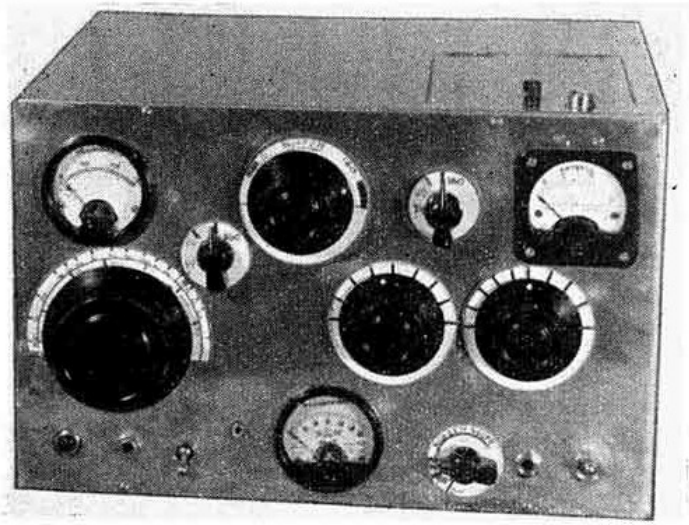
A Simple Transmitter for the Beginner

By C. H. L. EDWARDS (G8TL)*



THE transmitter to be described in this article is easy to build and simple to operate, and should, therefore, appeal to those amateurs whose experience and financial resources are limited. It is complementary to the simple receiver described in the December 1956 BULLETIN and the writer has endeavoured to use valves and components which are cheap and easily procurable on the surplus market and to arrange the circuit so that both phone and c.w. can be used without the expense of a separate modulator.

The transmitter is designed to operate on two amateur bands, 160 metres and 80 metres. On 160 metres the power input is necessarily restricted to 10 watts by the conditions of the G.P.O. licence, but on 80 metres it can be raised to 35 watts on c.w. or 20 watts on phone. The modulation system adopted is one of the simplest arrangements possible and while not equal in efficiency to some of the more popular methods, it is a reasonably good compromise between economy and performance. The output valve in the transmitter is a beam tetrode (type 807) and the modulation is applied only to the screen grid. It is therefore an " efficiency-modulating " system, the r.f. efficiency rising to a maximum from positive modulation peaks and falling to a minimum on negative modulation peaks: with no modulation, the carrier power is relatively low. The minimum anode voltage applied should be around 500 volts although better results can be obtained if voltages up to 750 are available. The peak audio voltage required to fully modulate the valve is slightly more than the operating value of the d.c. screen voltage, which is approximately between one half and one third of the rated screen voltage (280 volts) for c.w. operation. The linearity with this method is invariably good with beam tetrodes and distortionless modulation can be achieved up to 80 per cent.

For telegraphy operation the working voltages in the circuit are altered so that the output valve functions at its maximum efficiency; thus on 80 metres for instance, the c.w. input is 35 watts, but when switched to phone operation, the power input is reduced to 20 watts.

The power required for this transmitter can be obtained from any power pack capable of supplying 150 mA at 500 volts and 100 mA at 300 volts: in addition, of course, there should be a supply for the valve heaters which require 3 amps at 6·3 volts. Since the design features of a power supply system are quite orthodox, no detailed description is given here.

The Circuit

The set comprises three valves in all, a 6SN7, 807 and 6V6. Fig. 1 shows a block diagram of the circuit arrangement. The variable frequency oscillator (v.f.o.) uses a conventional

