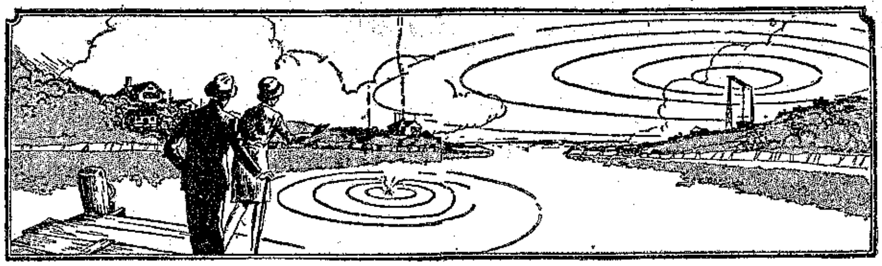
Music from the Air

How a transmitter and receiver works



described by Colin W. Smith from 2YA

In general principle the ripples made by waves or by a stone thrown into water are the same as the radio waves. This illustration shows the similarity.

YOU have all been to the seaside when the surf was rolling in with a great long line of breakers, and no doubt very many have seen light floating objects and noticed that they do not move in with the breakers but merely drift with the tide. This shows us quite clearly that the water does not move, except, of course, where it breaks, but that the waves are something different. They result from a transfer of energy from one place to another. The waves you witness on the seashore travel only a few feet a second, often not that.

Now we come to sound, which also consists of waves. Every time a sound is made some object vibrates and that makes the air vibrate; our ear receives the varying air-waves, and we hear. Again the air has not moved—it is that same mysterious transfer of energy, although in this case the sound travels just over a thousand feet a second.

In electricity and light the same phenomenon occurs. We still have the waves, but they travel at the remarkable pace of 186,000 miles a second. Again we must remember that it is not the medium through which they travel that is moving, but this strange nothingness called energy.

NOW we will return to the seashore. At different times the waves, according to the wind and tide, are different distances apart. On one day they might be separated by perhaps 10 feet, while on another 30. If we had the necessary apparatus we could measure the distance from the top of one wave to another, and we could conveniently speak of this distance as the wave-length. We could do the same with sound and electricity but, although the wave-length could be made to vary, the rate of travel remains the same. The breakers do not come in faster because the waves are closer together, but more waves come in.

We will now go right up the scale to the type of ray that is used for X-ray work. That is one of the smallest we know of, and there are just 25 billion waves or ripples a second, and from this remarkable number electricity although travelling at the constant pace, varies to below 20 waves every second. Your electrical supply travels in waves which leave the source at 60 to the second, and the hum you hear in your set is this turned into sound waves.

Between these two limits we have visible light at about 300 million waves a second, shortwave broadcasts take place on 20 million waves and broadcasting on one million. These figures are only approximate, and of course variations take place on either side. We speak of the number of waves a second as the frequency and so my voice is now being carried by electricity which travels at 186 thousand miles a second, and there are 720,000 waves each second, in other words 2YA's frequency is 720,000 cycles or 720 kilo (a thousand) -cycles. Now, if the distance between each wave were measured it would be found to be 416 metres; in other words, 450 yards, so that will give you some idea of the rate at which my voice is now travelling. These waves, all of which have more than 15,000 ripples a second, are called high frequency waves, and you will remember they were experimented with by Hertz, and have been called Hertzian waves.

They have remarkable penetrating power, for they can go underground, through space, through buildings, and through water.

It can be seen that the frequency multiplied by the wavelength must equal the speed of radio waves which always remains constant at 186,000 miles a second. This is the equivalent, roughly of 300,000,000 metres. Now putting that down in simple form we have

$$F \times W = 300{,}000{,}000$$

Now we can remember from our algebra that the following is the same thing stated differently:

$$F = \frac{300{,}000{,}000}{W} \text{ Cycles}$$

But we do not want cycles, so we divide the frequency and the speed of electricity each by a thousand, and we have:

$$F = \frac{300{,}000}{W}$$

$$\text{or } W = \frac{300{,}000}{F}$$

NOW sound, as I told you, is very much the same as electricity in its movements, but slower. The waves of audible sounds (that sounds Irish, but some sounds are inaudible) leave the object which is making that sound at a rate of between 25 and 15,000 a second. These have not the penetrating power of electricity, and consequently do not carry far. Broadcasting, in a nutshell, supplies a means of getting these high frequencies to carry the voice frequencies. If we have a coil of wire and a condenser, and induce a charge of electricity into it, this charge will surge backward and forward from one set of plates to the other, and will pass through the coil. So long as the energy is constantly supplied, this surging will be kept up.

Now, if the aerial is connected to one set of plates and the ground is to the other, the surging takes place just the same, and as it oscillates backward and forward it gives the aerial alternately a positive and negative charge. The number of waves leaving the aerial can be regulated by altering the value of the condenser or the coil, and the station will transmit on this frequency until either is altered. At the broadcasting stations there are many different circuits, and the final result is a strong charge going into the aerial and leaving it on a definite frequency—a definite number of waves a second. As I remarked before, the value of this current is varying regularly between positive and negative; in other words, it is an alternating current—perfectly regular in all ways. It was this current that Marconi used in his early experiments, and which is now used for Morse, but it is altered for ordinary broadcast.

THE microphone is a wonderful little instrument. At the present moment it is picking up the slow vibrations in the air caused by my voice. They are being strengthened by a valve which is tucked away in the microphone housing and taken into another amplifier until it is a very big voice indeed.

At this stage it is taken to the oscillating current which goes into the aerial, and in a very remarkable way it is super-imposed on it, and the wave now leaving the aerial is said to be modulated.

Your receiver merely reverses the procedure that is taking place in the broadcast station. You have a coil and a condenser, perhaps a coil only in the very simple sets. When the value of the condenser and the coil are at a certain figure, and this is the same as at the transmitter, your set and the transmitter are in resonance, and you can receive the waves from it. But it offers a very high resistance to all waves that it is not in resonance with, and that is why you cannot hear the other stations. It is really the case of a lock and key. From your point of view the key is the transmitting station and cannot be altered. But you have the power to alter the lock, so that you can admit one key and keep out all the rest.

THE power you receive from a transmitting station is very small. It can be measured only in thousandths of a volt. If you connected a pair of telephones (or earphones, as they are generally called) to this tuned coil and condenser you would hear nothing, though the energy is undoubtedly there. No it is travelling through space at a rate too fast for the diaphragm, that is that thin piece of metal in the earphones, to respond to. The slow speech vibrations which are imposed upon the faster ones must be stripped away, and this is the function of the detector. Now I told you last time the interesting times some of the earlier experimenters had in trying to find a sensitive detector, but when you come to consider there are only thousandths of a volt of energy obtainable, you need something fairly sensitive to receive them.

The crystal is one of the best detectors. It will strip away high frequency and leave the low, but the sound waves have been converted to electrical waves, and before we can hear them they must be changed back to sound waves. This is the function of the phones or loudspeaker. The crystal has no means of strengthening up the weak currents, and so you can only listen to the station on the phones. If you wish to use a loudspeaker, valves must be added. Now the valves, as we noted in talking about the birth of radio, has made radio as we understand it, possible. If a wire is arranged in a vacuum and heated to a white heat it will give off electrons (small (*Concluded on page 29.*)