RADIOTRONICS

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RADIOTRONICS

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By the way—

Our front cover this month illustrates the forming of a stem for the 892-R transmitting valve. A close-up of a finished stem is shown at the side.

Following our announcement of the Australian production of the 2E26 we feature this month a description of a versatile transmitter built around this valve.

Two new miniature valves, X79 and N78, have been added to the Radiotron range. These have been registered by the R.T.M.A. and have been allotted the type numbers of 6AE8 and 6BJ5 respectively. As such they will be found in the new Radiotron Valve Data Book and Characteristic Chart.

We would advise all subscribers that supplies of the 1951 Radiotron Valve Data Book are now exhausted and no further orders can be accepted.

We wish to thank readers who responded to a request for early issues of "Radiotronics". Our Head Office file is now complete.

The August issue will be devoted to a practical article on antenna and transmission line considerations for T.V.

Subscribers are reminded that all 1950 issues, as well as February, March and April, 1951, are out of print.

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An Application of Negative Current Feedback

Negative current feedback is used less than negative voltage feedback, perhaps because its characteristic of increasing the output impedance of an amplifier (see Appendix) is usually undesirable. However, although this type of feedback increases output impedance, it reduces distortion and improves frequency response in the same way as does negative voltage feedback.

Fig. 1 gives an economical application of negative current feedback to obtain these results. The only addition to the conventional a-f end of a battery receiver is the resistor *R* across which a voltage is generated proportional to the current in the voice coil. This voltage is applied to the cathode circuit of the first a-f amplifier thus providing the negative feedback.

The dissipation of the 1S5 filament is little affected by the feedback circuit. A drop of about 0.01 volt results from including *R* in the d.c. return of the filament, and an additional voltage not greater than 0.1 volt is applied to the filament at 250 mW output into a 2.2 ohm voice coil, provided that *R* is not greater than 0.3 ohm.

Further, as the value of resistor *R* is small compared with the voice coil impedance its use has little direct effect on the current flowing in the voice coil. Without negative feedback, an increase of the impedance of the voice coil such as occurs for instance at high frequencies or at the low-frequency resonance, decreases the current flowing in the voice coil. When negative current feedback is applied this reduction in current causes a smaller negative feedback voltage to be applied to the amplifier with the result that the output current remains more nearly constant.

Although the circuit of Fig. 1 is that of the a-f end of a battery receiver (vide Radiotronics receiver RA41) the type of current feedback used may also be applied to a.c. receivers by returning the cathode of the a-f amplifier to ground through the resistor in series with the voice coil. The impedance added to the filament or cathode circuit is sufficiently small to be ignored at audio and intermediate frequencies. An alternative connection in either battery or a.c. operated receivers is to apply the feedback voltage to the low potential end of the volume control so that maximum compensation, or hum reduction (vide Radiotronics 145, page 107), is obtained at low volume control settings with little effect on the sensitivity of the receiver as measured with the volume control at maximum.

In small receivers in which cost does not allow a complicated bass compensation circuit to be used, the more constant current in the voice coil at the resonance of the loud-speaker increases the bass response, and the reduced damping at resonance due to the increased output impedance of the amplifier accentuates this effect. The resonant frequency must of course be chosen to provide the increased output in a suitable part of the frequency spectrum; for example with a speaker resonance at 200 c/s an increase in acoustic output at resonance would give "boxy" reproduction, but reinforcement at say 120 c/s would usually be beneficial to a small mantel receiver. In fact it is the practice in some commercial receivers to use two or three components in a frequency-compensated negative voltage feedback circuit to obtain just such an effect.

The improvement in frequency response obtained from the circuit of Fig. 1 is not confined however

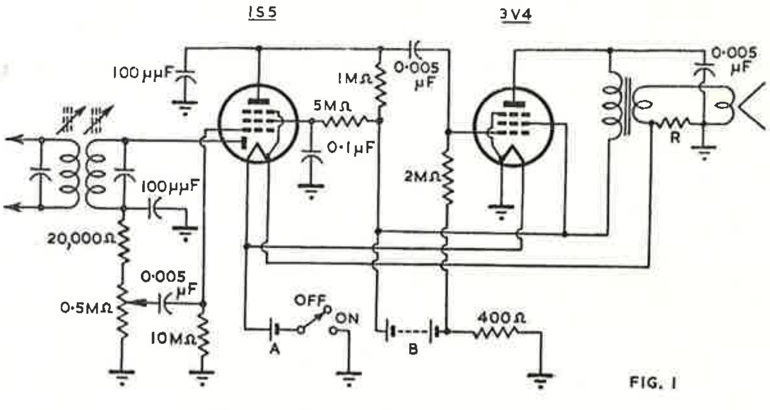

Fig. 1. Circuit of a-f section of battery receiver with negative current feedback.

to the resonant frequency of the loud-speaker. Fig. 2 shows that whereas the original circuit gave a response 1½ db down at 100 c/s, 4 db down at 2000 c/s and 8½ db down at 3000 c/s, the use of even the 0.22 ohm feedback resistor gives a curve ½ db down at 100 c/s, 0.7 db up (due to phase shift in the feedback network) at 2000 c/s and 3½ db down at 3000 c/s.

Fig. 2 also shows the change in gain due to various values of resistor *R* at any frequency. The curves were taken with an a-f voltage applied to the top of the diode load equivalent to the modulation from a medium-strength signal, and the volume

Contributed by the Circuit Design Laboratory, Valve Works, Ashfield.

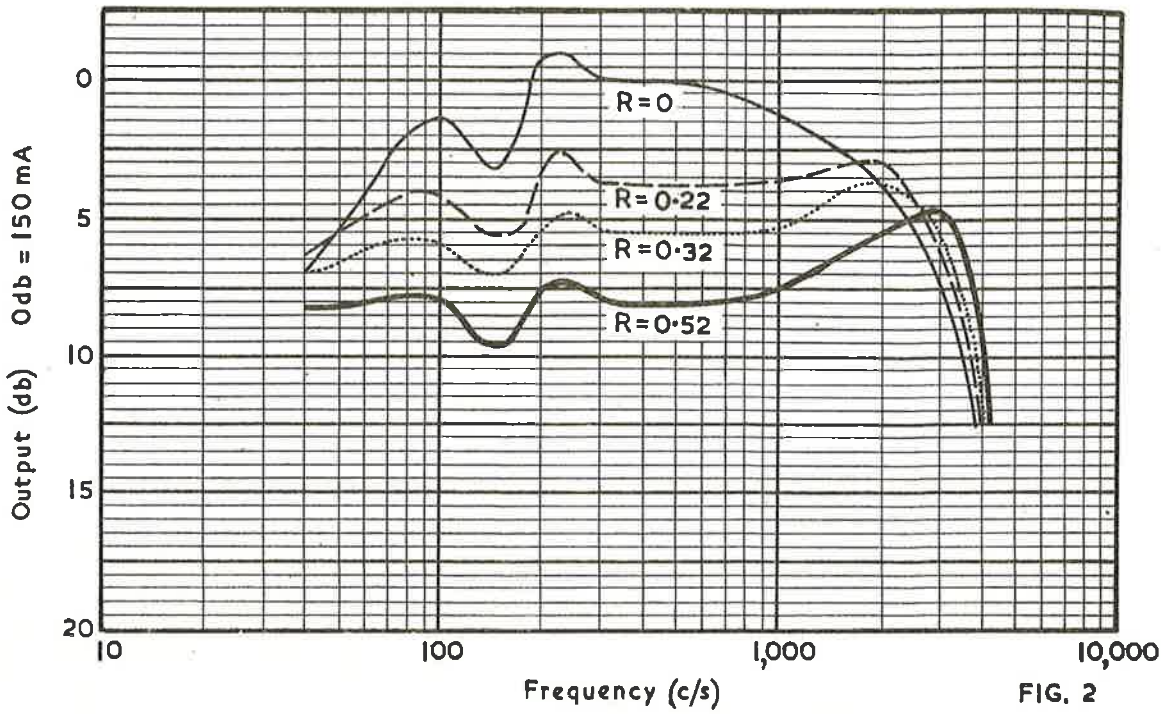

Fig. 2. Variation of gain and frequency response with changes in feedback resistor R.

control was adjusted to give an output of 50 mW at 400 c/s when *R* was short-circuited. The input and the volume control setting were left unchanged while frequency response was plotted for different values of *R*. Thus a 0.22 ohm resistor gives a $3\frac{1}{2}$ db reduction of gain at 400 c/s. Gain reduction due to *R* varies slightly with the volume control setting, being a maximum with the control at zero.

Because of the small amount of feedback used, no great reduction of distortion is obtained from the negative current feedback. In fact at full output the effect of dissipating some of the power in the resistor *R* is that for a given power in the voice coil the distortion is increased. Nevertheless from Table 1 it will be seen that over most of the power output range some reduction of distortion is obtained, at least at mid-frequencies. The indicated output in the table is that which would be applied to the voice coil, if the output transformer efficiency were 100%.

TABLE 1. Distortion percentage at 400 c/s for various values of power output and resistance.

	Power Output (mW)			
R (ohms)	50	100	200	270
0	1.2	1.8	4.0	7.8
0.22	1.2	1.6	2.6	8.6
0.32	1.2	1.6	2.7	9.0
0.52	1.2	1.6	2.8	11

The amount of feedback available from a given size of resistor is proportional to the amplification factor of the output valve and to the gain of the remainder of the a-f amplifier. Thus the greater the a-f gain available, the smaller the feedback resistor *R* can be and the smaller the power loss in it for a given amount of negative feedback.