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COMPONENT INFORMATION

C1, 100pF variable condenser (Jackson Bros. type C.804).
C2, 75pF pre-set air spaced condenser (Jackson Bros.).
C3, 9, 100pF silvered mica condenser (Dubilier).
C4, 5, 0·001μF silvered mica condenser (Dubilier).
C6, 7, 8, 11, 15, 16, 19, 23, 27, 28, 0·01μF mica condenser (Dubilier).
C10, 350pF air spaced variable condenser (Jackson Bros.).
C12, 24, 25, 50pF pre-set air spaced condenser (Jackson Bros. type C.801).
C13, 17, 10pF silvered mica condenser (Dubilier).
C14, 26, 200pF air spaced variable condenser (Jackson Bros.).
C18, 0·002μF silvered mica condenser (Dubilier).
C20, 0·1μF 500V (working) mica condenser (Dubilier).
C21, 25μF 25V electrolytic condenser (Dubilier).
C22, 50μF 25V electrolytic condenser (Dubilier).
C29, 8μF 500V (working) electrolytic condenser (Dubilier).
L1 (v.f.o. coil)—160m: 42 turns 20 s.w.g. enamelled wire.
80m: 14 turns 20 s.w.g. enamelled wire.
L2 (buffer anode coil)—2, 26 turns 20 s.w.g.
L3 (p.a. coil)—160m: 65 turns 24 s.w.g. enamelled wire.
80m: 40 turns 20 s.w.g. enamelled wire.
L4 (aerial loading coil)—160m: 85 turns 28 s.w.g. enamelled wire tapped every five turns to centre of coil.
80m: 40 turns 22 s.w.g. enamelled wire tapped every three turns to centre of coil.
All coils wound on 1½ in. diameter bakelite. Denco (Clacton) Ltd.
M1, 0-5mA m.c. meter (Pullin).
M2, 0-100 mA m.c. meter (Pullin).
M3, 0-1A r.f. meter (Pullin).
RFC1, 2, r.f. chokes (Bulgin type SW68).
S1a, b, 2 pole 2 way wafer switch, ceramic or paxolin.
S2a, b, c, d, 3 wafer 2 way 2 pole ceramic switch.
S3, single pole 3 way wafer switch.
S4, change-over switch (Bulgin type S273).
R1, 25K ohms ½ watt resistor (Dubilier).
R2, 500 ohms 1 watt resistor (Dubilier).
R3, 3K ohms 1 watt resistor (Dubilier).
R4, 4K ohms 1 watt resistor (Dubilier).
R5, 50K ohms ½ watt resistor (Dubilier).
R6, 50 ohms ½ watt resistor (Dubilier).
R7, 50K ohms potentiometer (Dubilier).
R8, 300 ohms 5 watt resistor (Dubilier).
R9, 100 ohms ½ watt resistor wound with 8 turns of 22 s.w.g. enamelled wire.
R10, 25K ohms 2 watt resistor (Dubilier).
R11, 200K ohms potentiometer (Dubilier).
R12, 100K ohms potentiometer (Dubilier).
R13, 300 ohms 3 watt resistor (Dubilier).
R14, 100 ohms 1 watt resistor (Dubilier).
R15, 17, 220K ohms ½ watt resistor (Dubilier).
R16, 100 ohms ½ watt resistor (Dubilier).

Miscellaneous Components

2 Octal valveholders for V1 and V3 (Bulgin type VH85).
1 Five pin UX ceramic valveholder for V2 (Bulgin).
1 Indicator lamp assembly (Bulgin type D.170).
1 Jack socket for microphone (Bulgin type J2).
1 Closed circuit jack socket for Morse key (Bulgin type J6).
1 Large knob for v.f.o. tuning (Bulgin type K362).
3 Medium knobs for buffer, p.a. and aerial tuning condensers (Bulgin type K361).
3 Pointer knobs (Bulgin type K107).
1 Epicyclic drive for v.f.o. tuning condenser (Jackson Bros.).
2 Flexible couplers for v.f.o. tuning (Bulgin type EH16).
1 Chassis, front panel and cabinet.

