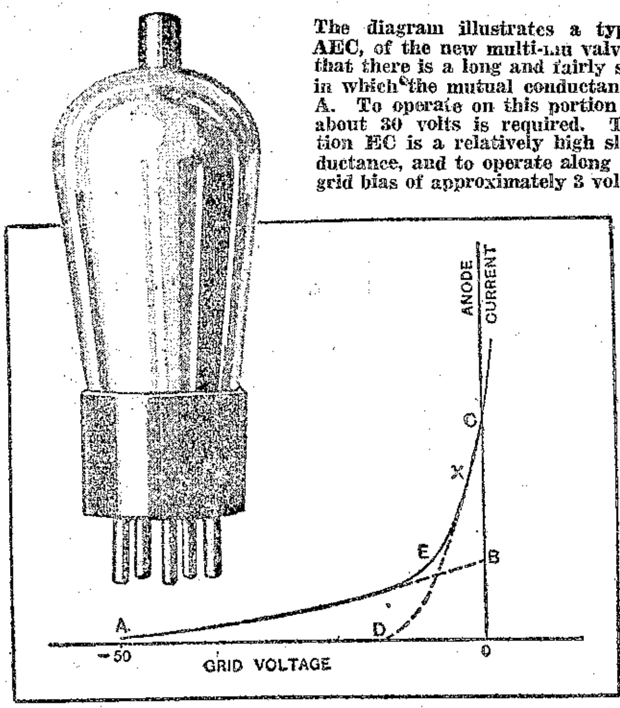
The VALVE—What it Is—and Does

Characteristic Terms Explained

SINCE valves are very different from one another, we must have some means of illustrating the points of difference, so with each valve is a set of characteristics. A typical one accompanies this article. Let us go through the items and see what they all mean. The most important undoubtedly is the filament or heater volts. If we do not know this we can ruin our valve in a fraction of a second. In the "filament" in the case of battery valves and the "heater" in the case of a.c. valves is the first of the three elements in the average valve. It is a piece of fine wire which, when hot, emits electrons—they are the little things that do all the work in the valves. In battery valves the electron emitting substance is heated directly with the current. With the a.c. valves the substance is close by the wire that carries the heating current. This body is known as the "cathode," whereas the wire carrying the current is known as the heater. It is the same as the filament of the ordinary valve. The filament in the ordinary valve, remember, incorporates both cathode and heater. This filament or heater has a certain resistance and if a higher voltage is used than the manufacturers recommend, more current will flow through than is supposed to, but it will only carry a certain current with the result that it burns out and the valve is useless.



The diagram illustrates a typical characteristic AEC, of the new multi-mu valves. It will be seen that there is a long and fairly straight portion AE in which the mutual conductance decreases toward A. To operate on this portion a high grid bias of about 30 volts is required. The short deep portion EC is a relatively high slope or mutual conductance, and to operate along this portion a small grid bias of approximately 3 volts is required. If an orthodox double characteristic is obtained by combining the electrodes of a high new valve BD, with the slope of a low new valve AC, the general characteristic is then AEC.

Plate Voltage.

THE plate (anode) voltage is that which is applied to the third electrode, the plate or anode. As the direct current has to pass from the plate to the filament, across the vacuum, while not as critical as plate voltage, the maker's recommendation should not be greatly exceeded.

Grid Volts.

THIS relates to the number of negative volts (usually small in comparison with the plate voltage) that are applied to the third element or grid of the valve in order to keep it charged negatively. By so doing we can control the electron flow. This is important if quality and economy are desired.

Screen Grid Volts.

THIS relates to the voltage to be used on the extra grid in the special screen grid, variable mu or pentode valves. It is sometimes referred to as the auxiliary grid. It, like the plate, completes the circuit through the vacuum of the valve.

Plate Resistance.

THIS refers to the resistance or impedance the valve offers to current passing between the plate and the filament. The impedance of a valve can always be found by dividing the change in the plate voltage with the change in plate current.

Plate Current.

THIS indicates the amount of current that the valve will pass from the plate to the filament when the recommended plate voltage is used. The same applies to "filament current," but referring, of course, to the filament.

Mutual Conductance.

AS the grid of the valve is made more negative with respect to the filament, the plate current decreases, and vice versa, and it is the ratio of changing grid voltage to plate milliamps which denotes the mutual conductance.

Let us refer to the characteristic curve reproduced on the next page. The vertical lines represent current flowing in the plate circuit and the horizontal lines grid bias volts. Thus with this valve when there are 8 volts bias five mils will pass if there are 150 volts on the plate, and one mil if there are only 100 volts on the plate. From the 150-volt curve we see that by applying 4 volts bias we reduce the plate current from 16 (at 0 bias) to 10 (at 4). Thus 4 volts bias reduces the current by 6 mils. Therefore the mutual conductance in 6÷4=1.5. It is expressed in milliamps per volt, or ma/v.

The Americans use the term micromhos. The mho, which is the reciprocal of an ohm, is measured by dividing the amplification factor by the impedance. It is usually expressed in micromhos—a millionth of an ohm. To calculate conductance in micromhos multiply the amplification factor by a million and divide by the impedance. This is sometimes referred to as transconductance.

Amplification Factor.

THIS is the ratio of a set of grid and plate voltages to plate current. For instance, referring to the curve, we see that at no grid volts and 150 plate volts our valve takes 16 mamps of current. If now we add 5 volts bias, we reduce the plate current to 8. This is the same as 100 volts without bias. In other words, 5 grid volts are equal to 50 volts on the plate, therefore the amplification factor is 10.

Impedance.

THE impedance of a valve is ascertained by the ohms law, which states that the value of current flowing in a circuit measured in amps is equal to the voltage dropped in that circuit divided by the resistance (in ohms), or, putting it down more clearly, C=E÷R.

This can be applied to the valve, but we must take figures relating to changing current It will be seen that at zero grid volts an increase of 50 volts on the plate (for 100 to 150 volts) brings about an increase of 8 mamps. (8 from 16), so from rewriting our formula we get 50 x 1000÷8, which gives us an impedance of 6300.

Choosing a Valve.

HAVING briefly dealt with the main characteristics of the valve, it is necessary now to consider the points one has to bear in mind when a valve has to be chosen. First, there is the filament voltage, and this depends entirely upon the means at our disposal. If we have a six-volt accumulator we will use 6-volt valves. If we have a 2.5 power transformer we will use 2.5. a.c. valves. The next is the filament current. This is not at all important in a.c. valves providing the secondary of the power transformer is wound with sufficiently heavy wire to carry the current required. With d.c. valves one has to depend upon an accumulator and a dry cell, therefore it is important. Especially if dry cells are to be used, valves taking more than .06 to .1 should not be used. The .1 valve will place a very heavy drain upon dry cells if more than two are used. There are very many valves now with characteristics below .06 filament amps. The last valve is rarely a .06 type, and almost invariably requires at least .1 (.06 type valves can be obtained in 2, 4, and 6-volt filament voltages, and of English, Continental, and American makes). It