Versatile V.F.O./Transmitter

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AFTER passing the Radio Amateurs' Examination and prior to taking the Morse Test, G3NHR decided to build a transmitter to operate on 1·8 Mc/s that at a later date would be useful as a v.f.o. for driving a more powerful p.a. operating on 3·5, 7, 14, 21 and 28 Mc/s. At about the same time G3BPM was testing series gate modulation‡ and it was upon the transmitter to be described that the original tests of this method of modulation were made. The result is a versatile v.f.o./transmitter for phone or c.w. operation, the modulator being capable of modulating a higher power transmitter at a later date with little change.

Circuit Description

As the transmitter was to be used as a driver for the higher frequency bands, the choice of circuit for the v.f.o., V1 (Fig. 1), had to be given careful consideration. After studying the various circuits in the literature it was decided to adopt the Tesla oscillator [1] in view of its superior stability both in respect of voltage and temperature variations, and because of its constant output over the frequency range covered. The valve used in this particular arrangement is a high slope pentode which has proved stable and free from microphony. The h.t. supply to the v.f.o. is fed from a neon stabilizer. Keying is in the oscillator cathode circuit thereby providing full break-in facilities.

The v.f.o. is coupled to the buffer stage (V2) through C8. This stage effectively isolates the v.f.o. from the driver-amplifier (V3). The anode circuits of both V2 and V3 are tuned by dust cored coils and are preset to the mid-point of the band covered (1·75-2 Mc/s). The anode circuits of both V2 and V3 are individually decoupled to assist in keeping the whole unit stable.

By employing both buffer and driver-amplifier stages not only is the v.f.o. isolated from the output stage but adequate grid drive is available for the small beam tetrode (V4) operating as the power amplifier. The grid drive from V3 with only 240 volts on its anode is in fact considerably in excess of the requirement for the p.a. and 5 mA of grid current is easily obtained. To reduce this to the required level, resistors are fitted across the anode tuned circuits of both V2 and V3. With a power supply of 240 volts, 10 K ohms has proved a satisfactory value of damping resistor to give 2·4 mA drive to the power amplifier across the whole band with very little variation. Should V3 be operated with 300 volts on the anode it might be necessary to reduce these resistors to avoid over-driving the p.a. It is most important that the drive should be limited to 2·5 mA, both in the interests of the p.a. valve and to avoid excessive harmonic output.

A mixture of fixed and self bias is used on the p.a. stage to achieve optimum operating condition and to ensure protection to the p.a. stage under key-up conditions. Anti-parasitic resistors have been included although the stage is quite stable without them in the original transmitter; however they are a sensible precaution.

The p.a. valve feeds a parallel-fed pi network [2] which has a combination of both fixed and variable capacitors to ensure that only the Top Band can be tuned. The network is arranged for 80 ohms output to enable either a modified Z Match aerial tuner or the higher powered transmitter to be fed with standard coaxial cable. The p.a. screen is directly coupled to V5 acting as a " series gate " modulator, R27 and C30 being the screen decoupling components. One advantage of this particular arrangement is that the same modulator will easily modulate a 150 watt p.a. stage later by merely changing the existing valve V5 to a 12BH7 and increasing the negative bias from 67½ volts to 105 volts. It would then be necessary to feed the screen of V4 through a resistor of approximately 27 K ohms. V6 is the speech amplifier and is designed for a crystal microphone. On c.w. the maximum voltage on the p.a. screen is controlled by R24 and R25 acting as a potential divider across the high voltage supply. V5B then functions simply as a cathode follower and helps to ensure that the p.a. stage screen supply is stabilized.

Just as v.h.f. parasitic oscillation is avoided by the use of the anti-parasitic resistors in the p.a. stage, low frequency parasitic oscillation is prevented by using only two r.f. chokes in the equipment. These two chokes are in stages well separated electrically from each other.

The number of stages may be considered to be excessive for a Top Band transmitter but are most necessary to enable the output to be used for driving a high power p.a. At the same time the arrangement helps to ensure that the signal on Top Band is beyond reproach.

Practical Construction

The transmitter is completely screened and also has screening between the various stages. From Fig. 2 it will be seen that the v.f.o. and the p.a. stages are in individually screened boxes located at either end of the chassis with the buffer and driver in between. The latter stages have inter-stage screens below the chassis and screening cans on the valves themselves. V1 and V4 are located inside their respective boxes, the box for V4 being well ventilated.

