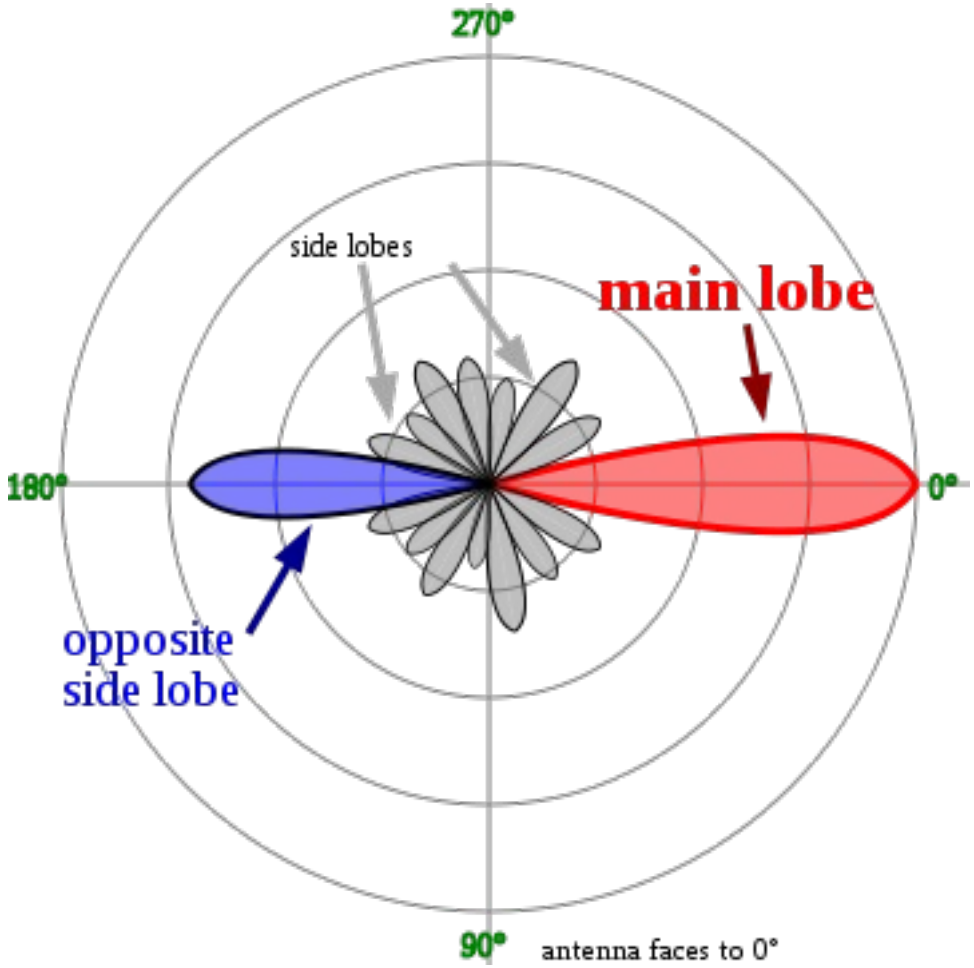


WHAT THE ANTENNA SAID

Stuff we'd all like to know.