Listening tests on the amplifier confirmed the electrical measurements. Increasing the value of *R* from zero gives a noticeable reduction in mid-frequency response or, for the same mid-frequency level, an increase in high and low frequencies. Pleasant low-frequency response is dependent on a suitable resonant frequency in the loud-speaker, but reasonable variations, say ± 15 c/s from 125 c/s, do not destroy the value of the bass boosting.

APPENDIX

Effect of Negative Current Feedback on Output Impedance of Amplifier.

Fig. 3 gives the essentials of the amplifier circuit for feedback calculations. *Z* and *R* represent the voice coil impedance and the feedback resistance respectively, referred to the primary side of the output transformer, the transformer itself not being required in the calculation. The value of *R* is so small that negligible degeneration occurs in the first stage of the amplifier.

The generator *E* is used to represent voltages generated in the voice coil by its own movement due to its lack of complete damping, and the current *I* is set up by *E*.

Thus when $R = 0$,

$$I = \frac{E}{r_{p2} + Z}$$

Let I' represent the current when $R \neq 0$

$$\text{Then } I' = \frac{E}{r_{p2} + Z + R} - \frac{I'RA_1\mu_2}{r_{p2} + Z + R}$$

$$I'\left(1 + \frac{A_1\mu_2R}{r_{p2} + Z + R}\right) = \frac{E}{r_{p2} + Z + R}$$

$$I' = \frac{E}{r_{p2} + Z + R}\left(\frac{r_{p2} + Z + R}{r_{p2} + Z + R + A_1\mu_2R}\right)$$

$$I' = \frac{E}{r_{p2} + Z + R\ (1 + A_1\mu_2)}$$

Thus the output impedance of the circuit with feedback is $r_{p2} + Z + R\ (1 + A_1\mu_2)$, and the increase due to feedback is $A_1\mu_2R$. On the secondary of the output transformer, impedances are altered by the square of the turns ratio of the transformer but the factor μ remains unchanged.

When the feedback voltage is applied to one end of a heater, the other end of which is earthed, as in a battery-operated amplifier, the effective feedback voltage is one half of the voltage developed across R.

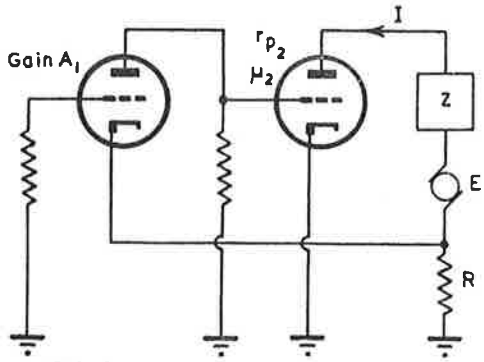

FIG. 3

Fig. 3. Circuit for calculation of change of output impedance.

Mental Calculations

Radio engineers usually work with instruments calibrated to a decimal scale and frequently record their results in decibels. Much time is consequently wasted in converting from ratios to decibels if each conversion entails reference to a conversion table. Quicker results can be obtained when a slide rule is used and if fractions can be converted mentally into decibels the loss of time is negligible.

The number of decibels difference in level between W_1 watts and W_2 watts is

$$10 \log_{10} \frac{W_1}{W_2}$$

from which it follows that the number of decibels difference between voltages E_1 and E_2, developed across the same impedance, is

$$10 \log_{10} E_1^2/E_2^2 = 20 \log_{10} E_1/E_2$$

Similarly the number of decibels difference between currents I_1 and I_2, flowing in the same impedance, is

$$10 \log_{10} I_1^2/I_2^2 = 20 \log_{10} I_1/I_2$$

Thus one method of converting a ratio to decibels (db) is by obtaining the appropriate logarithm and then multiplying this by 10 or 20 as required.

Since the logarithm of a power ratio is multiplied by 10 to obtain a result in db, whilst the logarithm of a voltage or current ratio is multiplied by 20, there is a common misunderstanding that it is necessary to specify whether a power or voltage ratio is referred to when a db figure is quoted. However, a fourfold increase in the power output is approximately a 6 db change ($10 \log_{10} 4 = 6.021$) and since output power is proportional to the square of the output voltage it also represents a twofold increase in the output voltage, once again a 6 db change ($20 \log_{10} 2$).

Contributed by Circuit Design Laboratory, Valve Works, Ashfield.

Use of slide rule

A more convenient method than the above for obtaining db from a slide rule is available if the rule has a log-log scale (usually calibrated from 1.1 to 100,000 on two scales). For voltage or current ratios the cursor is set to 10 on the log-log scale and 2 on the C scale is set to the cursor. From the relationships above an increase in voltage or current of 10 times is equivalent to a 20 db increase; if we consider the 2 on the C scale to represent 20 db, any multiplying factor on the log-log scale falls directly opposite the appropriate number of db. For example 20 times is the equivalent of 26 db, 3.5 times is 10.9 db and so on. To obtain good accuracy it is advisable to use the section of the log-log scale between 3 and 100, dealing with powers of 10 separately. Thus a ratio of 0.0055 (5.5×10^{-3}) is the equivalent of -45.2 db ($14.8 - 60$).

If power ratios are under consideration, a tenfold increase is equivalent to 10 db, so the 1 on the C scale is placed opposite the 10 on the log-log scale and readings are taken as before. For example an increase of 50 times is represented by 17 db, or 5 times by 7 db.

It is not necessary to alter the slide rule setting for each db reading when using the log-log scale so that little time is required for each conversion.

Conversion by mental arithmetic

For occasions when a slide rule is not available, however, it is very useful to be able to perform conversions mentally. It is possible to memorize a conversion table, but this is unnecessary because, starting with the knowledge that an increase of two times in a voltage ratio is equivalent to 6 db, and 10 times to 20 db, it is comparatively simple to build up such a table mentally as required. The backbone of the table is as follows

db	0	2	6	8	12	14	18	20
factor	1	1.25	2	2.5	4	5	8	10

This is built up simply by adding 6 db for each two times increase from a ratio of unity, i.e. 2, 4 and 8 times represent 6, 12 and 18 db, and by subtracting 6 db for each halving of a multiplying factor of 10 times i.e. 10, 5, $2\frac{1}{2}$ and $1\frac{1}{4}$ times are represented by 20, 14, 8 and 2 db.

The next step in the table can be built up from noticing that a 2 db decrease represents a multiplying factor of 0.8 times. From this fact we can add the values for 4, 10 and 16 db:—

db	4	10	16
factor	1.6 (2×0.8)	3.2 (4×0.8)	6.4 (8×0.8)

To complete the table we need values for each of the odd numbers of db. Noticing that 2 db down is equivalent to multiplying by 0.8 we can assume that the error in taking 1 db down as 0.9 is small, and the table can then be written in full.

Accurate values are recorded in the third line for comparison.

db —										
0	1	2	3	4	5	6	7	8	9	10
factor —										
1	1.12	1.25	1.4	1.6	1.8	2	2.3	2.5	2.9	3.2
true factor —										
1.00	1.12	1.26	1.41	1.59	1.78	2.00	2.24	2.51	2.82	3.16

db —									
11	12	13	14	15	16	17	18	19	20
factor —									
3.6	4	4.5	5	5.8	6.4	7.2	8	9	10
true factor —									
3.55	3.98	4.47	5.01	5.62	6.31	7.08	7.94	8.91	10.0

Comparing the multiplying factors computed in this manner with the true factors it will be seen that the greatest error (at 15 db) is just over 3% which is negligible for the type of calculation intended to be performed by this method.

When working with "db down" the number of db can be subtracted from 20 and the multiplying factor from the table can be divided by 10 e.g. 7 db (20 – 13) down is equivalent to a multiplying factor of 0.45. A small amount of practice at such mental conversions soon results in many of the factors being memorized (or else becoming immediately obvious) without any conscious effort in this direction.

Wire gauges

Once decibels have been mastered, A.W.G. (B & S) wire sizes can be calculated mentally with good accuracy merely by remembering that 30 B & S wire has a nominal diameter of 0.010 inch and that each unit change of gauge represents approximately 1 db. The following table shows the accuracy obtained by using this and the previous db information.

A.W.G. gauge	16	18	20	22	24	26	28
diameter (10^{-3} in.)	50.8	40.3	32.0	25.4	20.1	15.9	12.6
estimated dia. (10^{-3} in.)	50	40	32	25	20	16	12.5

A.W.G. gauge	30	32	34	36	38	40
diameter (10^{-3} in.)	10.0	7.95	6.31	5.00	3.97	3.15
estimated dia. (10^{-3} in.)	10	8	6.4	5	4	3.2

Thus to calculate the diameter of 22 A.W.G. we work out that 8 db (30-22) is equivalent to an increase of $2\frac{1}{2}$ times, so that the required diameter is 25 (10 x $2\frac{1}{2}$) thousandths of an inch.

Coil winding

It is interesting to note that between the gauges of 32 and 40 A.W.G. the percentage increase in diameter of enamelled wire as compared with bare wire varies only between 9% and 11% of the original size of the bare wire, so that a flat 10% allowance for enamel gives good accuracy over this range, which includes all sizes normally used in the bare enamelled state for universal windings.

With reference to the calculation of gear ratios for universal windings, the method outlined in Radiotronics 146, although it was not pointed out in the article, is sufficiently simplified that in most cases the required calculations can be performed mentally. Thus, given wire gauge (in the A.W.G. system), former diameter and cam throw, no outside aids need be used to obtain the required gear ratio.