V1 is enclosed with the v.f.o. components and no ventilation is provided. This may seem contrary to usual practice but in fact ensures a high degree of long term stability of calibration because the whole stage acts as an oven, raising the v.f.o. operating temperature rapidly above the ambient temperature. After a surprisingly short time the v.f.o. is exactly on calibration and remains so for long periods. Even the initial drift is very small and compares well with other types of v.f.o.

The modulator is built on a small sub-chassis mounted above the buffer and driver amplifier stages and as it is fitted with a small B7G plug and socket, it can be removed

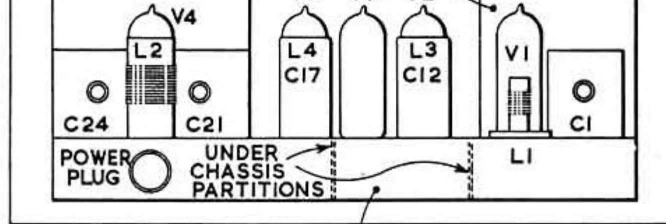

Fig. 2. Rear view of the chassis layout with the screening covers removed.

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‡ " Series Gate Modulation," *R.S.G.B. Bulletin*, May 1959.

easily for access to V2 and V3. The potentiometers VR1 and VR2 and the switch S1 are fitted to the panel with flying leads.

The anode tuned circuits of V2 and V3 are mounted in small aluminium screening cans above the chassis; miniature 1600 kc/s i.f. transformers can be used if the capacity is altered to that shown.

The cabinet was supplied by Philpotts Metalworks and the details of the chassis and panel are shown in Figs. 2 and 3.

No power supply details are given as the original transmitter was operated on d.c. mains with the negative potentials derived from batteries. Any power supply capable of 250-300 volts at 75 mA and 65-75 volts at 5 mA will prove adequate.

The completed unit measures 13 in. × 9 in. × 4 in. and it is quite easy to fit the components without overcrowding.

Setting Up

First check all soldered joints and connections for dry joints. It is a good idea to paint each connection with a spot of thin shellac as examined; any missed are then quickly spotted. Next check with a test meter to ensure that no short circuits exist between the high voltage lines and chassis; also check the continuity of the heater circuit. When checking is complete the power supplies can be connected. The heater and other voltages should be measured to see that they are correct. Switch S1 to "PHONE."

The v.f.o. can now be calibrated. With a receiver, tune across the desired band (1·75-2 Mc/s) until the signal is heard. It is then a matter of ensuring that the band just covers the dial; adjustment may be effected by C3. Exact calibration is best carried out with a crystal calibrator, BC221 frequency meter or a similar wavemeter which has been checked against MSF or the B.B.C. on 200 kc/s.

To check the grid drive to the p.a. a 0-5 mA meter is placed in series with the negative 22·5 volts supply to the p.a. stage; L2 and L3 can then be adjusted for maximum grid current with the v.f.o. set to 1·9 Mc/s. The drive should not vary across the band. If the grid current exceeds 2·5 mA the value of the damping resistors should be reduced.

With switch S1 set to "c.w." the p.a. anode circuit tuning can be tested with a non-inductive 80 ohms load. If such a load is not available, four 6·3 volt 0·3 amp. lamps in series can be used. The anode current should be 30 mA with a 300 volt h.t. supply.

