Receiving FM Programmes in the Medium Wave Band

by Peter Lankshear

In the February/March 1992 issue of *Radio Bygones*, the Editor lamented the passing of the medium wave band BBC Radio 3 transmissions and as a consequence, the loss by the owners of elderly receivers of a favourite programme.

All is not lost, however, for it is possible for vintage radio enthusiasts to have the best of both worlds by receiving FM signals and retransmitting the programmes through the miniature medium wave band AM transmitter to be described. Although of course the retransmission will be monophonic, chances are that in many cases, reception will be quieter, and at night, of better quality than from the old medium wave transmissions subject to fading.

Programme material need not be limited to FM transmissions. Any suitable source such as a record or CD player or tape recorder can be used. Taped reissues of classic radio programmes and old gramophone recordings have an added dimension when heard through a radio of the appropriate period.

Not a New Idea

The use of a modulated RF source for localised reception is not new. During the 1930s several American manufacturers provided tiny transmitters using a pentagrid frequency converter valve for coupling record players to receivers not fitted with pick-up terminals.

Some experimentation with this type of transmitter showed that the audio quality did not meet modern standards. It appeared that the best approach for today's requirements would be to design what is essentially a miniature medium wave transmitter.

Some specifications were drawn up and are as follows:

1. To prevent interference, power should be very limited, but sufficient to cover the area of a small building.
2. Should be suitable for monaural or stereophonic sources with sufficient gain to operate from headphone, extension speaker or audio line outputs of the programme sources.
3. Must be capable of 90 per cent modulation with no audible distortion.
4. Construction and circuit should be simple and use only readily available components. This would exclude the use of a modulation transformer.
5. Adjustment should require only a minimum of test equipment.
6. To permit continuous operation, power consumption should be minimal.

The unit described readily meets these specifications.

Series Modulation

Various systems were considered and series modulation using valve technology seemed to be the best option. Many broadcast transmitters of the 1930s era used series modulation with its advantages of wide frequency response and not requiring a modulation choke or transformer. Solid state transmitters often use a form of series modulation, but suitable amplifiers and their adjustment are more complex than is warranted for this project.

Early radio was very fortunate that Class C oscillators could be easily modulated with low distortion. In fact, many of the first generation of medium wave transmitters were simple modulated oscillators. Separate modulated RF amplifiers were eventually needed to meet the requirements of crystal control and reduction of frequency shift with modulation, factors that are largely academic in this project.

With this in mind, some experimentation with a double triode as a combined oscillator and series modulator produced encouraging results and the addition of a simple voltage amplifier provided full modulation with an audio input of less than 1 volt. The addition of a simple power supply would make a compact self-contained unit a viable proposition.

The unit in the photographs was built on a small chassis and the results are excellent. For the past two years it has been in continuous use, connected to an FM tuner and providing a signal with reception quality at least as good as from the old MF transmission. Several similar units have been built and all are working very satisfactorily.

How Does it Work?

Referring to the circuit diagram (**Fig. 1**), V3A is a conventional tuned anode oscillator with automatic bias provided by a 47kΩ grid resistor. Details of the coil are shown in **Fig. 2**. Dry wood makes a practical former and the pre-set tuning capacitor can be a standard MW padder or a pair of IF trimmer capacitors connected in parallel. It is convenient to mount the coil and capacitor assembly in an old IF transformer can. A 270pF capacitor isolates the transmitting 'aerial'. The 470pF bypass capacitor from the cathode of V3A to earth is a compromise between effective RF bypassing and high modulation frequency loss.

A conventional resistance coupled high-mu triode amplifier V2 raises the programme audio level sufficiently to drive the modulator, V3B, connected in