MHE TRANSMITTER

Thirty Watt Phone Rig

Mobile Home Emergency

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6 and 10 Metres

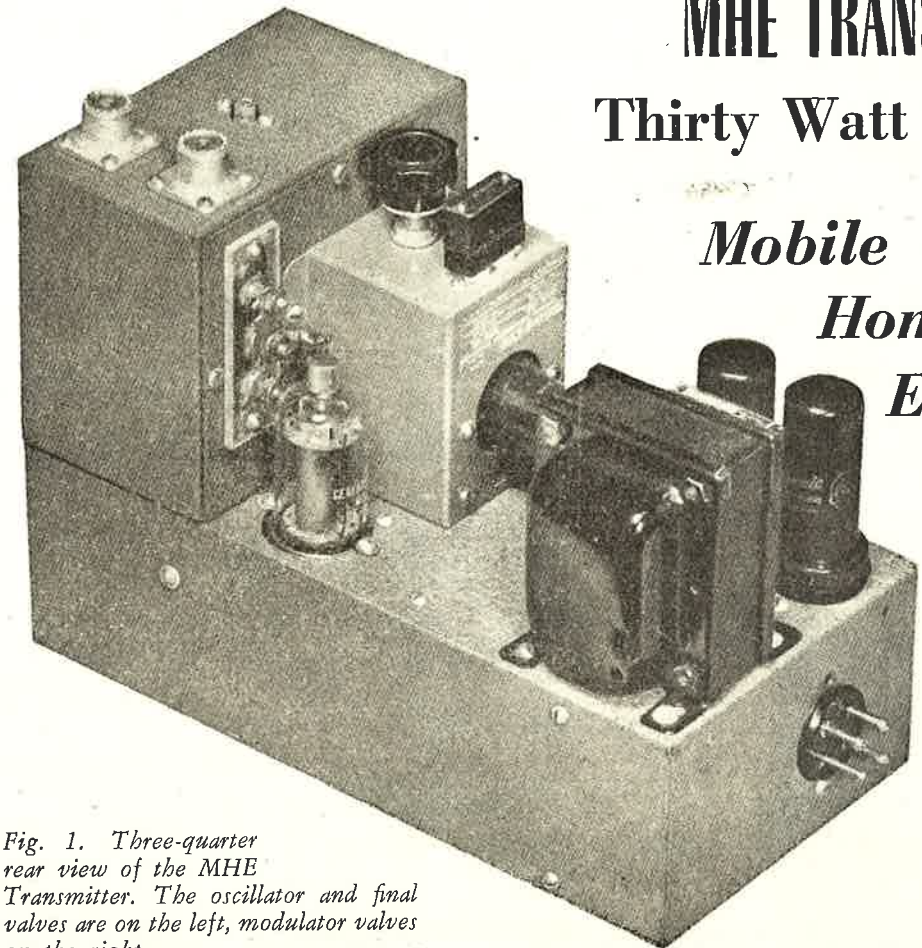

Fig. 1. Three-quarter rear view of the MHE Transmitter. The oscillator and final valves are on the left, modulator valves on the right.

Fig. 1 shows the complete four-valve MHE Transmitter. The 6AG7 oscillator valve and the 2E26 final are at the left, and the two 6V6 modulator valves are on the right. The over-all size is 5 by 8 by 11 inches, making the rig suitable for use in a car, on a corner of the operating table, or as a small transmitter which can be employed practically anywhere in an emergency. Power requirements are 6 volts a.c. or d.c. at 2.35 amperes and 300 volts at 140 mA. For use as a home station, the final may be run with 500 volts in order to take advantage of the full power capabilities of the 2E26.

No coil changing is required. It is only necessary to change the crystal and operate two switches in order to move from six to ten metres, or vice versa. Separate antenna terminals are provided so that two antennas may be connected to the transmitter at all times.

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Electrical details — transmitter

With reference to the circuit diagram of the transmitter, Fig. 2, the r-f section consists of a 6AG7 valve acting as a Tri-tet oscillator and a 2E26 as the final. The oscillator unit used in the MHE Transmitter is a Bliley CCO-2A. This unit is indicated on the circuit diagram by the dotted lines. It is possible to duplicate the circuit of the Bliley CCO-2A if desired.

The output frequency of the oscillator unit will be 27–29.7 megacycles if a 13.5–14.85 megacycle Bliley AX2 crystal is used and direct output on 50–54 megacycles will be achieved by using a 25–27 megacycle Bliley AX3 crystal. The 2E26 final amplifier operates as a straight amplifier on both the six and ten metre band.

The Bliley oscillator is normally wired with a link coupled to coil L_2. This link was left in place but it is not used. Instead, a tap is made on coil L_2 three turns down from the plate end. Using this method of feed permits an untuned grid circuit in

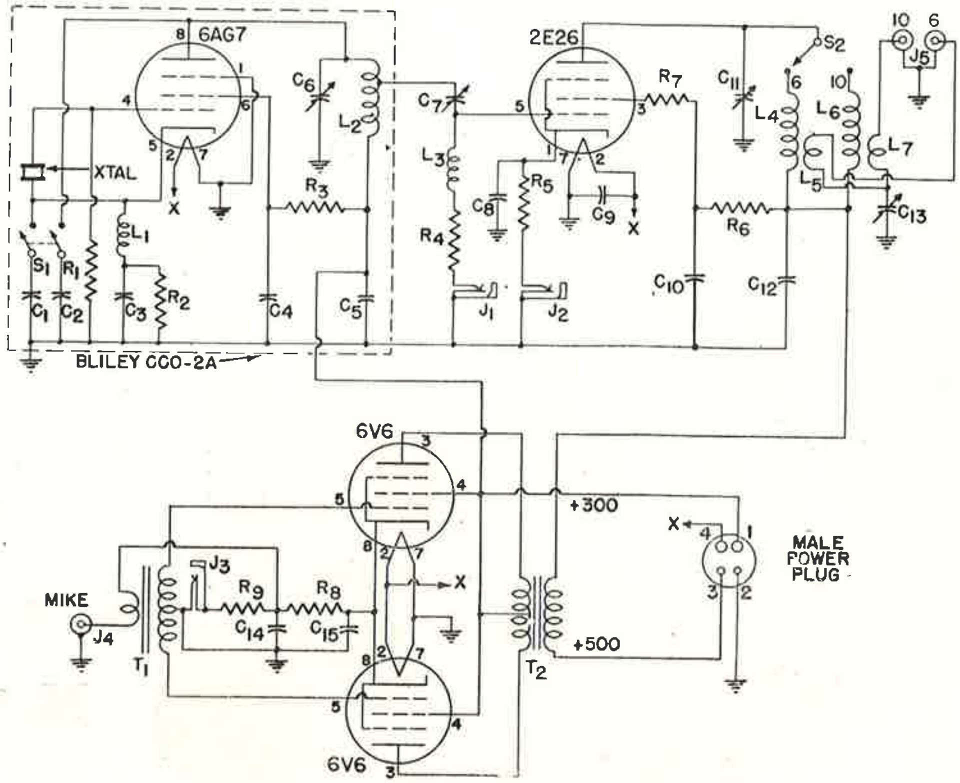

Fig. 2. Circuit diagram of the MHE Transmitter.

CIRCUIT CONSTANTS — TRANSMITTER

BLILEY CCO-2A:

C_1 .... 50 $\mu\mu$f
C_2 .... 40 $\mu\mu$f
C_3, C_4, C_5 .... 0.002 μf
C_6 .... 30 $\mu\mu$f variable
L_1 .... 9T # 14 enamel wire, close wound, ½ in. I. D.
L_2 .... 9T # 14 enamel wire, space wound, ½ in. I. D. tapped 3T. from plate end
R_1 .... 33,000 ohm, ½ watt
R_2 .... 220 ohm, 1 watt
R_3 .... 7500 ohm, 2 watt
S_1 .... DPST slide switch
XTAL... Bliley 14 mc AX2 for ten metre operation; Bliley 25 mc AX3 for six metre operation

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C_7 .... 4-30 $\mu\mu$f trimmer
C_8, C_9 .... 0.0025 μf mica (600 volt working)
C_{10}, C_{12} ...... 0.0025 μf mica (1000 volt working)
C_{11} .... 20 $\mu\mu$f variable
C_{13} .... 75 $\mu\mu$f variable
C_{14}, C_{15} .... 25 μf 50 volt electrolytic

J_1, J_2, J_3 .... Close-circuit jacks
J_4 .... Mike input jack
J_5 .... Coaxial cable output jacks for 6 and 10 metres
L_3 .... 2.5 μH RF choke
L_4 .... 4T # 18, spaced 8T/inch, ¾ inch I. D.
L_5 .... 3T # 18, spaced 8T/inch, ¾ inch I. D. Spaced one turn or $\frac{3}{16}$ inch from cold end of L_4.
L_6 .... 7T # 20, spaced 16T/inch, ¾ inch I. D.
L_7 .... 4T # 20, spaced 16T/inch, ¾ inch I. D. Spaced three turns (or ¼ inch) from cold end of L_5.
R_4 .... 12,000 ohm, 1 watt
R_5 .... 270 ohm, 2 watt
R_6 .... 35,000 ohm, 5 watt
R_7, R_9 .... 100 ohm, 1 watt
R_8 .... 150 ohm, 1 watt
S_2 .... see text
T_1 .... SB mike to PP grid transformer
T_2 .. Modulation transformer, 15 watt audio, 100 mA primary and secondary, 10,000 ohm to 7400 ohm.

the final, which simplifies the tuning.

Condenser C_7 is a small ceramic trimmer which permits a limited range of adjustment of the drive to the 2E26. Resistance R_4 and R_5 provide the operating bias and jack J_1 allows grid current to be read for tune-up adjustments. Total cathode current may be read by use of jack J_2 and this jack may also be used as a keying jack for c-w operation. If c-w operation is contemplated as a regular thing, it might be wise to arrange a switch so that the plate current to the final does not have to flow through the secondary of transformer T_2.

