The Designation of Valves

Previous lectures of Mr. Dawson have dealt with valves in the abstract. On a recent evening Mr. Dawson, engineer of Philips Lamps (N.Z.) Ltd., took up a new attitude and dealt with the different uses of receiving valves in a set.

THE 5 valves used in a five-valve receiver cover four distinct functions, high or radio frequency amplification, absorbing two valves, detection or rectification carried out in one valve, followed by the first stage of low or audio frequency voltage amplification, and the final valve provides what is called power amplification.

Tuning In

TO listen to Mr. Dawson's lecture, the listener had to tune in to a wavelength of 420 metres. The transmitting aerial on Mount Victoria was being traversed by waves or rapidly fluctuating currents. A simple analogy was taken. These waves were compared with the familiar snake made in our young days with a rope. With such a rope it is possible to get several waves along its length at one time, and the term wavelength compares with the distance from one hump in the rope to the next. If the humps in the rope were 420 metres apart the rope would roughly represent 2YA's carrier wave when no one was talking into the microphone.

Now, just as with a rope snake, the distance of the humps of the wave were apart depends upon the rapidity with which the end of the rope is agitated. The measure of rapidity is called the "frequency" and in simulating 2YA's carrier wave one would require to shake the rope up and down some 714,286 times per second. We alter our receiver tuning dials until the receiver is most responsive to this particular frequency of 714,286 vibrations per second.

Modification of the Carrier.

NOW the energy transmitted by 2YA is not on nearly as simple a form as the rope comparison so far. That merely deals with the carrier wave. Now when a person speaks into the microphone variations in microphone current in sympathy with the tone and inflexions of the voice are caused. The frequency of these current fluctuations will vary between some 200 and 4000 per second. Now these slower or speech frequency fluctuations are impressed on the carrier wave and carried by it.

Suppose in the rope snake the person at the far end starts shaking the rope at a frequency corresponding to audible voice tones then the original shape of the rope waves will be considerably modified and represents roughly the character of the transmitted energy from 2YA's aerial.

Therefore in our receiver two widely separated frequencies of vibration, namely, that of the carrier wave some 714,000 times per second and the voice frequencies varying between, say, 200 and 4000 per second, are dealt with. Vibrations of 714,000 odd are inaudible to the human ear and to differentiate between them we call the carrier wave frequency high or radio frequency and the speech frequency low or audio frequency since the latter are audible to the human ear

Radio Frequency Amplification.

NOW to return to the receiver. In the receiving aerial voltage fluctuations are induced similar to those in the transmitting aerial. The purpose of the first two valves in a five-valve receiver is to amplify or strengthen these extremely feeble voltages without changing their character in any way. So these are called high or radio frequency amplifiers. The strengthened voltages are applied to the grid circuit of the next valve, the detector, whose purpose is to strip from the main carrier wave or snake the slower vibrations impressed by the speech. The radio frequency energy does not get beyond this point in the set, but the speech frequency or low frequency voltages are impressed on the grid of the next valve through an audio frequency transformer, and they are amplified and impressed on the grid circuit of the power amplifier valve. Now the purpose of this valve is not to amplify or increase voltages as in the radio frequency amplifiers, but to use those amplified speech frequency voltages to cause large fluctuations in plate current, which fluctuating currents flowing through the windings of the loudspeaker reproduce the sound of the voice accurately—that is, if correctly controlled.

Other Sets.

FOR those who do not operate five-valve sets let us explain for a moment the functions of the valves in your set.

If a single valve set is used the valve acts principally as a detector, but in nearly every case—that is in regenerative sets—it acts as a radio frequency amplifier as well by use of the principle known as regeneration.

If the set is a two-valve one, the first valve is almost certain to be a detector and radio frequency amplifier as in the case of the single valve set, while the second valve is a power amplifying valve.

The usual three-valve set has a detector followed by a stage of audio frequency voltage amplification and by a stage of power amplification.

