What are the Principles of Fading?

Explanation of a Commom Phenomenon

By J. M. Bingham

As radio broadcasting is fast becoming established as a public utility, the number of licensed listeners continues steadily to increase. Those listeners who have made a study of the subject and have safely passed the dial-twiddling stage, give full credit to the wonderful quality of the YA stations. There are some, however, particularly new-comers to the listening-in fraternity, who may be inclined to blame the broadcaster for every defective note they hear on their loud-speaker. Certainly, reception is not always what one would like it to be, but more often than not the trouble is quite beyond the control of the broadcasting station.

A very frequent cause for complaint is the distortion occasionally heard in the evenings, and commonly called "night distortion." This trouble is entirely atmospheric and is a form of fading which has frequently been commented on and explained in these columns. However, for the benefit of the aforementioned new-comers, another explanation of the subject will not be amiss.

In the accompanying article Mr. J. M. Bingham, chief engineer of the Radio Broadcasting Company, deals with the subject in a popular and strictly non-technical manner:

THE range of a broadcasting station is entirely governed by the medium separating the transmitter from the receiver. It is not necessarily air, but for want of a better name, theorists give it the term, "ether." When a broadcasting station is "on the air" it is causing vibrations or waves in this ether, which travel outwards in all directions. These waves vary in intensity in accordance with the speech or music entering the microphone at the studio, and when picked up by the receiving aerial, cause corresponding variations to affect the receiving mechanism, thereby reproducing the original performance from the loudspeaker.

A peculiar property of these ether waves is that they can be absorbed or reflected by electrically conducting substances, and this property of reflection is utilised to a certain extent in one form by the "beam" transmitting stations. Again the fact that electrical conductors will absorb these waves may be instanced in the use of shielding, now common in most receiving sets.

WHEN a wave leaves the transmitting station, it travels outwards in all directions. One component hugs the surface of the ground and becomes gradually absorbed as the distance from the transmitter increases. Other portions of the wave continue to travel upwards.

Now the atmosphere surrounding the earth and through which the ether waves travel, may have varying conditions. At daytime the presence of the sun's rays causes the atmosphere to assume a condition where it is "ionised" or rendered more or less conducting. The waves, therefore, which travel upwards from the transmitting aerial become absorbed, leaving only that portion which travels along the ground as effective on the receiving antenna. This condition is shown in centre diagram.

A receiver located at A receives the ground wave at good strength, whereas B receives it weakly and C not at al'.

When night falls, however, conditions change. The lower and comparatively dense atmosphere loses the conducting property which it had when the sun's rays wer present, but the upper or rarefied atmsophere still retains a certain amount of ionisation.

The upper stratum of rarefied air where this ionisation begins to manifest itself is known as the heaviside layer from the scientist Heaviside, who was first to advance a theory on the subject.

THE upward waves, therefore, which during the daytime were absorbed, are not absorbed at night, but travel onwards till they reach this conducting layer. Some are refracted and lost, but others which strike at a somewhat more acute angle are reflected back to earth again as in the upper diagram.

"A" still gets good signals, due to the ground wave, but B is now getting signals from two directions—one along the surface of the ground and the other due to reflection from the Heaviside layer. C is also getting signals, but whereas during the daytime he got nothing owing to the fact that the ground wave died out before it reached him, he is now getting signals by reflection.

"B" is in an unfortunate position, however. In the daytime all was well. He had a straight-out wave to receive from one direction only, but night has fallen and his receiving set is called upon to accommodate two portions of the same signals which have travelled different paths. If they arrive in their proper relationship, reception will probably be all right, but if from any cause the reflected wave becomes disturbed, the two portions will tend to oppose each other and distortion accompanied by fading will result.

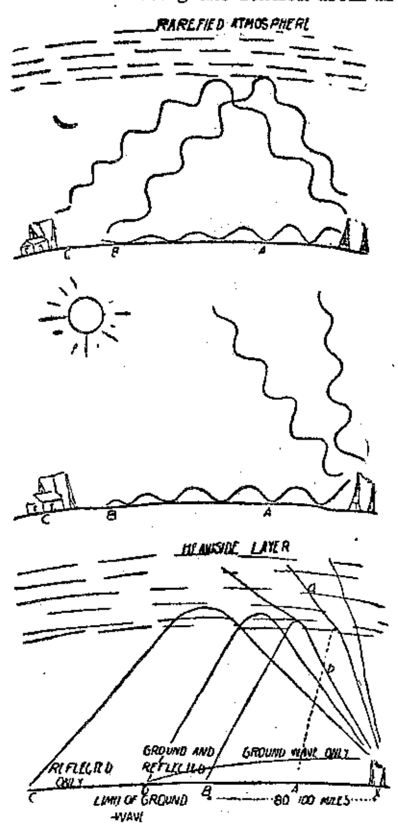
THE atmosphere is always in a state of turmoil, and meteorological conditions affect the height of the Heaviside layer. These variations may take place rapidly or very slowly, but in whatsoever manner they occur there is bound to be a corresponding variation in B's reception conditions.

Reference to the lower figure will show that although A is well within the range of the ground wave, he does not get any of the reflected wave. The wave A, which might be expected to reflect, does not do so, as it strikes the Heaviside layer inside the critical angle and is refracted instead of being reflected.

However, B striking at a somewhat greater angle is reflected back to earth again at B. It will thus be seen that for every broadcasting station there is a zone surrounding the station from X to B, where no reflected wave is received at any time. This zone varies considerably with the wave length used in general for broadcast purposes may be taken at about 80 miles.

The ground wave, on the other hand, is only slightly affected by day or night conditions, and the range at which it loses its effectiveness depends almost entirely on the power of the station.

IT can readily be understood, therefore, that from X to B reception is practically the same for both day or night, as it is the ground wave only



that is effective. From B, where the reflected wave begins to be in evidence at night, to D, where the ground wave ceases to be effective, is the zone where distortion fading will be in evidence, as this is the area in where both components are received. From D to beyond C no ground wave is received, but only the reflected wave at night. There are thus three conditions for every broadcast station: (1) An area close to the station where reception is constant both by day and night; (2) a zone beyond where good daytime reception is obtained but liable to distortion at night; and (3) a zone of still greater radius where weak or no signals are heard during the day, but where fairly good reception is obtained at night.

These conditions are entirely beyond the control of the broadcasting station, although the unfortunate broadcaster usually has to take the blame.

The obvious solution is to confine all the radiated waves to the ground, but means for doing this have yet to be devised.

Increasing the power of the station not only increases the daytime range,