signal generator and oscilloscope are available, when the procedure is as follows:

(1) Feed an audio signal to the base of TR5 observing the output on the oscilloscope,

(2) Increase the input until limiting occurs,

(3) Alter the emitter resistor until the limiting just disappears,

(4) Find the value of emitter resistor which just produced distortion on the peak of the other polarity,

(5) Choose a value half-way between the results obtained in (4) and (5).

Decreasing the base dividing resistors may increase the signal handling capacity further but there is no point in exceeding a comfortable listening level or the transistor dissipation.

APPENDIX " C "

Distortion figures are included as a matter of interest as is the complete frequency response curve up to 20 kc. (Figs. 6 and 7).

Frequency Distortion: 100 c/s, -50 dB; 330 c/s, -50 dB; 1 kc, -48 dB; 3·3 kc, -47 dB; 10 kc, -48 dB.

MODIFICATION NOTIONS FOR THE TYPE 19, Mk.III

FOR TRANSMISSION AND RECEPTION ON THE LF BANDS

F. G. RAYER, A.I.E.R.E. (G3OGR)

The 19 Set is a well-known surplus item, of basically simply but effective design, robustly built and intended for reliable working under exacting conditions. This article discusses some practical ways in which it can be made more useful for amateur-band operation.—Editor.

THE Army Mk. III No. 19 Set is available at low cost and can be adapted for amateur use. The original Type 19 gives transmitting and receiving facilities on the 80m. and 40m. amateur bands. Modifications described here are for 80 and 160 metres.

The receiver covers 2·0-4·5 mc and 4·5-8 mc in two switched bands, calibrated at 0·1 mc (100 kc) intervals. It is RF/FC/2IF/DDP, with 465 kc IF—and very good it is for the LF bands.

Reception

HT at 275v. is specified but 200-250v. will be satisfactory. An ordinary receiver PSU giving about 40-60 mA at 250v. or so will be adequate. Take positive to pin 6 of the " power input " or upper connector. The set obtained by the writer had no VHF section. This leaves space for a mains transformer and PSU components. An external pack is then unnecessary.

The heaters are connected for 12v. DC or 12·6v. AC. A 12·6v. supply was obtained by connecting the two 6·3v. 2A AC windings of a mains transformer in phase. Check with a meter, as phase opposition gives no output. A small separate 12·6v. heater transformer could be used. The feed goes to pin 3 of the power input socket.

Some of the receiver-section valves are in series with the intercom. amplifier heaters and those of the transmitter section. If the heater circuit is not modified it is not possible to take out unwanted valves. Heater circuit arrangements appear to vary. It is not difficult to re-wire the receiver for the usual 6·3v. AC. Pin 1, or the chassis, is the common HT negative and heater return. For reception only, no other supplies are wanted.

The output stage is indicated as operating headphones. These can be medium impedance and are taken to chassis and pin 4 of the " output " (bottom) connector. Good output was obtained for a speaker. With a 2/3 ohm unit, results were best with a matching transformer having a ratio of about 15 : 1. Primary goes to chassis and 4, and secondary to speaker. Initially, it had been planned to use the 6V6 of the intercom. section as an audio output stage for the speaker. This seemed pointless after testing, but might be kept in view.

Performance was fully up to the RF/FC/2IF standard, both as regards sensitivity and selectivity. Tuning is with the right-hand control, which has a ball *plus* friction drive, ratio about 75 : 1, and dial markings were found to be exact. The left hand dial has a friction drive only, and tunes the aerial (PA) section. It is peaked for best output. Frequency readings here are a rough guide, and depend somewhat on the aerial used.

For AM reception the function switch is put at R/T and the " On A " switch on. The meter switch can be at any position (it reads receiver HT voltage, if wanted). Another position checks heater voltage and naturally results in no reading when using AC. (It is as well not to leave the meter switched to check AC.) At the " AVC " setting the meter falls back somewhat with increased signal strength, on *strong* signals. Some valves had risen out of their holders during transit of the Set.

Top Band Reception

Coverage to include 1·8-2·0 mc can be obtained by putting a ·002 μF capacitor in parallel with the 2-4·5 mc padder. This slightly shifts tuning in the 3·5-3·8 mc region. The padder may also need adjusting. A re-calibrated dial is of course wanted.

The air-cored FC signal frequency coil can be brought into line at 1·8-2·0 mc by placing a small ferrite core in the former, and peaking this for maximum output. This core can screw into a hole in a piece of wood cut to fit in the end of the coil. The aerial circuit is tuned with its separate control, so needs no modification.

