The Countryman's Mobile Transmitter—Receiver

A Compact Unit for 1.8 and 3.5 Mc/s

By F. W. CRABTREE (G3BK)*

WHEN considering the design of the transmitter-receiver described in this article the author's requirements were for a compact station for use when mobile and also for use from a car during weekend and holiday excursions into the country. Previous experience had shown that operating time was, more often than not, limited by the capacity of the car accumulator and emphasis was, therefore, on economy in power requirements especially during "receive" periods.

The Countryman's station consists of three main units —transmitter, speech amplifier-modulator and receiver— and is contained, together with all associated switches, in a 12in. x 8in. x 5½in. cabinet assembly. The h.t. power supplies are separate and consist of a 120 volt battery for the receiver and v.f.o. stage of the transmitter, and a 300 volt 100 mA vibrator pack for the buffer, p.a., speech amplifier and modulator stages. The transmitter has a power input of 10 watts on 'phone or c.w.

The receiver, which is designed for headphone operation, requires only 13 mA at 120 volts for h.t. and 0.45 amps at 12 volts for heaters. The author was somewhat doubtful about using headphones, but a few weeks of operating mobile and from a fixed site has convinced him that the receiver as described, with its low powered requirements and hash-free background, is ideal for the purpose for which it is intended.

*28 Regent Avenue, March, Cambs.

R.F. Section

The circuit of the r.f. stages of the transmitter is given in Fig. 1. V1 is a series tuned Colpitts (Clapp) v.f.o. on 1.75 to 2.0 Mc/s; it obtains anode and screen grid voltage via S1a from the 120 volt h.t. battery. V2 acts as a buffer amplifier on 1.8 Mc/s and as a doubler on 3.5 Mc/s. For c.w. operation V2 is keyed in the screen lead. The p.a., a Mullard QV04-7, has a combination of grid leak and cathode bias. The voltage drop across the cathode resistor R8 when excitation is removed holds the power input to the p.a. to a value approximately equal to the normal operating power. Consequently the current drawn from the vibrator pack is more or less constant as the transmitter is keyed. The tank circuit of the QV04-7 is the conventional pi-filter network. No difficulty has been experienced in loading up to an input of 10 watts when using the whip aerials described later in the article.

Speech Amplifier and Modulator

The QV04-7 is anode and screen modulated by a 12AX7 class B zero bias modulator. The modulator stage is driven by a 12AU7 connected as a two-stage audio amplifier. The circuit, shown in Fig. 2, is extremely simple and is a "must" for all low powered transmitters of this type. A carbon microphone inserted in J2 obtains energizing voltage from the cathode current of both halves of the 12AU7 valve. The driver and modulation transformers are from the SCR522 unit and are numbered A103016 and A103018 respectively. The pin connections to these two transformers are given in the circuit diagram.

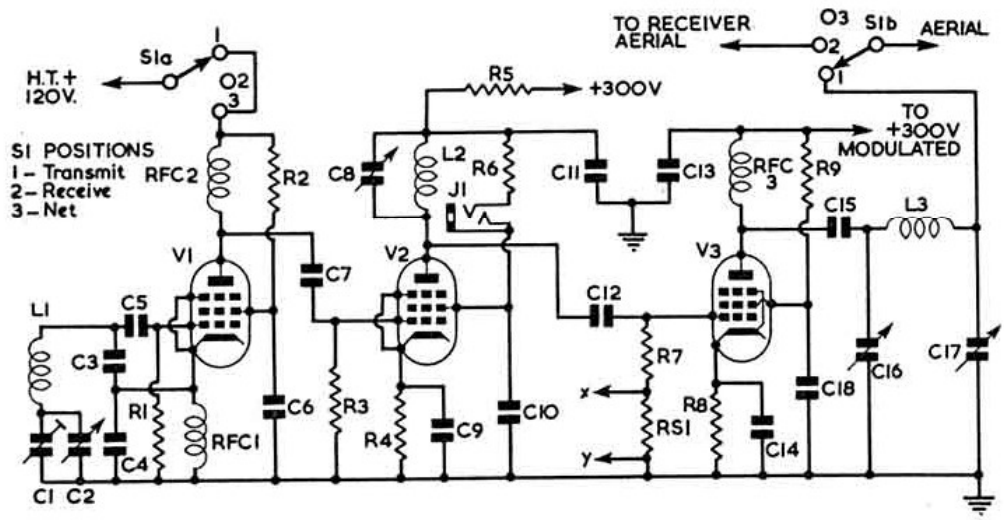


Fig. 1. Circuit of the transmitter section.