PART

DUE

OR

WHY ***MY*** EFHWA
ANTENNA WORKS

and

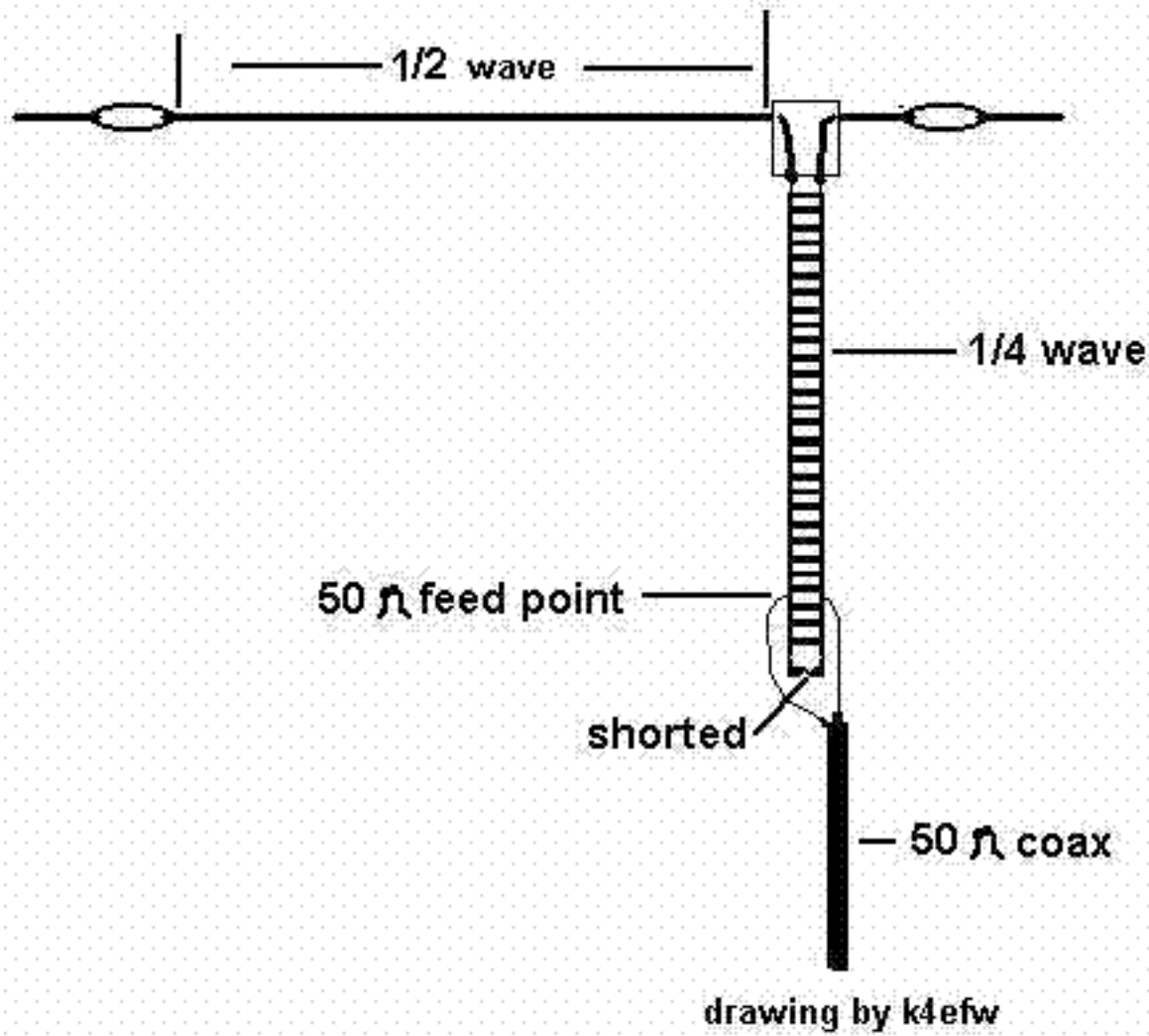
YOURS DOESN'T WORK

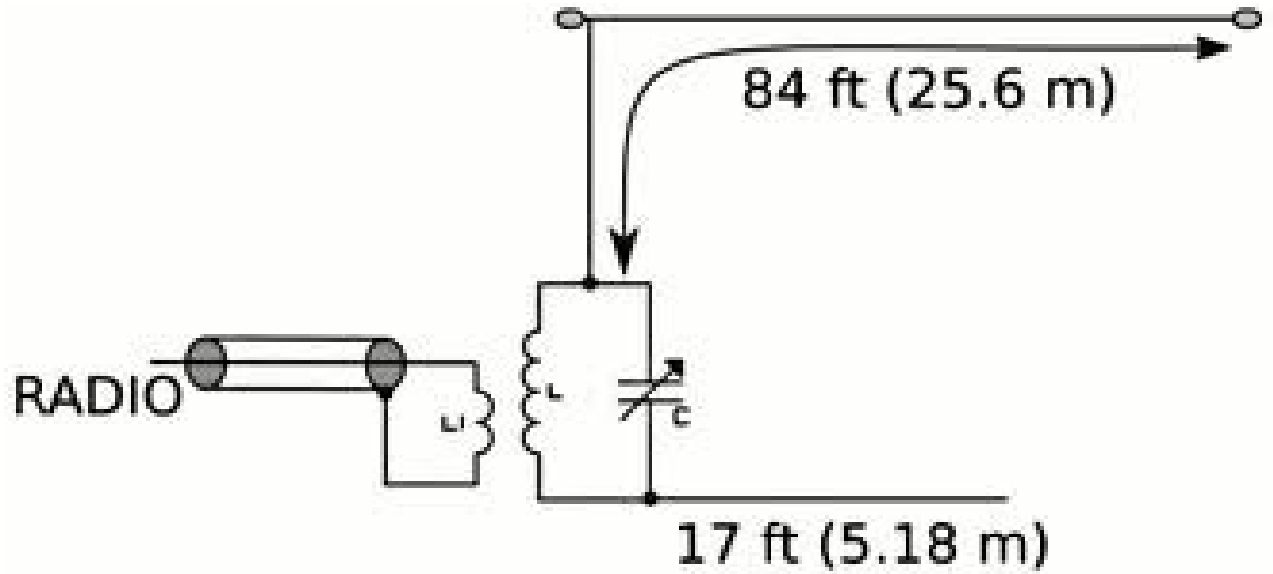
Quick Quiz about EFHWAs (end-fed half-wave antennas)

