



# Inspecting Electrical Panels

Inspecting panels from the  
1920s through today

Presented by Mike Casey  
Keystone Inspection Conference  
October, 2011

## Our Agenda

- A brief history of alternating current
- Current flow and neutral separation
- Review safety requirements
- Discuss older fused panels and 120v systems
- Service equipment sizes and types
- Service and sub-panel inspection
- GFCI and AFCI breakers
- Report writing and recommendations
- Summary

## In The Beginning...

- Man harnessed electricity, brought it into the home...and it was good most of the time...



## Why AC Instead Of DC?

- Edison Versus Tesla! Throw down of the 19<sup>th</sup> century!
- Thomas Edison was heavily invested in DC power and promoted DC current for the U.S.
- Nikola Tesla had a better idea – Alternating Current

## **DC Current vs AC Current**

- In 1887 Nikola Tesla filed 7 U.S. patent for Alternating Current
- The difference between DC and AC power is all about how electrons flow

## **Direct Current**

- Direct Current must have a direct and continuous flow of electrons from negative to positive poles
- Low voltage and high amperage
- Much larger wire size required
- Resistance creates significant power loss

## Alternating Current

- **Electrons alternate back and forth along a wire**
- **Low amperage/High voltage**
- **Much smaller wire size required**
- **Able to push current long distances with less loss and convert (transform) the power near the use point (pole transformers)**

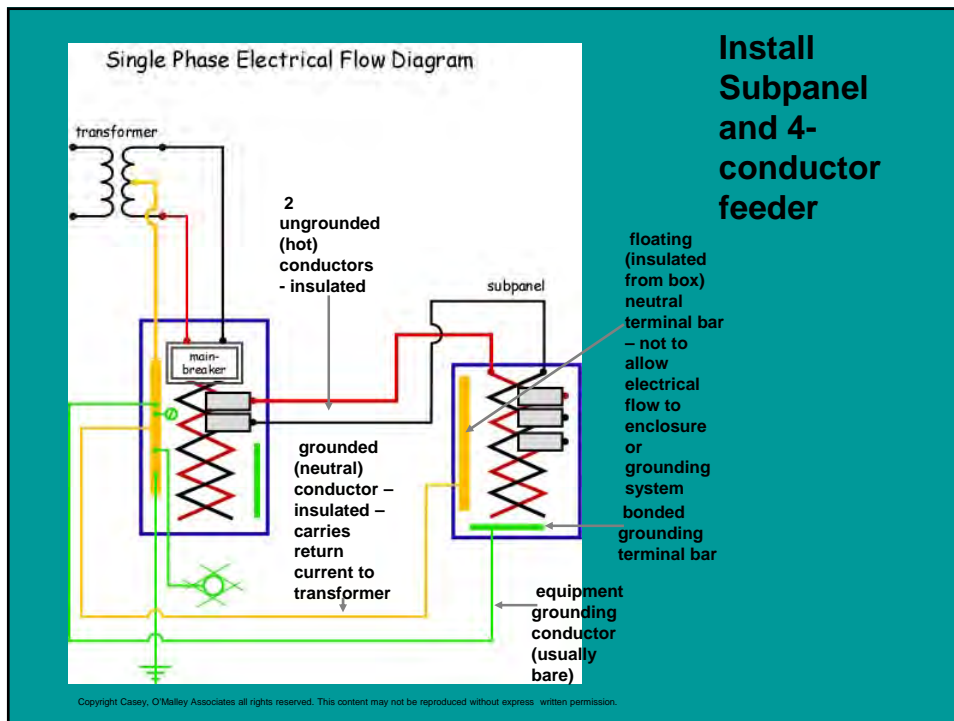
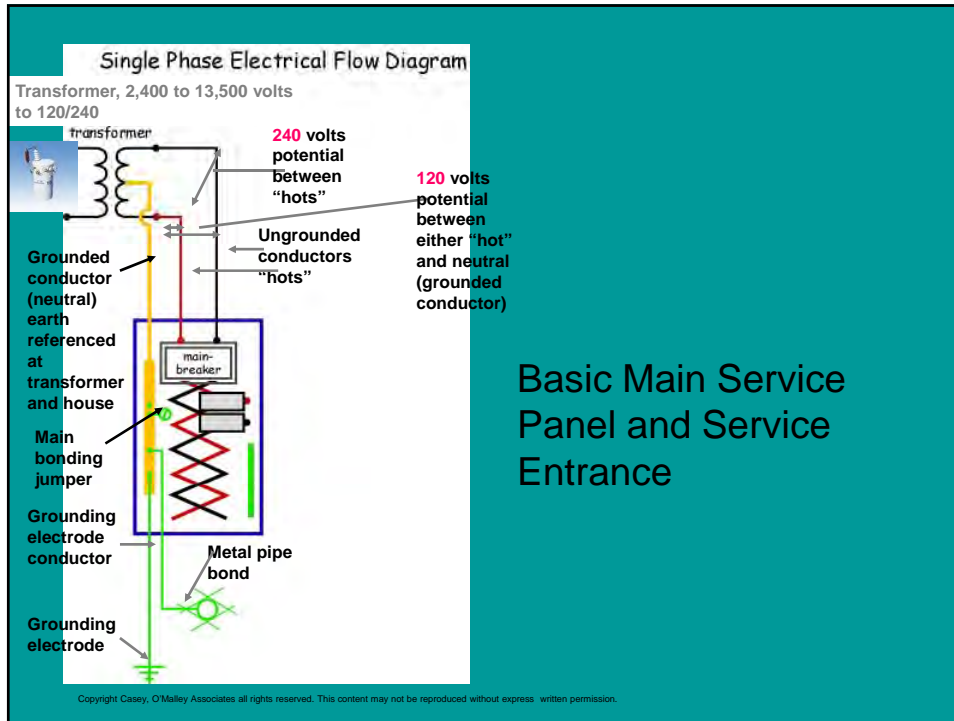


