downcoming radio wave is equal to its angle of incidence. For example, in **Fig 1** imagine a wave leaving the aerial A at a downward angle of say 20°, this wave finally meets the earth (ground), at point D and is then reflected upward again at an angle of also 20°, ie the same angle.

This reflection does not always take place at the surface but depending on the frequency, and condition of the ground, the actual reflection may occur some way down below the surface of the ground. In addition, depending on the frequency, not all of the waves are reflected and as the frequency gets beyond about 14 MHz, more and more waves are 'absorbed' by the earth and less reflected.

At some distance away from the aerial, the reflected waves, now angled upward, will meet and combine with the direct waves leaving the aerial, that is those angled above the horizontal. The way in which the reflected waves will combine with the direct waves depends on several factors such as the orientation of the aerial with respect to the ground, its height above ground, its length and of course the conductivity of the ground; the ground is never a 'perfect' conductor. At the same angles above the horizontal, the reflected and direct waves combining will be in phase with each other, that is the field strengths will be maximum at the same time; thus the resulting field strength will be equal to the sum of two waves. At other angles above the horizontal, the two waves will be out of phase and the field strength will be minimum. The resulting field strength here will be the difference between the two waves.

Ground reflections

Thus the effect of ground reflection is to produce a series of points around the aerial where the resultant field strength is increased to a maximum, greater than the direct wave on its own, and others where the field strength is at its minimum or somewhere in between. When plotted these look like a number of power lobes at various angles of radiation. See **Fig 4.** The slope, number and power of these lobes as well as their angle of radiation is effected by the height of the aerial above ground as well as the other factors mentioned earlier (see **Fig 3**).

When considering the effect of reflection, it is convenient to imagine the reflected wave coming from an image aerial that is situated at the same depth below ground as the height of the 'real' aerial above ground. **Fig 2** shows such an arrangement. You will see that in the vertically aligned aerial, the current, shown by + and −, is in phase therefore ground reflection affects vertically and horizontally polarized aerials quite differently.

Because the ground is not a perfect conductor some of the higher frequencies are not reflected at all but absorbed by the ground. This takes place more and more as the frequency gets nearer to 30 MHz with the result that a lot of the energy radiating at very low angles is lost because it never gets reflected.

Another effect that ground reflection has on an aerial is to alter its radiation resistance or impedance. This is why the SWR changes when you raise the aerial up. The reason for this is that some radiated waves go vertically up again. As they pass the aerial they induce an additional current in it. Depending on the phase of this induced current the radiation resistance of the aerial changes. However, as the height of the aerial approaches a half wave length, the effect on radiation gets smaller and can easily be tuned out.

Fig 4 is a diagrammatic representation of the radiating fields from a half wave aerial at various heights above ground. The height is shown as a multiple of fraction of the wave length of the operating frequency being considered. You will see that as the height of the aerial is increased so the number and shape of the lobes change and their radiating angle gets lower to the horizontal. There is a marked change in the field of radiation of an aerial at a quarter wavelength height (**Fig 4A**) as compared to the same aerial one half wave length high (**Fig 4B**). At a half wave length there are only two major lobes of radiation angled at about 30° from the horizontal. Increasing the aerial height further

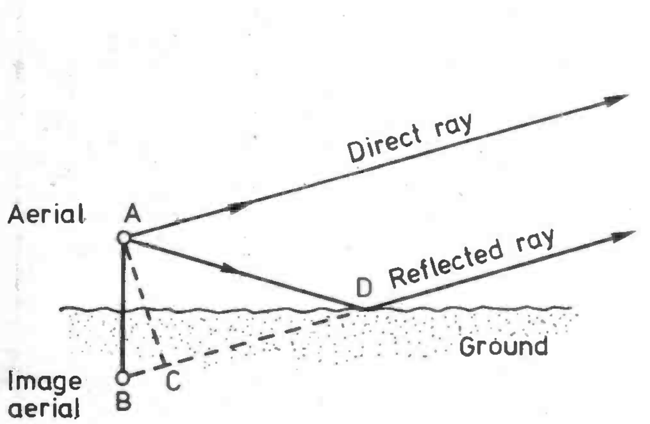

FIG. 1

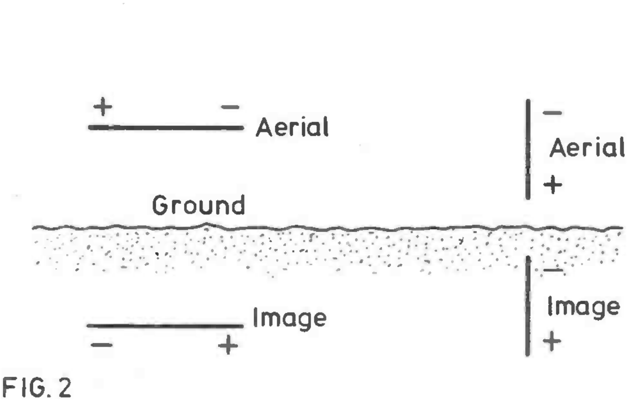

FIG. 2