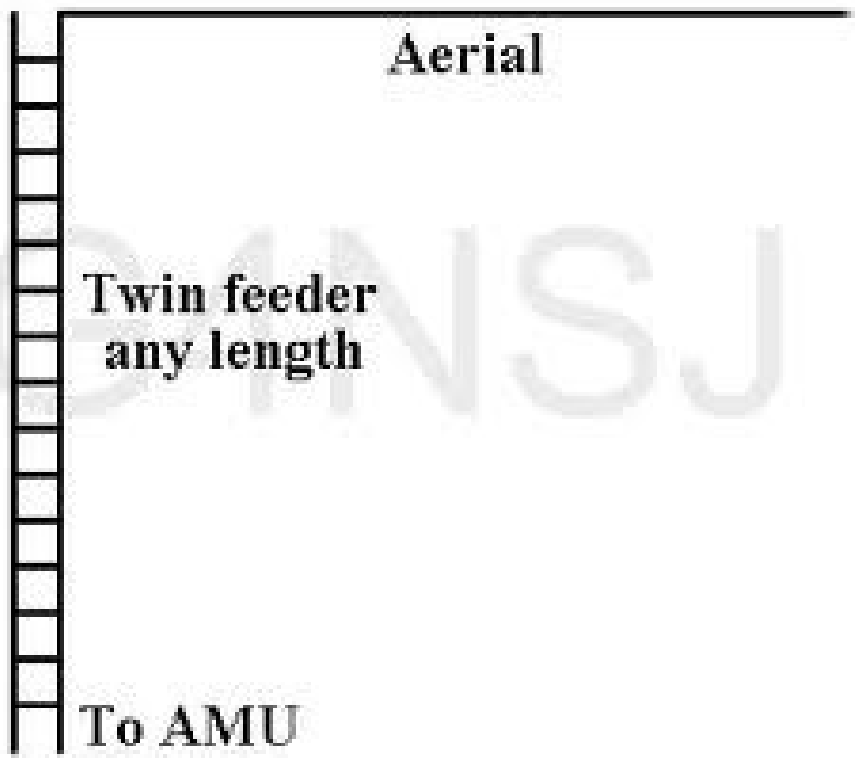
Which one of the following diagrams is correct ?

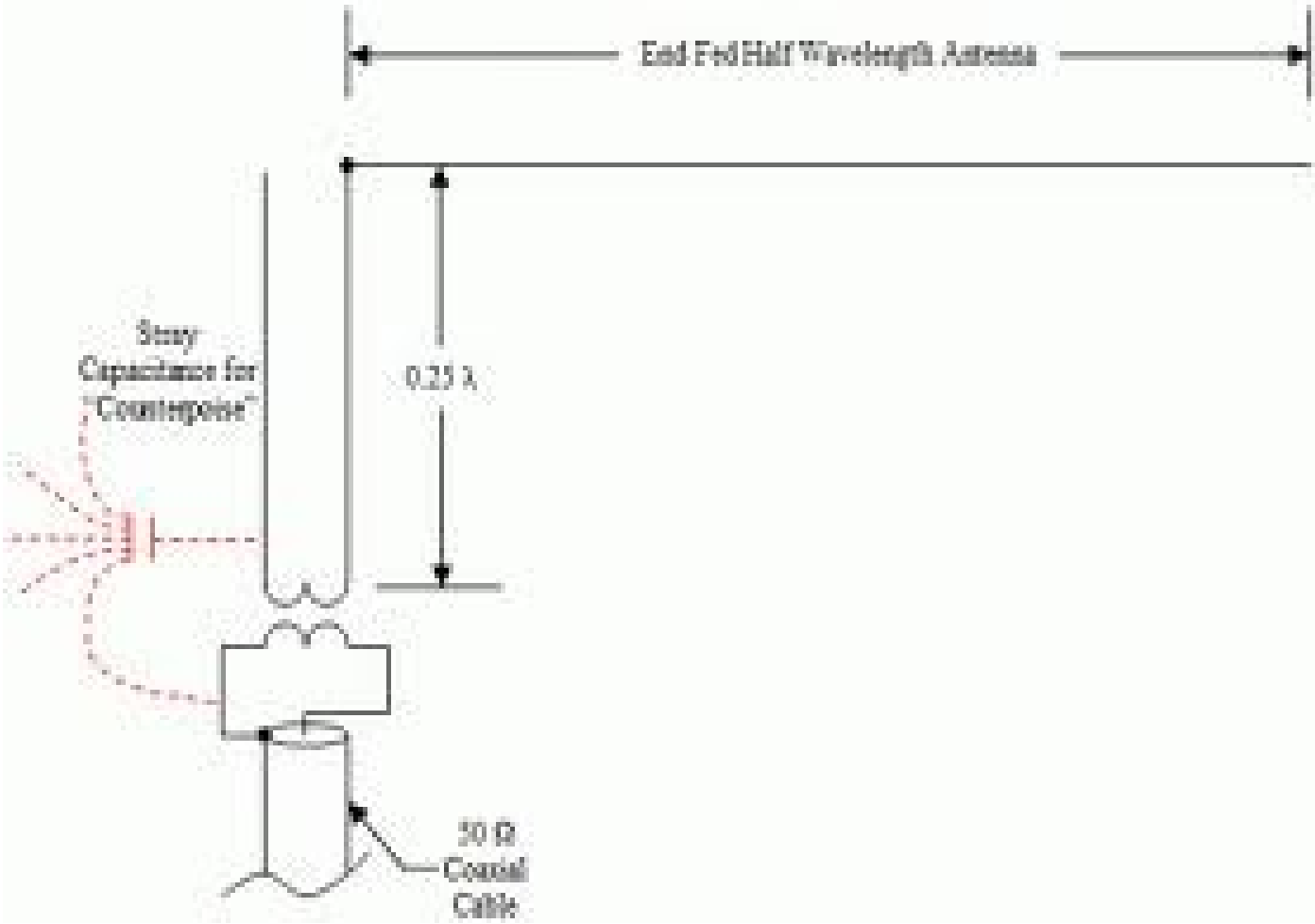
AND

What is wrong with (some or all) of them ?


