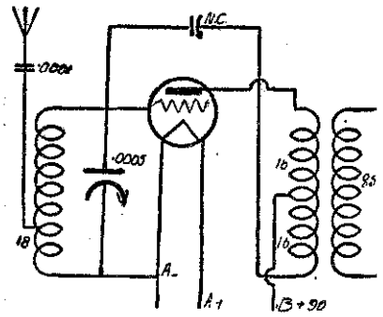
far too much volume for comfort, so I advise anyone considering building one of these sets to got in for nothing except push-pull audio.—B.D. and PUSH-PULL (Nelson).

The method of neutralising is that known as split primary, and should be equally effective as that originally



described. However, the 2RF B.D. works well as described. Failure to neutralise means wrong values or too high voltage on the detector. The parallel feed described in "Guide" gives excellent results, and should make the two R.F. even more popular.

There is no doubt if volume is to be handled, push-pull is the best amplifier (described by "Pentode" in our issue of November 2).

Primary Variation.

W. D. CAMPBELL writes: Re neutralising of Browning-Drake, wind another wire on with primary (about 15 turns, primary the same), the primary connections are the same, but there is no central tap. The start of primary and the finish of the other wire (both 30's), go to B +. The finish of primary, of course, goes to plate, and the start of the other to neutralising condenser.

This method I have found very satisfactory. Use one wire of cotton-covered and one enamelled.

Finer Details of Radio

The Three-Electrode Valve as an Amplifier

By "PENTODE"

IT can truthfully be said that the valve plays the greatest part in most sections of radio, and modern methods of speech reproduction. Unless some alternate component had been invented and used, radio could not have progressed so far and so rapidly. As a rectifier the crystal cannot hold its own against the valve when properly used. One or two so-called valveless amplifiers have been introduced, tried and then cast aside in preference to ones using the valve.

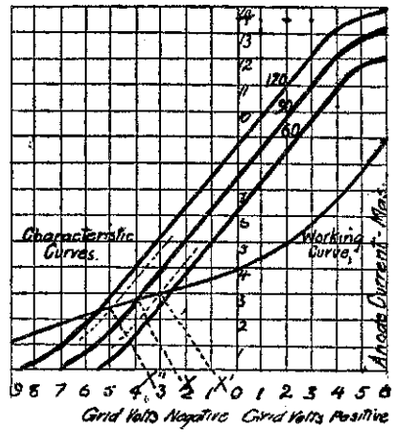
Since the valve plays such a great part in the receiver, it is just as well to get a fair idea of its performance not only when tested by the usual means, but also under actual operating conditions. This article will deal with the electrode valve when used as an amplifier, the next issue with the valve as a detector, followed by a discussion on the new screen grid and pentode valves.

What the Graph Indicates.

THERE are quite a few really enthusiastic amateurs who do not fully understand and realise the importance of the graphs generally supplied with each valve, and to these a few lines will be devoted to a simple explanation. As the name suggests, the three electrode valve has three elements—the filament, the grid and the plate. Two circuits are employed, the grid and the plate and filament, the latter being common to both. The one is called the input or grid circuit, and the other the output or plate circuit.

When the filament is heated by the low tension supply, electrons are given off, which, being of a negative character, are attracted by the positive potential applied to the plate by the high tension or B supply. Each of these electrons carry a small charge of electricity, and a current flows from the filament to plate, through the meshes of the grid.

Now consider what would happen if various potentials were applied to the grid. If of a negative character, this



would oppose the negative electrons emitted from the filament, and reduce the current flowing in the plate circuit, while if a positive potential was applied to the grid, electrons would be attracted to the grid and a current would flow in the grid to filament circuit. This is undesirable, as will be explained later.

AS an example, let us take a general purpose valve and see what relationship exists between the applied grid potential and the plate current. Starting with a constant "B" voltage of 90 volts, the normal resistance of the valve allows a current of 7.3 milli amperes to flow with the grid at 0 volts. Apply 4 volts negative bias to the grid and the anode current drops to, say, 2.75 milliamperes. Still further increase the negative grid bias, and a point will be found where the applied grid potential completely cancels the effect of the 90 volts "B" battery, and no current at all flows in the plate circuit. In the example taken this occurs when 7 volts negative bias are applied.

Now, it can be seen that seven volts applied to the grid controls the plate circuit to the same extent that the 90 vols "B" supply do, and from this the voltage amplification of the valve can be determined. In this case it amounts to 90/7 or 13 approx.

Reference to the diagram shows how this can be depicted on paper in graph form. The horizontal lines indicate the anode or plate current in milliamperes, while the vertical lines show the applied grid voltage. The negative on the left and the positive upon the right. The two dotted lines indicate the curve when plotted with the various anode voltages shown. Neglect for a moment the third curve plotted across the graph and consider the performance of the valve when the grid is made positive.

Space Charge.

ON first thoughts it would appear that the grid, being positive, would attract the electrons to itself, robbing the anode and keeping the plate current more or less constant.

When the filament is heated electrons fly off with a comparatively small velocity, forming what is known as a space charge around itself. Without the attraction caused by the positive plate potential these electrons would merely fly off, circle round and return by the filament once more to the filament. As the plate voltage is increased so the number of electrons which pass from filament to plate increase. This continues until the space charge is no longer present, all the available electrons being drawn away by the positive plate voltage. In this condition the valve is said to be saturated. Now, instead of increasing the plate voltage to produce this effect, it can be done by increasing the grid voltage in a positive direction. The reason that the electrons do not all fly to the grid is due to the fact that their velocity carries them past the grid into the direct influence of the plate voltage, and only a small proportion actually settle on the grid producing grid currents. So much for the characteristic curves given with various valves, and let us see if these curves still hold good when the valve is used in a receiver.

Under Working Conditions.

GIVEN a valve possessing characteristics as shown in the accompanying graph, let us see what happens when used in the position of an audio frequency amplifier, a transformer primary being in the plate circuit. With a plate voltage of 90 a grid bias of 4 volts can be given and the valve is operating at the position marked x.

Alternating current voltages are applied to the grid, which for our argument can amount to 1 volt on either side of the operating point. These are reproduced in the plate circuit as voltage variations of this value multiplied by the voltage amplification of the valve. In this case it is 13, and the output would be 26 volts alternating current of the same frequency as that of the input. Neglecting the steady anode current of 2.75 milliamperes, the alternative anode volts would be associated with varying anode amperage, as can be seen from the graph. On the positive 1 volt, half of the grid swing, the anode current would vary by approximately 1 milliamp. This current variation would be applied to the primary of the transformer in the anode lead of the valve. This primary has a fairly high A.C. resistance or impedance, causing a voltage drop across it. This voltage drop depends upon several factors, namely, the impedance of the transformer primary, the A.C. current flowing, and the frequency of the alternating current. Without knowing the value of all these the plate voltage cannot be defined, but it is lower than that originally used and will move the operating point of the valve