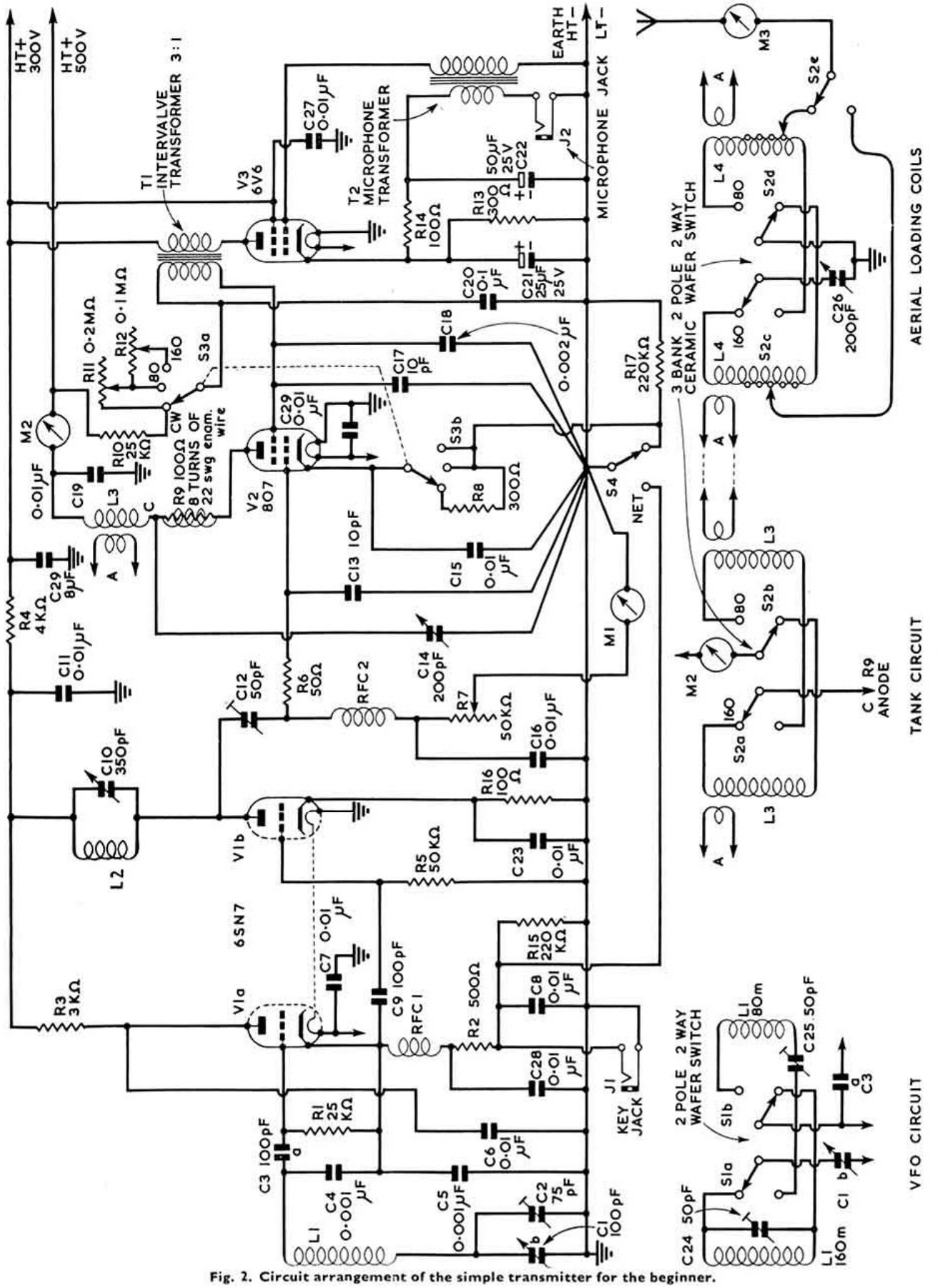


Fig. 2. Circuit arrangement of the simple transmitter for the beginner.