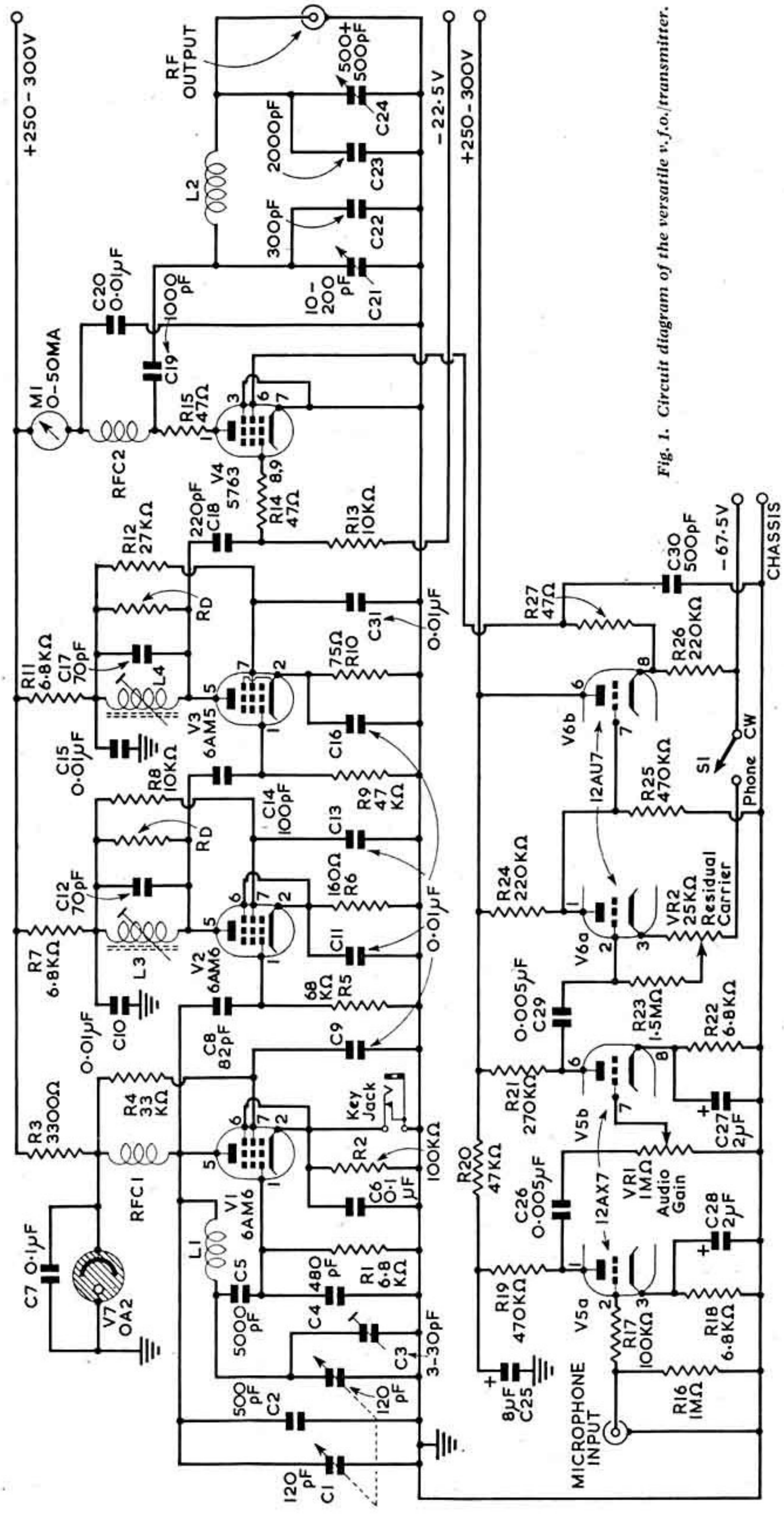

Fig. 1. Circuit diagram of the versatile v.f.o./transmitter.

To adjust the "series gate" modulator to the correct condition, turn VR1 to minimum and VR2 to maximum, switch S1 to "PHONE," and, by means of VR2, set the p.a. anode current to between 5 and 8 mA. Next, while speaking into the microphone, slowly increase VR1 until the speech peaks cause the p.a. anode current meter to kick up to the reading achieved when the p.a. is correctly tuned and loaded, i.e. 30 mA. If the quality is satisfactory in a phone monitor the transmitter is ready for use on the air.

In the original transmitter built to this design, no spurious oscillation occurred in the p.a. stage. To check for this

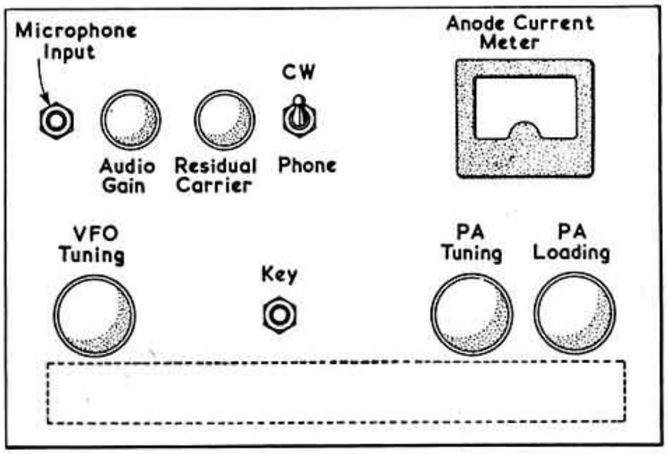

Fig. 3. Panel layout.

condition, leave the key up, set S1 to "C.W." and reduce the bias on the p.a. stage until a current of approximately 25 mA is indicated in the anode meter. Swing the tuning and loading controls over their whole range; if all is well the meter reading will remain constant, but if any oscillation is taking place wide variation in the readings will occur for small variations in either the loading or tuning controls. This operation must be carried out very quickly to avoid damage to the p.a. valve as the anode dissipation will be high. Should oscillation be present it must be completely eradicated before bringing the transmitter into use. Possible causes of instability are V4, the decoupling and anti-parasitic components. The latter should be tested for correct value.

