Findings of Australian Commission--Professional Trio for 2YA--The Church and Broadcasting--Listeners' Conference

THE RADIO RECORD

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The Why of Wireless

Interesting Series Setting Out Scientific Facts Simply

(By "Electron.")

PART V.

The plate current, although dependent on the plate and grid voltage, cannot be increased indefinitely. With a given filament brilliancy the number of electrons shot off per second is limited, and when all of these reach the plate no increase of plate pressure will increase it. The value is then said to be delivering its saturation current. The saturation current can be increased by passing more current through the filament, thus increasing its brilliance, but this is obtained at the expense of the life of the valve.

THREE ELECTRODE VALVE AS AMPLIFIER.

This piece of apparatus has so many uses that the name "valve" is too limited, and the American appelation, "tube," is better. The term "valve," however, is still used in England.

When the voltage between the grid and filament is gradually varied, the repulsive action of the grid on the electrons is gradually varied in the same way, so that a feeble current in the aerial circuit will produce a much larger current of exactly the same kind in the plate circuit.

When one considers the exceedingly complex form of sound wave coming from, say, an orchestra, and that the current from the microphone is amplified by valves several times in succession at the studio, sent up to the transmitting station by telephone wires, amplified there by more valves, and then broadcast, amplified, perhaps, another six times in the receiving set, the wonder is, not that the signal is slightly distorted, but that it should be recognisable! This will show that the modern amplifying tube is wellnigh perfect.

It has uses other than in wireless telephony. It is used frequently in long telephone lines overland, where the resistance of the wires would cause the messages to become too faint. In this way very much smaller and thinner wires can be used, and the saving in copper is many times greater than the cost of the valves.

DULL EMITTERS.

The ordinary valve filament has to be raised to a high state of incandescence before it will emit electrons in sufficient quantity. The filament, as a matter of fact, burns more brightly as a valve than does the ordinary electric lamp for illuminating purposes.

It was found that if the filament were coated with the metal thorium (a metal closely allied to radium) this thin coating would give off electrons in as great a quantity when it was operating at a dull red heat. A valve of this type is known as a "dull emitter," and has the advantage of requiring much less power to operate it, as well as having a longer "life."

The dull emitter must not be run higher than its rated voltage, as the coating will be burned off, and it will thereafter have the characteristics of a bright emitter. If a dull emitter of 1 volt is given the full pressure of a 2-volt accumulator, the result would be the same as trying to run a 100-volt lamp off the 200-volt mains.

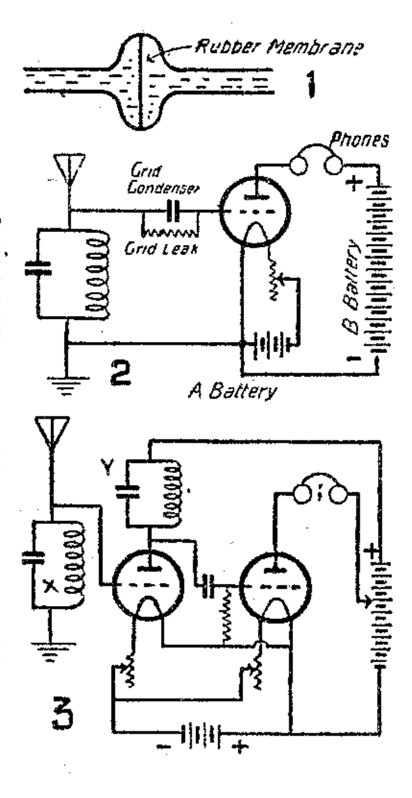
The dull emitters have been condemned as being "microphonic." What is meant is that if the valve is tapped or jarred when alight, it will cause a peculiar singing or twanging sound in the phones. The reason for this is that the filament core is made of a very hard metal, which at the dull red heat is still considerably "springy." When the tube is jarred the filament vibrates to and fro, and the relative movement of filament and grid causes a variation of plate current, with the aforementioned effect. The filament of the bright emitter is quite soft at its working temperature, and does not vibrate when jarred. This tendency of dull emitters can be nullified by using some feet of rubber for the set, if these noises are prevalent, but in the vast majority of cases no trouble will be experienced.