Block diagram Fig. 1 shows circuits in use during reception (*see* p.546).

The Transmitter Side

For transmission, up to 500v. can be taken to pin 4 of the power plug and this supplies the 807 PA anode only. The aerial (AE) position of the meter switch depends for a reading on an external RF rectifier, so without this

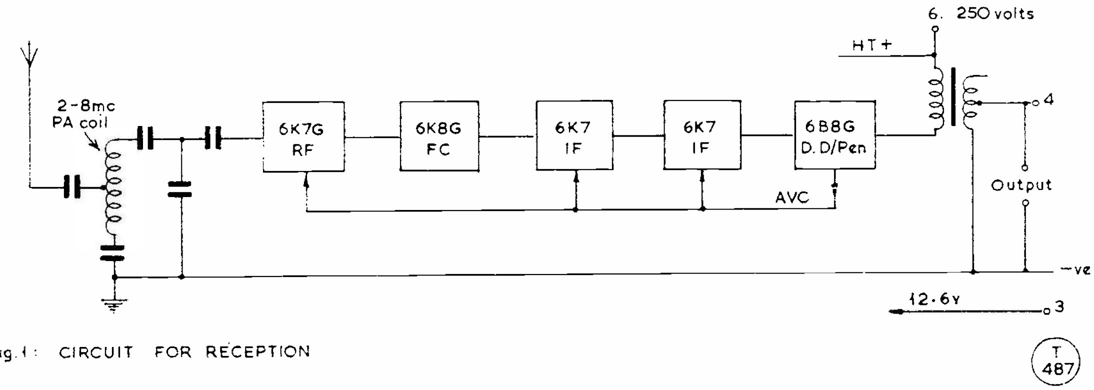


Fig. 1: CIRCUIT FOR RECEPTION

gives no indication of tuning. As there is a tapped PA coil with loading controlled by an external variometer, it is necessary to use this, or a tuner, and place an anode current meter in the PA supply.

Briefly, a second mixer receives input from the frequency changer and an oscillator at IF, to produce output at the reception frequency. This passes to a driver, diode drive level control valve, and the PA. As a result, transmission is automatically on the same frequency as reception, throughout the tuning range. A 4-gang condenser pack (right-hand control) tunes all circuits including the driver, but excluding the PA anode.

Frequency coverage is large, 2·0 to 8·0 mc, and does not allow setting up for transmission with a calibration accuracy to meet amateur-band licence conditions. This might be overcome by using some other source of frequency measurement, such as the R.502 wavemeter. But it seems that in any case reduced coverage, at least on transmission, is really required for amateur use. Block diagram Fig. 2 shows circuits in use for transmission.

Transmitter Modifications

This is where the fun begins! As transmission is on the receive frequency, it would seem a good plan to cut receiver coverage down to 3·5-3·8 mc and other wanted bands, and rely on the present mixer circuits for conversion of this narrow band for PA drive. But the large 4-gang capacitor is so built in that replacing it by a smaller value is extraordinarily difficult (the 19 Set was designed for use in a tank!). Unfortunately, series condensers to reduce coverage cramp the tuning at the HF ends of reduced bands.

Other odd points arise: Probably, few AT-station operators want MCW operation. The existing grid modulation might be improved. A *pi*-type PA circuit would be useful. Also, if the equipment is to be used on Top Band, input needs limiting to 10 watts.

Various ways of modifying the 19 Set can doubtless be worked out. The idea preferred at G3OGR was to leave the whole receiver as it is, and make such changes to the transmitter section as would allow it to cover 1·8-2·0 mc and 3·5-3·8 mc with its own calibrated 1·75-2·0 mc VFO. Relay control by a mike push switch was not required. The meter ought to do also for PA tuning. The large connectors and sundry other facilities, such as intercom. amplification, can also be eliminated.

Removing Unwanted Circuits

Unfortunately it is not simply a matter of changing a few connections. To speed the work, flat and box 4 BA and 6 BA spanners are almost essential, plus small wire cutters and one or two screwdrivers. Resistors and such are cut out with long ends, for future use.

