The Fading Question--Children's Sessions--How To Entertain With Radio--Advice To Novices

THE RADIO RECORD

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The Why of Wireless

Interesting Series Setting Out Scientific Facts Simply

(By "Electron.")

In this series of articles "Electron," who is a Bachelor of Science, is explaining in simple language the fundamental principles of wireless. This is the fourth of what is proving an interesting series, which has yet to be concluded.

Part IV.

THE DETECTOR.

We have now reached the stage of the modulated or compound wave flowing up and down the receiving set. The question now is—where will we place the 'phones? If we place them in the aerial or anywhere in the main wire, no signals will be heard. Why? Because of two reasons. (1) The telephones have hundreds of turns of wire round the magnets and if that is placed in the aerial the result will be immediately to alter the "tuning" of the set. (2) It has been pointed out before that the telephones, consisting as they do of many turns of wire, will form a "choke" coil and will absolutely prevent the carrier wave from flowing.

We might get over the first objection by placing the 'phones as shown in figure 1*a*, but the second objection is a much greater one. This was the trouble which caused all the delay to early wireless investigators. Many different methods were tried, but the most successful by far was the crystal. When connected as in sketch 1*b*, several crystals when properly connected have the peculiar property of allowing electricity to pass fairly easily in one direction, but almost totally preventing it from flowing in the reverse direction. The crystal acts, therefore like a non-return valve and the result is to reconvert the high frequency modulated current into a low frequency audio current similar to what flowed in the microphone in the studio. This is shown in figure III. The currents are in the first place little independent pulses as shown by the areas shaded vertically in figure III. These pulses are smoothed out into the curve under the slant shading of the same figure just in the same way as the explosions in the cylinders of a motor-car are smoothed out into a steady force. This is the reason for the so called telephone condenser shown in the figure and frequently recommended in various circuits. However, it is rarely necessary, as the flexible leads to the 'phones or loudspeaker form a condenser themselves.

The reason for the crystal behaving in this way is not clearly known, several reasons having been put forward. Several crystals and compositions have been used, but at the present time only two forms have any large vogue—the galena and the corborundum. Galena is sold under various trade names and is a compound of lead and sulphur, being of a slate grey colour. The usual method of mounting is to fasten the crystal in a metal cup with screws, clamps, or by means of a metal of low melting point. The other contact is by means of a wire of very small diameter. In fact, the smaller this contact is the better will the crystal function.

Carborundum or silicon carbide is a manufactured article consisting of carbon and silicon. Its main advantage is that the pressure of the contacts can be quite heavy—several pounds, in fact—so that there is no danger of the contacts slipping. This gives us the permanent detector, that is, a detector whose adjustment is made once for all. In the galena crystal the fine delicate contact for the "cat-whisker" has a tendency to slip, and as some points are more sensitive than others this leads to a somewhat tedious hunt for sensitive spots. The main disadvantage of the carborundum detector is that for maximum sensitiveness a constant electrical pressure from a local battery has to be supplied, and this reduces the simplicity of the set.

THE EDISON EFFECT.

When Edison was carrying out his experiments with electric lamps he introduced into one of the lamps a little sheet of metal connected with the outside of the globe, as in figure 4. He found that on connecting this plate to one end of the glowing filament with a wire that a small electric current flowed from the filament to the wire connected to the plate, but not in the reverse direction. Now this is remarkable, because the space round the lamp is practically a perfect vacuum, so that it would seem that it is impossible for electricity to flow through a perfect insulator.

Edison, however, saw no immediate use for the discovery, and after merely noting it, proceeded with the perfecting of the lamp for lighting purposes.

THE FLEMING VALVE.

Several years later Professor Fleming, of England, took up the study of this "Edison effect," and after going into the matter thoroughly came to the conclusion that the reason for this peculiar current was that the glowing filament is so intensely hot that the atoms composing it are in a state of great agitation something like a pot of boiling water. The result of this intense atomic agitation is that many electrons are shot off into space and many of them finally arrive on the cool metal plate. We have, therefore, a stream of electrons shot off from the hot filament and arriving on the plate. This, as has been explained before, constitutes an electric current and in the conventional way we say the current flows from the plate to the filament. It will be remembered that this happening was hinted at in the first of this series. If it is grasped that the electron flow from the filament to the plate and the conventional direction of the current is in the opposite direction, then the main difficulty has been surmounted.

Note that this effect takes place only when the filament is lit. It is the heat which causes the electron flow. Also the effect can only be noticed if the plate and filament are in an almost perfect vacuum.