C1, 100$\mu\mu$F pre-set.
C2, 35$\mu\mu$F variable.
C3, 300$\mu\mu$F silver mica.
C4, 1000$\mu\mu$F silver mica.
C5, 50$\mu\mu$F silver mica.
C6, 9, 10, 11, 14, 18, 0.01μF Dubilier Minicap.
C7, 12, 100$\mu\mu$F mica.
C8, 150$\mu\mu$F variable.
C13, 1000$\mu\mu$F mica.
C15, 2000$\mu\mu$F mica.
C16, 150$\mu\mu$F variable.
C17, 2 x 0.0005μF midget variable broadcast type (sections in parallel).
L1, medium wave broadcast coil.
L2, 1.8 Mc/s—120 turns 36 s.w.g. d.s.c. close wound, 3.5 Mc/s—64 turns 28 s.w.g. enam. close wound. (Wound on 2 pin former Eddystone Cat. No. 781.)
L3, 1.8 Mc/s—78 turns 24 s.w.g. enam. close wound 3.5 Mc/s—45 turns 20 s.w.g. enam. close wound. (Wound on 1½ in. dia. former fixed to home constructed 2 pin base.)
RFC1, Eddystone Cat. No. 1010.
RFC2, Eddystone Cat. No. 1066.
RFC3, Eddystone Cat. No. 1022.
R1, 55,000 ohms.
R2, 47,000 ohms.
R3, 100,000 ohms.
R4, 700 ohms.
R5, 6,800 ohms.
R6, 20,000 ohms.
R7, 18,000 ohms.
R8, 300 ohms.
R9, 25,000 ohms.
RS1 5 mA meter shunt (see text).
S1, 3 pole 3 way ceramic wafer switch.
J1, closed circuit jack.
V1, 2 EF91 or equivalent.
V3, QV04-7 Mullard.

Receiver

The receiver presented a great problem. Various t.r.f. combinations were tried and consideration was given to using 1.4 volt filament valves. However, the superhet circuit given in Fig. 3 was finally chosen. Separate controls are used for signal frequency and oscillator tuning thus obviating ganging and tracking difficulties. The frequency changer V1 is followed by two 465 kc/s i.f. stages. A crystal diode is used for the second detector feeding into one triode of a 12AT7 as a.f. amplifier. The second half of the 12AT7 is the b.f.o. The spare 1⅛in. diameter hole seen at the top left in the plan photograph is available for an output stage should one be required. Such an addition is not recommended as the extra power required would

increase the h.t. drain beyond the limits of a dry battery.

Heater Supplies

The heater circuits to the three units are all separately switched to enable maximum power cuts to be made. Fig. 4 gives the heater connections for use with either a 6 volt or a 12 volt accumulator.

Construction

The complete unit is housed in a cabinet assembly supplied by Philpott's Metalworks Ltd., Loughborough. The front panel measures 12in. x 5½in. and is bolted to a 12in. x 8in. x 2¼in. chassis. Two louvred end panels, seen in place in the plan view photograph, are bolted between the front panel and the top of the chassis. The cabinet is completed by a top and back panel, all in one piece, which is held in place by eight self-threading screws. A base plate is fitted to the bottom of the chassis. This type of cabinet gives ease of construction and servicing.

It is suggested that marks corresponding to the dotted lines shown in Fig. 5 be made on the chassis before construction is commenced and an endeavour made to confine each unit to its own area. The transmitter controls C2, C8, C16 and C17 and the receiver i.f. and audio gain potentiometers R7 and R13 should be equally spaced along the bottom of the front panel. It will be found that the aerial loading condenser C17 will have to poach a little into the receiver area. The receiver main tuning condenser is controlled by a small reduction drive. Both this and the v.f.o. control are directly calibrated. Ivorine scales which have been roughened with fine sandpaper are used. These can be marked with pencil or ink and the markings removed with a damp cloth if necessary. Alternatively white art paper can be fastened with Durofix on to metal scales. Both these condensers should be capable of 360° rotation. One-half of each dial (i.e. 180°) is used for 3.8 to 3.5 Mc/s and the other half for 1.8 to 2.0 Mc/s.