A one-hundred ohm resistor in the screen-grid circuit, R_7, completely killed a parasitic which occurred when the final operated on six metres. Inclusion of this resistor did not affect operation on ten metres. Resistor R_6 is the screen dropping resistor and C_{10} and C_{12} are the screen and plate by-pass condensers.

Coils L_4 and L_6 are the plate tank coils for six and ten metres. A home-made switch S_2, which is described later, selects one of these two coils. Fixed links L_5 and L_7 couple either six or ten metre energy to the output jacks. Condenser C_{13} is a trimming condenser which aids in the loading adjustment. The link coils specified have been adjusted for optimum operation when the final operates at 500 volts with a cathode current of 0.066 ampere and with a 50-ohm feed line to the antenna.

Modulation for the final is obtained from a push-pull 6V6 stage. A single-button microphone provides sufficient drive for the 6V6 valves. No gain control is used because a small reduction in the output of the microphone drops the modulation down beyond a usable point. Jack J_3 allows measurement of the cathode current of the 6V6 valves. The mike should not be plugged in when reading cathode current as the mike will tend to shunt the meter.

Mike voltage for the carbon microphone is obtained from the cathode circuit of the 6V6 valves. Only a carbon mike may be used with the circuit shown.

Mechanical details — transmitter

Inasmuch as the original idea behind the MHE Transmitter was to provide a unit capable of being used in a car for mobile work, the front panel space is as small as is practical. Fig. 1 shows a side view of the transmitter. The main chassis is a 5 inch by 3 inch by 10 inch metal chassis. On the front section of this chassis is mounted a 3 by 4 by 5 inch box with the five inch side horizontal. The total front panel size is therefore 5 by 7 inches.

The Bliley CCO-2A unit mounts on the rear of the small box as indicated in Fig. 1. A hole is drilled in the large chassis directly beneath the CCO-2A unit to pass the filament and high-voltage leads. This grommeted hole can be clearly seen in Fig. 4. The output lead from coil L_2 is brought through a separate hole and goes directly to C_7 which is mounted on the 2E26 socket.

The socket for the 2E26 is mounted beneath the chassis by means of two $\frac{3}{4}$ inch metal spacers so that the top of the 2E26 valve base is about even with the chassis. Note the cathode, filament and screen by-pass condensers, which connect from the terminals to ground with no leads except their own. It is also important to have a short lead from the grid of the 2E26 to the r-f choke (L_3). The remainder of the grid cathode and screen wiring is not critical and may be done as desired.

The small box contains the two 2E26 tank circuits and their associated output circuits. Fig. 3 shows the inside details of this arrangement. Condenser C_{11} is mounted on two $\frac{3}{4}$ inch metal spacers, which brings the shaft $1\frac{3}{4}$ inches up from the bottom of the small box. Condenser C_{12} grounds underneath the bottom of the front metal spacer and the other end ties to a one-inch ceramic insulator which is mounted $1\frac{1}{2}$ inches back from the front panel and $\frac{3}{4}$ inch in from the right-hand side of the box. Condenser C_{13} mounts in the exact centre of the box.

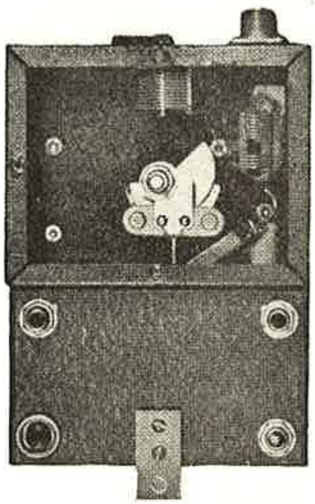

Fig. 3. Front panel view of the MHE Transmitter with panel of top portion removed.

Switch S2, which selects the proper output tank, is shown clearly in Fig. 1. A piece of $\frac{1}{8}$ inch polystyrene $\frac{7}{8}$ inch wide by $2\frac{3}{4}$ inches long is mounted over a rectangular slot which is cut into the rear of the box. This rear plate may be removed from the box so that it is not too difficult to cut this slot. The slot is $\frac{5}{8}$ inch wide and 2 inches long. It is cut so that it is $\frac{7}{16}$ inch in from the side and $\frac{5}{8}$ inch down from the top of the back plate.

Three 8–32 brass machine screws are mounted on the piece of poly. The machine screw which forms the centre pole of the switch is mounted in the centre and the two other screws are mounted on $\frac{5}{8}$ inch centres on each side of the centre machine screw. The switch blade itself is made of a piece of brass $\frac{7}{8}$ inch long. A hole is drilled in one end so that it will pivot on the centre machine screw. Notches are then filed in the opposite end of the switch blade so that it can be fastened securely under one or the other two machine screws.

The centre pole of this switch connects directly to the 2E26 plate cap on the outside of the box and to the variable condenser C_{11} on the inside of the box.

The final tank coils and links are made up from Barker & Williamson Miniductors. The ten metre coil L_6, and the ten metre link L_7, are made from one B & W No. 3011 miniductor. This coil has a ¾ inch I.D. and is wound 16 turns per inch with No. 20 wire. The miniductor should be pruned until only 14 full turns are on the form, making sure that the ends are kept long for leads. Three turns should now be removed from the inside of the coil, leaving 4 full turns on one end for L_7 and 7 full turns on the other end for L_6.

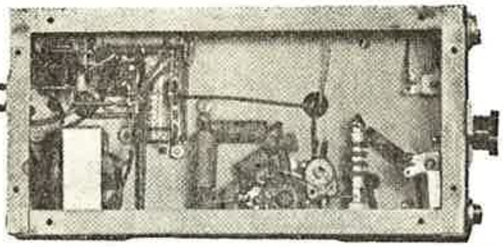

Fig. 4. Underside view of the MHE Transmitter.

The six metre coil is similarly made from a No. 3010 Miniductor. A total of 8 turns is used, and one turn is removed inside, leaving 4 turns for L_4 and 3 turns for L_5. The No. 3010 coil has a ¾ inch I.D. and is wound 8 turns per inch with No. 18 wire.

Referring to Fig. 3, the ten metre coil and link are mounted vertically, being supported by their four leads. The leads of L_6 go to the switch (top machine screw) and the ceramic insulator. One link lead goes to the front coaxial connector and the other to the stator of C_{13}.

The six metre coil and link mount directly behind the ten metre coil and at right angles to it. The connections are made in a similar manner to those for the ten metre coil and link.

The modulator circuit is placed on the rear of the chassis, referring to Fig. 1. The modulation transformer, T_2, and the two 6V6 valves are placed side by side. These two valves should be placed as far back as possible so that the 6AG7 may be easily removed from the oscillator unit.

Fig. 4 shows how the microphone transformer is placed under the chassis. The wiring in this section is not critical except that it is advisable to use shielded cable to run from the microphone jack on the front panel to the junction of resistors, R_8 and R_9. The placement of the other front panel jacks is shown in Fig. 3. Upper left, J_3, upper right, J_1, lower left, J_4 and lower right J_2. The aluminium piece which appears on the front panel is a mounting bracket used to hold the transmitter on the power supply.

Electrical details — power supply

The MHE Transmitter requires a dynamotor or vibrator-type power supply when used in a mobile installation, and a regular a.c. power supply for home use. Only the latter type of supply will be considered here.

For maximum power input to the 2E26 valve 500 volts is needed. The remainder of the circuit requires 300 volts. This could be obtained by using a dropping resistor with a 500-volt supply but a substantial amount of power is lost in this resistor. However, a 500-volt supply capable of approximately 0.170 ampere would be adequate. Conversely, a 500-volt 0.070 ampere supply used with a 300-volt 0.100 ampere supply would do the same job.

Entirely aside from the power supply required for this specific transmitter, a medium voltage power supply of moderate current capabilities is an asset around any shack. For this reason a duplex power supply was designed for the MHE Transmitter. Fig. 5 shows the circuit diagram for this power supply.

Two heavy-duty receiver-type power transformers

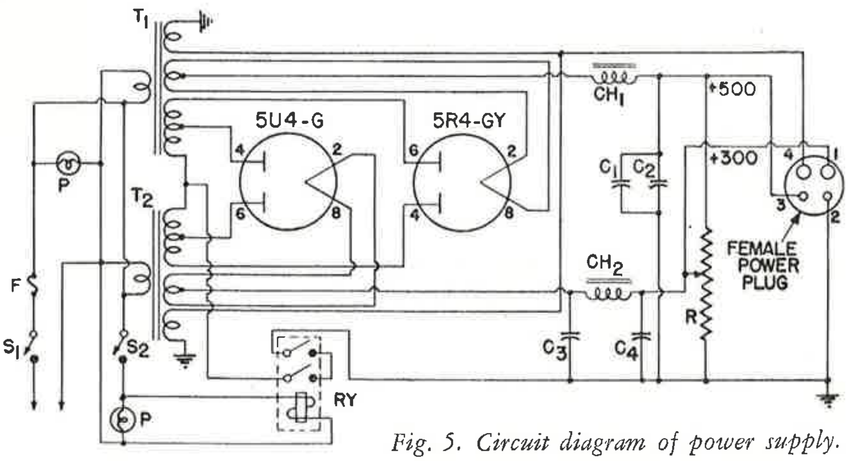

Fig. 5. Circuit diagram of power supply.

