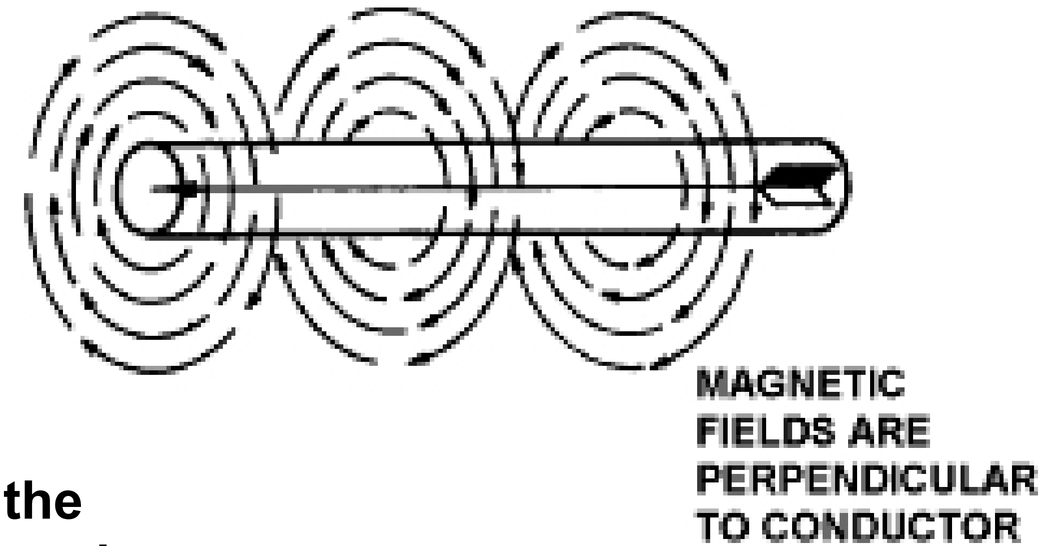
New England Radio Discussion Society:
"Electronics for Amateur Radio operators"

"Getting down to nuts and volts"

Phase Two, PPT2
September 2016

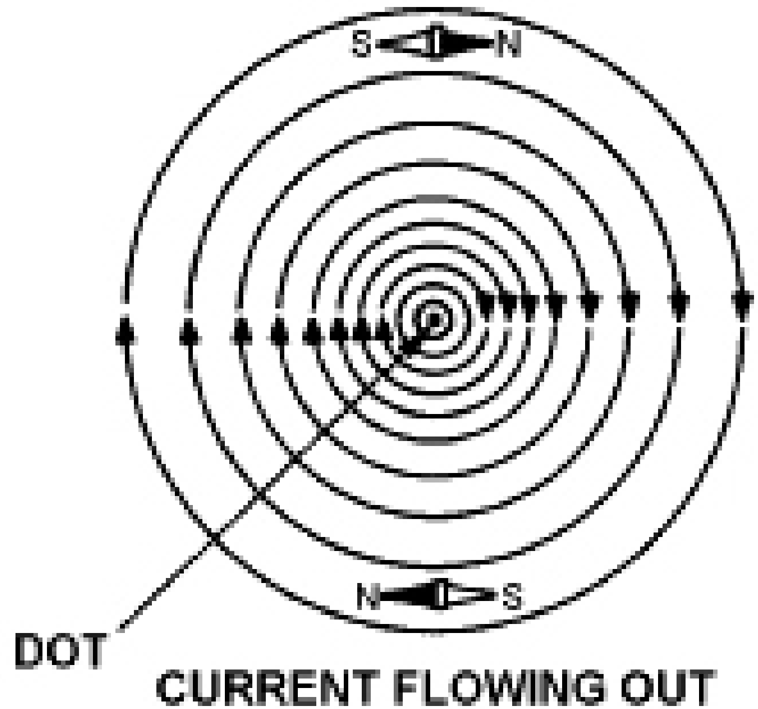
Visualize the invisible fields



Note the feathered arrow symbol

REVIEW:

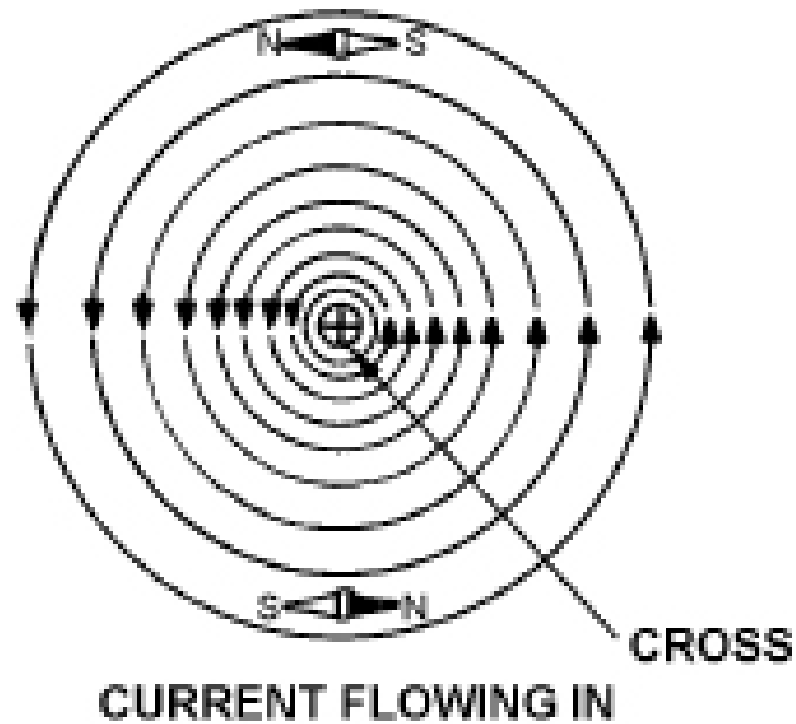
The dot is the head of a conceptual arrow as it flies towards you!