1/2 wave
1/4 wave
50 Ω feed point
shorted
50 Ω coax
drawing by k4efw


84 ft (25.6 m)
RADIO
L
L
C
17 ft (5.18 m)


Aerial
Twin feeder
any length
To AMU


End Fed Half Wavelength Antenna
Stray Capacitance for "Counterpoise"
0.25 λ
50 Ω Coaxial Cable

This is another test .....

Testing one, two, three, four.

Good antenna, are you surprised ?

" The end-feed PAR antenna works way better than expected (Highly recommended) "

AND

" I used my 40-20-10 EndFedz on Field Day (see www.ve3hg.wordpress.com) and it worked way better than I had expected.

It's flat on 20 CW and 40 is still under 2:1 and changing coax lengths made no appreciable difference. Had one end in a pine tree at 35' or so and the other end in a tree at 25' and 50' of coax. Worked into W6 and W4 at 3 watts out using R40/20. Tuning was more affected by antenna placement than anything else."

This is YET another *2 tests* .....

Testing one, two, three, four.

Can you resolve these ?

"There's a reason that this antenna has 5.0 out of 5 on the ratings. It is easy to tune, easy to setup, and works great. All of the other reviewers are hit the nail on the head too.

I use this antenna with my IC-703+ and can work just about anything I can hear."

vs

"ANY end fed antenna without a counterpoise or groundplane will have feedline radiation, that goes for the PAR antenna especially.

There is a rule that cannot be broken.

The current flowing into the end-fed antenna MUST be equaled by current flowing out of a counterpoise at the point of feed. "

Or this ?

QRP stations get away with this stuff, because the power is so low no one notices the current on the feedline shield or the resulting voltage on the cabinet of the radio and everything connected to the radio. It is a real problem, however.

WITH THIS ?

I used this kind of antenna with good results when I was in college. I fed mine with openwire line in the classic end fed zepp configuration, to a balanced tuner. I used this when I lived in an apartment as a stealth antenna and it worked far better than any "compromise" antenna I tried, since it is not a compromise. My antenna was cut for 75M, and I worked all bands using it.

(cont.)

It was a lot of fun to use this antenna. I did have to fool around with feedline lenght a little bit to get it to match on all bands. Using up to 1KW I had no problems with RF, which is the constant "wivestale" knock against this antenna. You will hear the "experts" blow about it somehow isn't "balanced", or causes "TVI" etc etc. I didn't find this to be the case at all. Frankly I don't think most of these "experts" have ever used this antenna and are just busy being "experts". I have not found many other hams who have ever tried this antenna.

W9OY

Enough TESTING Already....

NOW...for an
EXAMPLES of DIS-INFORMATION
from QRP-L
and some other "places".

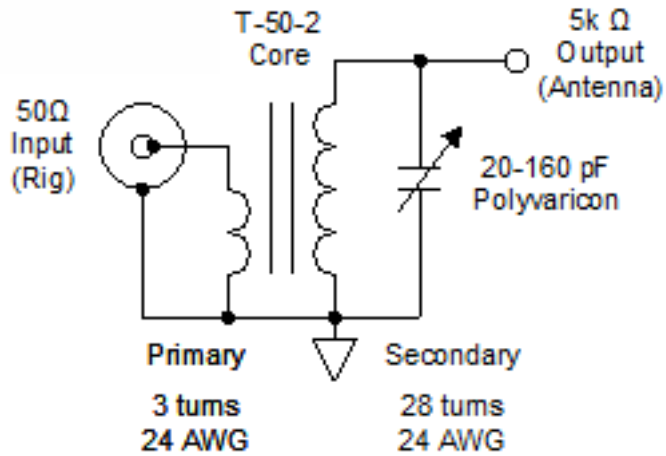
Can this be true ?

Part ONE

The Question

Hello,
I have built this coupler.
http://www.aa5tb.com/coupler2.html
I finally got it working. But looks like tunning is very touchy.
Could it be because I used a 266pf polycap?
Or is that normal?
TIA
Gabriel Moreno - N6OSB

A 40m through 17m Mini End Fed Half Wave Antenna CouplerSteve Yates - AA5TB



The Response

Gabriel,

Put a capacitor in series with the top end of the polycap to reduce the "touchiness" - 470 pf will bring the series combination down to about 160 pF.

I would also suggest adding a "counterpoise" wire - maybe 16 feet long - it connects to the "ground point" on the inductor and tuning cap - the other end just is run out on the ground. That should bleed off residual RF.