CIRCUIT CONSTANTS — POWER SUPPLY

C_1, C_2 . . . . 8 μF 1000 volt filter condenser
C_3, C_4 . . . . 10 μF 450 volt electrolytic
CH_1, CH_2 . . . . 8H 200 mA choke
F . . . . 5A fuse
P . . . . 240 volt pilot lamp
R . . . . 50,000 ohm 50 watt divider, tapped 30,000 ohms up from ground end.
S_1, S_2 . . . . SPST toggle switch
T_1, T_2 . . . . 338-0-338 volts at 200 mA; 5.0 volts CT at 3A; 6.3 volts at 5A.
RY . . . . DPDT relay, 240 volt coil

are used with their high-voltage secondaries in series. The total high-voltage output is fed to a 5R4-GY rectifier. An a.c. voltage of one-half the above is also obtained from the centre taps of the two transformers, and this voltage is fed to a 5U4-G rectifier valve. With such an arrangement, one d.c. voltage will normally be twice the value of the other. In this case the desired voltages were 500 volts and 300 volts and this was made possible by using choke input on the high-voltage supply. If the circuit constants indicated are used, and the two power supplies are loaded down with the currents drawn by the MHE transmitter, the proper voltages will be obtained.

The two 5-volt windings are used to supply power to the filaments of the two rectifier valves, the two 6.3-volt windings are paralleled and brought to the output connector. The d.c. voltage is turned on and off without affecting the filament voltage by breaking the centre-tap of the rectifier system with a relay. The contacts of this relay are wired in series to achieve the greatest possible make and break distance.

Resistor *R* of Fig. 5 serves as the bleeder for both power supplies. The tap at 30,000 ohms may be adjusted by means of an ohmmeter. It is relatively important that this tap be placed accurately to prevent overloading the resistor.

The power supply shown is larger than is actually required. The chokes are specified as 200 mA chokes. A 150 mA choke would suffice in the 300-volt supply and a 75 mA choke would be large enough for the 500-volt supply. However, made as shown, the power supply is capable of 200 mA output from either voltage, or a total of 200 mA if both voltages are used.

Mechanical details — power supply

Fig. 6 shows the MHE Transmitter in place on the power supply and Fig. 7 is the same view with the transmitter removed. The underside view of the power supply is given in Fig. 8.

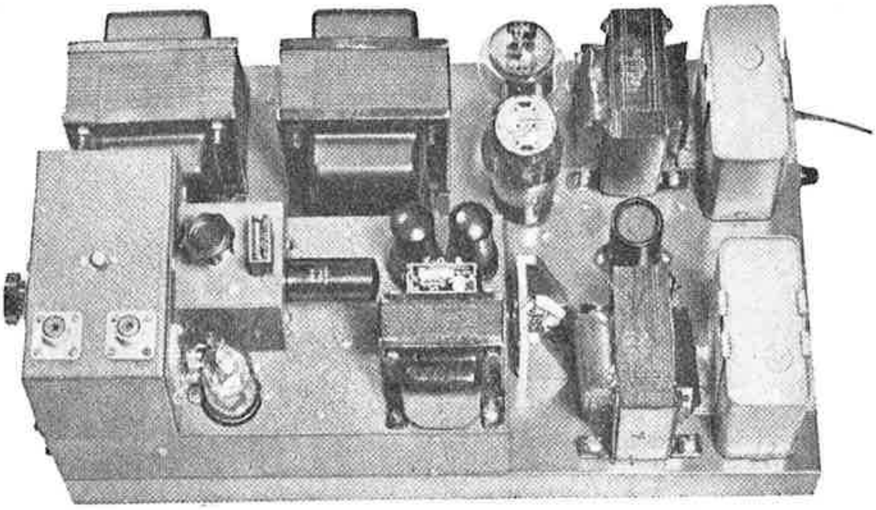

Fig. 6. Top view of MHE Transmitter and power supply.

The power supply chassis is a 10 or 17 by 2 inch steel chassis. Front panel controls — S_1, S_2 and the pilot lights — are on the left hand side as seen in Fig. 7. The fuse and a.c. power cord may be seen on the right-hand side. Layout of circuit components is not critical and almost any arrangement can be employed.

The female power plug is a four-prong socket mounted on a piece of $\frac{1}{4}$ inch aluminium at a height to mate with the male output plug on the transmitter. Two right-angle pieces of aluminium are used to support the socket as illustrated. Spaghetti sleeves cover the socket prongs to keep stray hands away from the high voltages.

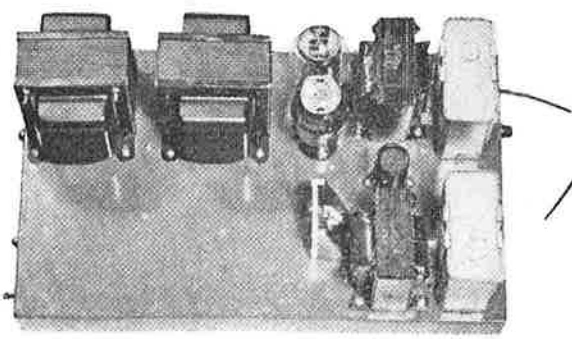

Fig. 7. Top view of power supply.

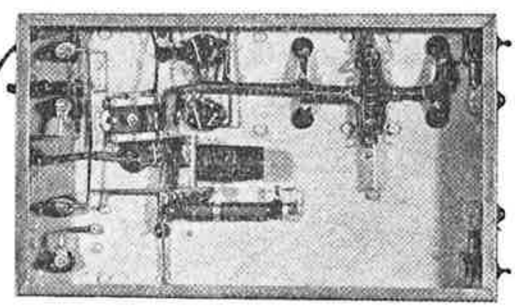

Fig. 8. Underside view of power supply.

Using the transmitter

For mobile work a shock-mounted platform should be designed for the MHE Transmitter. The transmitter itself can be mounted under the dashboard and operated directly or it may be placed in a remote spot in the car. Some adjustment of the link coils may be required in order to feed a car antenna properly.

The MHE Transmitter makes an ideal emergency or standby transmitter. If the main rig goes off the air, the MHE rig has enough power to do a decent job by itself.

Tyro amateurs will find this transmitter easy to build. There are no critical parts required and there should be no difficulty getting the rig to operate properly.

Operating notes

With 300 volts supplied to the CCO-2A oscillator the plate and screen current will run about 30 to 35 mA. With 500 volts on the 2E26 plate the measured power output was 22 watts on ten metres and 19 watts on six metres. Under these conditions the 2E26 cathode current was 66 mA and the 2E26 grid current 2–2.5 mA. Modulator cathode current normally runs 60 mA.

Wiring Techniques

How many times have you built a piece of high-frequency ham gear, which had been described in glowing terms in your favorite radio publication, only to come to the conclusion that the author of the article probably never had it working either? You proceed to check and recheck the wiring, closely inspect the photographs to be certain that your layout is identical, measure the values of all components, and still it oscillates when it shouldn't, won't oscillate when it should, or just doesn't have the pep that the article led you to expect it to have.

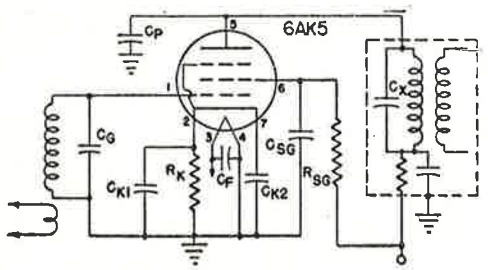

Fig. 1. Circuit diagram of mixer circuit described.

Before you condemn the gadget and discard it, consider the one remaining factor in the construction, a factor which incidentally is not apparent from the circuit diagram and not always apparent from the photographs. That factor is the method of wiring, such as the placement of leads, the points of connection to the various components and the length of leads. Also to be considered is the type and characteristics of the components used. All of these points become increasingly important as higher frequencies are considered.

In a high-frequency circuit composed of resistance, capacitance and inductance, it is important that you use only resistance where such is called for, use capacitance only where a capacitor is specified, etc. This may sound obvious, but a resistor has long leads, and if these are not shortened, they add inductance in series with the resistor and the leads have a capacitance to ground. Minor details? Not at all. For example, a one inch length of No. 20 solid wire has an approximate inductance of .02 microhenries. This means that one inch of this wire will resonate at 146 megacycles when paralleled with 60 mmf. of capacity. We can control the lead lengths of various component parts, but we cannot control the components themselves, except to select the best.

The small size one-half and one watt composition resistors are generally suitable for high-frequency circuits. In the capacitor line, silvered-mica button capacitors, high-capacity ceramics and regular tubular ceramic capacitors are suitable for bypassing, coupling and padding applications.

Fig. 1 shows the circuit diagram of a typical mixer circuit using a 6AK5 miniature valve. This type of circuit embodies most of the principles of high-frequency wiring techniques. These same principles are of course applicable to radio-frequency amplifiers and oscillators. Fig. 2 is a photograph of this 6AK5 mixer circuit wired in two different ways. Circuit-wise the two methods are identical, but the layout on the left uses high-frequency components and high-frequency wiring techniques, while the right-hand layout illustrates the more common type of wiring technique which should be avoided at high frequencies.

With reference to Fig. 2 the tuning condenser, C_g, is in the lower left section of both circuits with the grid coil directly above. The i-f transformer is mounted in the upper-right portion, with only the six leads extending below chassis. The similarity in layout stops at this point. In the right-hand unit

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mica condensers all go to ground at a common point, and the length of leads involved becomes excessive. The left-hand unit uses silvered-mica button condensers which are mounted around the valve socket so that each condenser is opposite the socket pin to which it connects. One end of the button condenser bolts to the chassis and the other end has a lug which ties directly to the socket lug. There are no leads added to these condensers and hence a minimum lead length is obtained.

to be preferred over copper braid. Q meter tests made at 146 Mc/s on braid and solid copper of the same cross-section showed that the solid strap had a Q two and a half times as high as the Q of the copper braid. This great decrease in I^2R loss is a definite help at these frequencies.