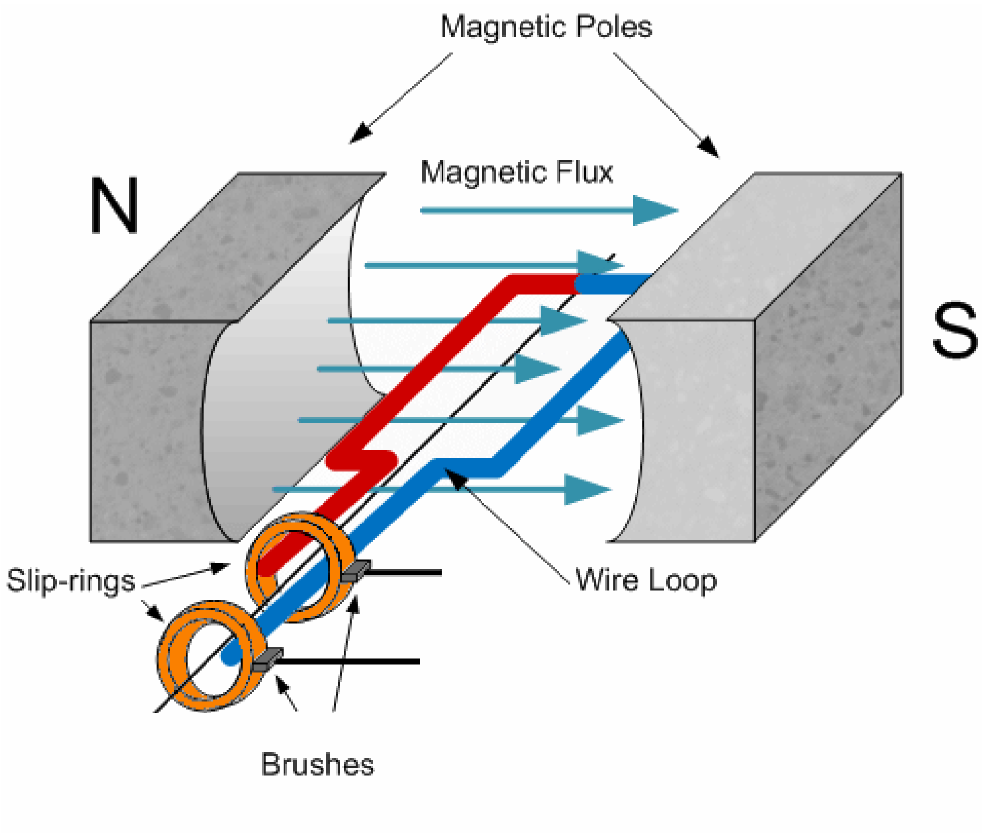
<<- Magnetic field

Review:

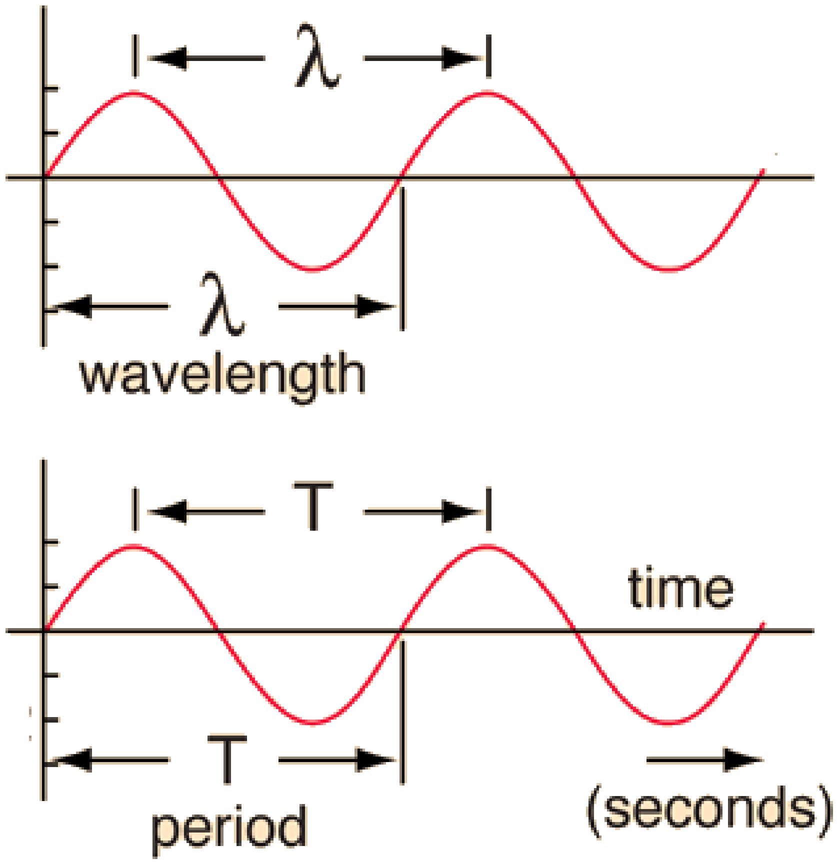
The cross is the tail feather of the arrow as it flies away from you.



