

cathode resistor if the two valves are matched and the anode load resistors are equal, and the ratio of the two anode-to-earth output voltages is μ :—

$$\frac{E_A}{E_B} = 1 + \frac{R_L + r_p}{(\mu + 1)R_k} \quad (1)$$

Precise balance can be provided by selection of R_k and R_L for given tube characteristics, but if high gain and reasonable power supply voltage requirements are to be realized, μ must be exceptionally large.

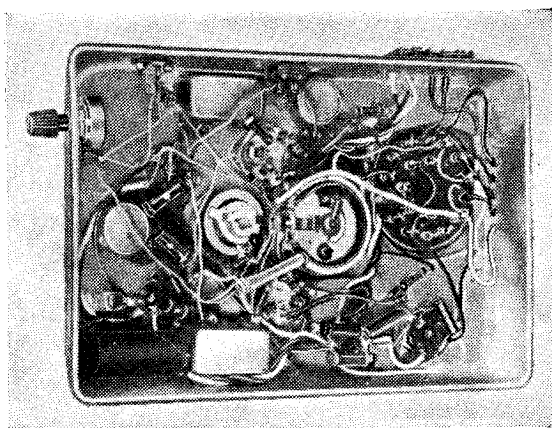
The cascode amplifier consists of a conventional triode with a cathode-driven triode as its anode load (Fig. 2). Analytically the cascode takes the form of a fictitious triode with characteristics μ' , r'_p , and g'_m the values of which, expressed in terms of the characteristics of the component triodes (assumed identical) μ , r_p , and g_m , are:

$$\left. \begin{aligned} \mu' &= \mu(\mu + 1) \\ r'_p &= (\mu + 2)r_p \\ g'_m &= \frac{\mu'}{r'_p} = \frac{\mu(\mu + 1)}{(\mu + 2)r_p} = \frac{\mu + 1}{\mu + 2} g_m \end{aligned} \right\} \quad (2)$$

Typical twin-triodes in cascode connection should thus provide characteristics as follows:—

Type	μ	r_p	g_m	μ'	r'_p	g'_m
6SN7						
7N7	20	7 k Ω	2.9	420	0.15M Ω	2.8
6SL7						
7F7	70	44 k Ω	1.6	5000	3.2M Ω	1.6

Anode characteristic curves for these two types were constructed for design reference (Fig. 3). The curves represent measurements on one valve of each type, and may not be good averages in the accepted sense. They do provide, however, an approximate basis for selection of operating points and load-line constructions. Dynamic checks with loads as indicated on the curves and anode supply voltage (E_{bb}) of 475 V

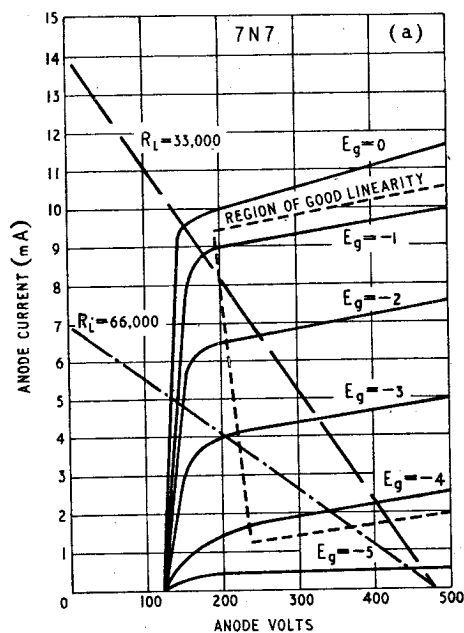


Under-chassis view of the complete i.t.c.p. amplifier.

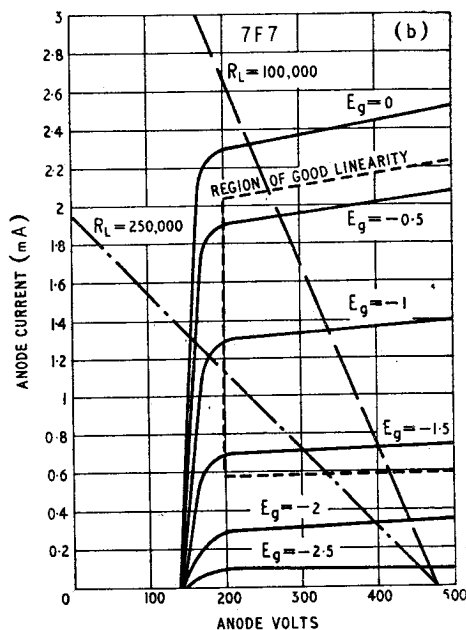
(the approximate value normally available in an audio-frequency power amplifier, and the maximum available from my regulated adjustable supply unit) check reasonably well with the curves, and even better with the computed values. Within the regions of good linearity to the two cascodes the 6SN7/7N7 should provide a gain of approximately 128 with a load resistance of 66k Ω and a anode supply of 475 volts, while the 6SL7/7F7 should provide a gain of about 360 with a load of 250k Ω and the same anode supply voltage. On the basis of this analysis the experimental amplifier was laid out using 7F7's in the i.t.c.p. stage.

The final circuit of the amplifier is shown in Fig. 4. Type 1625 output valves (12-volt heater versions of the 807—similar in general characteristics to the KT66) were used because they were at hand—as were the

Fig. 3. Cascode amplifier anode characteristics and dynamic check test.



DYNAMIC CHECK — $R_L = 33,000$, $E_{bb} = 475$ V, $E_{g2} = 120$ V, $E_g = -2$ V,
 $E_{IN} = 0.1$ V r.m.s., $E_{OUT} = 7.5$ V r.m.s.



DYNAMIC CHECK — $R_L = 100,000$, $E_{bb} = 475$ V, $E_{g2} = 150$ V, $E_g = -1$ V,
 $E_{IN} = 0.1$ V r.m.s., $E_{OUT} = 14$ V r.m.s.