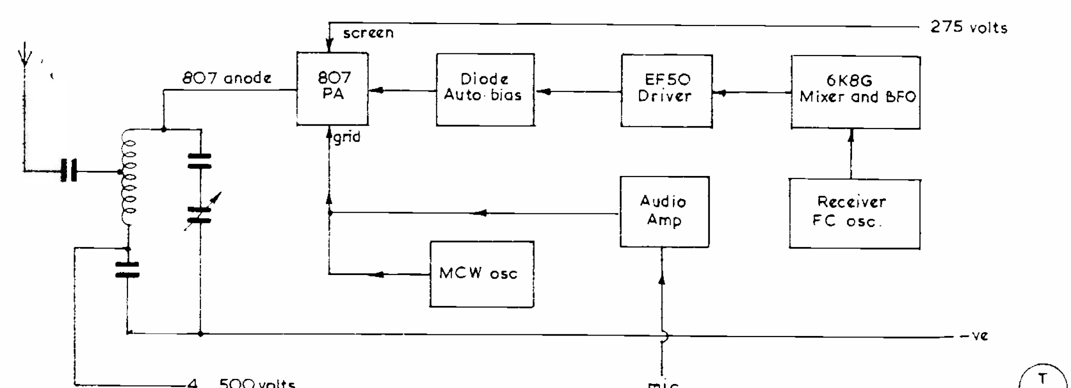
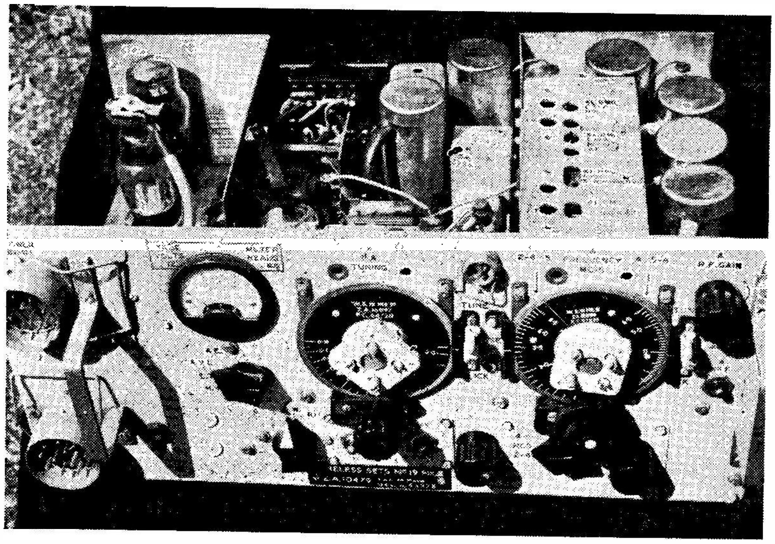


Fig. 2: CIRCUITS ORIGINALLY IN USE FOR TRANSMISSION



The 19 Set in its original condition, covering 2.0-8.0 mc, and incorporating an intercom. amplifier for talking between the tank crew. The receiver section is to the right.

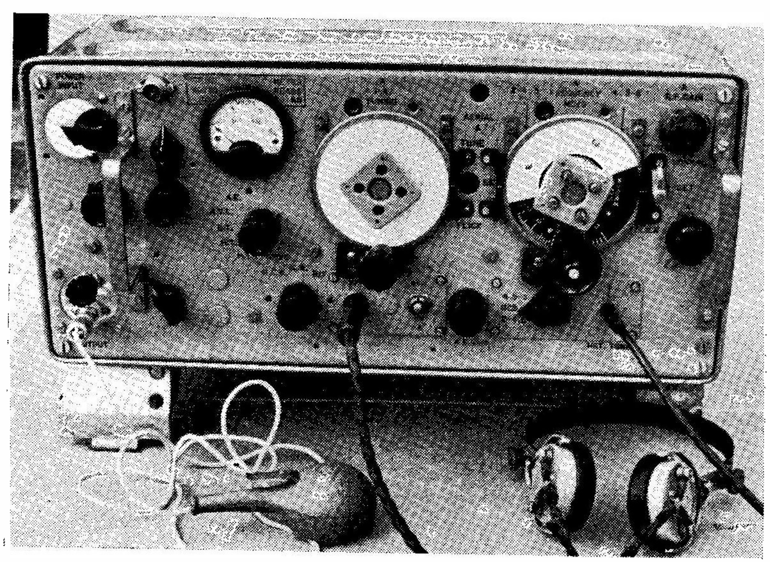
The intercom. section is completely removed; also the relay. As a telephony transceiver was envisaged, the BFO was cut out. The MCW facility and tone filter are not wanted, so these circuits and the MCW/CW/RT switch were likewise stripped out. The only position for the new VFO control appears to be in place of the original PA tuning capacitor, so the PA (which is to be changed to *pi*-output anyway) is taken away, and also the existing driver and mixer (used during transmission in the original).