REVIEW: The mechanical rotating generator



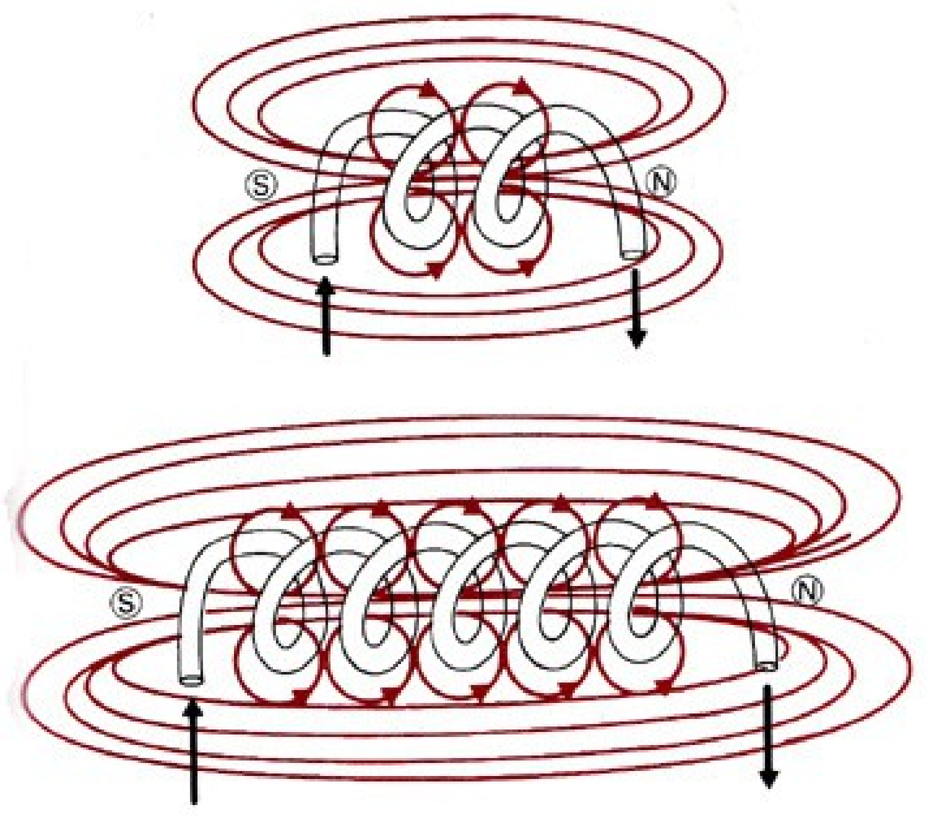
Review: The relationship between a wave's period and frequency