Clapp circuit which is renowned for its excellent frequency stability. This drives the second half of the 6SN7 (V1b) as a buffer amplifier which amplifies the drive supplied to the output stage, and also reduces any tendency for the adjustment of the output stage to influence the frequency generated by the v.f.o. As previously explained, the output stage V2 uses a beam tetrode (807). The modulating voltage applied only to the screen grid is provided by a 6V6 (V3) audio frequency amplifier. This simple amplifier is quite adequate since relatively little power is required for screen modulation

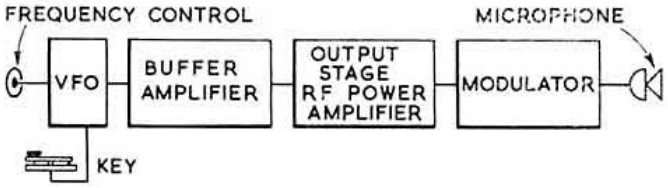


Fig. 1. Block diagram of the simple transmitter.

as compared with the more usual anode and screen modulation. An ordinary carbon microphone is used, the energizing current for it being derived from the voltage drop across the bias resistor of the 6V6 cathode circuit. Keying is effective by breaking the cathode circuit of the oscillator. Usually it is considered bad practice to key a frequency determining oscillator, since it so easily results in a chirping note or violent key clicks. However, if the tuning controls and the drive to the power amplifier and the aerial loading are carefully adjusted, reasonably satisfactory keying can be achieved. To protect the 807 in key up conditions, a bias network is switched into the cathode circuit which limits the anode current to 50 mA. This is removed when the valve is modulated and grid bias is provided by the resistor R7 in the grid circuit. This is shown as a variable resistor, but if preferred, a fixed value of 25K ohms can replace it, the grid drive to the 807 being varied by the condenser C12. The screen of V2 (the p.a. valve) has a fixed resistor R10 in the c.w. position, which allows the valve to operate in class C at its normal rated output.

To limit the 807 screen voltages for both bands, two variable screen series resistors R11 and R12 are switched in series with the resistor R10. When the transmitter is set to operate in the 80m band, R11 (a 200K ohms variable resistor) is inserted which reduces the screen voltage to around 150 volts. This will allow the valve to operate at approximately half its normally rated output. To limit the input to 10 watts in the 160m position a further variable resistor R12 is inserted in series with the other resistors already in the circuit. In order to prevent the generation of any spurious oscillations a choke wound on a resistor (R9) is connected direct on to the anode cap. Condensers C13 and C17 are also included in the circuit as a precaution against any instability.

The circuit diagram (Fig. 2) shows the coils for only one band for the sake of simplicity. These could be for either 160 or 80m as desired. For those, however, with more experience, diagrams of the coil switching have been included under the main circuit.

Construction

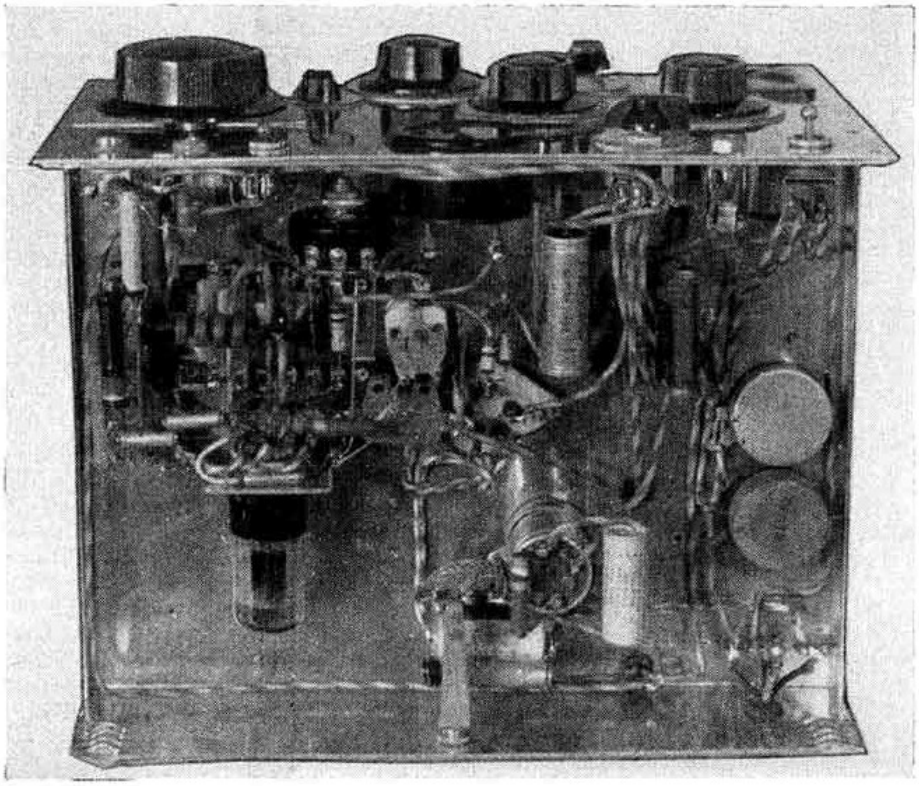
There is nothing critical or difficult in the construction of this transmitter. The aluminium chassis measures 9 in. × 12 in. × 2 in. and is bolted to a 12½ in. × 8 in. front panel, on which are mounted the meters, switches, jacks and control dials.

