

Power Output Calculation

The Pentode Valve



THE reader should now have a fairly comprehensive grasp of the principles governing the calculation of power output, and, bearing this in mind, it is both possible and permissible to treat the pentode and push-pull operation in less detail.

In broad outline to the pentode, which will be treated first, the same methods of calculation are applicable as those for the triode. There are, however, certain considerations additional to those already discussed, and

ing that, with a triode, undistorted power output is a maximum when the external load is double the internal impedance of the valve, dreams of speakers possessing impedances of innumerable ohms. His enthusiasm whetted still more by the knowledge that the power corresponds to the current squared times the effective resistance of the speaker, his dreams become nightmares connected with the winding of countless thousands of turns on absurdly diminutive moving coils.

Seriously, though, it does seem at first sight as if the pentode demands for efficient operation a speaker having a much higher impedance than is standard. It is a fact that a speaker of somewhat higher impedance than usual can be employed with advantage, but to attempt to "match" the valve with a speaker having a vast number of turns (to arrive at an impedance twice that of the pentode) is likely to end in disaster, and will certainly not be productive of the results anticipated.

In Fig. 1 there is shown a group of anode-voltage and anode-current curves of a typical pentode. It is at once apparent that the form of these curves differs considerably from that of the curves associated with a triode. The curves for the pentode show a marked tendency to become flat-topped at the higher anode or plate voltages—in other words, a considerable change in anode voltages is productive of only a miniature increase in anode current, or, conversely, a small change in current corresponds to a very large change in plate voltage.

It is this fact which limits the load which can usefully be employed in the anode circuit of the pentode. It was explained in connection with the triode that, with an inductive load, the momentary voltage at the plate can be appreciably higher than that of the battery or other source from which it is derived, this phenomenon being due to the collapse of flux when the current through the inductance is reduced. With a pentode operating on the flat-topped portion of its curve, quite a small reduction in plate current is associated with a substantial increase in the momentary voltage at the anode, this momentary voltage perhaps reaching a dangerous figure.

On the group of anode-voltage anode-current curves of Fig. 1, there have been inserted three "load lines" corresponding to loads of 5000 ohms, 10,000 ohms, and 30,000 ohms respectively. The normal operating point is located at a spot corresponding to an anode and screen voltage of 150 and a negative grid bias of 11 volts. The plate current under these conditions is just short of 17 milliamperes. Assuming the whole of the available grid bias is used, the peak negative grid voltage will be 22.

Examining the "load line" corresponding to a load of 30,000 ohms, it will be seen that this does not cut the curve corresponding to a negative grid voltage of 22 until the anode peak volts are in the region of 500. The import-

monic distortion in the load line corresponding to 30,000 ohms.

Fortunately there is no need to incur either of these disadvantages of the pentode. In fig. 2 has been plotted the power output with a typical pentode and varying load resistance up to 30,000 ohms. It will be seen that the power output is very high for load resistance round about 10,000 ohms, and with a load of this value there is little danger of running the peak volts above about 300, which a well-made valve should stand.

Once a suitable load line has been decided upon, and inserted, the process of output power calculation does not differ from that applicable in the case of the triode, so that there is no necessity to repeat this part of the subject again.

It has been assumed that the speaker is coupled to the output valve by a transformer or choke-condenser filter. The effect of disconnecting the speaker while the pentode is operating is to replace the normal load by a load of very high inductive value and thus again incur the dangers of excessive peak voltages. Thus it follows that the speaker should not on any account be disconnected from the pentode while the filament of this is alight—always switch off the pentode before changing the output circuit.

(To be continued.)

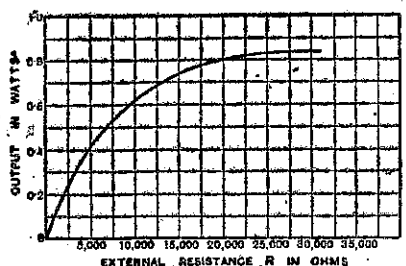
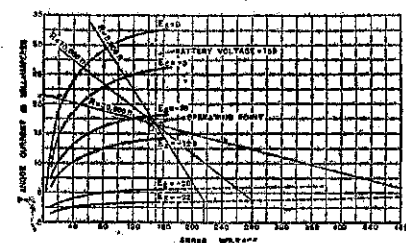


Fig. 1 (upper).—Anode voltage-anode current curves for a typical pentode. Owing to the horizontal nature of these curves a dangerously high anode peak voltage may be developed. (A3.)

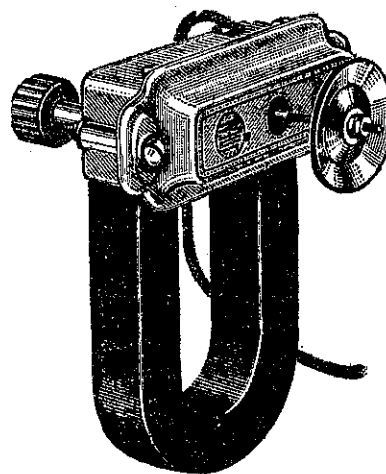
Fig. 2.—Power output curve for the pentode. (A4.)

these are such as to modify considerably the results which might otherwise be expected.

The internal structure of the pentode will be familiar to most readers. It retains the high amplification factor and high impedance of the four-electrode or screen-grid valve of which it is a development, the development consisting of the interposition of an earthed electrode (making five electrodes in all) between the screen-grid and the plate; the purpose of the earthed electrode is to prevent secondary emission from the plate reaching the screening grid.

The high amplification factor associated with the pentode renders more than one audio stage unnecessary for most purposes; it is, in fact, a matter of no little difficulty to induce a pentode to be friends with a prior audio stage unless the most elaborate precautions are taken. Still, the use of a pentode does undoubtedly simplify the audio channel of a receiver, and in a short-wave receiver, where more than one audio stage is apt to bring up the "background" too much, the five-electrode valve is an unqualified boon.

The high impedance of the pentode is a direct inducement to abuse it. The loudspeaker enthusiast, remember-



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