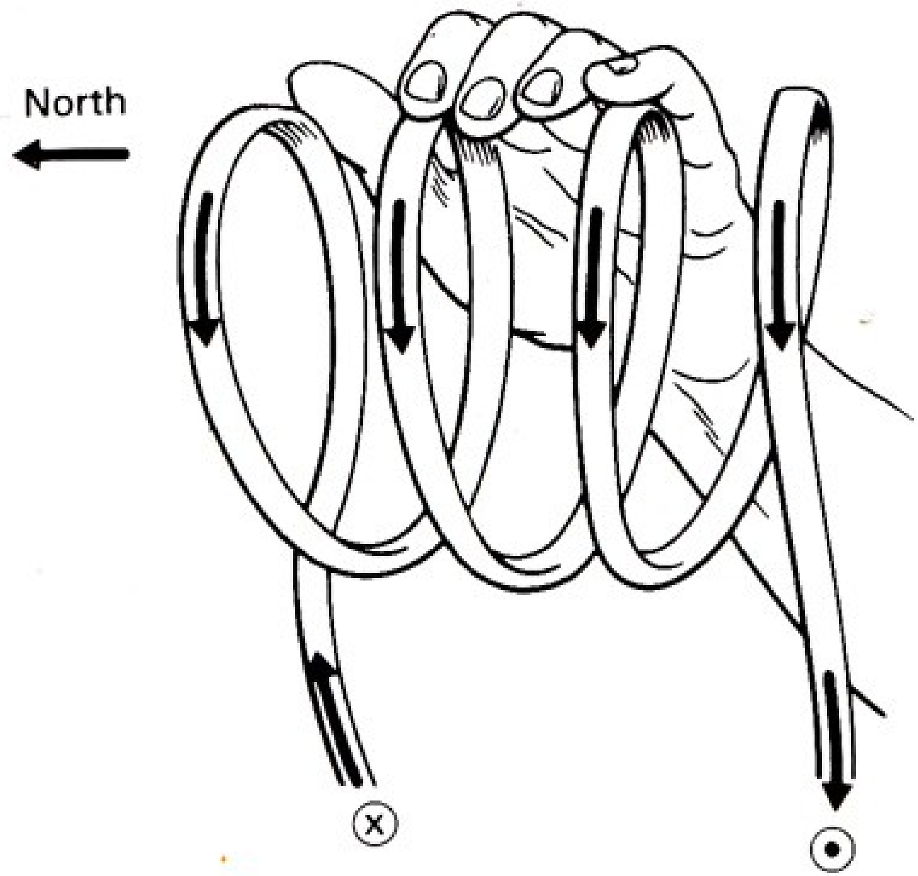
$$f = \frac{1}{T}$$ f = frequency

$$T = \frac{1}{f}$$ T = period

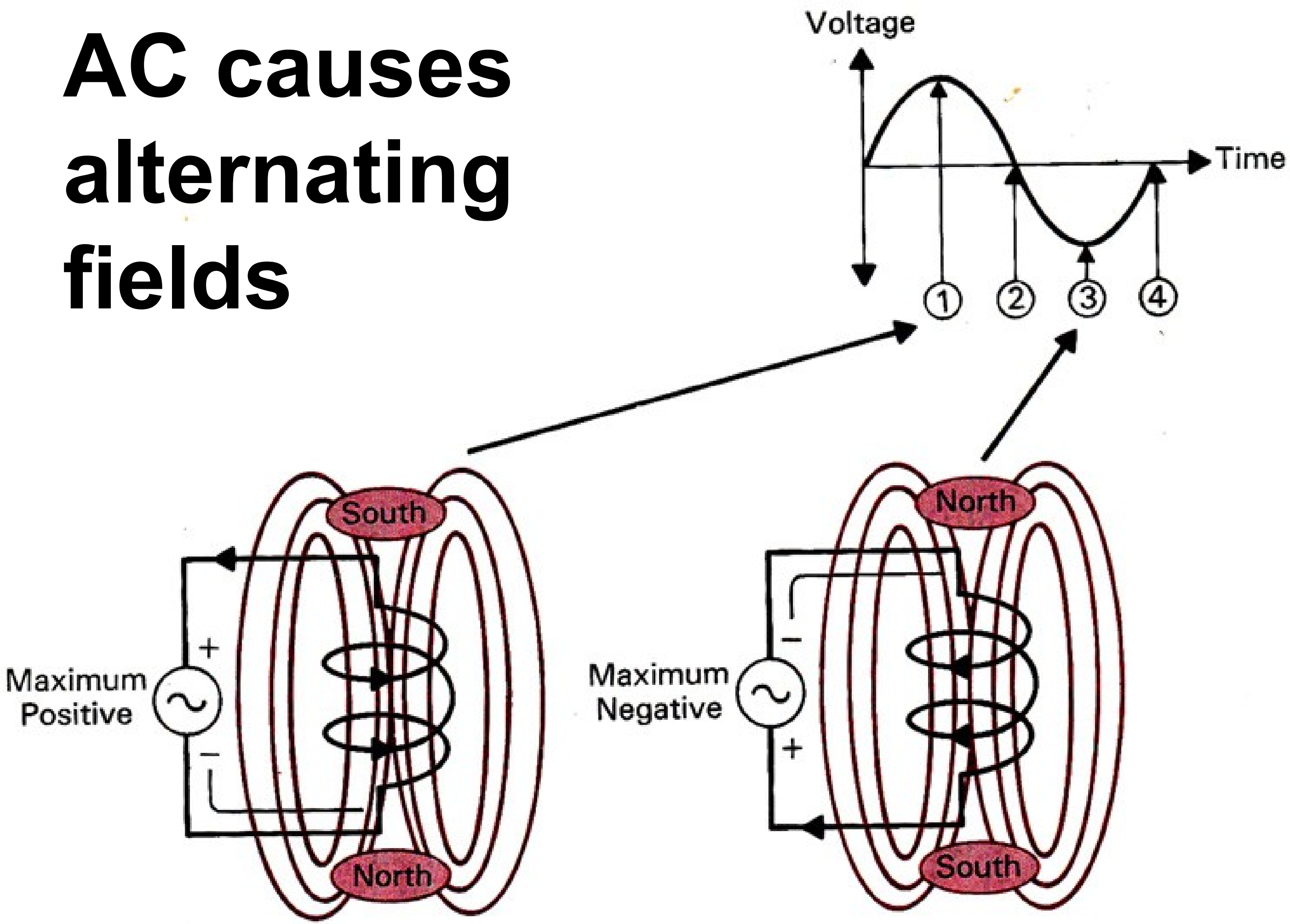
Magnetic fields exist around coils of current-carrying conductors



