When completed, connect up batteries, and using the phones, see if oscillation is smooth and under good control. The reaction condenser on the riht should have the same readings for the position when the set goes into oscillation and for when it comes out. Any lag usually indicates a wrong grid leak or an inefficient choke soil. Have a number of leaks on hand ranging from 2 to 7 meghoms, and try each until the best value is found.

Connect up the antenna and with receiver on the threshold of oscillation, turn the left hand tuning condenser slowly round until a whistle is heard. This indicates a station and immediately slacken off reaction, at the same time making final adjustments on the tuning condenser. The coil used for reaction will be found by experiment, depending upon one or two factors, and no set rules can be laid down for any particular coil.

### Dead Spots.

VERY often it will be found that there are certain sections on the tuning range that it is impossible to get the receiver to oscillate. These are called "dead spots," and can usually be overcome by adjustments upon the aerial coupling. Unscrew the neutralising condenser slightly, and the reaction will be found to work normally. Do not expect to tune in to Holland right away, as it takes quite a while to get used to a short-wave set, and when a station is recieved the builder will be surprised to see how finely the stations tune on the dials. As many as ten stations can come in on each degree, and one or two commercially made sets use a small magnifying glass in order to take more accurate dial readings.

## *Testing R.C. Units*

RESISTERS and condensers should be tested periodically with a pair of 'phones and a 45-volt battery. A comparatively strong click should be heard in the 'phones when connecting the anode resistance in series with the battery and 'phones. A much smaller click should be heard for the grid leak and, after the first click, in the case of the condenser, no more noises should be heard. If any of these components prove faulty they should be replaced, especially the coupling condenser, which, if leaking, will give a positive potential on the grid of the following valve. This not only gives distorted signals but in time will ruin the valve, especially if it happens to be followed by either a speaker or transformer. This is the first and most likely fault that a service man looks for when called in to overhaul the set.



# *The Pentode as an Amplifier*

### *Lecture by Mr. W. M. Dawson*

IN his lecture to the Wellington Radio Society last week Mr. W. M. Dawson (Technical Engineer to Philips Lamps, N.Z., Ltd.) took as his subject "Pentode Amplification," treating that aspect of radio in a comprehensive yet entertaining manner. Following is a brief summary of the address.

As the reproduction of musical frequencies is bound up with the loudspeaker and the output valve it is essential that these be considered together. They should be fully capable of translating the music exactly in accordance with the strength of the electrical impulses fed to the amplifier, yet when they are delivered by the speaker they are frequently distorted, meaning by distorted minus many of the tones and overtones that give the colour, body and balance to music. The ideal reproducer will not alter the character of the signals but will deliver them as they enter the amplifier, this ideal is hard to realise, yet to a very great extent it can be attained through the careful balancing of loudspeaker and output valve.

A loudspeaker needs power to reproduce with equal intensity the range of frequencies collected from the carrier wave of the transmitting station. This power can in the ordinary speaker be derived only from the plate circuit of the output valve, and the resultant strength is proportional to the power fed into the speaker. This is the limitation to volume. Modern ideas of satisfactory volume with speakers require an amount of energy corresponding to a plate current change of 15 milliamps. Fluctuations in plate current are fed through the coil of the loudspeaker causing variations in the magnetic field created by the energised coil. These fluctuations in density affect the tension on the reed or plate of soft iron resulting in air waves which are interpreted by the ear. The greater the changes in density the greater the strength.

A change in plate current of 15 milliamperes means a swing of 7½ mas. above and below normal, and unless the valve is sufficient to accommodate this swing distortion occurs. The swing of 7½ mas. must take place on the straight portion of the curve so that in practice the valve must be able to accommodate a greater swing. Disregarding the curved portion at the zero mas. end there must be room for a 7½ mas. swing. The only three-electrode valve that can accommodate such a swing without distortion is one with a low impedance. Such a valve gives greater plate currents with a given plate voltage. By low impedance something between 2000 and 4000 ohms is understood.