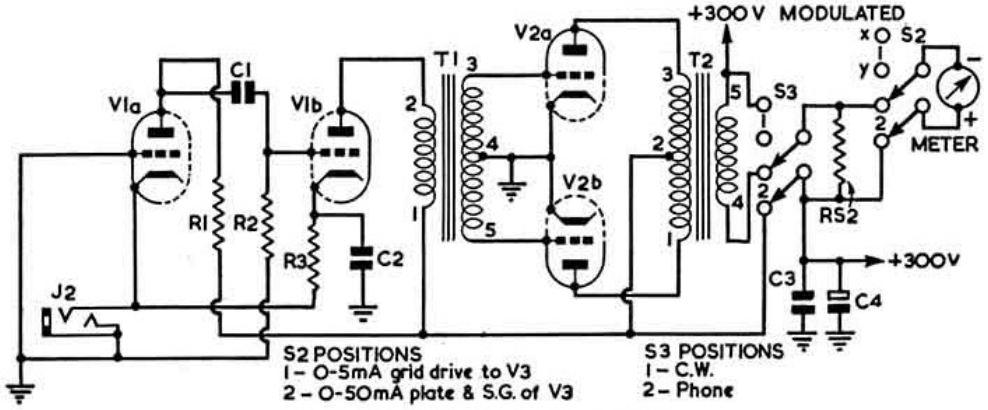


Fig. 2. The speech amplifier and modulator.

C1, 0.003μF mica.
C2, 5μF.
C3, 0.01μF.
C4, 100μF electrolytic.
J2, closed circuit jack.
R1, 56,000 ohms.
R2, 500,000 ohms.
R3, 2,200 ohms.
RS2, 50 mA meter shunt.
S2, S3, d.p.d.t. toggle.
T1, driver transformer.
T2, modulation transformer.
V1, 12AU7.
V2, 12AX7.
Meter, 0–5 mA m.c.

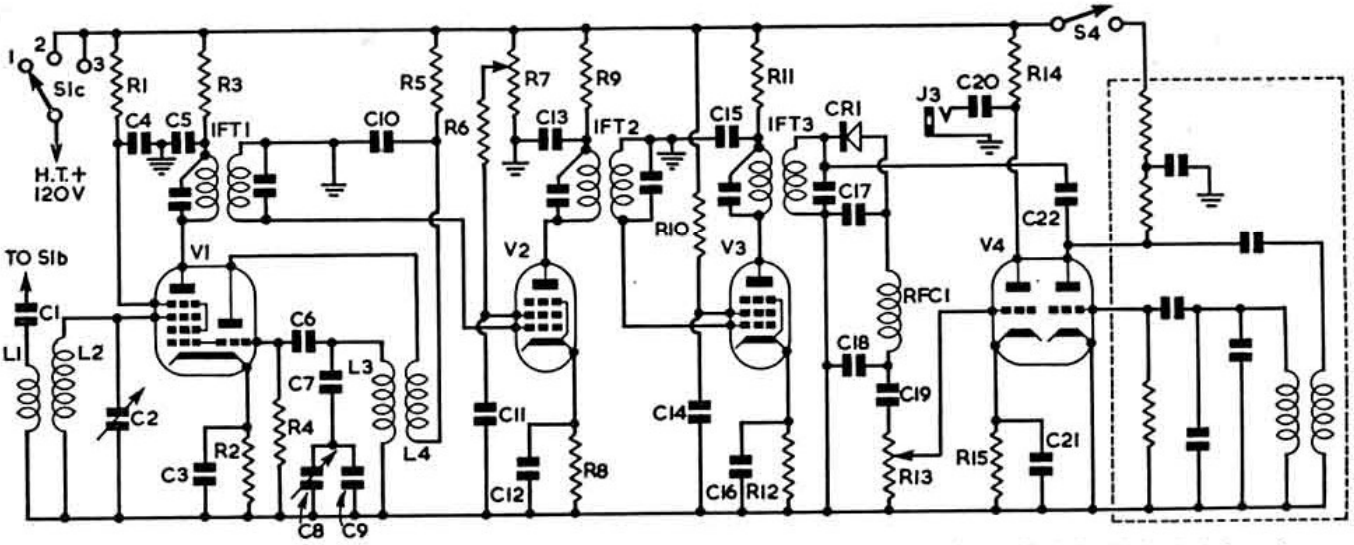


Fig. 3. Circuit diagram of the receiver. The components within the dotted square comprise a Maxi-Q 465 kc/s b.f.o unit.