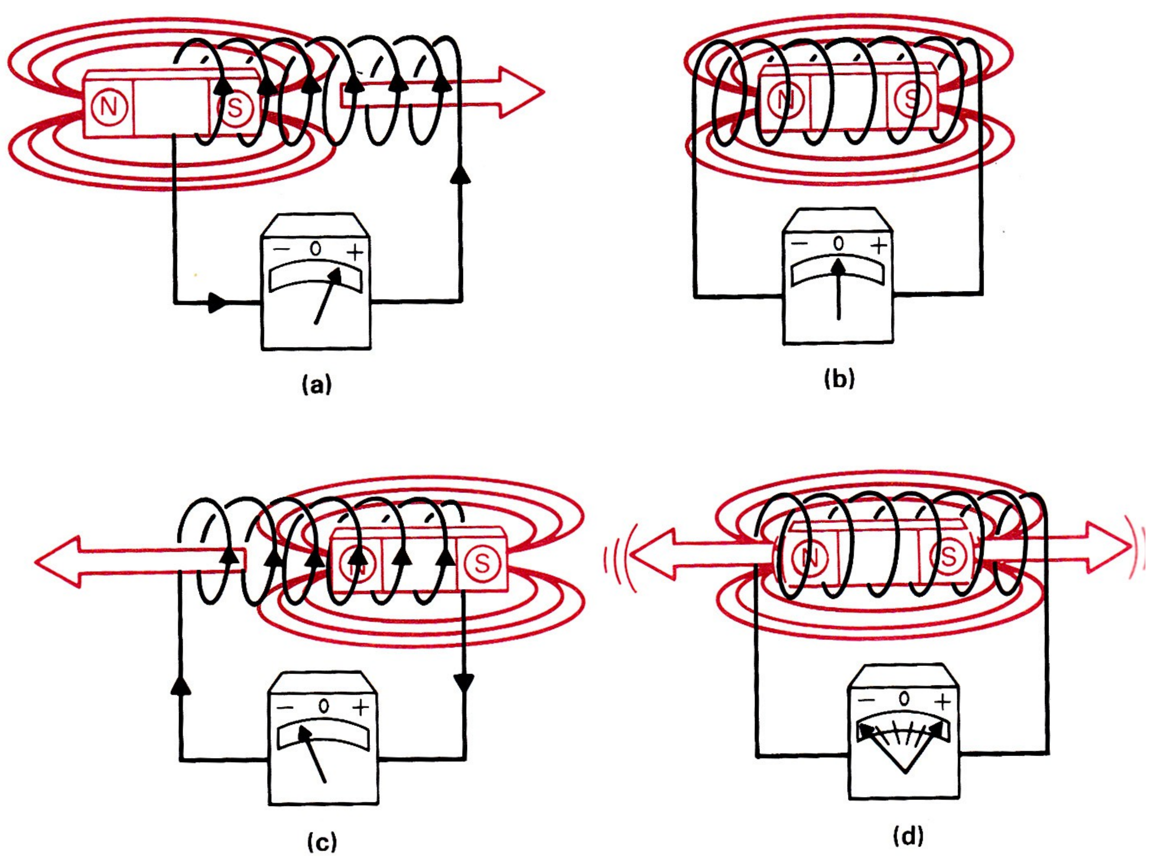
The Left Hand Rule

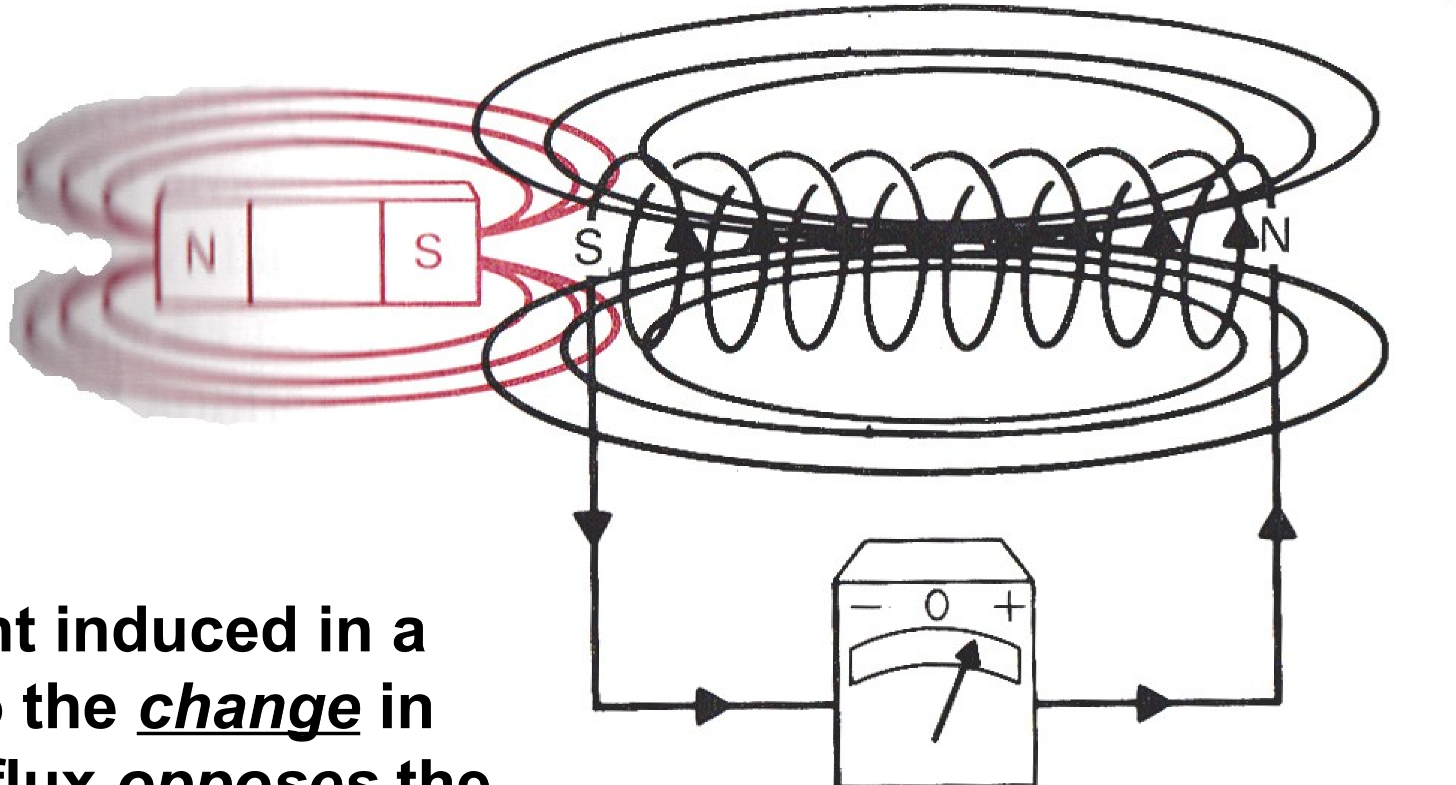


AC causes alternating fields



(1) Current can cause a magnetic field, and (2) a moving magnetic field can generate current