Fleming, being occupied with wireless, saw at once the immense importance of this new principle. Owing to the stream of electrons passing in one direction only it is clear that if an oscillating electrical pressure is applied to the plate and filament the apparatus will act as a non return valve just like the crystal. Fig. 5.

The "valve," as it is called, has several great advantages over the crystal. (1) There are no sensitive or dull spots, so that no searching with the cat-whisker is necessary. (2) As long as the valve is alight we know that the set is ready for reception. (3) The current from the aerial is supplemented by the electron flow from the filament, so that the valve has a magnifying or amplifying effect as well as its legitimate one of rectifying.

OTHER USES OF FLEMING VALVE.

The Fleming valve just described was soon displaced by an improvement, but before we go on to discuss this it will be advisable to study other applications of the pure Fleming valve. Its main use is to change alternating or oscillating current into steady or direct current and therefore it has come into prominence as a simple and cheap way of converting the alternating current of the domestic supply into direct current for charging accumulators. These rectifiers go under various trade names, such as "Tungar," "Rectigon," etc., but fundamentally they are simple Fleming valves constructed to deliver a fairly heavy current at a low voltage

This type of valve is also used in transmitting stations to produce the high direct pressure necessary to operate the transmitting valves.

THE DE FOREST VALVE OR TRIODE.

The Fleming valve is sometimes called the two electrode valve because there are two separate constituents—the filament and the plate. It was found by de Forest, of America, that the usefulness of the apparatus could be very much increased by adding a third electrode midway between these two. This third electrode is made of wire gauze or a spiral of fine wire, as is shown in figure 6, and from its appearance is called the grid. Figure 6a shows the working parts of a small valve with the front half of the plate removed. The plate is always made to surround the filament entirely in order to collect as many of the electrons as possible. Figure 6b shows how the valve is drawn in diagrams for the sake of clearness, but, of course, this would be very wasteful because of the loss of electrons downwards.

The efficiency of this type of valve is increased greatly by use of a second battery connected between the plate and the filament as shown in figure 7. This battery is connected with its positive terminal connected to the plate, and this will be seen to draw all the electrons towards it. The pressure of this battery may vary from 20 to 100 volts, depending on the valve and the use to which it is put.

We have then a stream of electrons flowing steadily from filament to plate, and, of course, these electrons have to pass through the spaces in the grid. Normally the grid is neutral, that is, it takes no active part in the flow of the electrons, but if the grid is made negative the effect will be to repel the electrons, which will therefore be unable to pass through to the plate.

The three electrode valve therefore is more than a non-return valve. It is rather somewhat like a tap which can turn on or off at will a strong flow of water.

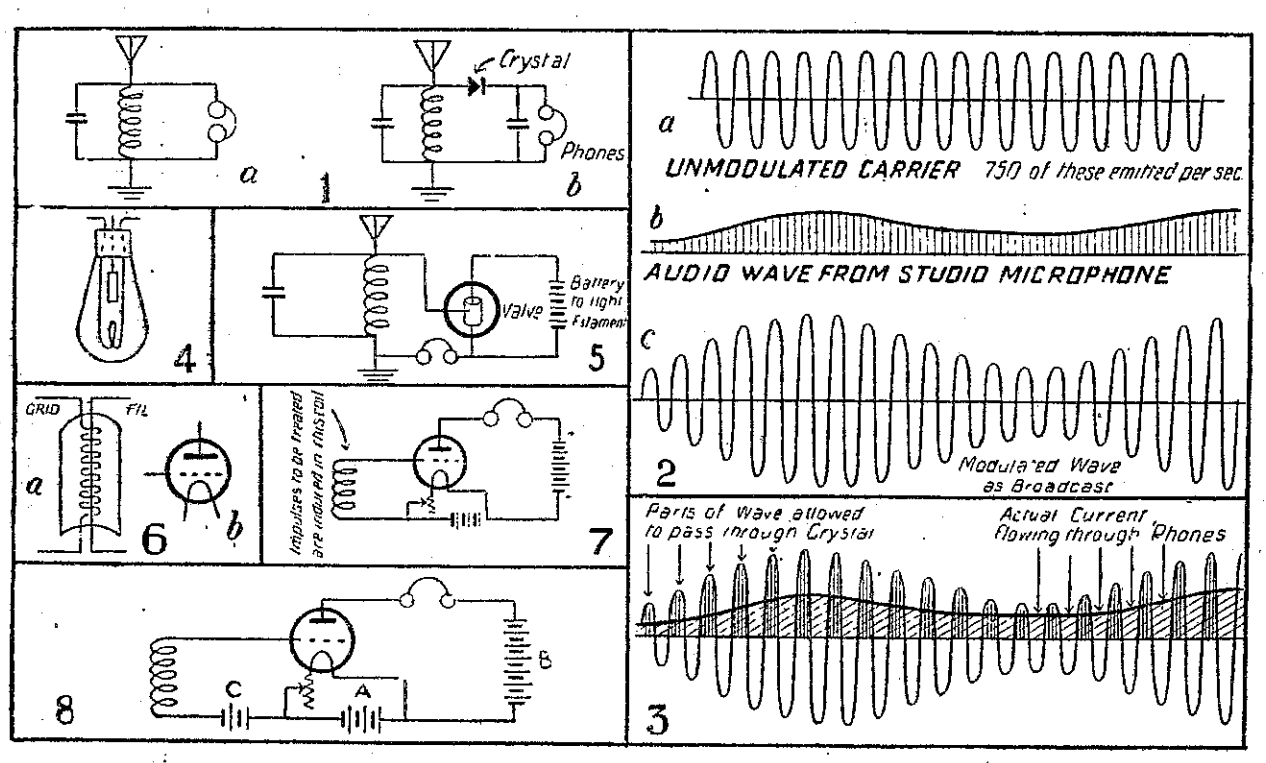
Notice that the aerial current does not pass through the 'phones any longer—it is merely used to operate the grid, and it should be further noted that the grid is "pressure operated," that is, it does not require current to operate it, but merely a small increase or decrease of electrical pressure.

