

Characteristics of Valves--Valuable Lecture for Listeners

THE purpose of my series of lectures from this station (said Mr. Dawson) is to explain in a simple, non-technical and I hope palatable manner, some very important considerations in the correct choice of valves and associated apparatus used in your receiving set, and to draw aside the veil of mystery which to many surround that real brain of the set, the valve.

Please have by you the sketch marked Fig. 1, on page 8 of the "Radio Record" of September 14, for as a preparatory study we will to-night consider the construction and basic action of the ordinary three electrode valve.

That familiar silvery-lined glass bulb contains in a high degree of vacuum three essential elements or electrodes as they are called, the filament, the plate, and the grid, each of which connects to a pin or pins in the base of the valve, and each of which has its associated circuit named after the electrodes, the filament circuit, the plate circuit, and the grid circuit.

The filament is very similar to that contained in an ordinary electric lamp. Its purpose is, however, not to emit light, but electrons, which we may regard as being very minute particles of negative electricity. When the filament is heated by turning on the receiver switch and causing a current from the A battery to pass through it, particles of negative electricity may be expelled from the surface of the heated filament. The number of electrons which it is possible to expel depends on factors relating to total emission. For the present it will suffice to regard the filament as a source of electrons which are particles of negative electricity.

THE filament circuit commences at the negative pole of the A battery up the negative leg of the filament, down the positive limb to the positive of the A battery, and through the battery itself to the original starting point.

Surrounding the filament of some little distance from it is the "plate" or "anode," consisting of a thin sheet of metal, usually of nickel, tungsten, or molybdenum. The purpose of this plate is to attract to it the electrons emitted by the filament and to enable it to do so it is given a positive electrical charge by connecting to it the positive

Speaking from 2YA on Saturday, September 15, Mr. W. M. Dawson (technical engineer, Phillips Lamps, N.Z., Ltd.) inaugurated a series of lectures on aspects of radio that will be of definite instructional value to listeners. The series will be continued at fortnightly intervals. The addresses will follow the news sessions and precede the evening programmes.

terminal of the B battery as shown in figure 1.

In this diagram you will be able to pick out the elements of the valve (F for filament, G for grid, and P for plate). You will also notice some small crosses or plus signs on the plate; they indicate a positive charge, also near the filament you will see small minus signs inside circles; they represent negative electrons.

NOW it is a well known electrical principle that like electrical charges repel one another, and that unlike charges attract. So that as the plate is positive it will attract the negative electrons which will travel across the intervening space between filament and plate returning via the telephones and B battery to the filament which originally emitted them. This then constitutes the plate circuit, and the purpose of the plate is to attract the electrons emitted by the filament.

The third element of the valve is the grid. It surrounds the filament closely, that is, between the filament and the plate. The grid consists of a spiral cage of fine wires of nickel or molybdenum. As the grid is placed between filament and plate the electrons in their travel through space must on their way to the plate pass between the turns of wire forming the grid, and the grid is so placed that it may effectively control the flow of electrons from filament to plate.

If we place a positive charge on the grid there will be an added attraction drawing the electrons towards the plate, some will flow to the filament via the grid, but the main effect will be to increase the flow from filament to plate.

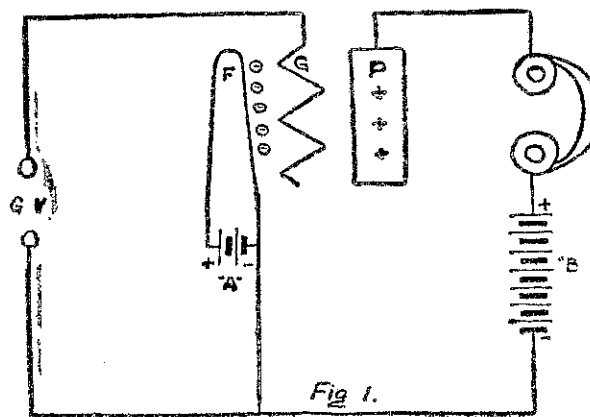
Conversely, if we place a negative charge on the grid the negative grid has the effect of repelling the negative electrons and many are driven back to the filament instead of reaching the plate, so that the nature and amount of charge on the grid controls the flow of electrons to the plate.

