independent of temperature over a wide range. It is also unaffected by 10 per cent changes in mains voltage. The RF output, after leaving the sealed box containing the oscillator components, is shunted by a 100-ohm resistor. The diode D1 is a varicap type whose bias is changed for sideband switching, simultaneously with the change of crystals in the carrier generator.

pensation is made for the 1 kc frequency shift which is employed in the CW mode, so that the receiver calibration and the netting function remain accurate.

All power supplies use silicon rectifiers, and a surprisingly small transformer gives 750v. at 200 mA, to the final 6146's (as well as all the other requirements) without the slightest sign of running unusually warm.

The grid-block keying, applied to a mixer and the driver stage, together with the very high oscillator stability, results in an excellent CW note which, in on-the-air tests, attracted many favourable comments. The main multi-contact relay, operated by the Vox circuitry, is in parallel with an internal aerial change-over relay to which the same adjustable delay is applied. (This can be varied from "instantaneous" to a matter of two seconds or thereabouts.)

Construction

In addition to the two printed-circuit boards, construction is also simplified by the provision of two preassembled cable-forms which fit snugly in position and present short and quickly-identified leads in all the right places. There is no electrical difficulty in the assembly—the soldering is really almost a pleasure. Such slight snags as arose were concerned purely with the mechanical difficulties of getting small components into the right places, while holding nuts, bolts and washers with the number of hands available. A pair of good long-nosed pliers is an essential, and it was found that a pair of surgical forceps which could be locked on to nuts or washers, was also a great help.

After the assembly, the alignment. The makers state that a valve voltmeter is essential, and indeed one *was* used. But it could have been done without, provided that a general-coverage receiver with an S-meter was available. There are so many frequencies to check, to see if crystals are oscillating, and so on, that either the one or the other is very necessary.

Alignment tools are provided, and every tuned circuit does cover the precise range needed, with a

Table of Values

Fig. 3. Linear Master Oscillator (VFO) for SB-400

C60	= 2-10 μμF, var.	C140	= .001 μF
C61	= .0022 μF	C141,	
C62	= .0025 μF	C142,	
C63	= 45 μμF, var.	C143	= .005 μF
C64	= .0021 μF	R60	= 10,000 ohms
C65	= 12 μμF	R61	= 330,000 ohms
C66	= 10 μμF	L1, L2,	
C67	= 350 μμF	L3	= Coils as supplied
C68	= 300 μμF	V6	= 6AU6
C69	= 10 μμF		

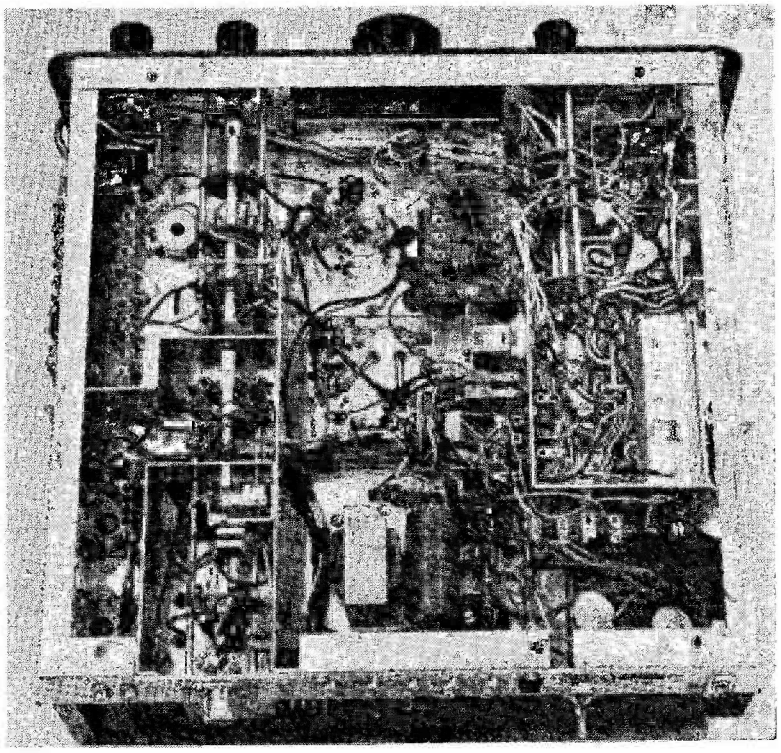
NOTE: Circuit-element nomenclature as in Heathkit SB-400 Manual.