Dull emitters will be found to give off a small plate current, even when cold, so that it is advisable to disconnect the "B" battery when the set is not in use, in order to prevent it being run down needlessly.

Later advances by the manufacturers have produced a valve which operates at a temperature so low that it is not even red. These valves are the true "dry cell" valves, and no accumulators are necessary at all. These valves are particularly useful for owners who are an inconvenient distance from battery charging stations, and who have no "battery charger" of their own.

THE VACUUM TUBE AS DETECTOR.

In the preliminary discussion on three electrode tubes it was stated that when the grid is made positive it will cause a large increase of plate current, and if made negative it will decrease the plate current.



When the tube is required to act as a detector (that is, as a non-return valve) the characteristics required are that normally no current should flow in the plate circuit and when the grid becomes positive a current will flow, the value of this current being of course proportional to the voltage of the grid. When the grid becomes negative it must suddenly stop all plate current from flowing.

Tubes can be manufactured quite easily with these characteristics, but they must be used in a special way. Firstly, the plate voltage should be low—just about 25 to 30 volts, otherwise the attraction of the plate for the electrons will be greater than the repulsive action of the grid when it is a negative, and the tube will cease to rectify. Secondly, the grid for this purpose should be slightly positive, and this is obtained by means of a small condenser called the grid condenser. The capacity of this condenser is exceedingly low, about .0002 of a micro farad, and its action is that while it allows the high frequency currents to flow (as explained in a previous article), it will not allow the electrons which have collected on the grid to escape.

The action of this grid condenser in allowing the high frequency currents to pass "through" it is very similar to a thin membrane of rubber in a water pipe, figure I. If the water is forced from the left the membrane will stretch or yield to the right, but as soon as the pressure is released it will come back to its vertical position. If the right hand side is compressed the membrane will stretch towards the left. If now the water is alternately pushed and pulled from, say, the left, it will cause all the particles of water to oscillate to and fro along the pipe, and to this motion the membrane will offer practically no resistance. It will, however, effectually prevent a steady flow of water from traversing the pipe.

The grid condenser therefore will allow the grid to have its pressure raised and lowered just as if it were not there, but will keep the electrons on the grid and thus have it always slightly positive.

In order to prevent the grid from becoming too positive (due to fresh electrons alighting on it every time it rises in pressure) they are allowed to leak away slowly through a very high resistance connected across the plates. The value of this resistance is in the vicinity of one million ohms which, for convenience, is called one megohm. The actual value of this "grid leak" must be adjusted to suit the particular valve and sometimes rises to as much as 5 megohms.

The arrangement of a tube fitted with grid condenser and grid leak to form a single valve detector is shown in figure II, which should now be self-explanatory.

THE HIGH FREQUENCY AMPLIFIER.

The detector valve described in the preceding paragraph is perfectly satisfactory if the signals in the aerial are loud enough to be heard in the 'phones after detection. If the distance from the broadcasting station is too great, then the signals must be amplified before being applied to the detector and the tube arranged for this purpose is called a high frequency amplifier, since it amplifies the high frequency waves just as they are received from the aerial.

The arrangement is shown in figure III. The feeble high frequency currents in this case go straight to the grid of the first valve and correspondingly, but much magnified currents flow in the plate circuit. Note here that these plate currents are still of high frequency, and therefore must still be tuned so that another coil and condenser are required as shown at Y. For certain reasons to be explained later it is illegal in New Zealand to connect the grid to the aerial direct, but these diagrams are explanatory only.

These magnified high frequency currents flow through the grid condenser to the grid of the second valve, where they are rectified as previously described.

Several new points are of note. First the pressure of the plates of these two valves should not be the same, so that separate contacts have to be supplied. Secondly, if the grid leak were connected straight across the grid condenser it would raise the grid of the second valve up to that of the plate of the first. This would obviously render the second valve useless, and therefore it is connected straight on to the filament. Thirdly, it will be seen that the same "A" and "B" batteries can be used for both valves, although the actual pressures and currents are not the same. The brilliancies of the filaments are regulated by means of the variable resistance shown in the negative side of the filaments.