This leaves the receiver. As the heater tags were quite easily reached, heaters were put in parallel for 6·3v. Separate switching of some screen grids, originally used, becomes unnecessary, so the receiver frequency-changer screen resistor is soldered directly from tag 4 to the nearby IFT HT tag, and two separate red HT feeds emerging from the receiver are joined.

The large panel connectors were removed. The green lead, 4 to transformer, will be the audio output circuit. When all is finished, only HT and 6·3v. leads issue from the receiver section, plus a connection from the last IF cathode (for the tuning indicator). The receiver should be complete, except for the RF stage grid circuit, which originally was incorporated with the PA coil.

After stripping out the circuits which are not to be used it is probably wise to complete and test the receiver. This is done by inserting the 6K8G frequency changer, two 6K7G IF valves, and a 6B8G as double-diode-pentode, connecting 6·3v. and 250v. supplies. An aerial is taken through a condenser to the vacant RF stage anode tag. If all circuits have been restored where needed (especially HT feeds) results should be satisfactory.

The RF stage can then be brought in. This was originally tuned by the PA coil and condenser, now



The 19 Set conversion as described in the article makes it into a single-unit transceiver station for the LF bands, running about 10 watts on the Tx side—see circuit p.549. The receiver line-up is RF-FC-2/IF-Det audio giving good sensitivity and selectivity.

removed. However, a small box surrounds the wave-change switch, and contains two coils used for the driver grid circuit, signal frequencies being tuned with the 1st section of the 4-gang condenser pack. These coils are used for the new RF stage.

Locate the switched primary lead (blue) and extend this for an eventual aerial connection. Take earth ends of primaries to chassis. The long lead which went from the RF valve cap to PA circuit is then connected *via* a 300 $\mu\mu$F capacitor to the 1st gang section. Replace the small box lid. The gang trimmer is unsoldered, and a panel 50 $\mu\mu$F trimmer fitted in the "A NET" hole.

Results should now be as originally. Used in this way, the receiver needs only 1·5 A. at 6·3v. and about 40 mA HT. If phones are not favoured, the original coupling transformer can be removed and a small output transformer, with a ratio of about 45 : 1 and intended for a 2/3 ohm speaker, can be fitted instead.

Metalwork

Existing holes are used whenever possible. The top connector hole is blanked off and takes the T/R/N switch. The lower connector hole accommodates both a miniature 1-megohm potentiometer (microphone gain) and the coax connector for the microphone.

The PA bandswitch and condenser occupy top and bottom of a slot (VHF section). Other panel holes used for changed purposes are as follows: Buffer 80/160m. (key); drive potentiometer (MCW/CW/RT), grid/S-meter (Ae./AVC etc.); aerial (VHF aerial); output jack (switch IC), mains on/off (switch "A"), aerial trimmer (Net), mains lead (Het.).

The 807 holder is originally sunk below chassis level. This has to be done in the new position, or a miniature 807 used. The metal case as supplied was as new, but completely unventilated. This does not seem to matter for operating periods of moderate length, but beyond this ventilation would be desirable. Some holes can be easily made in the back with a screw-up type of valve-holder punch.

Power Section

The supply provided was 300v. at 120 mA. This allows 50 mA for the PA, about 45 mA for the modulator, and 20-25 mA for the VFO/driver stages.

Other supplies should suit, if to hand, but less than 275v. main HT is not much recommended. With the values given, RF output on Top Band is larger with 33 mA at 300v. (10w.) than with 40 mA at 250v. (also 10 watts).

Transmitter VFO

This covers 1·75-2·0 mc with a little overlap, when using the EF50. The central drive can be removed so the large PA condenser was replaced by a 150 $\mu\mu$F capacitor, though 100 $\mu\mu$F would do.

The "flick" setting screws are removed, also the central nut, knob bearing, capacitor and plate. A pin holds the mechanism on the spindle, with a grub screw behind. A surplus condenser with flat front plate was bolted on. A capacitor with centre-bush fixing needs mounting on a flat metal plate, bolted to the mechanism support plate. A component with back and front bearings is recommended.