Another good stunt is to place a portion of the i-f transformer tuning capacity at the plate pin of the transformer. This long lead has inductance and is liable to cause a high-frequency parasitic even

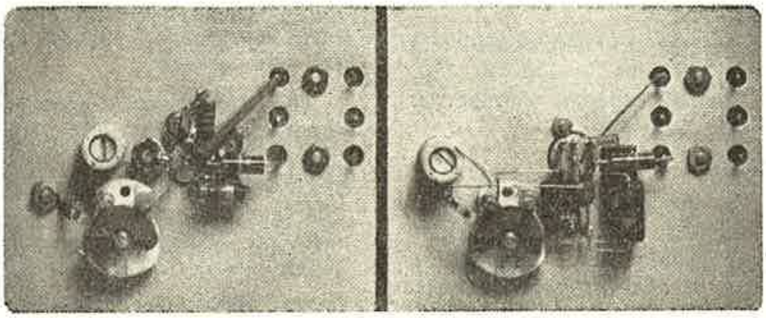

Fig. 2. Wiring techniques — high frequency construction on the left, usual construction on the right.

Another interesting point is the grid coil and condenser combination. In the right-hand unit the coil leads connect to the condenser and then two long leads of wire go from the condenser (C_g), one to pin No. 1 and the other to ground. These long leads have inductance which is in series with the condenser coil combination. Note how this series inductance is eliminated in the left-hand unit. The top coil lead goes directly to pin No. 1 and the condenser is connected to pin No. 1 through a piece of one-eighth inch wide copper strap. This strap has very little inductance. The lead from the grid to the coil has inductance but it forms a part of the coil inductance. The other two leads ground directly to the chassis, the condenser being connected through its lug to ground and the coil lead being soldered directly to the metal base of the Millen slug-tuned form.

Making all ground leads to one point has long been a favorite wiring trick, but in high-frequency work it is usually far better to ground to chassis at the closest point. Incidentally, make sure that the chassis is clean and bright before tightening the ground lug. In some cases, where grounds are made at random, it may be necessary to shift the grounding point slightly, although usually this will not be necessary.

A solid copper strap as shown will always give a lower inductance lead than a wire lead, and is even

though the i-f transformer works at a relatively low frequency. The left-hand unit shows a capacitor from pin No. 5 to ground. (The resistor-like component with the five color bands is this capacitor.) As long as this capacitor is in the order of 15 to 20 $\mu\mu$F most high-frequency oscillation voltages will be short-circuited. In effect this capacitor (not shown in Fig. 1) is in parallel with C_x. It would be even better if the padding capacitor in the i-f can were to be removed and wired in right at the socket.

The last point is the proper use of the two cathode connections on the 6AK5 valve. As shown in the circuit diagram, pins 2 and 7 are both bypassed to ground. This gives a lower impedance path to ground and is definitely desirable. If the ultimate in proper bypassing is to be used, then the double cathode leads would be used differently. The original idea in making two cathode leads available was to prevent a common coupling impedance. This is done by wiring the grid returns to one cathode connection, and the plate and screen returns to the other cathode connections. In this system, only one side of the cathode is bypassed to ground. Inasmuch as this latter system is not always a convenient method, the wiring as shown in the diagram may be used and will be perfectly satisfactory except for the most critical cases.

300-WATT *Modulator*

By George E. Jones, Jr. ——— RCA Tube Dept.

Here is a speech amplifier and modulator capable of delivering 300 watts of audio power through a multi-match modulation transformer into a wide range of class C loads.

The 811-A modulators are operated at zero bias and a plate voltage of 1250 volts. A 400-volt, 180-milliampere supply for the speech amplifier is included on the modulator chassis.

Circuit considerations

A circuit diagram for the modulator is given in Fig. 1. The 6SJ7 amplifier stage is a high-gain stage (gain of approximately 180) designed to operate from the output of a high-impedance crystal or dynamic microphone. The input network (R_1C_1) has been designed to eliminate r-f feedback, a difficulty often experienced when high-voltage r-f fields are present. This network attenuates any r-f voltage picked up in the input circuit before it reaches the grid of the 6SJ7.

One half of the first 6SN7 valve is used as an amplifier directly coupled to the second half of the valve, which is used for phase inversion, to obtain a push-pull signal for the following 6SN7. The cathode and plate resistors, R_{10} and R_{12}, respectively, should be matched resistors. The direct-coupled amplifier and the phase-inverter circuit is an adaptation of the well-known "Williamson Circuit". The second 6SN7 is a push-pull amplifier for driving push-pull, triode-connected, class A, 807 drivers. The plate resistors R_{17} and R_{18}, in the push-pull 6SN7 stage, must be matched resistors to insure a balanced signal in the push-pull stages. Resistors having a tolerance of 5 per cent. (gold band) are used for R_{10}, R_{12}, R_{17}, and R_{18}. For all other resistors, a tolerance of $\pm$ 10 per cent. (silver band) is satisfactory.

Construction

The unit is constructed on a conventional 2 by 13 by 17-inch chassis and utilizes a $10\frac{1}{2}$ by 19-inch rack-mounting front panel. Layout of the parts is shown in the photographs. For operating convenience, all the necessary controls are located on the front panel. From right to left, in Fig. 3, are shown the microphone input connector, the gain control R_7, the cw-phone control switch SW_2, the power indicating pilot light PL_1, and the power-supply on-off switch SW_1. Meter M_1 is mounted in the centre of the front panel and is wired into the centre tap of the transformer which supplies the 811-A filament power. The meter is placed at ground potential and indicates valve current (total grid and plate current) of the modulator valves. The front panel and all controls are at ground potential for safety reasons.

The chassis layout is shown in Fig. 2. The power-supply components, viewed from above, are grouped at the upper left-hand side; the modulation transformer is mounted directly behind this supply. The speech amplifier starts at the upper right-hand side and continues to the rear of the chassis. This layout provides a very short, direct input connection to the speech amplifier, and isolates the high-gain amplifier stages from the power supply and modulator output transformer.

Wiring is simple and the 2-inch-deep chassis, shown in Fig. 3, provides easy access for wiring and soldering all components. The layout was chosen to minimize the possibility of oscillation, "motor boating," or hum pick-up; lead dressing and placement of parts are not critical. In order to obtain maximum gain with minimum hum, it is necessary to tie the a.c. and d.c. returns to one common ground point in the first stage of the speech amplifier. Microphone cable connector J_1 should be connected to the common ground point instead of being grounded directly to the metal chassis. This jack should be insulated from the chassis, and the input wiring of the 6SJ7 should be kept as short as possible to avoid extraneous pickup.

Adjustment and operation

Variable resistor R_{29} in the power supply, just ahead of filter capacitor C_{14}, should be set for 400 volts at the output end of the second filter choke L_2. Ample decoupling is provided by capacitors C_4, C_8, C_9, and C_{11}, and resistors R_6, R_9, and R_{13} to minimize interstage coupling which could result in motor boating.

The 807 push-pull, triode-connected class A stage has a potentiometer (R_{20} accessible at the rear of the chassis) in the cathode circuit for balancing the plate currents of the two valves. This adjustment is made at static (zero signal) conditions, and, once set, need not be changed unless the 807 valves are changed. Test measurements on the completed speech amplifier show that positive grid current begins to flow in the second 6SN7 and the 807's at the same input-signal level, so the values of biasing resistors for the various stages are nearly optimum. In

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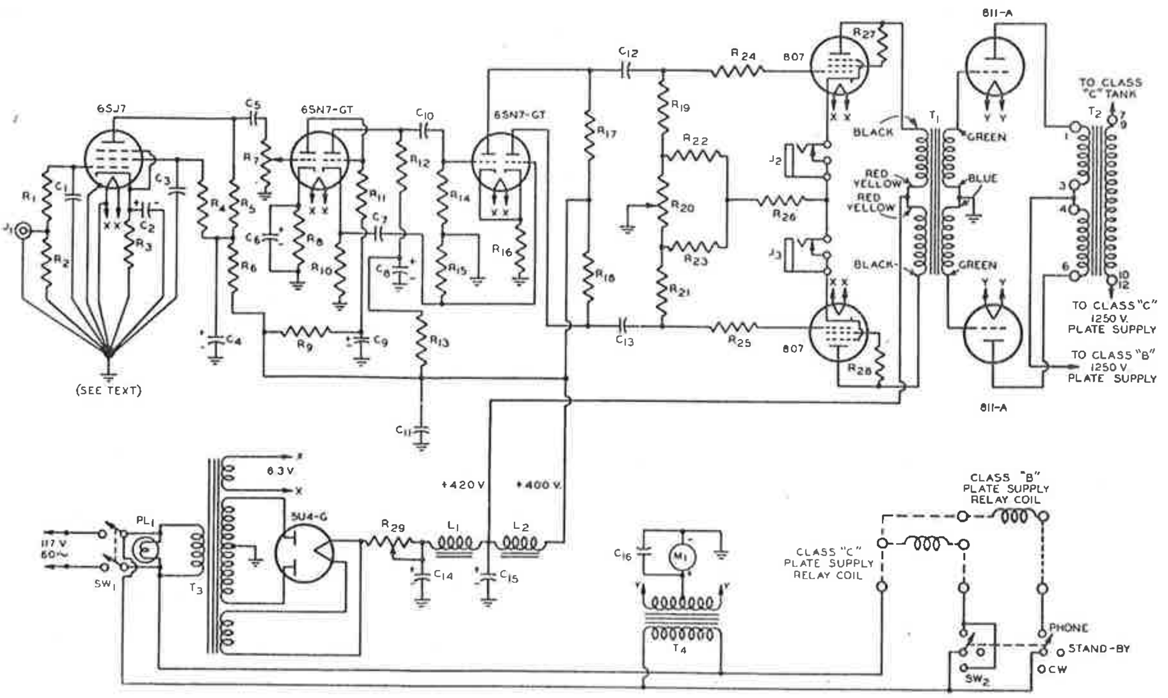

Fig. 1. Schematic diagram of the 300-watt modulator, speech amplifier, and power supply.