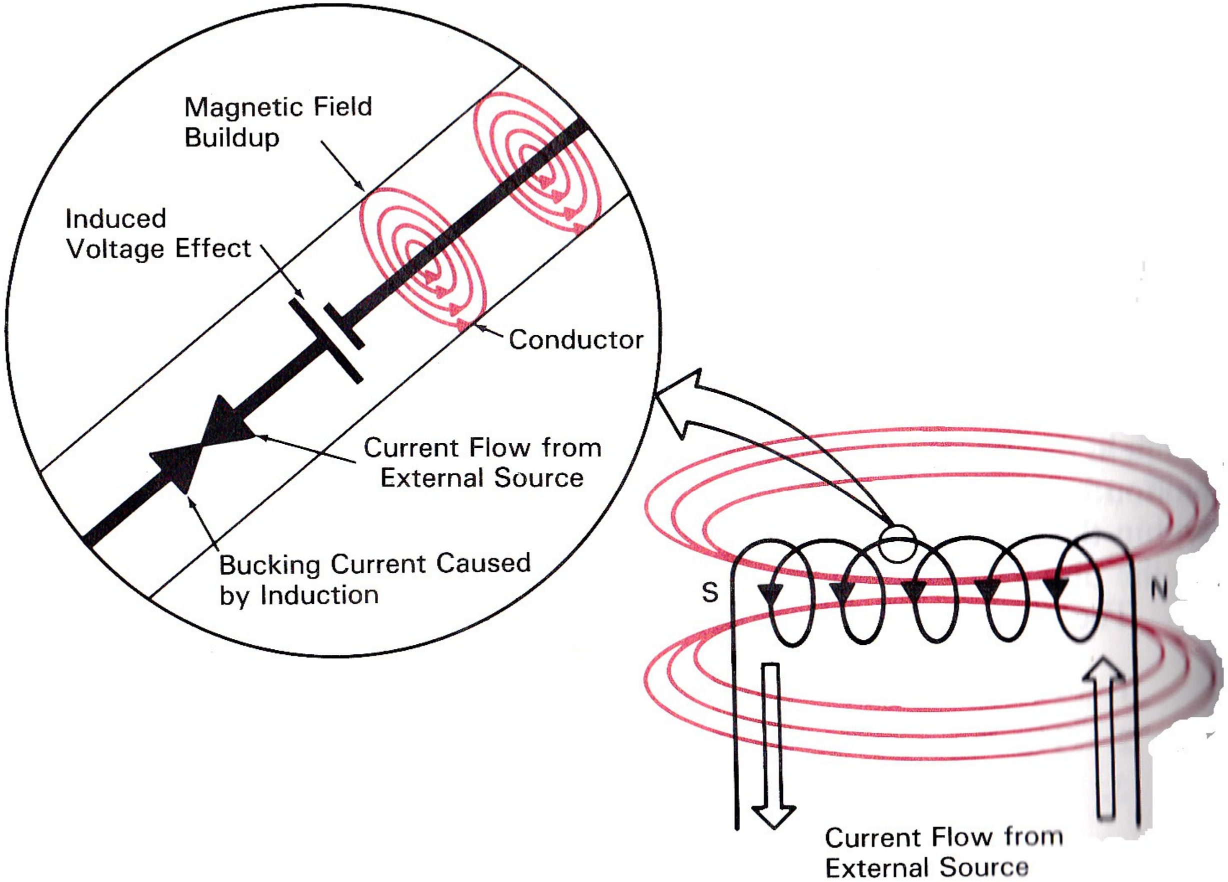




The current induced in a coil due to the *change* in magnetic flux *opposes* the cause that produced it.*

*** Lenz’s Law.**

The expanding field induces a voltage that causes a bucking current. The result opposes the current that was applied to cause the magnetic field in the first place.



This is dubbed *self-induction*.

Self-induction causes a “back EMF.”

Coils or conductors that cause this *counter-EMF* are called self-inductance coils.

