Tech Note - Theory - 04 Radio Frequency Fields

Some understanding of "fields" and what they are is essential to any real idea of how antennas operate and this statement becomes more true the higher in frequency we go. Most discussions of fields, in text books start by tossing out a vague reference to Maxwell's equations and proceed from there, complete with all kinds of mathematical equations!

Although I'm tempted, I will not do that. In consequence I cannot tell you exactly what a field is but neither do the books which are filled with the math, because no one really knows exactly what the thing is. Most of wave mechanics and that which explains antenna theory is done by mental visualization. However we can say this: the fields in which we are interested come in two flavors (kinds) and are called electric fields ("E" field for short) and magnetic fields ("H" field for short).

An example of an "H" field is a bar magnet under a sheet of glass with iron filings scattered on the upper side of the glass sheet and the resulting arrangement of the filings will display the magnetic field. Also the plastic comb run through ones hair will attract small bits of paper due to the electric charge the comb receives when rubbed against the hair.

The two properties all fields have in common are intensity and direction. The "E" field is from negative to positive and the "H" field is from north to south.

So far only stationary fields have been considered, however for a field to do any useful work it must be in motion. Now strange things begin to happen when a field starts to move.

The examples illustrate a single type of field each, but when a field of one type begins to move it will automatically generate a field of the other type to accompany it.

The directions of the two fields are perpendicular to each other, while each field by itself is at right angles to the direction of motion. Are you confused now? OK, have a look at Figure 1a.:

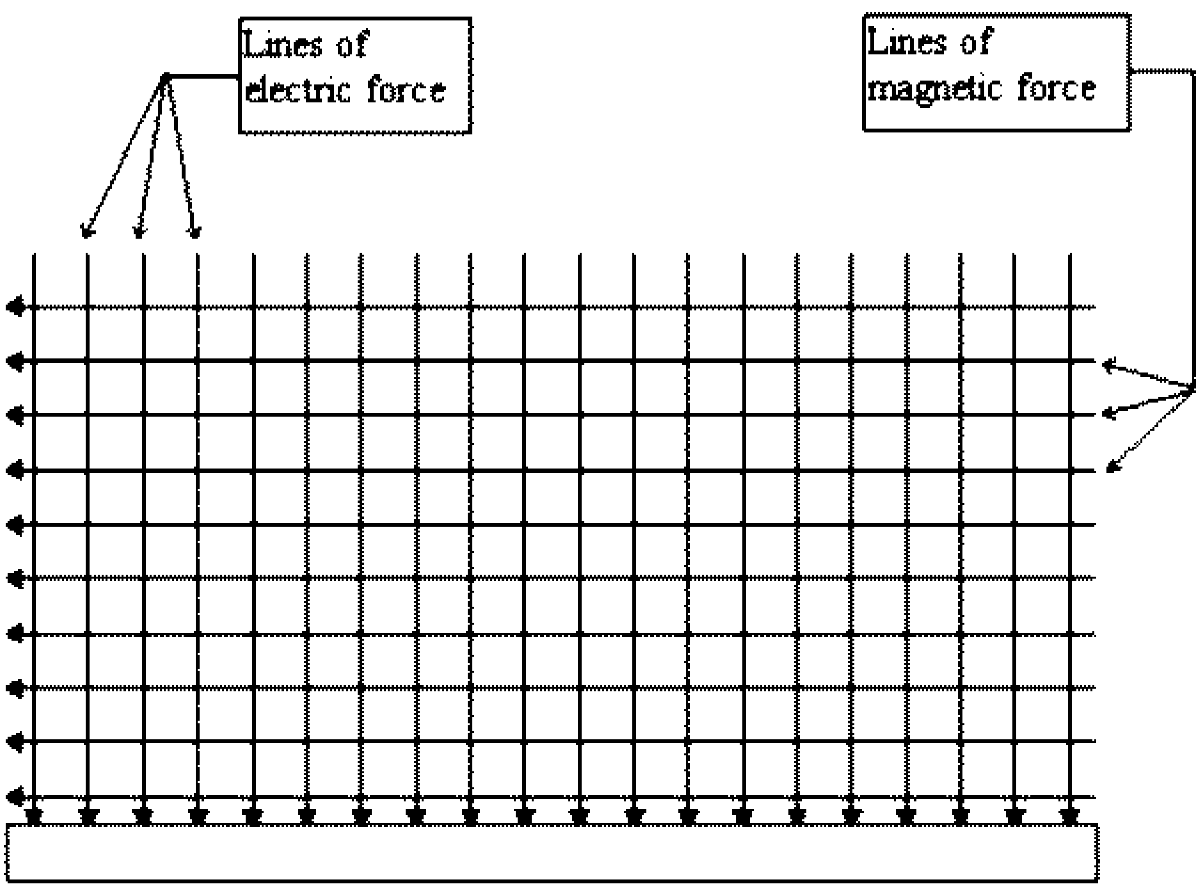


Fig 1a

Visualize the electric field as having direction parallel to the vertical bars of the screen while the magnetic field's direction is parallel to the horizontal bars (this puts the two fields at right angles to each other). At the same time imagine, the entire screen as moving directly away from you on the page or moving directly straight out of the page thus placing each field at right angles to the direction of motion (motor generator action).