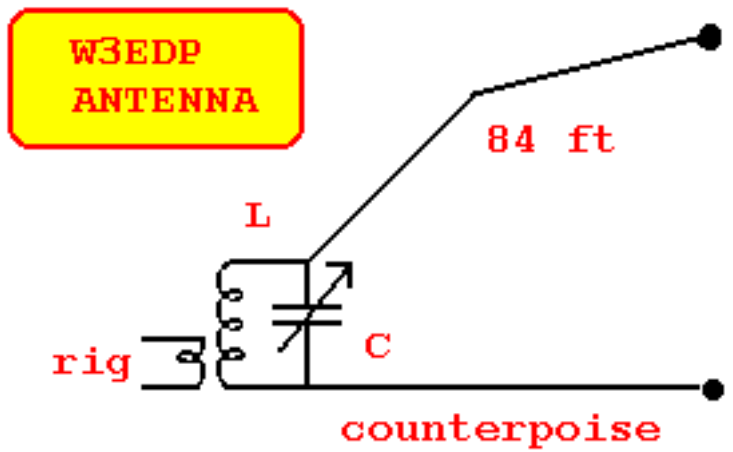
73,

Can this be real ? Part TWO

This time it's not from qrp-l, but it is from that purveyor of truth, the internet.

Case Study
The W3EDP HF Antenna

Another example from the internet:



Case Study
The W3EDP HF Antenna

The W3EDP end fed wire antenna lends itself readily to QRP and portable operation.
A simple matching unit is needed to couple the wire to the rig and a counterpoise is required for some bands, however there is room for experimentation here.
It has been shown that different lengths or removal of the counterpoise altogether, can improve performance, as described in RadCom, August 1996 by G3LCK.
The Tuning capacitor in the AMU can be a 365 - 500pF broadcast type or a miniature version is OK for QRP use.

Case Study
The W3EDP HF Antenna

Counterpoise lengths

- 3.5 & 7.0Mhz - 17ft
- 14Mhz - 6.5ft
- 28Mhz - none

Tuning Unit

Values for coils in the unit, based on a 2 inch former and 16 swg wire:

- 3.5Mhz 21 turns
- 7.0Mhz 7 turns
- 14.0Mhz - 5 turns.

X5XXX Notes:

Some folks have told me the modifications below make the antenna something other than a W3EDP. I can tell you that it works very well with 5 watts.

Create a "bundle" of counterpoise wires, 1/4 wave length for each band you will use. Attach the bundle to the tuner in place of the counterpoise pictured above.

Be cautious, 1/4 wave length elements can have high RF voltages present, even at QRP power levels.

I've been able to work 160-10, including WARC bands with this type of antenna.

Remember this one thing
today, if nothing else.

If you need some sleep,
you should start your nap now.

Bottom line

An antenna by any other name (like counterpoise, radial, stub) is STILL an antenna.

There are **** NO **** exceptions.

WHY ?

An antenna ALWAYS exists whenever there is an osc. wave traveling down *a* wire OR an electro-magnetic wave encounters *a* piece of wire.

(Repeat three times and remember it always, it is the most important thing to know about antennas. It **IS** an accurate working definition of an antenna. There are no others that are as emphatic; that is to say as definite and clear.)

O.K. Bob, but what can I do to know the "truth" when I see such ***things*** about an end-fed ?

things = BULL-$%#!

(Time to wake up from that nap !!!!)

"Learn sumtink 'bout this stuff."

Internalize some truths.
Perhaps we can start here:

One Way to Discuss Antennas

I live for just such an explanation,
don't you ?

de "Electromagnetic Radiation Explained" by Jim Hawkins - WA2WHV

(How Radio Waves Are Born)

The concept of radiation can be stated as follows:

If there is an alternating current in a conductor, an alternating magnetic field will be created surrounding the wire. The alternating magnetic field due to the current in the wire will create an alternating electric field in space further out from the conductor. WE HAVE LIFTOFF! The first transition from conduction fields to space fields has been made. Now, carrying it further, the alternating electric field, which was just born in space will create a magnetic (due to the corresponding displacement current in space) field further away from the conductor (according to Eq.17). The alternating magnetic field will then create another alternating electric field (according to Eq. 16). This process, which continues on away from the conductor is called electromagnetic wave propagation.

de "Electromagnetic Radiation Explained" by Jim Hawkins - WA2WHV

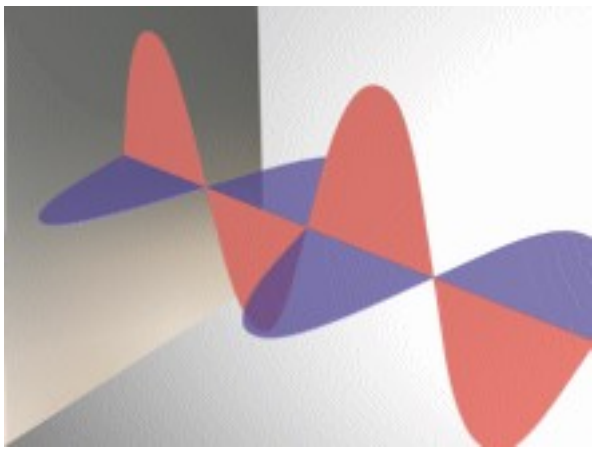
(How Radio Waves Are Born)
Page TWO

But, in order to radiate power, we must have both an electric E field and H field in phase. Just like the initial electric field E in space, a magnetic field H is created from the electric field intensity or displacement current at the surface of the conducting wire. Both E and H fields, perpendicular to each other generate successive H and E fields, which are perpendicular to the previous pair of fields. The combination of these, in phase fields give rise to what is called the Poynting vector, which is perpendicular to both E and H fields and in the direction of propagation. The Poynting vector represents the actual power propagated in space. The magnitude of the Poynting vector is equal to the cross product of the E and H fields as in: P = E x H. It is measured in Watts per square meter and is, therefore, a power density.

de "Electromagnetic Radiation Explained" by Jim Hawkins - WA2WHV

(How Radio Waves Are Born)

Page THREE



The induction E and H fields close to the conductor are stored and, therefore, not radiated. They are separated
by a 90^0 phase with each other. When the fields collapse,
energy is returned to the system.