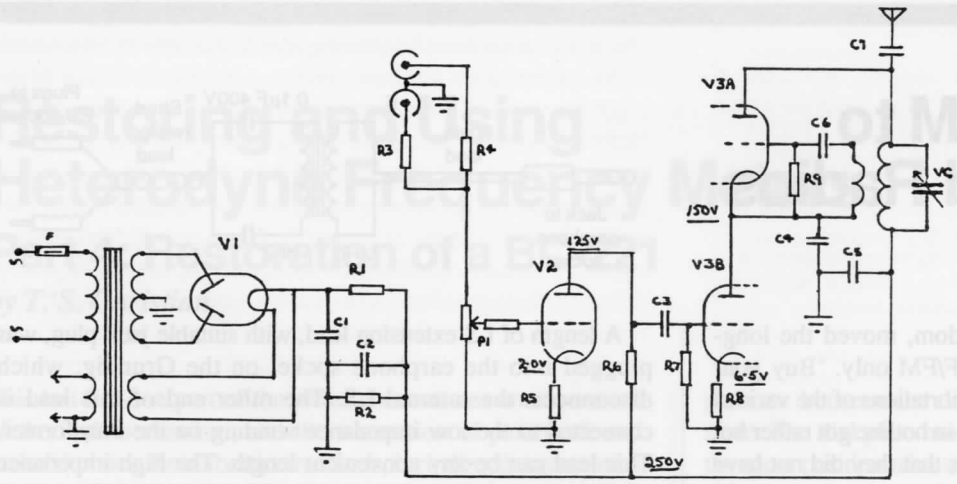

Fig. 1 - Circuit diagram of the AM Converter

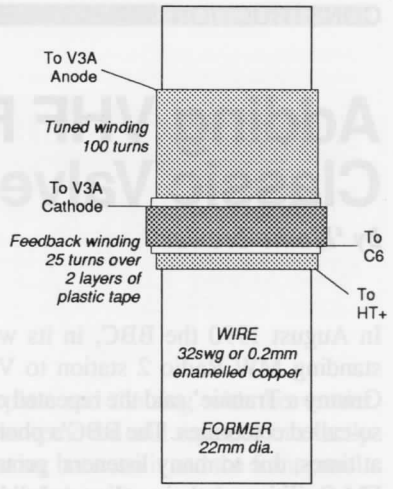

Fig. 2 - Coil details

series with the oscillator. Both audio valves use cathode bias, with the resistors left unbypassed to provide a measure of negative feedback.

Audio inputs can be mono or stereo, and are isolated by a pair of 10kΩ resistors. For mono input one socket is ignored. Modulation level is set by P1, a standard volume control potentiometer.

Power supply requirements are neither demanding nor critical. The filaments draw 600mA at 6.3V, and HT can be anywhere between 225 and 350 volts at less than 5mA. In fact, the power could be borrowed from any but a very small receiver, but operation is more convenient with an integral supply.

The supply shown is very conventional and practically any power transformer will be satisfactory. That fitted in the prototype is rated at 285–0–285V and uses a 5Y3GT rectifier. Some alternative rectifier valves are suggested in the components list but in any event, the type of rectifier originally used with the transformer would clearly be correct. Transformers from 'modern' equipment may have been used with semiconductor diodes. Provided that their PIV rating is adequate and they are shunted with high voltage 0.01µF capacitors, silicon diodes would be satisfactory and efficient.

The hum filtering resistor should have a 5 watt rating and is selected to provide around 250 volts HT. For a 250V transformer 10kΩ should be about right, and for 350V windings 27kΩ is a good starting value. For intermediate voltages, use pro rata resistor values.

Construction

Construction has no special requirements and the chassis can be installed in a ventilated utility cabinet for better appearance. Even a wooden cabinet may be appropriate in some instances. Although layout is not critical, short leads are always an advantage, especially between the volume control and the grid of V1. The purpose of the 47kΩ 'grid stopper' in this lead is to discourage breakthrough from nearby RF transmissions from radio telephones, etc.

Setting Up

With construction completed and wiring checked, apply power and check voltages. With HT around 250 volts, if all is well voltages should be within 20 per cent of those indicated on the diagram. Attach a yard or two of wire to the aerial terminal and with a receiver nearby search for a carrier signal. In the unlikely event of one not being found, check that the oscillator coils are in the correct feedback relationship. If in doubt, reverse the connections to the feedback winding.

Check by tuning the receiver upwards from the low frequency end of the dial, that you have not selected a harmonic. The first carrier encountered is the fundamental. Now tune the oscillator to the desired frequency, although as the frequency will be influenced by the aerial capacitance, the exact setting should be left until the transmitter is installed in its final location.

Connect a programme source to the audio input, and adjust the modulation by means of the gain control to a level that does not cause distortion on peaks. If an oscilloscope is available, set peaks to 90 per cent modulation.

All that remains is to set up the equipment in its permanent position and run out sufficient aerial wire to provide and adequate signal for your receivers. To reduce the possibility of modulation hum, a **separate** earth lead to a good earth is desirable. ***RB***

Components

Capacitors

C1	8µF or larger, 450V electrolytic
C2	8µF or larger, 450V electrolytic
C3	0.002µF 400V polyester
C4	470pF 250V mica or ceramic
C5	0.047µF 400V polyester
C6	470pF 250V mica or ceramic
C7	270pF 250V mica or ceramic
VC	Padder or IF trimmer block

Resistors

(all 0.5W unless otherwise specified)

R1	See text
R2	100kΩ 1W
R3	10kΩ
R4	10kΩ
R5	1.8kΩ
R6	100kΩ
R7	470kΩ
R8	2.2kΩ
R9	47kΩ
P1	100kΩ to 0.5MΩ potentiometer

Valves

V1	*5.0V heater:* 5Y3, 5Z4, 5V4, U50, GZ30, GZ32 or GZ34 *6.3V heater:* 6X5, EZ35, U70, 6X4, EZ90, 6V4, U78, EZ80, EZ81 or 6CA4
V2	6AV6, 6AT6, EBC90, EBC91, DH77, 6Q7, 6SQ7, 6B6 or DH63
V3	12AU7, ECC82, B329, 6SN7, B65 or ECC32

Miscellaneous

Fuse, 0.5A; Transformer, see text; valveholders to suit valve types used