When a field moves past an electrical conductor, a current determined by the field will flow in the conductor.

This happens because an electric field is always present whenever either kind of field moves, and an electric field implies a voltage difference between the stronger and weaker parts of the field. But a voltage difference if connected across a conductor, forces current flow within the conductor, as a result current flows whenever a field moves past a conductor (current flow=magnetic field).

Likewise when a current flows, magnetic fields accompany it. Trying to say for certain which generates what is really a bit like the chicken and egg priority! At any rate currents and fields go hand in hand.

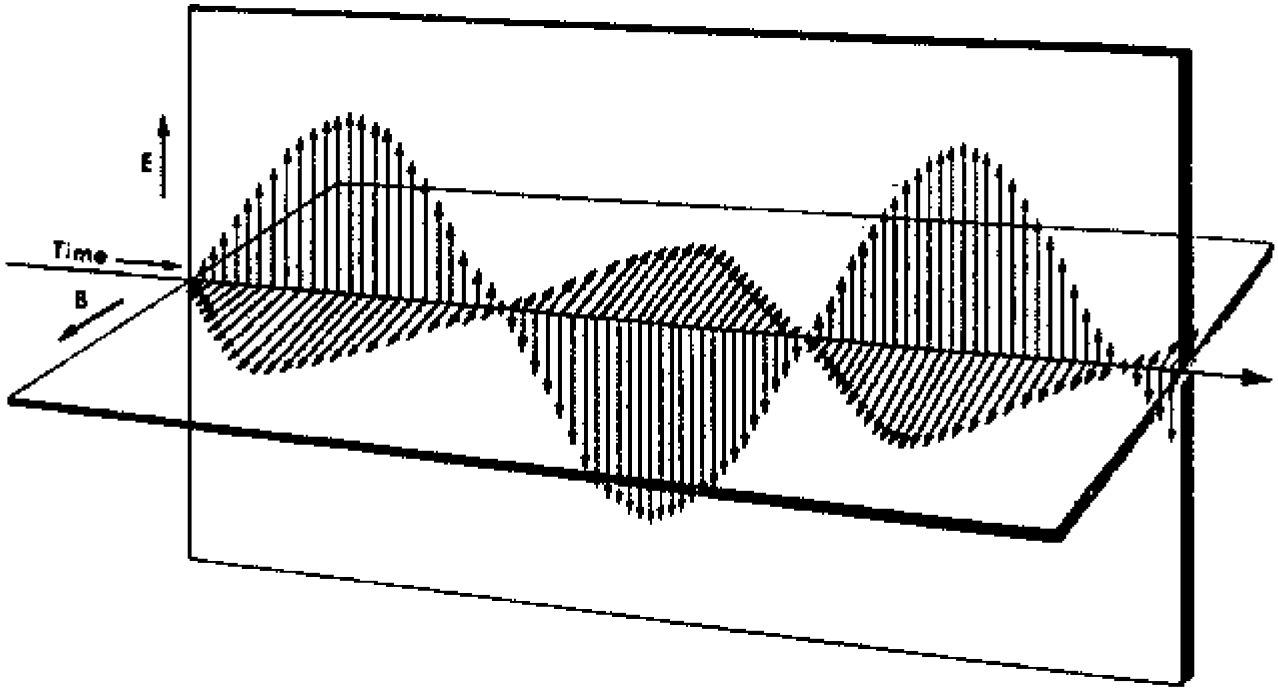
This effect is actually the basis of all electrical theory since it makes possible the generation of both AC and DC currents. The movement of magnetic fields past conductors or vice versa and the transformation of AC voltages to higher or lower levels by induced magnetic fields through current flowing in the primary of a transformer, then recovering the current from the field in the secondary. Also motors are no more than rotating fields fastened to a shaft with a pully at one end.

It is also the basis of our hobby, since all radio energy travels in these fields from antenna to antenna.

It has been noted that any field in motion automatically generates one of the other kinds of fields to accompany it. There is a special name for such a pair of fields in transit from somewhere to someplace else. It is an expression we have all used: "**Wave**", but more specifically it would be **Electromagetic Wave**

In Summary:

1. Fields have intensity and direction
2. The "E" field is measured in volts, pos. or neg.
3. The "H" field is measured in gauss north or south.
4. When one field begins to move, it automatically generates the other field to accompany the first type of field.



A graph of the changes with time in the electric field strength *E* and the magnetic induction *B* as an electromagnetic wave passes an observer.

Fig. 1b - The electromagnetic wave in transit.