C1, 100μμF.
C2, 60μμF variable.
C3, 4, 5, 10, 11, 12, 13, 14, 15, 16, 21, 0.01μF Dubilier Minicap.
C6, 100μμF silver mica.
C7, 60μμF silver mica.
C8, 75μμF variable.
C9, 50μμF silver mica.
C17, 10μμF.
C18, 20μμF.
C19, 20. 0.01μF.
C21, 3μF.
C22, wires twisted together.
CR1, GEX34 (G.E.C.).
IFT1, 2, 3, miniature 465 kc/s.
J3, open circuit jack.
L1, 1.8 Mc/s 10 turns, 3.5 Mc/s 6 turns (over earth end of L2).
L2, 1.8 Mc/s 115 turns, 3.5 Mc/s 55 turns.
L3, 1.8 Mc/s 90 turns, 3.5 Mc/s 62 turns.
L4, 1.8 Mc/s 12 turns, 3.5 Mc/s 6 turns (over earth end of L3).
(All coils close wound with 36 s.w.g. d.s.c. wire on 4 pin formers Eddystone Cat. No. 763.)
RFC1, Eddystone Cat. No. 1010.
R1, 25,000 ohms.
R2, 8, 12, 300 ohms.
R3, 9, 11, 1000 ohms.
R4, 50,000 ohms.
R5, 3,000 ohms.
R6, 120,000 ohms.
R7, 50 000 ohms potentiometer.
R10, 82,000 ohms.
R13, ½ Megohm potentiometer.
R14, 100,000 ohms.
R15, 2,000 ohms.
S4, s.p.s.t. toggle.
V1, 6BE6 or 6K8.
V2, 3, 9003.
V4, 12AT7.

L1 in the v.f.o. circuit, is a Wearite PHF2 medium wave broadcast coil. This coil is wound in sections and it was necessary to remove about a half of one section. The band-set condenser C1 is mounted below chassis near to C2 with access for a trimming tool immediately to the left of the meter. Both sides of C8 must be insulated from chassis. RS1 is the original shunt taken from the 0-5 mA meter. RS2 is made to shunt the meter to read 0-50 mA for anode and screen current to the p.a. The b.f.o. unit is mounted under the chassis between the modulator and r.f. sections with the wire leads coming from the open end near to V4. Screened wire, soldered down to suitably placed solder tags, is used for all the long heater and h.t. connections. The headphone output is on the right-hand end of the chassis and the key and microphone jack sockets are on the transmitter end.

Power connections are all brought to an octal valve base in the middle of the rear of the chassis. The 120 volt h.t. battery is fastened and connected to the vibrator pack. This pack is connected to the transmitter-receiver by means of a four-way cable with octal plugs at each end. It is necessary to have a switch on the power unit to switch off the vibrator during "receive" periods. The earthed side of the input to the vibrator supply must be connected to the earthed pole of the car battery. If a synchronous vibrator is used, the polarity of the output will depend on the input.

Adjustment

There are no d.c. relays, and testing and aligning can, therefore, easily be carried out in the shack with a suitable a.c. power pack. It is suggested that the r.f. stages be dealt with first. With heaters on and 120 volts from a dry battery applied to V1 the v.f.o. should be calibrated by reference to 100 kc/s and 1000 kc/s standards. If C2 does not give sufficient spread, remove a few more turns from L1 and increase the capacity of C1. With h.t. applied to V2, adjustment of C8 should give about 3.5 mA grid drive to the p.a. on both bands. Without load the anode and screen current to the p.a. should dip to about 18 mA at resonance. The standing anode current of the 12AX7 modulator is 16 mA rising to 36 mA on modulation peaks. The 12AU7 draws about 8 mA. There is a slight drop in p.a. anode and screen current on modulation peaks due to the extra current taken by the class B stage causing a voltage drop in the h.t. supply.