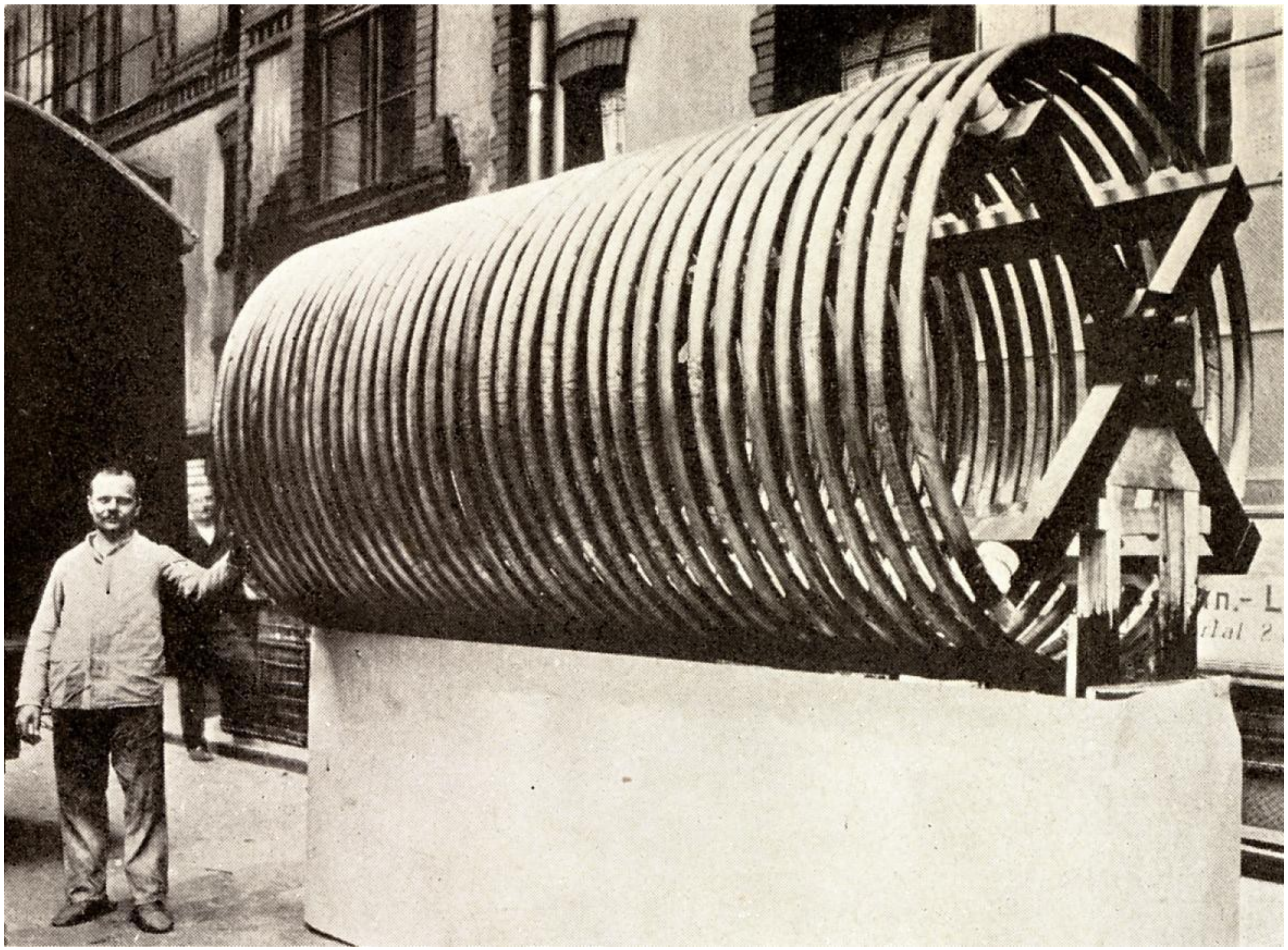
More commonly this effect is simply called *inductance*.

Coils have inductance!

These are examples of toroidally-wound inductors.

Most hams simply call them *toroids*.

Here’s a photo of a somewhat hefty antenna loading inductor.



QRP?

☺

The inductance of a coil is measured in a unit called the *Henry*, honoring an American physicist named Joseph Henry.

Four factors affect the amount of inductance (L) of a coil:

(1) the number of turns
(2) the area of the coil
(3) the length of the coil (the core), and
(4) the core material

$$L = \frac{N^2 \mu A}{l}$$

Where,

$L =$ Inductance of coil in Henrys

$N =$ Number of turns in wire coil

$\mu =$ Permeability of core material

$A =$ Area of coil in square meters

$l =$ Average length of coil in meters

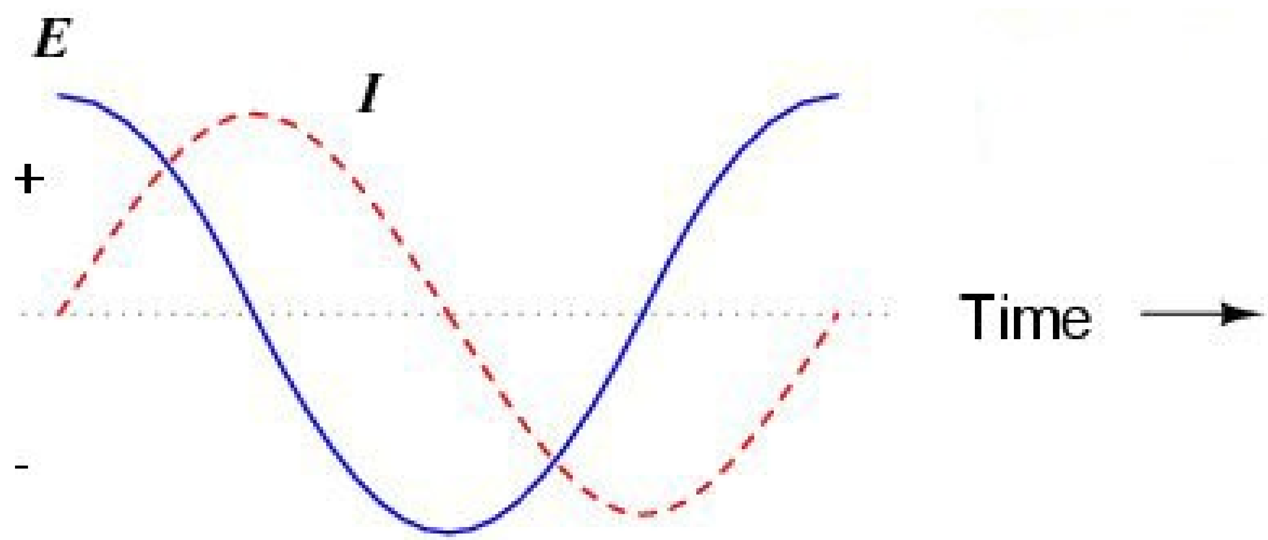
NOTE: The "length of coil" is the length of the core