Radiated E and H field (shown left as radiated from a plane in space) are IN PHASE because they are delivering power to space. Energy is lost from the radiating system in this way and appears as a radiation resistance.

de "Electromagnetic Radiation Explained" by Jim Hawkins - WA2WHV

(How Radio Waves Are Born)
Page FOUR

Radiation Resistance (electronic "friction") -

When the voltage and current are observed at the terminals of a radiating conductor or antenna, one component of alternating current is 90 degrees out of phase with the alternating voltage and another component is in phase with the alternating voltage. The component of current which is 90 degrees out of phase behaves like and, therefore is considered a reactive component. No power transfer or loss takes place due to the reactive component. The portion of current that is in phase with the alternating voltage is considered current due to power transfer. A portion of the power transferred or lost is due to the ohmic resistance of the antenna or radiator. It will be found, however, that there is an additional amount of power transferred, which the ohmic resistance can not be held accountable for. This power transfer is due to radiation. As far as the power source or transmitter is concerned, all power transfer appears as a total resistance and can be treated as so at the antenna feed point.

(How Radio Waves Are Born)

Page FIVE

The energy lost can be thought of as being due to a "drag" or force acting against the motion of electrons which carry the electric charge. Part of this "drag" is due to energy transferred in collisions between atoms and the moving electrons, setting the atoms in motion, manifesting itself in the form of radiated heat. How, then is a "drag" felt, due to radiation?

In the American Radio Relay League article, "Why an Antenna Radiates" by Dr. Kenneth MacLeish, he describes the notion of *Bootstrap Forces*. Since the electric fields exist down to the surface of the electron and there is a force against charged as they accelerate through a magnetic field, the electron experiences a force or "drag" as it accelerates through it's own field! That portion of drag, due to the dynamic or radiated electric field is the force of radiation resistance. That is, the electron is pulled by it's own bootstraps! Part of the fields which drag the electron, collapse back into the conductor as it decelerates, thus returning energy to the electron in the opposite direction. This returned force is the back-emf due to inductance, which is part of the reactive component of the antenna impedance.

A 2nd Way 2 Discuss Antennas

Well, it's shorter at any rate.

Einstein Quote # 1

“The wireless telegraph is not difficult to understand. The ordinary telegraph is like a very long cat. You pull the tail in New York, and it meows in Los Angeles.

The wireless is the same, only without the cat.”

3rd Way to Discuss Antennas

Getting better !!

Sounds f.b. *BUT* what exactly is being described ?

After moving to a new condo last year a random length endfed wire was put into the trees. It loaded poorly with a home brew parallel LC tuner so I added about 10 ft. to the length and then it loaded easily from 160 - 10m. Some long radials were run into the woods and pushed under the fallen leaves. A second (Green) wire was put up of random length off a roll which also tuned up easily. I then took down the first wire and measured it.... 150 ft. long. The green wire stood out like a sore thumb so it was replaced with a more invisible black wire. (cont.)

The green wire also measured 150 ft. long.
Coincidence ? That is how far my slingshot shoots. :-) The current wire (150') is used from 160m to 6m with my FT-817 and the HB tuner.. It's good for 160m in winter, 6m in summer, and all other bands in between. I'm not saying it's efficient but with 4 watts output it worked EU on 160m and W4, 5, 8, and 9 on 6m. A station in Cuba could not get my call right so that doesn't count for 6m DX.... but it is encouraging
:-) 72

DA RULES

Another attempt at an easier way to "know antennas".

"DA RULES"

- Antennas should be placed high and be large ('enuf').
- Add more wire to the counterpoise to 'get out'.
- You must have a "low SWR".
- Add a counterpoise to your EFHW when in doubt.
- You MUST be using a vertical to work DX.
- You MUST have a beam to work DX.
- You MUST have a tower to work DX.
- You MUST have the latest 'rig' to work DX.
- You MUST have a 'full gallon' to work DX.

Had enough yet ?

Why Do We See Such Things ?

- We don't know "da rules".
- We know "da rules" but we aren't sure why they are rules.
- We wonder why we 'have to' design an antenna.
- We wonder how come our neighbor gets out and we don't, so we ask our neighbor what's going on.
- A few years later we ask on qrp-l, cause we find out our neighbor doesn't REALLY know what's going on.
- We get an answer and it turns out to be not quite correct.
- Finally we read (parts of) 'The ANTENNA Book' and find out that it's contradictory and hard to find out what's going on reading.

AND *EXACTLY* WHAT IS A "COUNTERPOISE" ANYWAYS ?

Counterpoise - Hey it's a weight used for mechanical leverage...er,um, what's that got to do with r.f ?