Four-valve sets nearly always use the first valve as a radio frequency amplifier the second as a regenerative detector, the third as an audio frequency voltage amplifier, and the last valve as a power amplifier.

Six-valve sets may use two or three of its valves as radio frequency amplifiers followed by a plain detector, next one or two stages of audio frequency voltage amplification, and finally the power amplifier.

True, some six-valve sets operate on the superheterodyne principle, and the functions of the valves differ from those just sketched out. The scope of these articles does not permit dealing with special types of receivers in which but a limited number of listeners are interested.

Seven and eight-valve sets have additional radio frequency and audio frequency voltage amplifiers, the last valve in all cases acting as a power amplifier.

Purposes of Valves.

NOW, as the different valves in the set serve widely-different purposes, it follows quite logically that the valves in the different sockets can be designed specifically for the job they are to undertake, and that a "general purpose" valve to work in any of these sockets must of necessity be a compromise in design.

To fit a set with general purpose valves throughout is therefore to deny the set the chance of showing what it really can do. One does not buy the entire family stock of footwear of the same size and pattern merely because they are to be used by members of the same family, no each pair is chosen for the particular needs of the wearer and the particular time when they are apt to be worn.

The valves in the set deserve equal consideration in their choice and the main aim of this and succeeding articles is to enable the listeners to make intelligent choice of future valves for their sets.

Examining the Stages.

Commencing at the input or aerial end of the business, and working through to the loud-speaker, examining each stage, will be examined in turn.

Taking the radio frequency amplifiers, then there are usually two of these valves ,the output of the first usually being fed into the second through a radio frequency transformer. This transformer consists essentially of two coils of wire: that containing the fewer number of turns being included in the plate circuit of the first valve, and the other winding forming part of the grid circuit of the succeeding valve.

Although there is a step up ratio of turns from primary or plate coil to secondary or grid coil, practically no voltage increase takes place in the radio frequency transformer itself, so that we are almost entirely dependent on the valve alone for the amount of amplification obtained in this stage. Consequently, to obtain maximum results a valve with a large amplification factor is needed. This is, however, not the only factor concerned, because wherever energy is transformed from one circuit to another, the relative impedances of valve and coil have a decided effect on the voltage transferred to the second circuit.

Now most high amplification valves have a high impedance. This is not in itself a serious objection in a radio frequency amplifier, b t the number of turns provided in the primary winding of the transformer is frequently insufficient to enable a high impedance valve to work to full efficiency through this particular transformer.

This could, of course, be rectified by adding more turns to the primary of the transformer, but where a receiver has been built for low impedance valves in the radio frequency amplifier, it is obvious that making this alteration will not appeal to the average owner.

Consequently in some receivers full advantage cannot be taken of a high amplification factor, high impedance valve. Under these circumstances it is wise to choose the valve that combines the highest amplification factor with low impedance. It is possible to get valves with an amplification factor as high as 15 and the impedance yet under 7000 ohms.

Howling.

THERE is one further point in connection with the choice of a radio frequency amplifier and that is the means adopted in the set to keep the radio frequency from oscillating, and distorting the reception and annoying our radio neighbours.

The substitution of a more efficient valve in a radio frequency socket may make the set uncontrollable, in such a case do not discard the better valve, but have a competent person reneutralise the set to take the better valve.

Turned Anode Coupling.

WHILE most sets use this transformer to couple the valves together, and are referred to as transformer coupled sets, there are some which use a different system known as "tuned anode" coupling. The primary and secondary windings in this case combined into one winding tuned by a condenser.

With tuned anode coupling the impedance of the coupling is high and it is not detrimental to use a very high impedance valve, provided the amplification factor is correspondingly high, the impedance of such a valve may rise to 30,000 ohms a. the amplification factor be as much as 35..

Our next talk a fortnight from tonight will deal with detectors and audio frequency amplifiers. In the meantime I wish you good-night.

In his next lecture on Saturday, November 24, Mr. Dawson will deal with detectors and audio frequency amplifiers.