certain amount of latitude. As a matter of interest, after the alignment was completed, the SB-400 received its first air-test on 3500 kc. The LMO dial was set to this frequency and checked against the crystal calibrator of a Drake 2B receiver, and it was within 100 cycles without any further adjustment! Good luck, possibly, but a master adjustment is available; also the scale cursor is movable to compensate for small differences in calibration on different bands.

The assembly manual, which runs to 120 pages, contains 64 pages of actual step-by-step instructions, interleaved with pictorial diagrams for progressive checking. In addition there are several pages of instructions on operating and trouble-shooting; a complete circuit diagram; and several stage-by-stage drawings which make the mode of operation very easy to follow through.

All components (including valves) are supplied, with the sole exceptions of key and microphone. There are enough "phono plugs" (miniature coax plugs) to make up all required connections to a matching receiver, including the usual muting and anti-vox circuits. Provision is also made for controlling a linear amplifier if one is used. The amount of shielded cable supplied, however, is insufficient to run to all the possible external connections.

It is not possible to switch quickly from normal



The wiring may appear complex, but it all fits into place in orderly sequence. The carrier generator printed-circuit board (the electrical version of which is shown in Fig. 2) can be seen at top right, and the mains transformer in the bottom right-hand corner. The wave-change switch runs the whole depth of the chassis, at the left, with its end just above the aerial socket with the section switching the PA coil. The two 6146 sockets are in the bottom left-hand corner.

independent transmission to transceiver-type operation, as certain jumper cables have to be rearranged; and as no SB-300 receiver was available, it was not possible to test the transceive capabilities. However, so high was the stability figure that once the transmitter was netted with a really stable receiver, one never lost the zero-beat condition.

Although the price is naturally higher in this country than in the U.S.A., the SB-400 appears to be a worthy addition to the number of SSB transmitters at present available.

THE G3RKK HF-BAND TRANSMITTER

FURTHER NOTES, DEALING WITH QUERIES AND SOME POSSIBLE MODIFICATIONS

A. J. SHEPHERD (G3RKK)

The original article appeared in three parts, in our issues for June-July-August 1964, and covered in detail the design and construction of a 10-80m. CW/AM phone transmitter running 50 watts. Here, the author deals with some queries and suggests possible improvements in the VFO-driver sections.—Editor.

FIRST of all, it is regretted that an error occurred in the power pack circuit Fig. 5 on p.287 of the July 1964 issue. The connection between Ch1 and Ch2 should be deleted. Also, L3 and L4 were reversed in the table of values for Fig. 2 on p.219 of the June issue.

It should be pointed out, however, that if it is wished to economise, the circuit of Fig. 5 may be simplified with little loss of performance. In the circuit as printed, *i.e.* Ch1 and Ch2 joined, the 5U4G valve can be removed completely and D1-6 replaced by 500 mA rectifiers, *e.g.* BY100. The series resistors R1 and R2 should also not be necessary with choke input filter. Provided that the mains transformer is of good quality, and silicon diodes (not valves or metal rectifiers) are used, interaction should not be a problem.

If the exciter HT supply with two stabilisers is used, it is recommended that V3 be changed to a VR105/30 and R13A increased to 2·2K 5w. The degree of regulation obtained was reduced by the small value of series feed resistor recommended. If the single stabiliser is used, a 350-0-350v. secondary will be adequate.

Since publication of the original article, *Electroniques* have introduced a new range of VFO coils. These were designed to include Top Band, but it is recommended that this arrangement be used even if 160m. is not required.

There were good reasons for operating the VFO on 80m. in the original design, but the advantages were reduced when it proved necessary to include a tuned circuit in V1 anode to give sufficient drive on 10m.

Some Modification Notes

The new arrangement uses a 1·75-2·0 mc VFO unit for 80m. and Top band; a 7-7·2 mc one for