power amplifier capable of supplying 3 watts of power. Since the amplifier must supply at least this, all arrangements up to No. 15 in Table 1 may be disregarded. This latter will supply 3.2 watts, and will be sufficient for our purpose. We see, however, that it requires 400 volts on the plate, and this necessitates the construction of a big transformer. Glancing down the column of plate voltages, we come to 250 volts as being required by two 245 type valves operating in push-pull. This gives us an output of 4.8 watts, which is ample for our purpose. Because of the comparatively low plate voltage, it is possible to effect a considerable saving in the construction cost. In addition, there is much less danger of filter condensers breaking down, and 250 volts is much less dangerous in the case of accidental shocks, than is 400.

Table 1.

Watts output.	Best arrangement to use.
0.5 or less	One 171A at 180 volts
0.5 to 1	171A's in push-pull with 135 volts; or a single 245 with about 200 volts on the plate
1 to 1.5	Single 245 at 250 volts
1.5 to 2	171A's in push-pull at 180 volts
2 to 5	245 valves in push-pull
Higher powers .	250 valves in push-pull

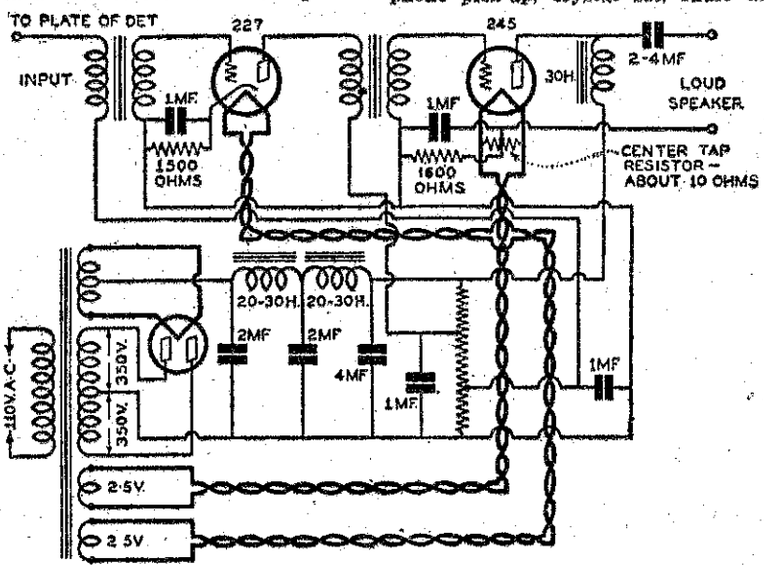
We would, then, feel more disposed to construct an amplifier using two 245's in push-pull rather than either the 250 singly, or the 210's in push-pull.

Output Expressed as Volume.

FOR some time reference has been made to the various power outputs, and it will be worth while to translate "power output" in the terms of volume of sound. The following is about the average: Power output up to .3 or .5 watts will give fairly low room volume; about 1.5 watts gives very good room volume; and 5 to 10 watts gives volume sufficient for a hall. It is unwise to build an amplifier to give an output of less than .3 watts, so in designing a power amplifier we must consider either the outputs .3 to .5, .5 to 1.5, or 1.5 to 3 watts. For usual home use for wireless set or gramophone such as in the amplifier described in another section of this issue, two 171A's (or their equivalent) in push-pull can be used successfully. These valves were used in the original model, and were found to give ample volume from either gramophone or crystal set on the local station. A second possibility for this range is the use of a single 245 type with 200 volts on the plate, but the advantage of the two 171A's with 135 volts is quite evident. For a greater output, 1.5 watts, a single 245 valve may be used with 240 volts on the plate. By increasing the voltage on the 171A's to 180, two watts may be delivered comfortably. From 2 to 3 watts of undistorted power may be supplied by two 245's with 250 on the plates. For higher outputs, use two 250's in push-pull. This position has been summarised in Table 2.

From the following discussion, it has become evident that the 210 type valve does not appear. This valve did not enjoy great popularity in New Zealand. It was used in America when A.C. amplifiers first became popular. This valve is capable of supplying approximately 1.5 watts at a plate voltage of 425, whereas a single 245 type can supply 1.6 watts with only 250 volts. It then seems hardly feasible to use the 210 with all the difficulties, and expense of constructing a sufficiently powerful amplifier.

Another interesting fact is that the 245 valve can be used to supply up to 5 watts of power, and this is sufficient for a small hall. Another interesting point is that the power valves have been limited to the 171A for general house purposes, the 245 for slightly greater power and hall use, and the 250 for still greater power. The 112 valve is also absent. This is a medium-power valve that is hardly used because, whilst ample power is available, one might as well use the 171A, and obtain the greater output.



Illustrating the use of a single 245 in an amplifier.

Push-pull v. Single Amplifier.

SOME years ago, push-pull was very fashionable. With the coming of the super-power valves it then lapsed, but now, with the popularity of A.C. operation, it is coming back into greater use. Among the reasons for its popularity are increased power output, less hum with A.C. operation, and less distortion.