The v.f.o. coils and condensers are built into a metal box 4 in. × 4 in. × 4 in. which is mounted on top of the chassis, the valve and resistance-capacity network being carried underneath. To the right of the v.f.o. box is the 807 and behind it the 6V6 leaving plenty of room for the modulation transformer, p.a. and aerial coils.

All tuning coils are wound on 1½ in. diameter formers, which are screwed to the chassis by small steel brackets and rigidly wired to the wafer switches if more than one band is to be included. Care should be taken to see that the coils are mounted at least one diameter from the metal chassis or sides of the box and preferably at right angles to each other. The link coils are four turns each of 18 s.w.g. sleeved or enamelled copper wire wound on such a diameter as to slide tightly inside the coil formers. These links are joined to each other by a twisted pair of insulated wires of the same gauge. Coupling to the coils is made by sliding these links in and out of the respective coil formers. For switching the aerial coils it is essential to use ceramic wafers since r.f. is likely to burn away those made of inferior material.

Any 3:1 or 2:1 audio frequency intervalve transformer will be suitable for T1, but the primary winding must be sufficiently heavy to carry the 6V6 anode current, i.e. 45 mA. The writer used a Ferranti OPM2 output transformer which functions very satisfactorily.

All wiring should be carried out with 18 s.w.g. copper wire, to ensure rigidity. Grid leads should be kept as short as possible: the grid stopper R6 and condensers C13 and C17 should be soldered direct to the valveholder pins. The choke



Underchassis view showing the arrangement of the components. The valve mounted horizontally at the left is V1, the first half of which acts as the Clapp oscillator, the second as the buffer amplifier.

R9 should fit directly to the anode cap of the valve.

The whole assembly is slid into an aluminium box 12½ in. × 9 in. × 8 in. with a lid cut into the top to allow access to the tappings on the aerial loading coils and adjustment of the link couplings. Connections to the power supply are taken to the rear. The photograph of the underside gives a general view of the layout of the components. The set could be made smaller or larger if required, to fit into a metal box of other dimensions.

Operation

To obtain the best results care must be taken in the tuning of the transmitter. First switch to the c.w. position and with the aerial link very loosely coupled to the aerial coil rotate the variable condenser C14 to give minimum dip reading in the anode current read on the milliammeter M2. Tighten the aerial coupling by sliding the link into the aerial coil. Next adjust the variable condenser C26 until maximum current is indicated in the aerial ammeter M3. Re-check by rotating the condenser C14: only a very slight dip should be observed indicating that the transmitter is fully loaded. Adjust the drive condenser C12 to give optimum output with full rated screen voltage. This is given as 280 volts for the 807 in the makers' data sheets. Both the anode current and r.f. current into the aerial should be noted. Next switch to the 80 metre position and adjust R11 (the series screen variable resistor) until the d.c. voltage is reduced to about half of the initial value (see Table 1). The drive should then be decreased

TABLE 1

Typical Operating Conditions of Output Stage (807)