To obtain the maximum transference of undistorted energy it is essential that the impedance of the output valve be no greater than half that of the speaker, and so the problem of matching arises. The impedance of a speaker, the resistance to the flow of alternating current, varies with the frequency of the current; the higher the frequency the higher the impendance. The impedance of the valve, on the other hand, remains substantially constant at all speech frequencies. At what frequency, then, must the speaker and valve be matched? If the impedance of the speaker is 4000 ohms at 100 cycles (corresponding to a note a little more than an octave below middle C) and the valve impedance 2000ohms, the speaker will give a good reproduction of bass notes with a falling-off in energy transfer at the high notes. If the matching is below this there will be more bass but a lack of brilliance, and the opposite is true when the matching takes place at higher frequency.

### The Pentode Valve.

THE new pentode valve attacks the problem from an entirely different angle. The impedance here is anything but low; in fact, in one make it is 67,000. The valve is a special development of the screen-grid; the plate is screened by an extra grid, and this is kept at high potential by the attachment of its terminal to the high tension supply. Another extra grid is provided and his attached inside the valve to the centre of the filament. The net result of these alterations from the normal three electrode valve is to provide very high amplification, in the region of 100, combined with the necessary heavy plate current. It will be remembered that though the high amplification factor is not out of keeping with a high impedance, the ability to handle a great current output is. And this is the characteristic of the pentode.

A plate swing of 10 mas. without distortion is possible, while the impedance of the speaker is a minor consideration for what is 4000 or 8000 ohms when that of the valve is 67,000. Thus the gain in uniformity of energy transfer at all audible frequencies.

### The Application of the Pentode.

THE usual method of introducing the valve into a circuit is to connect the auxiliary terminal at the side of the base to B plus, yet this is by no means the only method. In fact, the valve can be coupled so that either the high or the low frequencies are emphasised.

If the auxiliary grid is coupled to the plate terminal of the valve, it is converted into a four-element power valve with a low impedance of the order of about 4000 ohms. Coupled in this manner the tendency is to attenuate the upper registers, but to somewhat weaken the signal strength.

There is yet another method which will give prominence to the bass and that is by connecting a resistance of 5000 ohms between the auxiliary terminal and B plus and by passing this with a condenser to A minus.

### The Evolution of the Valve.

THE evolution of the valve has marked the progressive stages in the application of power. When the 201 type was developed it was thought that the acme of perfection had been realised, but in his search for more power the radio engineer was not content to rest here. Further research saw the development of the 112 and the 171, each requiring a greater plate current and delivering a greater output. Still the desire for power was unsatisfied, and push-pull amplification was devised and for some time filled the desire, but then this was superseded to some extent by the transmitting valves requiring 400 volts, for now, with the development of eliminators, there was little need to worry about the supply of input power. These valves were capable of supplying to the speaker a maximum undistorted output of 1 watt.

The pentode, capable of supplying the same output with 180 anode voltage, is displacing this as a power valve. Likewise the scramble for over-emphasis if the bass is passing, and if anything there is a reaction towards brilliance, but it has resulted in the development of apparatus capable of delivering a very wide range of frequencies.

To illustrate his points the speaker demonstrated with a simple apparatus that he claimed could be installed with a minimum of cost. A gramophone pick-up was operated and the output fed through two stages of amplification, the latter being a pentode, the filament of which was heated by alternating current. Volume and quality left nothing to be desired, and the points referring to bass and treble reproduction were clearly brought out—they needed no stretch of imagination.

### "Do's and Don'ts."

HAVING finished his explanations Mr. Dawson gave a few words of advice that would help considerably in the operation of the pentode.

It is possible to generate very high voltages between the elements with 150 volts on the plate. Something in the vicinity of 550 may arise because of the alternating signals, so that to interfere with the connections while the set is in operation is simply looking for trouble. The speaker will cause a "kick back" and if the operator receives this he may feel a little "off colour" for a while. Careless treatment may result in flashover between the elements, resulting in the breakdown of the valve—they are expensive to replace.

A one-to-one output transformer is to be preferred and under no circumstances should a high step down ratio be used with ordinary loudspeakers. With some dynamic speakers the moving coil is of very low impedance, and in this case a step-down transformer is necessary, just as it is when using a triode valve. Cheap transformers might be improved by disconnecting the B plus (of the transformer) and connecting it to the filament negative, and by connecting the B plus battery to the P terminal of the valve through a l.f. choke of 30 Henrys. Between this and the P terminal of the transformer insert a 2 mfd. condenser.

At the conclusion, Mr. Dawson answered the questions of his hearers and further elaborated some of the points.