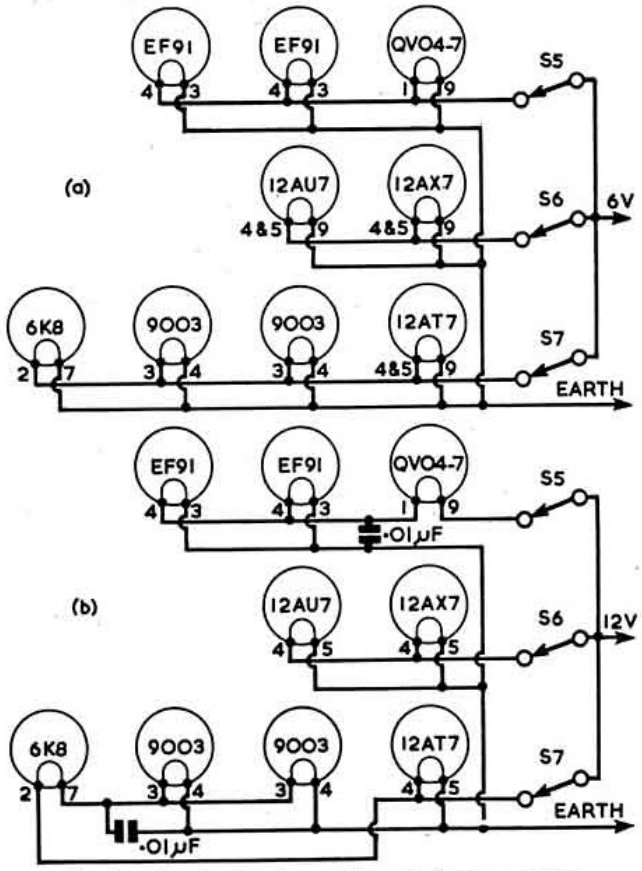


Fig. 4. Circuits for 6 and 12 volt heater supplies.

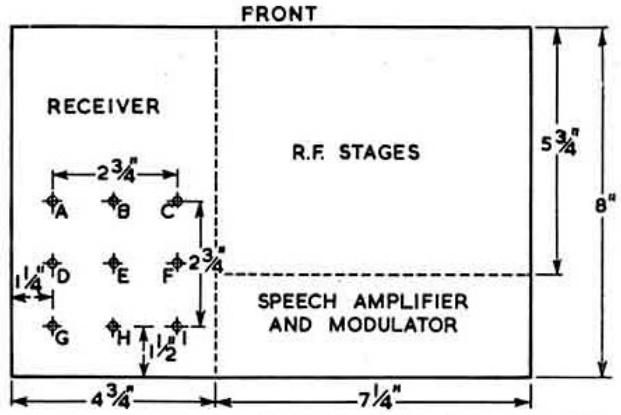


Fig. 5. Plan showing space allotted to each section. The points on the 2¾ in. square in the receiver section indicate positions of A—Aerial coil; B—V1; C—Oscillator coil; D—V2; E—IFT1; F—V4; G—IFT2; H—V3; I—IFT3.

The output from the v.f.o. can be used to assist in the alignment and calibration of the receiver. Coil data for the receiver is for the oscillator to be on the h.f. side of signal frequency on 1.8 Mc/s and on the l.f. side on 3.5 Mc/s. The value of R6 may require some adjustment so that the i.f. gain control R7 brings the i.f. stage near oscillation at the maximum setting of R7.

Whip Aerials

Co-axial cable must be used to connect the transmitter to the car whip. Both 8ft and 12ft Government surplus whips have been used with loading coils in each case between the bottom and second 4ft sections. The loading coil details are as follows:—

1.8 Mc/s band 8ft whip—145 turns of 30 s.w.g. enamelled wire tapped at 6, 12, 18, 24 and 142 turns.

1.8 Mc/s band 12ft whip—94 turns of 30 s.w.g. enamelled wire tapped at 4, 8, 12 and 92 turns.

3.5 Mc/s band 8ft whip—54½ turns of 28 s.w.g. enamelled wire tapped at 3, 6, 9 and 53 turns.

3.5 Mc/s band 12ft whip—38 turns of 28 s.w.g. enamelled wire tapped at 2, 4, 6 and 37 turns.

All coils are close wound on 1¼in. diameter paxolin formers.

