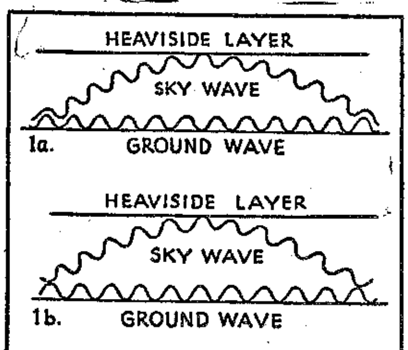
That Eleven Year Cycle

by

"COSMOS"

In this article "Cosmos" tells you in progressive sequence, the substance of considerable observation and research. He reviews the factors governing radio reception, and goes on to point out how good radio seasons have been dependent upon solar activity manifesting itself in eleven-year cycles.—Ed.

THE science of radio has made such enormous advances in the past decade that it is now in many respects well nigh perfect. There are many critics who aver that the modern electric radio is too powerful, but they are in the same class as the critic who can find nothing powerful enough, and no radio nearly as good (by his way of it) as the great set he built himself so many years ago. Properly and intelligently handled a good electric radio will convert those feeble voltage impulses that reach an aerial into a true and faithful rendering of just what they represent.



In 1a the ground and sky waves are synchronising, giving twice the normal signal strength. In 1b they are in opposition and there are weak or no signals.

If the output is marred by static or distortion, it is simply that science has so far been unable to design a set that will differentiate between those impulses that are meant to reach the aerial, and those that are not. A good strong signal has a strength of about ten micro-volts per meter when it reaches the aerial, and if a set is amplifying this signal to give room volume, it stands to reason that a static discharge of the same intensity will have the same volume as the wanted signal. If the static were persistent it would be ruinous to entertainment. In this case the ratio of static, or atmospherics, to wanted signal is 1—1. If the atmospherics had a strength of three microvolts per meter and were conflicting with a wanted signal of ten microvolts per meter, the ratio would be 3—10 and the atmospherics would be heard only as a background.

Static in these latitudes is more of a seasonal disturbance than a chronic one, and providing that the aerial can pick up a signal strength of ten microvolts per meter atmospherics will seldom mar a programme. At this point we must give consideration to the vagaries of radio waves in transmission. Consider fig. 1a. Here we see that transmission is accomplished by two fundamental circuits known as the sky wave and the ground wave.

The sky wave may be likened to a ball that bounces along, and the ground wave to a ball that is thrown. Many and varied are the phenomena that affect the sky wave, and while it is this sky wave component that gives us distant reception, it is also it that brings us distortion in its many guises. Above the Earth, at a variable distance, there is a refracting or reflecting layer, which since 1902 has been called the Kenelly-Heaviside Layer, after the investigators who almost simultaneously founded its theory. Kenelly an American, and Heaviside an Englishman. The distance that a sky wave will reach from a transmitter before it becomes too attenuated to be of use is governed by the percentage of absorption that takes place at each contact with the Layer and with the Earth.

The amount of absorption that takes place at each contact with the Earth is governed by the particular class of terrain at the spot of incidence, being much less when the Earth is wet, as it is then a good reflector of radio waves. As regards the Heaviside Layer the amount of absorption that takes place is more or less proportionate to the number of bounces that the wave must make between it and the Earth before it reaches its destination.

This in turn is governed by the height that the wave must go before it reaches an electronic density sufficient to reflect it back to earth, and it will be seen that the higher the wave goes before reaching its turning point the fewer will be the number of rebounds it will have to make before it reaches its destination.

In table 2 is shown the approximate heights at which the electronic density is sufficient to turn waves about ten metres long back to earth. With longer wavelengths corresponding to lower frequencies, the height at which the electronic density would be sufficient to turn the waves back to earth would be much less, and herein we find the reason for the great distances spanned by short waves, taking comparatively few strides to encompass the earth.

It must not be supposed that the Heaviside layer remains stationary for any length of time. Heising tells us that layer is constantly on the move, rising and falling rhythmically about every quarter of an hour. Rising at a speed of something like six miles per minute and falling much more quickly, probably at 20 miles per minute.

At this juncture it is well to consider the reason for the very decided attenuation that daylight and even moonlight has upon the sky wave component. We know that the ionised Heaviside layer is highest and least intense on a winter's night, lowest and most intense on a summer's day; higher and less intense on a winter day than on a summer day, that its height and intensity thus varies from night to day, from no moon to full moon, from season to season and from sunspot cycle to sunspot cycle.

The science of physics and chemistry tells us that when a diffuse gas is subjected to ultra-violet radiations some of its atoms lose electrons, which may either attach themselves to other complete atoms or remain as free electrons. The gas will then contain free electrons, positive ions or atoms which have lost an electron, and negative ions or atoms which have gained an electron, and in this state of electrons, positive ions and negative ions and gas is said to be ionised.

TABLE 2.

Winter Day	100 miles
Summer Day	200-350 miles
Winter Night	175-250 miles
Summer Night	250-400 miles
Spring and Autumn	150-225 miles

These figures are from Marshall, U.S., for waves of about ten metres. It is not intended that they represent the approximate turning point of broadcast frequencies, as the figures are not even proportionate, due to the varying factors that affect different frequencies.

Applying this knowledge to the ionised Heaviside layer we find that the layer is ionised more or less effectively according to the intensity of the ultra-violet rays to which it is subjected, most of which emanate from the sun, but undoubtedly the ionisation is to some extent due to emanations which possibly reach the layer after speeding through space from greater suns than ours. In a completely ionised state the Heaviside layer acts toward radio waves in the broadcast spectrum in much the same way as a short circuit affects an electric transmission line, and it is now that we can visualise why it is that distant radio reception, via the sky wave component, is almost directly influenced by the intensity of the light through which the waves make their way. On a winter day the intensity of light is only about one-fourth of its corresponding summer value, which accounts for the greater signal strength in winter and at night.

TABLE 3.

Watts power.	Miles.
5	1
500	10
50,000	100

To return to earth and the ground wave component as illustrated in table 1a, we find that reception via this path is practically independent of light and darkness, and that the signal strength at any distance from a transmitter is mainly governed by the class of country over which the waves have to travel. Referring to table 3, which gives the distances accepted as standard in the United States for true service range, we see that the distance is not all directly proportional to the power radiated, but is governed by the law of inverse (*Concluded on page 10.*)