The two-valve set shown in figure 3 will bring in distant stations quite clearly, but perhaps somewhat faintly. We could strengthen the signals further by adding another high-frequency valve before the detector, but this is not advisable for several reasons. First, if we add more H.F. stages of amplification we must necessarily increase the number of controls, since each H.F. valve must be tuned. Secondly, the amount of amplification thus obtained is not so great as can be obtained by amplifying the signals after they have been detected, because all the wires in the H.F. side act like little condensers if they run parallel to any other wires, with the result that the electrons are tempted to stay at all corners or where the wires are in close proximity to others. This property is so pronounced that it has been found that a considerable increase of signal strength can be obtained by winding the tuning coils as an open helix with a space between each turn. In fact, the main difference between the popular Browning-Drake and many other sets is merely in the design of the coils. This is what is meant by the phrase "low loss coils."

Both Aerial and Earth should be Carefully Insulated

Reception will be Materially Improved

An American authority makes out a case for thorough insulation of the earth wire as well as the aerial. He says that the radio user who desires efficiency, volume, range, and selectivity cannot attach too much importance to insulation of the aerial and earth wire.

As the collector of feeble radio impulses, the aerial is of supreme importance, and on a par with it, in carrying away the waves after they have been through the receiving apparatus, is the earth connection.

An analysis of radio broadcasting will, very probably, explain this most clearly. The wave that is sent out from a broadcasting station travels over an ever widening area, gradually becoming weaker and weaker as it goes hundreds or perhaps thousands of miles through more or less absorbing atmosphere and over imperfectly conducting ground.

Sensitive Aerial.

The receiving aerial may be pictured in the mind as the "fingers of the air." To make use of this feeble impulse, the aerial must be sensitive. Once the waves strikes the wire, it begins a journey to the receiver that may be as weakening as the projection from the distant broadcasting station.

The main cause of this weakening is poor insulation. A point of poor insulation is a point where there is a "leak." That is, the current is able to flow off the aerial wire and into the roof or the walls of the house. This involves a loss which manifests itself in weaker signals.

Use Best Insulation.

Impulses picked up by a distant receiver are so very minute that the most effective collective device possible should be used, and every possible method of insulation be utilised in order to give them a "clear track" into the set. When an aerial is on the roof, the lead-in should be held away by insulation from the sides of buildings. The lead-in should also be run through the wall or window with a porcelain tube or like insulation.

To Avoid Losses.

Inside the room short leads are best, but regardless of whether the lead is long or short, it should be insulated just as well as the wire on the outside of the house or apartment. The popular theory that inside or outside wooden, stone, or brick walls will not deduct from the efficiency of an aerial is false. The radio listener who has his lead-in tacked to the surface of a building may not think that power is diminished, yet there is probably a loss here that is reducing his range and selectivity. Even if the wire has an insulating covering it should not be run directly against a wall. The very proximity of the wall may cause a loss.

Insulate Earth Wire.

After passing through the receiving instruments the signal currents flow into the ground, and here insulation is again highly important. At first sight it seems unimportant by what path the impulses get into the ground. One would think that the more paths that were provided the better. This, however, is not the case. Only one earth should be provided, and that one the best earth available.

The important thing about the ground connection is that it have as low a resistance as possible. High resistance reduces the signal strength. The singular thing about radio currents is that they do not follow the path of least resistance. The word resistance is here used in its technical sense of electrical resistance. They follow the easiest path, to be sure, but this is not necessarily the path of least resistance. The easiest path for radio currents is the shortest path. We can, therefore, have the following queer condition:

Suppose a radio receiving installation has two earth connections, one near the receiver and the other at some distance from it. Most of the signal current will flow into the ground through the nearer earth connection. Very little of it will flow through the distant earth connection. If, therefore, the nearer earth connection happens to have a large resistance, the signal strength will be reduced. Now, if the nearer earth is removed the current must flow through the distant earth connection—it has nowhere else to go, and if the resistance of this ground is low the signal strength will be greater than when there were two grounds.

The practical application of all this is to be sure to support the ground wire on insulators up to the point where it is connected to ground. Water pipes are about the best thing on to which to connect the ground wire, and the connection at this point should be as positive as possible.

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