Band	Anode Voltage	Anode Current	Anode Power	Screen Voltage	Grid Drive
80m (c.w.)	500V	70mA	35W	280V	1–3mA
80m (phone)	500V	40mA	20W	160V	0·5mA
160m (phone)	500V	20mA	10W	90V	0·5mA

until the r.f. current just begins to fall: the aerial should then be coupled up as tightly as possible. The anode current and r.f. output current should have dropped by approximately one half of their initial value, if not, the grid drive and the anode loading should be varied until this condition is approached. In order to get within the 10 watt limitation for the 160 metre band, switch to the 160 metre position and adjust the second variable series resistor R12 in the screen circuit until the anode input wattage is correct. The screen voltage at this setting is approximately 90 volts. Keep the drive at a minimum and the aerial coupled as tightly as possible. When modulation is applied, there should be practically no movement in the anode milliammeter and only slight upward movement in the aerial ammeter, if the settings are correct. For phone operation the series resistors in the screen circuit will probably be a maximum, i.e. both R11 and R12 will be near the maximum setting.

Tropospheric Scatter

AT the meeting of the British Institution of Radio Engineers at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1, at 6.30 p.m. on October 30, M. Telford, B.Sc., will read a paper entitled "Tropospheric Scatter System Evaluation." Non-members of the Institution wishing to attend are asked to obtain tickets through members.

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June in Jersey . . . or A Busman's Holiday

By J. DOUGLAS KAY (G3AAE)*

WHEN the XYL finally persuaded the OM to leave the shack for a while and take a holiday in the Channel Islands the idea was to get away from it all and have a complete change from the ordinary daily routine—including Amateur Radio. Arrangements were made in January, and all went well until March when K6EIV, in a 14 Mc/s c.w. QSO, asked whether it would be possible to arrange a sked with any GC station on c.w. as a number of the W6 boys badly needed a Channel Islands contact for DXCC. "Muggins," of course, fell for it hook, line and sinker, and promised to take a small transmitter along on the holiday. Raising the question with the XYL did not result in divorce proceedings as had at first been envisaged: on the contrary she was most amiable and gladly agreed to the idea "provided it does not interfere with what we would be doing if you had not taken a transmitter." Some XYLs really are FB!

Arriving in Jersey on June 5 the first problem was to find a site to establish the station. Fortunately a cousin living on the outskirts of St. Helier kindly offered the use of his house or garage. The garage was chosen so that the OM could—if the opportunity arose—burn the midnight oil without raising the whole household. There was, of course, no mains supply in the garage, but this was soon rectified on a temporary basis.

The site was a corner house fairly low on a long hill running due north for several miles, and was flanked by tall heavily foliaged trees (on the other side of the road)—not a very promising position. It was decided to use the top of a waste pipe on the house for one end of the aerial, but the only thing at the far end of the garden was a wall about 15 feet high. However, after much rooting around, an extending ladder was found in the roof of the garage, and this was extended fully and placed against the garden wall, resulting in a horizontal support of about 25 feet at both ends.

The B2 transmitter was installed on June 6 and operation started on 7 and 14 Mc/s c.w. using a long wire aerial. Results were poor, and even the "C" in the call sign failed to attract much attention. After two days, during which some 20 contacts were scraped together, it was decided to give up 7 Mc/s and erect a dipole for 14 Mc/s. From the outset this was a roaring success, and the boys were soon queueing up in the approved manner.

During the next ten days, working approximately two hours a day, a total of over 200 contacts in 40 countries and all six continents were made before the big switch was finally pulled on June 17. All contacts have been confirmed by QSL either direct or via the RSGB Bureau.

One surprising feature was that at least half of the contacts gave someone their first QSO with GC. A listener report from B.R.S.20317 stated that GC3AAE was his 201st country on 14 Mc/s c.w. since 1955—no wonder the queue was so quick to form.

This was not a DX-pedition in the true sense of the word, but a holiday with a little Ham Radio added as an extra. However it was a most pleasant feature of the holiday, and one which it is hoped will be repeated on future dates.

Several of the local GC gang were contacted, and thanks are due in particular to GC2FMV for the loan of his standby receiver, and to GC2CNC who was also most helpful. Jersey is an island with great natural beauty and a wealth of amenities should the sun not shine every day, but if you are thinking of taking a few days holiday there why not pack a small rig in case you get too home-sick for the home station?

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