In one type of valve if the pressure across the plate and filament is 100 volts, it is found that a pressure of 10 volts between the grid and filament will be sufficient to totally stop the plate current, so that a pressure of 10 volts on the grid is equal to 100 on the plate. We have therefore a means of stepping up the voltage 10 times.

If now the grid is made positive with regard to the filament, the grid will behave like a small plate, and will attract still more electrons from the filament. The disadvantage of this state of affairs is that when the grid becomes positive some electrons will flow on to it and will remain there. Note that when an electron alights on the grid it will not be shot off towards the plate unless the grid is white hot as well as the filament. As this is never the case, it follows that when electrons are attracted to the positive grid they will remain there, keeping the grid positive and preventing it from varying in pressure as it should. When the grid becomes positive, therefore the signals become distorted, and the musical quality is much poorer.

Care should always be taken to keep the grid always negative with regard to the filament, and this is usually done by means of a third battery placed as in figure 8. For convenience in conversation, the batteries are given distinguishing letters. The battery used for lighting the filament is usually of four or six volts, and is called the "A" battery. The second, for supplying the pressure to the plate of 20 to 100 volts, is called the "B" battery, and the third, for supplying the negative bias to the grid, is called the "C" battery.

(To be continued.)



These diagrams are explanatory of matter in the text of this article, Part IV of the series, "The Why of Wireless."

ELECTRICITY IN THE AIR

Recent studies of the electrical charge of the atmosphere, made by Dr. Bauer of the Carnegie Institution, have shown that the increase with elevation of the normal voltage of the earth's atmosphere (as compared with the negatively-charged earth) varies with the time of year—being greatest when the earth is nearer the sun, as from October to March, rather than from April to September, when the earth is in the more elongated portion of its orbit. This is independent of the seasons, which are reversed in the two hemispheres. At the present time researches are being made into the problem of the solar cycle—that is to say, the approximate eleven-year period during which the prevalence of sunspots waxes and wanes. A number of years will be required to answer this question satisfactorily; and then the problem will assume the larger phase of a secular one, which part of a century may be needed to work out.

Importance to Radio.

While these considerations do not bear directly upon radio, it is certain that their solution will add data of importance to the understanding of many things connected with radio transmission and reception. While it is well known that the transmission of the magnetic waves of radio is affected by light, it has become certain that the "*potential gradient* of atmospheric electricity passes everywhere through extreme values during twenty-four hours at about the same universal times, irrespective of whether the observing station be enveloped by sunshine or darkness." This potential gradient has an average value of about 130 *volts per meter of vertical height*, being maintained by the great resistivity of the air. It may be doubled, and almost disappear again during each daily cycle, particularly in inland regions; but whether this electrical charge on atmospheric particles is renewed by solar, or more distant, radiation had been a matter of discussion.

Atmosphere Charged.

The charging from the atmosphere of an insulated conductor or aerial is a phenomenon observed as early as 1752, long before the production of artificial electromagnetic waves. The fundamental explanation of the source and distribution of the earth's atmospheric charge, which may bear a relation to the asymmetrical position of its permanent magnetic field, may throw much-needed light on the question of the propagation and fading of radio waves.

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