The whip aerial must resonate at the operating frequency. With C17 at half capacity on 1.8 Mc/s and near maximum capacity on 3.5 Mc/s and the transmitter tuned to a suitable frequency, it should be possible to find a tapping point on the appropriate loading coil where the anode and screen current to the p.a. show a marked increase. Slight adjustment of the v.f.o. to the point of maximum output will then give the exact resonant frequency for that particular tapping point.

The following notes may be found useful: an 8ft whip is the maximum length which should be used for

mobile work but a 12ft whip is worthwhile when operating from a fixed site. It has been found that the bottom sections of the Government surplus whips will slide over the normal car telescopic whip if the knob at the top of the car whip is first removed. A plastic feeding bottle for a baby makes an excellent protective cover for loading coils!

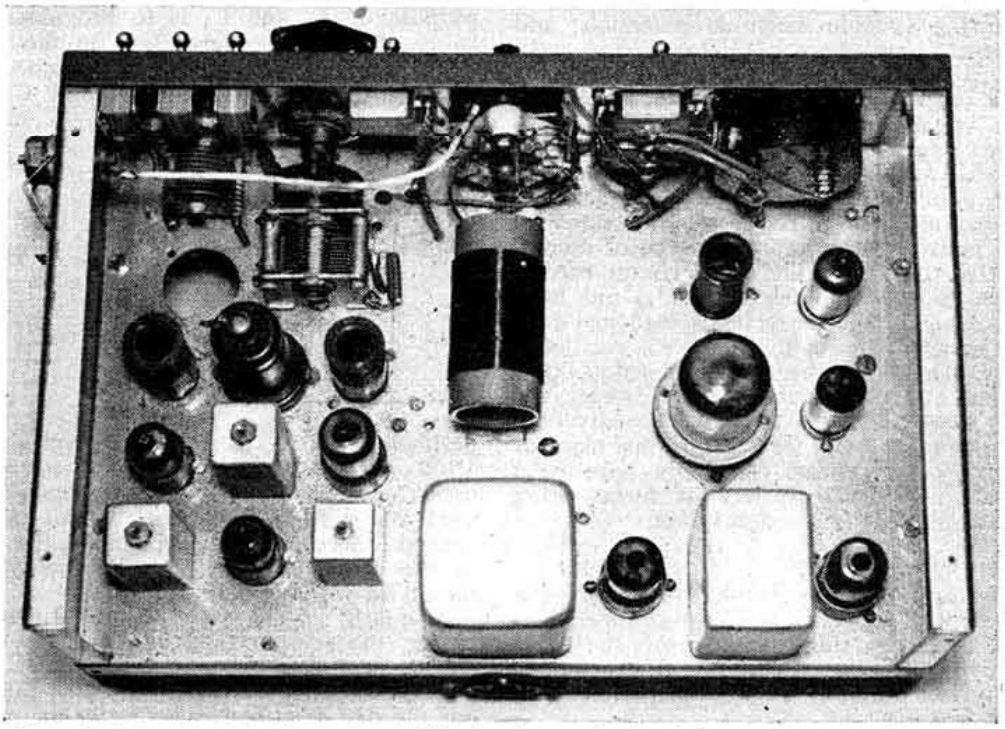
Accessories

A small case containing headphones, key, microphone, spare coils and valves, call-book, log book and the mobile licence completes the station. A stiff backed writing pad with a pencil attached by a length of string is useful.

Results

It was intended to use tree-supported and kite-borne long wires when operating from a fixed site but distances covered with whips have been so encouraging that other aerials have not yet been tried. When operating mobile on Top Band contacts with fixed stations 40 miles away have been 100 per cent. During 1955 N.F.D. contacts with portable stations up to 80 miles were made on Top Band while on 3.5 Mc/s the best contact was with the Port Talbot station (over 200 miles). These N.F.D. contacts were from a fixed site at sea level on the north Norfolk coast; a 12ft whip was in use.

A front view of the Countryman's transmitter-receiver. The main receiver tuning is immediately above the i.f. gain control and the mixer tuning above the audio gain.



Above chassis arrangement of components. The three heater circuit switches may be seen at the top left.