Einstein Quote # 2

“
–
Whoever undertakes to set him self up as a judge of Truth and Knowledge is shipwrecked by t he laughter of the gods.
”
–

Some favorite explanations (NOT)

"I would also suggest adding a "counterpoise" wire - maybe 16 feet long - it connects to the "ground point" on the inductor and tuning cap - the other end just is run out on the ground. That should bleed off residual RF."

or

"> In fact, if you have the EFHW wire the correct length, you DON'T need a
counter poise wire connected.

EFHWA tuners often don't need a counterpoise. That is because the connection
to the rig, the headphones (if used) and the connection to the key often
presents enough of a counterpoise for the system to work."

Interesting.....

"Very short end fed wire puts it to close to ground and losses to nearby conductors. The end fed wire should be pretty straight out and up, from the rig, or you may find that signals cancel."

(um..."what signals ?")

Of course the most completely wrong idea yet !

No one is dumb enough to still be using this, ... or are they ?

The GRANDE stupidiom of Antenna Ads:

" I worked everyone I heard ! "

WHAT does that mean ?;

- My receiver NOW works thanks to this new antenna ?

- You learned how to use your transmitter thanks to this new antenna?

- No static at the other end because of the new antenna at this end ?

Grande stupidium - Part TWO

(NEXT YEARS ANTENNA PROMOTION;)

I worked everyone I heard and even a few more .....

(that I didn't hear).

Einstein Quote #3

“

–

If you can't explain it simply, you don't understand it well enough

”

–

Da REAL RULES

I wouldn't lie to you.

THE ESSENTIALS TO **GROK**

- RF is naturally a RADIATION PHENOMENON

- ANTENNAS **ARE** TRANSDUCERS

- When we say "ANTENNAS";
  (Usually) **THINK** "ANTENNA SYSTEMS"

To **grok**

(pronounced GRAHK) something is to understand something so well that it is fully absorbed into oneself.

automatic, intuitive, reflexive, emotive as to essentials

RF POWER is:

- At it's MOST "efficient" when radiated/propagated electro-magnetic (E-M) wave.
- MUCH LESS "efficiently" generated & used by man within electrical circuits.
- Therefore RF POWER will tend to be converted into an E-M wave when given the opportunity.

THIS IS WHY EVEN SHORT INEFFICIENT ANTENNAS WORK WHEN RF POWER IS AVAILABLE (*AND* CAN BE COUPLED AT THE INPUT).

Another useful Definition of an ANTENNA

An antenna is a ***transducer*** that converts ***electrical energy*** into ***electromagnetic energy*** (and HOPEFULLY radiates it efficiently).

Definition of a TRANSDUCER

A ***transducer*** is a device that converts one type of energy to another. Energy types include (but are not limited to) electrical, mechanical, electromagnetic (including light), chemical, acoustic or thermal energy.

While the term ***transducer*** commonly implies the use of a sensor/detector, any device which converts energy can be considered a transducer.

FEEDLINES ARE ANTENNAS TOO !!

The parts of a feedline that have RF POWER traveling upon them act as part of the ***'antenna system'*** and can be made out of actual antennas. They have to be carefully created and used in order for them NOT to radiate. You couple power into them in EXACTLY the same ways you would with your antennas. ***As such they are more properly a special type of antenna that share ALL of the physical characteristics of antennas except one.*** The difference is that the energy remains as a traveling wave along a guide and cannot be ***transduced*** because a transmission line has opposing fields that cancel.

THE ESSENTIALS TO **GROK**

- RF is naturally a RADIATION PHENOMENON

- ANTENNAS **ARE** TRANSDUCERS

- When we say "ANTENNAS";
  (Usually) **THINK** "ANTENNA SYSTEMS"

AND PART DUE

- FEEDLINES are antennas that do NOT radiate

(Ideally)

- Unless you are in space, MANY things may affect your pattern...and you ALWAYS design in YOUR pattern to effect a SPECIFIC result

- Design in low losses and the bigger results will occur.

Which brings us right back,

to the beginning.

Bottom line

An antenna by any other name (like counterpoise, radial, stub) is STILL an antenna. There are no exceptions.

WHY ?

An antenna exists whenever there is a osc. wave traveling down *a* wire OR an electro-magnetic wave encounters *a* piece of wire.

(Repeat three times and remember it always, it is the most important thing to know about antennas. It **IS** the definition of an antenna. There are no others that are as emphatic; that is to say as definite and clear.)

The ONE Thing to Always Remember

Antenna (systems) ALWAYS :

* Either radiate or

* Turn the R.F. energy into heat.

There isn't much else they can do anyways.

Which means:

ALL r.f. circuit energy (power) put into the antenna is used.

And ***IF*** the antenna is an efficient radiator this POWER is almost all used in radiation.

There are no known exceptions.

Internet Resources:

Electromagnetic Radiation Explained
by Jim Hawkins - WA2WHV
hawkins.pair.com/Radiation.html

www.arrl.org/how-antennas-work

www.w8ji.com/antennas.htm

www.cebik.com

(1 link gives bad info...can you guess which ?)