PARTS LIST.

C_1 .... 0.0005 μF, mica, 600 v.
C_2 .... 4 μF, electrolytic, 25 v.
C_3, C_7, C_{10}, C_{12} & C_{13} .. 0.1 μF, paper, 600 v.
C_4, C_8, C_9 & C_{11} 20 μF, electrolytic, 450 v.
C_5 .... 0.005 μF, mica, 600 v.
C_6 .... 40 μF, electrolytic, 25 v.
C_{14} & C_{15} .... 16 μF, electrolytic, 600 v.
C_{16} .... 0.01 μF, mica, 600 v.
T_1 .... Driver transformer, primary to ½ secondary (5:1).
T_2 .... Multi-match modulation transformer
T_3 .... Power transformer, 400-0-400 v. 200 mA; 5 v. 3 amp.; 6.3 v. 5 amp.
T_4 .... Filament Transformer, 6.3 v. at 10 amp.

R_1 .... 100,000 ohms, ½ watt
R_2 .... 240,000 ohms, ½ watt
R_3 .... 2,000 ohms, 1 watt
R_4 .... 1.5 megohms, 1 watt
R_5, R_{14} & R_{15} . 470,000 ohms, 1 watt
R_6 & R_{11} ..... 47,000 ohms, 1 watt
R_7 .... Potentiometer, 0.5 megohm, 1 watt
R_8 .... 470 ohms, 1 watt
R_9 .... 30,000 ohms, 1 watt
R_{10} & R_{12} .... 22,000 ohms, 1 watt (matched)
R_{13} .... 22,000 ohms, 1 watt
R_{16} .... 820 ohms, 1 watt
R_{17} & R_{18} .... 47,000 ohms, 1 watt (matched)
R_{19} & R_{21} .... 100,000 ohms, 1 watt
R_{20} .... Potentiometer, 100 ohms, 2 watts
R_{22} & R_{23} .... 100 ohms, 10 watts
R_{24} & R_{25} .... 1,000 ohms, 1 watt
R_{26} .... 330 ohms, 10 watts
R_{27} & R_{28} .... 100 ohms, 2 watts
R_{29} .... Adjustable, 100 ohms, 25 watts

SW_1 .... DPST toggle switch
SW_2 .... Double-pole triple-throw switch

J_1 .... Microphone-cable connector
J_2 & J_3 ...... Normally closed jack

L_1 & L_2 ...... Filter choke, 8 henrys at 150 mA
M_1 .... Meter, 0-500 mA
PL_1 .... Pilot lamp, 240 v., 3 watts

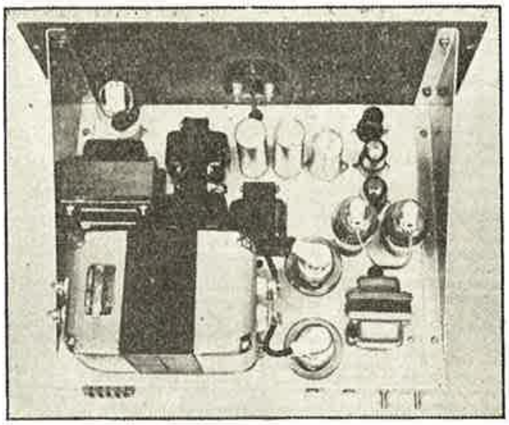

Fig. 2. Top view of the modulator; note that the well-planned layout of the modulator components permits the inclusion of a husky power supply on the same chassis.

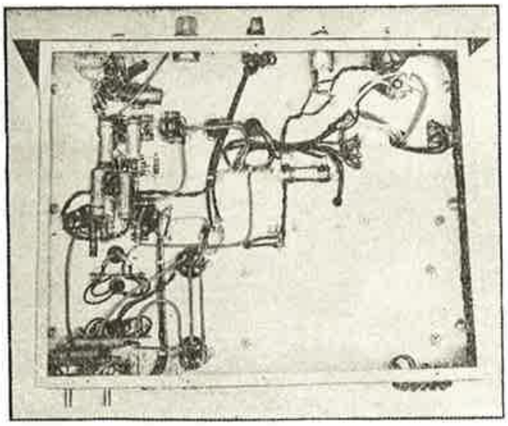

Fig. 3. Bottom view of the modulator; accent on simplicity and accessibility! Excellent performance, and no hum or feedback, without special dressing of leads or shielding!

operation the 811-A milliammeter will indicate about 125 mA on the peak swings of normal speech when the 1250-volt plate supply is off. When the plate supply is on, this current increases to approximately 450 mA on voice peaks for full output. With a sine-wave signal input, the 811-A's deliver approximately 300 watts into a fixed resistance load before the amplifier is overdriven (as evidenced by flattening of the sine-wave output voltage).

The driver transformer, T_1, is connected to obtain the maximum step-down ratio (primary-to-secondary) to provide for ample drive to the 811-A grids and also good regulation of the grid voltage for the class B stage.

The terminals on the multi-match transformer T_2, in the output, are connected so that the 9200-ohm, plate-to-plate load of the 811-A's is matched to the approximately 4000-ohm load of an 812-A push-pull, class C amplifier.

A suggested connection for the cw-phone control switch SW_2 is shown in Fig. 1 with dotted-in connections to the class B and class C plate power-supply relays.

The amplifier is stable at full setting of the gain control. The frequency response characteristic of the amplifier and modulator is flat from 100 to 7,000 cps; it drops off only slightly from 7,000 to 10,000 cps.

New RCA Releases

Radiotron 14GP4 is a new rectangular picture tube which requires no focusing coil or focusing magnet with resultant important savings in critical materials.

Featuring electrostatic focusing, the 14GP4 uses an electron gun of improved design to provide good uniformity of focus over the entire picture area. Furthermore, focus is maintained automatically with variation in line voltage and with adjustment of picture brightness. Need for alignment of a focusing magnet is eliminated and therefore tube installation and adjustment for optimum performance are simplified.

Because the electron gun is designed so that the focusing electrode takes negligible current, the voltage for the focusing electrode can be provided easily and economically.

In other respects, the 14GP4 is similar to the 14EP4. It is of the all-glass type with external conductive bulb coating, has a maximum high-voltage rating of 14 kilovolts (design centre), and produces brilliant $11\frac{3}{8}'' \times 8\frac{1}{2}''$ pictures on a face made of Filterglass. Employing magnetic deflection, the 14GP4 has a diagonal deflection angle of 70° and a horizontal deflection angle of 65°.

Radiotron 5CP12 is a five-inch cathode-ray tube designed particularly for those oscillographic applications, such as short-range radar service, where grid No. 1 is pulse-modulated to provide a temporary record of electrical phenomena. It utilizes a medium-long-persistence screen which exhibits orange fluorescence and phosphorescence.

Because of its medium-long persistence, the 5CP12 is especially useful where low- and medium-speed recurring phenomena are to be observed. The phosphorescence decays exponentially with a time constant of about 120 milliseconds; consequently, the low-level phosphorescence is of relatively short duration. As a result of this characteristic, the 5CP12

(Continued on page 150)

High Frequency R-F Chokes

On the higher frequency bands (10 metres and up) the amateur is faced with a double problem. Should he use r-f chokes in the grid or plate or filament circuit, and if so, what type of choke should be used. The question of "shall I use an r-f choke here" is often answered by looking through circuit designs to see if others used a choke in that place in the circuit. On the other extreme, an amateur may decide not to use any chokes because he has experienced trouble with r-f chokes causing parasitics.

This indecision on the part of the average amateur is partially caused because he does not understand how an r-f choke works. Or, if he understands r-f chokes, he may find that the proper choke is not available commercially. The purpose of this article is to explain briefly how r-f chokes operate and to give details on how to build good high-frequency chokes.

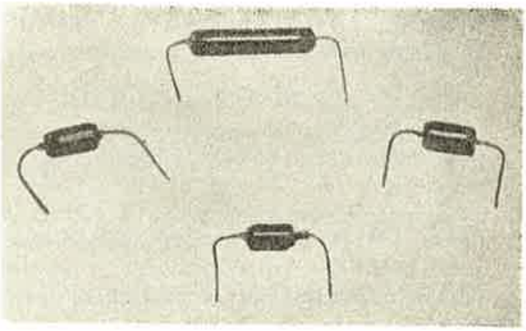

Fig. 1. One-band r-f chokes wound as described.

Operation of r-f chokes

A radio-frequency choke is normally used to provide a d.c. path from a point of zero r-f voltage to a point where r-f voltage exists. In Fig. 2A the r-f choke is in series with the high voltage lead and serves to prevent an r-f current from flowing through the power supply. Condenser C_1 presents a low impedance path for the r-f current so that the current can return to the cathode circuit of the valve. Fig. 2B shows an r-f choke in a parallel feed circuit. In this case the r-f choke must be designed so that practically no r-f current passes through it, because the r-f current must pass through C_2 to the tank circuit.

What property is built into r-f chokes which enables them to pass d.c. currents and yet act as effective barriers to radio-frequency currents? Obviously an r-f choke must have inductance, capacitance, resistance or some combination of these three. The answer is found in the word "impedance," which is another way of saying "resistance to radio-frequency current." The inductance, capacitance and resistance which are present in a choke combine in a certain way at certain frequencies and it is this combination that is called impedance.

It is not necessary for an r-f choke to act like a high inductance in order to work properly. Probably the most common r-f choke is the 2.5 millihenry type with four pies. This type is normally used as a series choke on the lower frequency ham bands.

This type of choke has a relatively high impedance which is due to capacitive reactance. Because this and other types of r-f chokes which cover a large frequency range are subject to resonant points at certain frequencies it is wise to use them only in circuits where they have been tried and found adequate.