The VFO coil is 40 turns of 24g. enamelled, close-wound on a 1in. diameter paxolin tube previously smeared with a fixative. It is tapped ten turns from the earth end. A 220 $\mu\mu$F 1% parallel capacitor gave satisfactory coverage so no trimmer was provided. The coil is mounted on the screen surrounding the EF50 holder.

Calibration is from 1·75-2·0 mc with a 100 kc crystal, when all is finished. Zero beat the VFO with the crystal harmonics in turn, marking the VFO dial. Use the VFO 2nd harmonic to get 50 kc marks. Appropriate markings are doubled for 80m.—1·9 mc becomes 3·8 mc, and so on.

A stabilised supply did not seem necessary for LF band work, so the plan to arrange this with an OA2 was dropped.

Switching

Six poles of the original 9-pole 3-way switch are employed for PA input, grid current, and receiver S-meter positions. Wiring provides "Receive" in the central position, with "Transmit" at one outer position, and "Net" at the other. Poles are employed as follows: R, T and N indicating Receive, Transmit and Net, Fig. 4.

(1) Aerial to PA tank at T, to receiver *via* 500 $\mu\mu$F at R, and to receiver through twisted wire capacitor of few $\mu\mu$F at N,

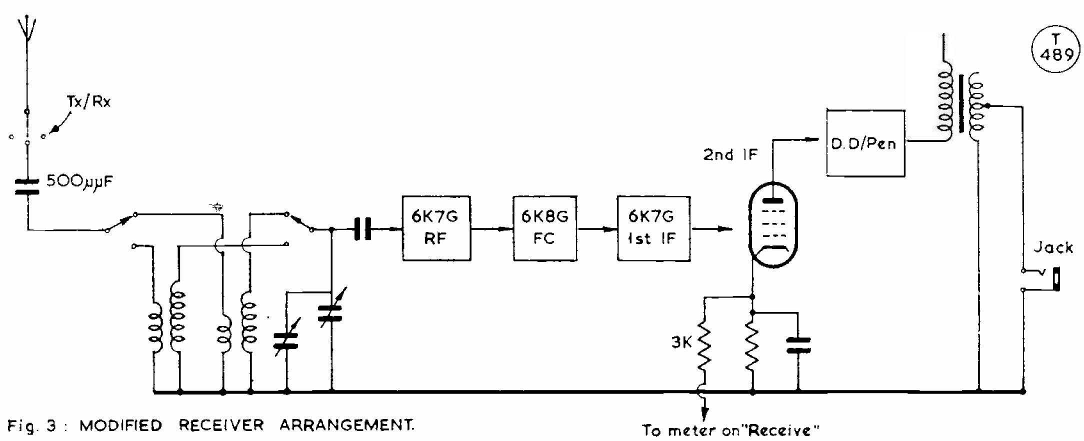


Fig. 3 : MODIFIED RECEIVER ARRANGEMENT.

