Power Output Calculations

Valves in Parallel and Push-Pull

THE parallel operation of valves needs but little explanation, as valves thus connected may be considered as a simple valve having an amplification factor equal to the average of the compound valves, and an impedance equal to the average impedance divided by the number of valves. In preparing, for accurate work, a series of plate-voltage plate-current curves preparatory to the insertion of a "load-line," the curves may either be taken for the bank of valves, or, if the valves are "matched," readings may be taken for one valve and multiplied by the number of valves, the resultant figures being used in preparing the curves.

Two parallel-connected valves will, theoretically, give precisely double the output of one, if the load is properly adjusted. At first sight one might think, from the fact that the output is proportional to the square of the currents, that the increase in output would be greater than this. Further consideration, however, leads one to remember that the load must be reduced in line with the lowered impedance, so that the power expended in the load is also reduced. In practice it is usually impossible, principally because of divergencies between the valves employed, to double output by means of connecting a second valve in parallel with the existing power valve. If the load is suitably reduced, however, as it might be by using a speaker of lower impedance, the experimenter will find little difficulty in adding half as much again to his present output by this means.

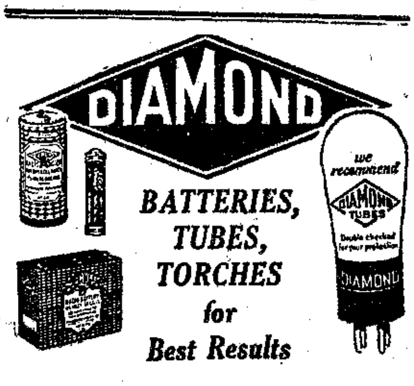
IN regard to the now popular push-pull operation, there seems to be a great deal of doubt regarding the theoretical increase in output occasioned by adding a second valve in this manner. If the matter is viewed in the following manner, however, it is difficult to see how any doubts can cloud the issue.

Starting with a single output valve properly loaded, we add a similar valve to it in push-pull, leaving the load the same. The effect, since the two push-pull valves are effectively in series, is to double the valve impedance while leaving the amplification factor unaltered. Clearly the output valves will not now be properly loaded. If we add to the push-pull valves two more, connecting them in parallel with the first two, this will have the effect of reducing the impedance once more to that of the single valve, so that the conditions in regard to the load are restored to those existing at the commencement. Now we have four valves all properly loaded and with approximately the same combined amplification factor as each valve singly, but we have twice the input, for two or more valves connected in push-pull will, of course, accommodate twice the grid swing that either valve will singly. Thus, in theory, four valves connected in parallel push-pull should be productive of eight times the normal output of a single similar valve—provided the input is doubled. In practice the gain is not so great as this for the same reasons as prevent parallel-connected valves from giving their expected output.

Since four valves in parallel are theoretically capable of giving eight times the output of a single similar valve, and since paralelling two valves only doubles the output, is natural to conclude that two valves in push-pull should give a theoretical four times the output of one. This is in fact the case, but it is necessary to increase the load so as to "match" the impedance of two valves in series (i.e. twice the impedance of one) in order to maintain the correct operating conditions for the two valves. If this is done, it can be safely anticipated that the output power will be at least trebled when a second power valve is added in push-pull connection.

In this simple explanation of push-pull operation, it has been assumed that the bias supplied to the valves has been their normal bias when operated singly. As many experimenters are aware, output may be boosted even more by biasing push-pull valves to the centre of the curved portion of their characteristic curve. The gain, however, is not—in the writer's opinion—sufficiently great to atone for the loss of one of the principal advantages of push-pull operation; namely, the elimination of audio-frequency currents from the battery circuit or other source of B current. Therefore, except where extreme economy in B current is desired, it is not recommended that this method of biasing be used.

(To be concluded next week.)



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