THE grid circuit commences at the negative end of the filament, goes across through space to the grid down to the terminals marked G.V., through whatever coil or transformer winding is connected to them and detuning again to the negative end of the filament.

Now the valve manufacturer generally wraps round each individual valve a data sheet giving certain information on the working of that type of valve.

The table printed below figure 1 is just such a data sheet, except that actual valves have been withheld. The first on the list is filament voltage. This determines the number of cells required in the A battery valves maybe

obtained to work from 2, 4, or 6-volt batteries, the figure given by the data sheet refers to the voltage actually impressed across the filament, for example, certain valves consume a quarter of an ampere of current at 5 volts. In this case the filament current is supplied from a 6-volt battery, the excess voltage, in this case 1 volt, being dissipated or "dropped" in the rheostat which may in your set be marked "sen-



This illustration has reference to the characteristics of valves, and will enable the lecture to be followed more closely. The factors of valves are set out below. This information should be held available for future lectures:—

Filament voltage	Vf
Filament current	If
Anode voltage	Va
Total emission	is
Amplification factor	g
Mutual conductance (Slope)	S
Internal resistance	Ri
Negative grid bias	Vg
Normal anode current	Cag
Largest diameter	d
Length	l

sitivity," "volume," or "battery." Some valves are made to operate directly from the battery without the necessity of using a rheostat. As each cell in your A battery gives approximately 2 volts it will be easy to determine how many cells are required to work a given series of valves.

In general it may be fairly stated that valves operating from 4 to 6-volt batteries give superior results to those operating from 2-volt batteries.

THE next term on the list is filament current. This factor decides the capacity or size of each cell in the A battery.

Modern receiving valves vary in their filament current appetite between a quarter and one-sixteenth of an ampere. Expressed as decimals these are, of course, .25 and .06 ampere. Naturally the smaller the filament consumption the smaller the permissible size of

the A battery or the longer a given battery will last on one charge.

The former means a saving in the initial cost of the battery and the latter a saving of upkeep cost and considerable fatigue where the user does not possess a battery charger and requires to take the battery to a service station to be charged.

A heavy filament current does not in any way imply better results, in fact, as a result of scientific research the filament current required for a valve has declined in successive steps from 1 ampere to $\frac{1}{2}$ ampere to $\frac{1}{4}$, $\frac{1}{8}$, and now 1-16 ampere, and the filament of the last-named type is much more efficient than that of the old 1 ampere type.

THE third factor we are going to deal with is total emission, as it also has to do with the filament. This factor is a measure of the total number of electrons which may be emitted from a filament at normal temperature.

The older types of valves, called bright emitters, operated at a dazzling white heat; with them the number of electrons that could be emitted increased rapidly with filament temperature increase right up to that sad moment when the filament melted or burnt out, as it was expressed—with sundry other expressions generally more forcible than polite.

With modern dull emitter valves the normal operating temperature of the filament is much lower and if the temperature is steadily increased a point is reached long before the filament melts, beyond which no increase in electron emission results. This maximum electron flow is termed the total emission. It is measured in milliamperes, that is, in thousandths of an ampere. A valve should have a high total emission in order that it may have a reasonably long useful life and this is made possible in modern valves by the use of certain rare metals such as thorium alloyed with the tungsten of the filament. By this means the electron emitting ability of the filament is increased some 16 times.

THE measure of efficiency of the filament may be expressed in milliamperes, emitted per watt of filament power and this may be found by multiplying together the filament voltage and amperage and dividing this product into the total emission in milliamperes.

My next talk will deal with characteristic curves, how to read and analyse them and the meaning and importance of such terms as amplification factor, internal resistance slope, etc. This talk will take place from 2YA on the evening of Saturday, September 29.

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