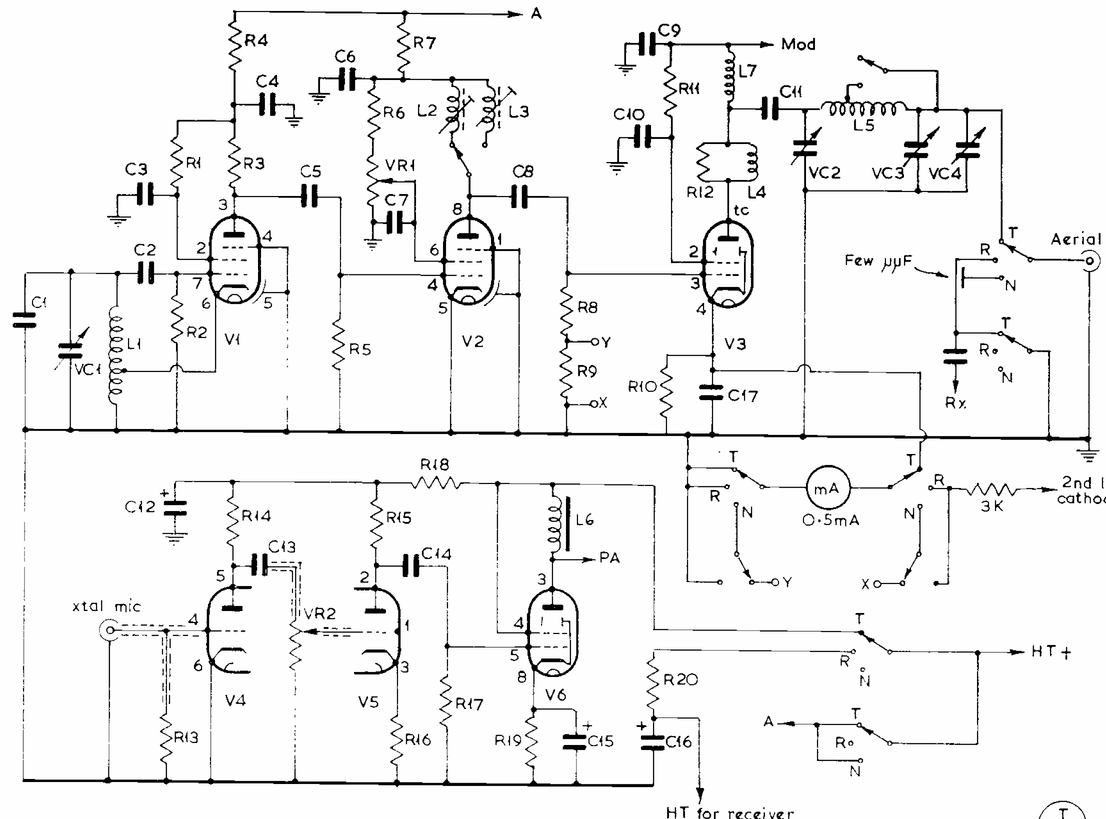


Fig. 4: TRANSMITTER & MODULATOR SECTIONS

Circuit of the Type 19, Mk.III, as modified for the LF bands.

(2) Receiver aerial lead shorted to chassis at T,

(3) HT to modulator (and thus PA) at T. HT to receiver *via* series resistor at R and N,

(4) HT to VFO and buffer-multiplier at T and N,

(5) Meter negative to chassis at T and R; to Grid/S-Meter switch section Y at N,

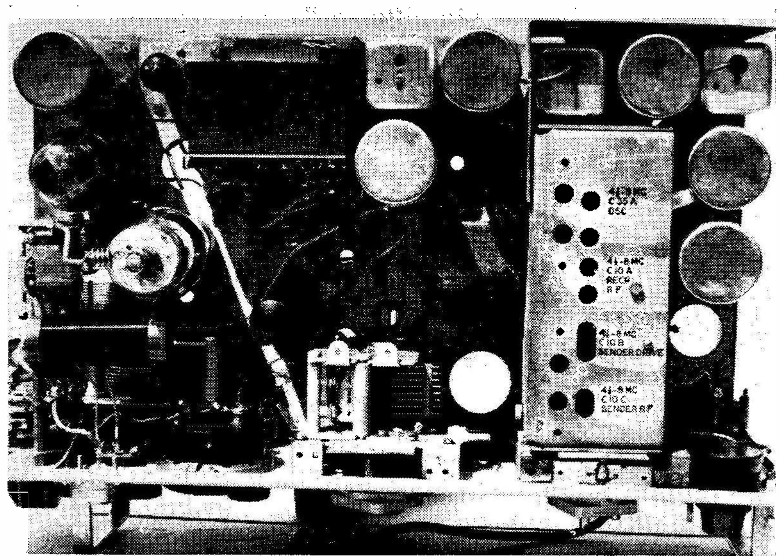
(6) Meter positive to PA cathode at T; to final receiver IF cathode circuit through series resistor at R; to Grid/S-Meter switch section X at N.

New Grid/S-Meter switch is two poles of the 5-way original meter switch. The meter operates as follows: (*a*) On T reads PA cathode current, range 0-150 mA; (*b*) On R functions as " dip " type receiver S-meter; (*c*) Normally functions as at (*b*) on N, giving 9-plus reading when VFO is tuned to receiver frequency, for netting; (*d*) If Grid/S-Meter switch is placed in second position, the meter reads 0-6 mA, PA grid current. If the Grid/S-Meter switch is left in this position, this does not change meter working at T or R. It is only