Distortion in a power amplifier frequently takes the form of the introduction of new frequencies—harmonics, they are called. From experiment, it has been found that the maximum permissible harmonic output to be 5 per cent. The maximum that a single valve in these tests could handle was .6 or .7 watts. At the same output, the two valves in push-pull had only 7-10th of one per cent. harmonic. Therefore, if the single valve is always operated below .7 watts, we can get essentially distortionless output from the valve, but with push-pull the output may be raised considerably.

When single valves are used in an amplifier it is essential that they have a power rating sufficiently high so as to prevent any possibility of overloading. When push-pull is used the normal rating of the valves may more nearly coincide with the value required for good reproduction, because good push-pull valves do not produce serious distortion even when called upon to supply more power than their rating. Those who have been following the design of manufactured receivers will note this decided tendency towards this use of valves in push-pull.

Because the home experimenter is always anxious to construct a power amplifier giving the best possible reproduction, it generally is advisable to use this type of amplification. For this reason, the amplifier we have selected for this issue has been one embodying this popular and distortionless circuit. It may be used with gramophone pick-up, crystal set, radio and detector stages from A.C. or a D.C. set, short wave adapter, or phones and radio amplifier. Believing that a separate amplifier is of more service than the audio stages of a set, they have been separately constructed, and the A.C. Browning Drake has been designed as a unit merely to feed this amplifier. In the writer's opinion, it is not worth while constructing a straight-out all-electric set. Sooner or later, not only will a gramophone be introduced, but a short-wave adaptor will find its way into the home of the wireless enthusiast, and he will want a good amplifier apart from his set.

The choice of valves for this set has now been made reasonably clear. It is merely a matter now of decision as to the amount of power required. Most of the power transformers supply up to 200 volts, and this renders them admirably suited to the 171A type of valve. This is all that can be desired for the ordinary home use, and unless unnecessary power is required, the writer would not recommend the use of any other valve. Generally speaking, the following are the best known examples of the 171A type of valve on the New Zealand market: Mullard AC4 and PM256; Philips C603, C605; Ce-Co J71A; Corror 610P; Osram P625A; Six-sixty 620SP. Some of these requires only 150 on the plate.

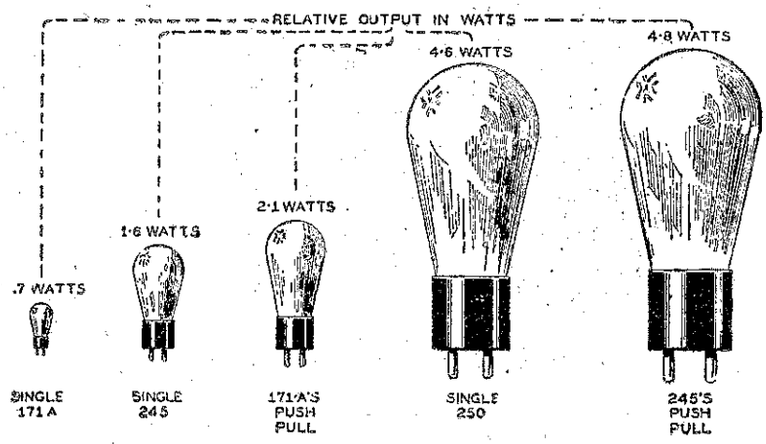
The 245 Valve.

AT various points in this article, we have referred to the type 245 valve. Because this valve is not readily known, it is worth while to give some data referring to it.

The details of the original 245 are as follows: Filament voltage, 2.5 A.C.; fil. current, 1.5 amps. A.C.; plate voltage, 180 to 250; plate current, 26 to 32 mills.; neg. G.B., 33 to 50 volts; amplific. factor, 3.5; impedance, 2000 ohms; power output, .75 to 1.6 watts. Other makers are producing this type of valve. We refer in Laboratory Jottings to the new Osram P625A.

In summarising the characteristics of the new valve, we can say that it is designed to supply fairly large amounts of power at medium plate voltages. We are thus able to obtain comparatively large amounts of power from a power supply of reasonable cost. Regarding the circuits for the 245, we show in the diagram a suitable circuit, though it may be used in push-pull in the amplifier previously referred to. The grid bias resistances have also been given in this article. Note that in using a single 245, none of the circuit constants need be changed except the bias resistance.

The question might be asked, "Can the power for this valve be taken from the 2.5 winding for the 227 valves?" It can, if the wire comprising the secondary of the transformer for this particular purpose is sufficiently heavy. For two valves in push-pull, 3 amps. will be needed, and each 227 valve requires 1.75 amps. If an amplifier alone is to be constructed, the total power to be supplied by this winding is a total of 4.75 amps., and to supply this, No. 14 gauge wire must be used. Where radio and detector valves are to receive their power from this winding, it must be at least No. 12 gauge. There are mechanical difficulties in winding a transformer with heavy gauge wire, so an extra winding would be preferable.



The relative outputs of familiar power-valves.