Da Books:

Radio-Electronic Transmission Fundamentals
by B. Whitfield Griffith
(Available from the ARRL)

Pre-1965 Edition of The ARRL Antenna Book

ANY edition of Walt Maxwell's book: Reflections

Da END

Well, sort of; if you want the rest of this sad story please continue.

Reference Material and a Discussion

Thanks for the article and references. Here is my experience with this antenna.

I used this kind of antenna with good results when I was in college. I fed mine with openwire line in the classic end fed zepp configuration, to a balanced tuner. I used this when I lived in an apartment as a stealth antenna and it worked far better than any "compromise" antenna I tried, since it is not a compromise. My antenna was cut for 75M, and I worked all bands using it.

It was a lot of fun to use this antenna. I did have to fool around with feedline lenght a little bit to get it to match on all bands. Using up to 1KW I had no problems with RF, which is the constant "wivestale" knock against this antenna. You will hear the "experts" blow about it somehow isn't "balanced", or causes "TVI" etc etc. I didn't find this to be the case at all. Frankly I don't think most of these "experts" have ever used this antenna and are just busy being "experts". I have not found many other hams who have ever tried this antenna.

I did use a good single point ground on the station, and located the tuner near the point where the openwire and the ground entered the shack, and my apartment was on the first floor. My tuner was a homebrew link coupled affair with plug in coils for each band. I made the openwire out of some parallel 18g wires seperated by 1" using electrical tape as the insulators. 100 ft of 10g copper bus for the coils for a half buck, 1000ft of 18g insulated wire for a half buck and 3 rolls of tape for a quarter at a hamfest. (When you're in college living off Velveta, eggs and day old bread you use what ever is cheapest.) I also built a Z match that worked with this antenna, but not as well as the link coupler. Today I would use the single coil version of the Z match for an all band portable setup. The antenna was very well behaved, easy to tune and got me on the air with a good signal, with no problems.

It's an easy antenna to make and experiment with. A few feet of wire, some tape, a couple of variable caps, little piece of coax to the rig....work the world. I love it Ham radio at its best.

W9OY

And here "IT" starts.
OR
The ***amazing*** Mr. Kirchhoff.

"I keep coming back to the light bulb example. You can't get current to flow into a flashlight bulb with only one wire connected between it and the battery. You must have a complete current path. The same goes for an antenna."

OR

"Unless Kirchoff's law is in error, the current on the shield must be 100% of the current entering the end of the

All I *NEED* to know about Kirchhoff being applied to antennas:

Kirchhoff is a parlor trick that is based on a closed loop circuit that has no transducers and has ONLY lumped constants/elements. It is a construct meant for modeling.

In opposition: Antennas are "open loop" circuits, they are (energy) transducers, and they are correctly modeled using distributed constants/elements.

The two imperatives above do NOT correlate.

MOST IMPORTANTLY;

When the physical reality does not match what you model, your modeling is wrong. Physical reality is never wrong !

Kirchhoff - Part UNO

Kirchhoff's circuit laws are two equalities that deal with the conservation of charge and energy in electrical circuits, and were first described in 1845 by Gustav Kirchhoff. Widely used in electrical engineering, they are also called Kirchhoff's *rules* or simply Kirchhoff's *laws* (see also Kirchhoff's laws for other meanings of that term).

Limitations

This is a simplification of Faraday's law of induction for the special case where there is no fluctuating magnetic field linking the closed loop. Therefore, it practically suffices for explaining circuits containing only resistors and capacitors.

In the presence of a changing magnetic field the electric field is not conservative and it cannot therefore define a pure scalar potential—the line integral of the electric field around the circuit is not zero. This is because energy is being transferred from the magnetic field to the current (or vice versa). In order to "fix" Kirchhoff's voltage law for circuits containing inductors, an effective potential drop, or electromotive force (emf), is associated with each

Kirchhoff - Part DUO

" The law is based on the conservation of charge whereby the charge (measured in coulombs) is the product of the current (in amperes) and the time (in seconds)."

Changing charge density:

KCL is only valid if the charge density remains constant at the point to which it is applied. Consider the current entering a single plate of a capacitor. If one imagines a closed surface around that single plate, current enters through the surface, but does not exit, thus violating KCL

Kirchhoff - Part DUO - Continued

Certainly, the currents through a closed surface around the entire capacitor will meet KCL since the current entering one plate is balanced by the current exiting the other plate, and that is usually all that is important in circuit analysis, but there is a problem when considering just one plate. Another common example is the current in an antenna where current enters the antenna from the transmitter feeder but no current exits from the other end.(Johnson and Graham, pp.36-37)

Kirchhoff - Part DUO - Continued

Maxwell introduced the concept of displacement currents to describe these situations. The current flowing into a capacitor plate is equal to the rate of accumulation of charge and hence is also equal to the rate of change of electric flux due to that charge (electric flux is measured in the same units, Coulombs, as electric charge in the SI system of units). This rate of change of flux, , is what Maxwell called displacement current I_{D};

Kirchhoff - Part TRES

This is simply the charge conservation equation (in integral form, it says that the current flowing out of a closed surface is equal to the rate of loss of charge within the enclosed volume (Divergence theorem)). Kirchhoff's current law is equivalent to the statement that the divergence of the current is zero, true for time-invariant ρ, or always true if the displacement current is included with **J**.