Table of Values

Fig. 4. Modified Circuitry of the 19 Set, Mk. III

C1	= 220 µµF, s/m	R13	= 1 megohm
C2	= 200 µµF, s/m	R14, R15	= 220,000 ohms, ½w.
C3, C4, C6	= ·05 µF, 350v.	R16	= 3,300 ohms, ½w.
C5, C8	= 100 µµF. mica	R17	= 470,000 ohms, ½w.
C7	= ·01 µF, 350v.	R18	= 33,000 ohms, 1w.
C9, C13	= ·002 µF, mica	R19	= 270 ohms, 1w.
C10	= ·001 µF, mica	R20	= 5,600 ohms, 2w.
C11	= ·005 µF, mica	VR1	= 50,000-ohm potentiometer
C12, C16	= 8 µF, 350v.	VR2	= 1 megohm potentiometer
C14	= ·004 µF, mica	L1	= VFO coil
C15	= 25 µF, 25v.	L2	= 80m. buffer
VC1	= 150 µµF	L3	= 160m. buffer
VC2	= 500 µµF	L4	= APC, 5t. 20g. on R12
VC3, VC4	= 2 x 500 µµF, BC type	L5	= PA coil, *see text*
R1, R2, R6	= 47,000 ohms, 1w.	L6	= Modulator choke, *see text*
R3	= 20,000 ohms, 1w.	L7	= RFC, 2·5 mH choke
R4, R11	= 10,000 ohms, 2w.	V1	= EF50
R5	= 100,000 ohms, ½w.	V2	= 6AG7
R7	= 2,200 ohms, 1w.	V3	= 807
R8	= 22,000 ohms, 1w.	V4, V5	= 6SL7GT
R9, R10	= meter shunts (*see text*)	V6	= 6V6G
R12	= 47 ohms, 1w.		



Interior view of the converted 19 Set, as an LF band transceiver. The VFO tuning condenser is at lower centre, the PA stage at left, modulator upper left, and the PSU items along rear chassis edge.

necessary to check grid current occasionally, as when changing bands, or going from one band end to the other. The 807 operates well with about 2 mA to 4 mA grid current.

PA cathode current has to be indicated because the switch is make-before-break and cannot be in the HT positive circuit. This does not reduce efficiency, but the anode input is less than you think if you do not allow for screen current, at least. Initially, measure the voltage drop across the 10K resistor R11. This voltage divided by 10 is then the screen current in mA. (About 10 mA.)

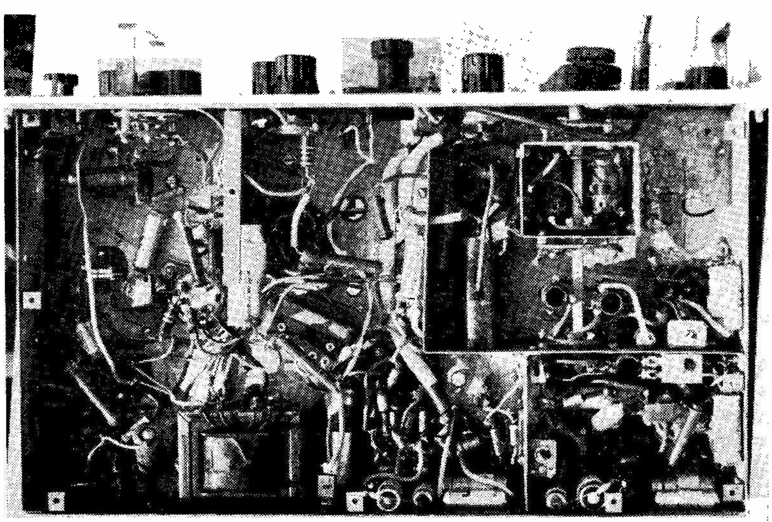
The cathode shunt R10 is most easily made with no power on the equipment. Connect a test-meter, potentiometer and battery in series, and from chassis to cathode tag, with a provisional length of resistance wire as shunt soldered on. Adjust the potentiometer for 50 mA and 100 mA, and if the meter reads low, disconnect the battery and increase the shunt value. In this way, a 0-150 mA range is quickly made. (Take care not to apply heavy current to the unshunted meter.)

The grid shunt is near enough if a 47-ohm carbon resistor is used, with the 0·5 mA 500-ohm meter. Some inaccuracy is unimportant here. For greater accuracy, check against a test-meter and make a shunt, or file the side of a slightly low value carbon body resistor.

Coils

The buffer coils were old BC receiver surplus, with unused windings taken off, and adjusted to peak at about the middle of the 160 and 80m. bands.

The 160m. coil can be 90 turns of 34g. silk-covered wire in a pile ⅜in. long on a ½in. dia. cored former. The 80m. coil can be 65 turns of 34g. enamelled close-wound on a similar former. Other coils could doubtless be used.