Results

G3NHR has used this transmitter for some time and results have been entirely satisfactory. Work is now in hand to build a more powerful transmitter for the h.f. bands which will be driven by this design. Anyone contacting G3NHR will be able to hear for themselves how effective is the transmitter.

References

[1] "The Tesla Oscillator," R.S.G.B. BULLETIN, March 1956.

[2] "The Design of Pi-Network Tank Circuits," R.S.G.B. BULLETIN, April 1952.

COMPONENTS LIST

C1, 120pF two gang.
C2, 500pF 5% silver mica.
C3, 3-30pF trimmer.
C4, 480pF 10% silver mica.
C5, 5000pF 10% silver mica.
C6, 7, 0·1μF 350 volt, paper.
C8, 82pF 10% silver mica.
C9, 11, 16, 31, 0·01μF 350 volt, paper.
C10, 13, 15, 20, 0·01μF 500 volt, paper.
C12, 17, 70pF 5% silver mica.
C14, 100pF 10% silver mica.
C18, 220pF 10% silver mica.
C19, 1000pF 1kV mica.
C21, 10-200pF air spaced.
C22, 300pF 10% silver mica.
C23, 2000pF 10% silver mica.
C24, 500pF two gang.
C25, 8μF 350 volt electrolytic.
C26, 29, 0·005μF 500 volt paper.
C27, 28, 2μF 12 volt electrolytic.
C30, 500pF 20% 500 volt silver mica.
L1, 38 s.w.g. closewound for 0·4 in. on 0·42 in. Aladdin former.
L2, 26 turns 24 s.w.g. 1¼ in. dia. closewound (20μH).
L3, 4, winding from miniature 1600 kc/s i.f.t. (100μH).
M, 0-50mA m.c.
R1, 6·8 K ohms 5% 1 watt (high stability).
R2, 100 K ohms 20% ½ watt.
R3, 3·3 K ohms 10 watts.
R4, 33 K ohms 20% ½ watt.
R5, 68 K ohms 20% ½ watt.
R6, 160 ohms 20% ½ watt.
R7, 11, 6·8 K ohms 20% 1 watt.
R8, 13, 10 K ohms 20% ½ watt.
R9, 20, 47 K ohms 20% ½ watt.
R10, 75 ohms 20% ½ watt.
R12, 27 K ohms 20% ½ watt.
R14, 15, 27, 47 ohms 20% ½ watt.
R16, 1 Megohm 1 watt (high stability).
R17, 100 K ohms 1 watt (high stability).
R18, 22, 6·8 K ohms 20% ½ watt.
R19, 25, 470 K ohms 20% ½ watt.
R23, 1·5 Megohms 10% ½ watt.
R24, 26, 220 K ohms 10% ½ watt.
RD, see text.
RFC1, 2, 2·5mH.
S1, s.p.s.t. toggle switch.
V1, 2, 6AM6 (Brimar).
V3, 6AM5 (Brimar).
V4, 5763 (Brimar).
V5, 12AX7 (Brimar).
V6, 12AU7 (Brimar).
V7, OA2 (Brimar).

Twinkletoes Wins Mullard Award for 1958

PETER ODELL (G3MUM), of Redcar, Yorkshire, is to be the first recipient of the Mullard Award. Familiarly known as Twinkletoes, Peter is completely paralysed except for the toes of one foot.

For many years Peter was a keen short wave listener and then at the suggestion of a Past President of the R.S.G.B. he joined the Society and became a B.R.S. About two years ago he was urged to study for a transmitting licence and after some persuasion he did so. In less than a year he had passed the Radio Amateurs' Examination and the Post Office Morse test. He has now been on the air as G3MUM for about 12 months.

Peter controls his station with the toes of his good foot, hence the affectionate nickname, "Twinkletoes." He never mentions his handicap over the air and apart from a reference on his QSL card to membership of the Invalid and Bedfast Club there is nothing to indicate that he is completely crippled.

Before receiving his licence Peter had great difficulty in speaking freely but now, as the result of increased confidence, he is able to speak much more easily. Incidentally, his operating methods are correct and quick.

In considering the nominations put forward on behalf of Mr. Odell, the Mullard Award Committee came to the unanimous decision that he had, by his example of fortitude and courage, rendered outstanding personal service to the community.

The decision to make the award to Peter Odell will undoubtedly give special pleasure to those who have received QSL cards and letters carefully written by his parents, who have so devotedly helped him.

The Mullard Award will be presented to Mr. Odell at a ceremony next month.