Like current or voltage or resistance, inductance can be expressed in Henrys, millihenries (mHy), microhenries (*u*Hy of *u*H), nanoHenries (nH), or even picoHenries (pHy).

An inductor will continuously oppose AC. Current causes the magnetic field to expand
and collapse, "cutting" the conducting coils, resulting in an induced CEMF.

When the current is at its maximum it has no rate of change. The CEMF is then zero.

Therefore, the CEMF is 90 degrees out of phase with the circuit current. It "leads" the current.



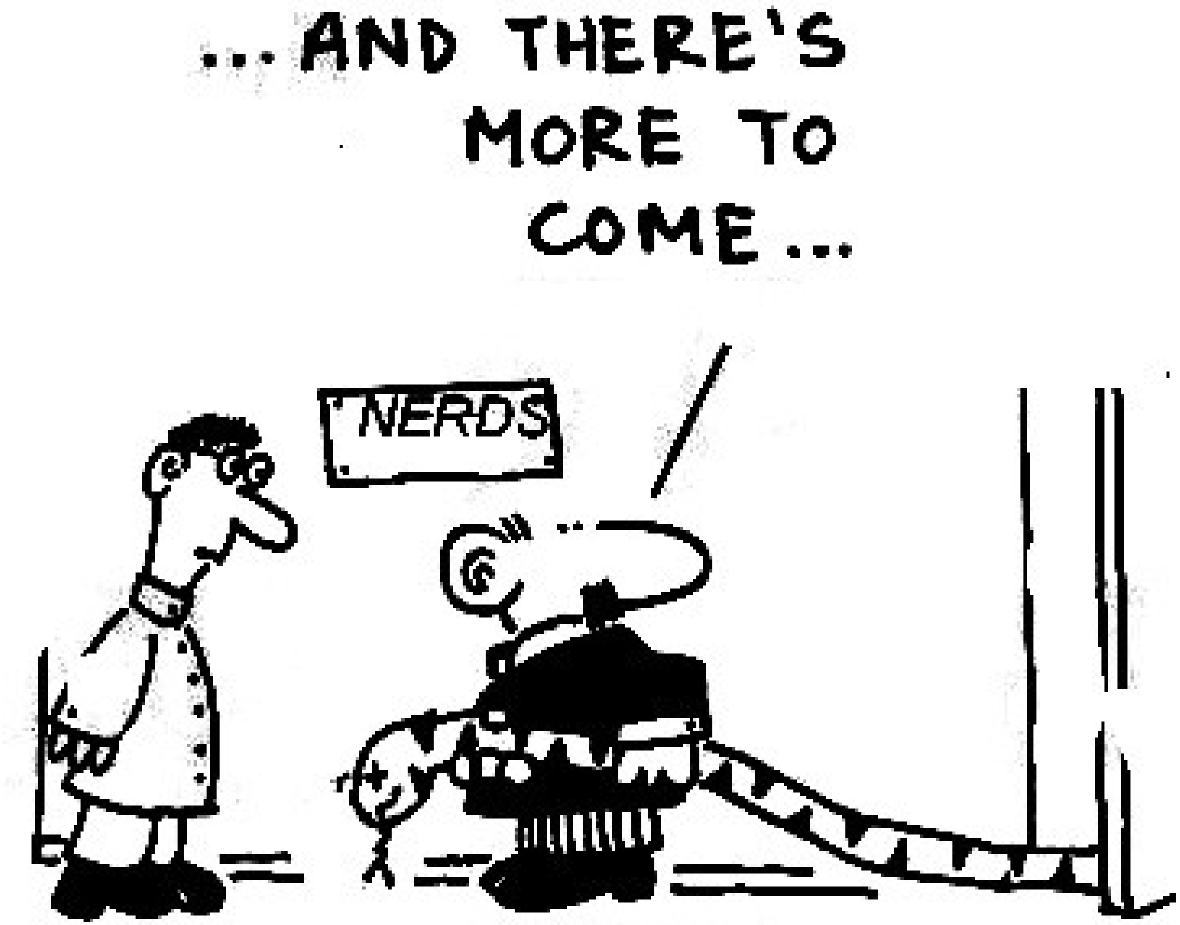
So, inductance opposes AC!

The property is called ***inductive reactance*** and it's directly proportional to frequency. It's symbol is X_L.

$X_L = 2 \Pi f L$, and

X_L is measured in ***ohms***

$\Pi = 3.14$



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