Underneath the converted 19 Set transceiver. Note the screened compartments, accommodating speech amplifier, PA stage and VFO section.

With the VFO at about the centre of the band, and meter switched to read grid current, each buffer coil core is rotated for best grid current. This was substantially more than wanted.

The original PA tank has insufficient turns. The PA coil is 70 turns of 22g. enamelled wire, centre tapped for 80 metres, on a 1in. dia. paxolin tube.

Results

The RF/FC/2IF receiver is actually very good on the LF bands. It is suggested the S-meter S9 point be placed at mid-scale.

Transmitter output into a calibrated RF wattmeter is fully up to standard. Coverage of 80 metres as well as Top Band is useful, because on end-fed wire is nearly always used on 160m. so can be employed on 80 metres also, often allowing distances to be worked which would be exceptional for Top Band.

Modulator

This was a 6SL7GT amplifier followed by a 6V6, because to hand. A 12AX7 (miniature) could replace the 6SL7. The 6V6 is in the original, and seems to modulate up to 10 watts PA input well. (6V6 data as for 6BW6.) A 6L6 would appear practical.

The modulator " choke " is a 80 mA speaker transformer primary. Unnecessary resistance here or in the smoothing choke drops PA volts. The modulator can be tested by temporarily connecting a loudspeaker—or feed the RF into a lamp or other load, and use another receiver. If overloading is avoided, speech should sound strong and clear.

Other Possibilities

Various experiments were carried out with the circuit. The 807 will actually take 100 mA at 500v. (50 watts) easily. This has been modulated by an external power-pack and modulator using 2/6L6's—but a wider spaced PA tuning condenser is needed, to avoid flash-over.

The screen of the 807 has also been modulated with fair success, with the 6V6 alone. This allows for larger PA inputs without the need for a big modulator.

MORE ABOUT INTERFERENCE SUPPRESSION FOR MOBILE

LESS COMMON CAUSES, AND THEIR CURES

J. E. AUSTIN (G3REM)

IN a previous article (" Interference Suppression for Mobile Radio," September '67, SHORT WAVE MAGAZINE) the writer made brief reference to causes of interference which are not so common, and it is proposed now to pinpoint some of these.

Aerial. A sudden onslaught of severe interference especially when " everything " starts to come in should lead to an immediate inspection of the aerial itself. In the case of broadcast receivers it has been found in almost every case that the aerial was at fault. The usual trouble is water that has worked its way down the rods and collected in the base. This causes a leak from the rods to ground and may be detected quite easily by putting a meter across the aerial plug. *Any* indication of resistance is too much as there should obviously be no connection between the rods and ground. Some types of aerials can be dismantled and dried out. Those which have been machine-sealed are best replaced. Finally, check the lead and braided copper screen for breaks, paying particular attention to the points where the lead passes through bulkheads, etc. See also that the earthy part of the aerial and the point of contact are not corroded. If you change your car after three years or so leave the aerial on as it is bound to be corroded and can cause more trouble than it is worth.

Battery. It is not often appreciated that noise can be present in the battery, but this is so and steps must be taken to prevent this noise affecting the receiver. An aerial will only pick up noise which is radiated into free space in its vicinity, so a good check is to note the noise when the aerial is connected and then to disconnect it and listen again. If noise is still present it is almost certain to be entering the receiver *via* the LT lead. The remedy is to fit an LT filter choke in the lead. Filter chokes for this purpose are available, built into standard car radio fuseholders, and they can be fitted in series with the existing fuseholder in a matter of seconds.

Windscreen Wiper Motor. This does not always give trouble and is often overlooked anyway—until it happens to rain! If the body of the wiper motor is at ground potential the usual 1 μF suppressor condenser can be fitted between the supply terminal and ground. However, many motors are mounted on flexible rubber fittings and in such a case a suppressor will not do the trick. Here it is necessary to bond the body of the motor to ground with copper braid, then checking, because quite often a capacitor is not required in addition to the bonding.

Gearbox Static. Not very common, but has been known to occur. Static noise can be generated in the gear train or bearings and has been encountered on odd occasions. To check, tune between stations and listen carefully when changing gear. A change in static intensity will become evident with each change in gear ratio and a steady pressure on the gear lever may reduce the effect. Here again, bonding is required and copper braid at least 1 inch wide should be fitted from the gear-box to chassis. Keep it short and resist the temptation to stretch it, as this will increase the self capacity of the braid and reduce its effectiveness. [*over*