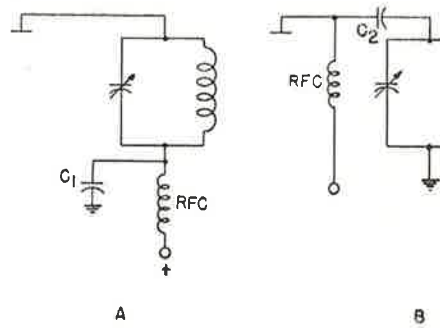

Fig. 2. Illustrating series and shunt feed r-f chokes.

In high-frequency circuits, r-f chokes are relatively important. Unfortunately the standard 2.5 millihenry choke will not serve in most cases, so that special high-frequency chokes are desirable. Because the frequency is high, the chokes become simpler to construct. In fact, single-layer windings are desirable.

In addition to their simplicity single-layer r-f chokes have an electrical property which is very desirable. If a choke is designed to be self-resonant at a frequency which is close to the frequency or frequencies of desired operation, the choke will be very nearly a perfect choke in that it will be effectively a pure resistance of a very high value. For example, if a choke is desired for six metre work, it might be designed to be self-resonant at 45 megacycles. This means that at 45 Mc/s the choke will appear to have no inductance and no capacitance. The impedance at 45 Mc/s will be quite

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high and will appear to consist only of pure resistance.

At higher frequencies the choke will appear to have a very high resistance and some small amount of capacitance. This capacitance may be in order of a micro-micro-farad. A small amount of capacitance in this order will not affect the operation of the choke.

A review of the above in capsule form shows us that—(1) Regular 2.5 mH r-f chokes, designed for operation over a wide frequency range, are generally not too efficient on the higher-frequency bands (10 metres and up). (2) For optimum operation, r-f chokes should be designed for one frequency, especially for the more critical service as parallel chokes, as shown in Fig. 2B. (3) Home-made chokes for low-frequency work would be bulky and difficult to construct, but for high-frequency work single-layer r-f chokes are easy to construct and have the advantage of being almost perfect chokes electrically.

Constructional details

High-frequency r-f chokes may be wound on practically any insulating material, such as wood, bakelite or polystyrene. The exact nature of the insulating material will determine, to some extent, the quality of the completed choke. Generally it is not necessary to go to these materials, as very satisfactory chokes can be wound on ordinary resistors. Fig. 1 shows four such chokes. The upper choke (for 10 metres) is wound on an old style two watt resistor ($1\frac{3}{4}$ inches long and $\frac{11}{32}$ inch in diameter). The two middle chokes are wound on new-style two watt resistors ($\frac{11}{16}$ inch long and $\frac{5}{16}$ inch in diameter), while the lower choke is wound on a new style one watt resistor ($\frac{9}{16}$ inch long and $\frac{1}{4}$ inch in diameter).

Winding data

Complete winding data for four high-frequency chokes:

10-11 Metre Choke—No. 30 enamel wire close wound to cover $1\frac{1}{2}$ inches on an old-style 2-watt resistor ($\frac{5}{16}$ inch diameter).

6 Metre Choke—44 turns of No. 30 enamel wire wound on new-style 2-watt resistor ($\frac{5}{16}$ inch diameter).

2 Metre Choke—17 turns of No. 22 enamel wire wound on new-style 2-watt resistor ($\frac{5}{16}$ inch diameter).

1.25 Metre Choke—16 turns of No. 22 enamel wire wound on new-style 1-watt resistor ($\frac{7}{32}$ inch diameter).

Use only insulated composition type resistors (not wire wound). Use resistors of a high value — one megohm or higher. File a small notch on each end to catch the wire and hold it. The wire can be soldered first to one pigtail, the choke wound, then the wire twisted around the other pigtail, the insulation removed, and then finally soldered.

Do not attempt to make any changes in specifications. Use the proper resistors and the right size enamelled wire. A thin layer of coil cement may be placed on the completed chokes if desired.

The 144 and 220 Mc/s r-f chokes specified above use heavy enough wire so that they may be employed in filament circuits if the current does not exceed one ampere. The 28 and 50 Mc/s chokes are to be used only in circuits where the current is of the order of 0.1 amperes, although they might possibly stand twice this current in amateur service. All of the chokes are suitable for use as shunt-feed chokes.

NEW RCA RELEASES (*Continued from page 148*).

provides high contrast between new and old information with change in target position — a feature making the 5CP12 suitable for short-range radar equipment involving medium-speed recurrent phenomena.

Like the 5CP1-A, 5CP7-A, and 5CP11-A — other previously announced 5C-types differing only in their respective phosphors, the 5CP12 has unusually high spot intensity, high grid-modulation sensitivity, and high deflection sensitivity. It utilizes electrostatic focus and electrostatic deflection; a "zero-first-anode-current" gun which permits the spot to be sharply focused on the screen and to remain sharp when beam current is varied over a wide range; and a post-deflection accelerator which makes possible a high-intensity spot with minimum sacrifice in deflection sensitivity and with slight increase in spot size.

Other design features include a large useful screen surface in relation to bulb diameter; separate base-pin connections for each of the four deflecting electrodes; balanced deflecting-electrode input capacitances; and the diheptal 12-pin base which enables operation at rated maximum values under reduced atmospheric pressure equivalent to an altitude of 40,000 feet.

Sources of Information

For those wishing to find an answer to a particular problem involving valves and their application, it was felt that an outline adopted by the "Radiotronics" staff might prove helpful.

Most inquiries received fall into one of three categories, the first relating to details about a specific valve. An example is, "what are the triode-connected operating conditions for an 807?"

Such questions are quickly answered by reference to back issues of "Radiotronics" or to the RCA HB-3 Tube Handbook if the valve is in the Radiotron range. For types peculiar to one manufacturer a search is made through the relevant catalogue. If the manufacturer is unknown, a quick look through a card index system will generally give the required information. This comprehensive index has been compiled over the years by the A.W. Valve Company, the practice being to enter all information concerning a valve as soon as it is announced by R.T.M.A. or in one of the many trade publications.

The older miscellaneous continental types not listed in the card index can generally be traced with the latest edition of Bran's "Vade-Mecum" or Babini's "International Radio Tube Encyclopedia." War disposal and current valves in use by the Armed Forces are located in the official Ministry of Supply publication, "C.V. Register of Electronic Valves", or the R.S.G.B. booklet, "Service Valve Equivalents".

Another useful publication is "Radio Valve Data", put out by "Wireless World", and available from most large booksellers. This, together with the A.W.V. "Radiotron Valve Data Book" (now out of print), "Radiotron Characteristic Chart", and the above-mentioned R.S.G.B. publication, will answer most inquiries, and should be in the possession of all our subscribers.

In the second category come requests for receiver and amplifier circuits, which can be satisfied by reprints of articles which have appeared in past issues of "Radiotronics".

Thirdly, are inquiries which necessitate more time with which to deal. A typical case is a request for design data for an electronic voltage-regulated power supply.

In the first instance, a search is made in recent issues of the "Index to Abstracts and References" published by "Wireless Engineer". These abstracts appear monthly in both "Wireless Engineer" and the "Proceedings of the Institute of Radio Engineers (U.S.A.)", and a complete index to these is issued yearly, priced at 2/8 sterling.

The 1949 edition of this index quotes two likely references under the alphabetical heading of "Regulators". These are numbered 1800 and 2646, and appear respectively in the July and October, 1949, issues of the "Proc. I.R.E." Examination of the abstracts shows the original articles would not be particularly helpful.

A search is then made under the heading of "Power Supplies" in the same index, and the following are noted under the sub-heading of "Stabilised": 231 ; 863 and 1200. These abstracts are found in the February, April and May issues of 1949 "Proc. I.R.E.", and deal with a three-part article which appeared in "Wireless World" for October, November and December, 1948.

These three issues are then examined and the material therein found to be applicable to the problem in hand. Further references are quoted in this article if additional detail is required.

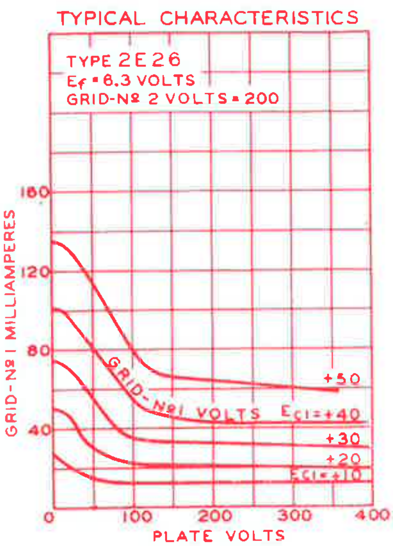
If no suitable references had been found in the 1949 index, earlier volumes would have been searched. Alternative heading titles are also likely to provide useful clues.

Other sources of information used are the "RCA Technical Papers Index", Volumes 1 and 2; cumulative indexes of "Proc. I.R.E.", "Proc. I.E.E.", "Journal Brit. I.R.E.", "Electrical Communication", "Post Office Electrical Engineers' Journal", and "Science Abstracts", "Industrial Arts Index".

Apart from technical journals, as mentioned above, textbooks and handbooks also provide good sources of reference material and should be consulted. Although the procedure outlined above may seem at first reading rather involved, in practice it is quite simple and fast.

If the search for information is being carried out in a public library, the assistance of the librarian should be sought if any difficulty is encountered in locating the desired material.

Radiotron *Type 2E26*



Owing to lack of space in the last issue of Radiotronics we were unable to include the characteristics curves on Radiotron type 2E26. However, we have printed herewith grid and plate characteristics with two values of screen-grid voltage.