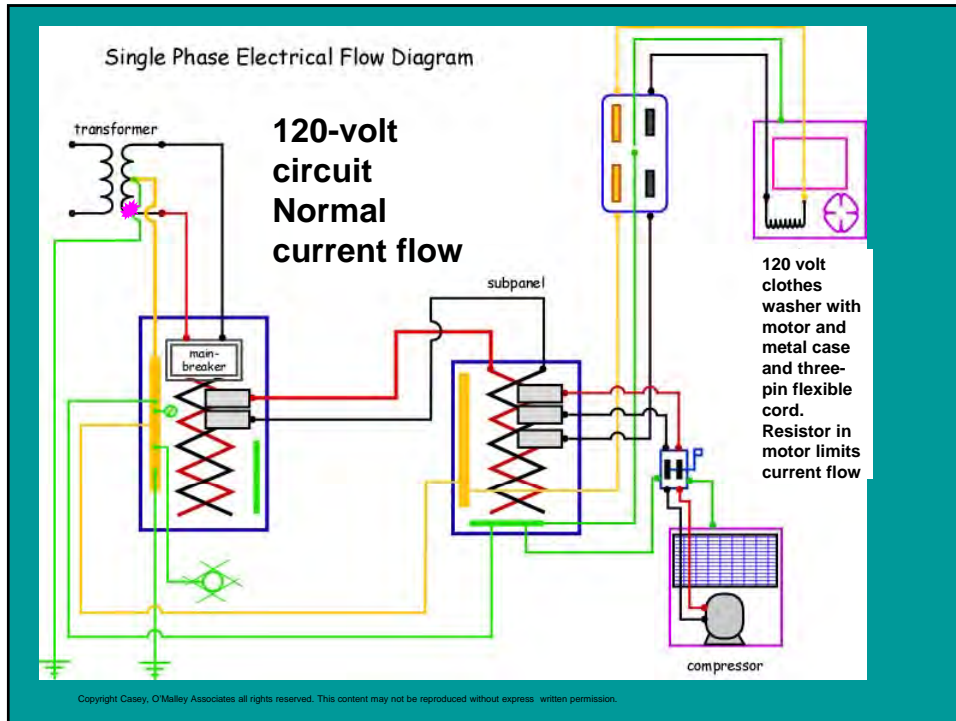
## Standard Terms of Measurement

- **Voltage:** Pressure behind electrons – similar to water pressure
- **Amperage:** Volume (current) – similar to gallons per minute – only so much can get through depending upon size of pipe/wire
- **Ohms:** Resistance of a material to electron flow – similar to size of pipe or pipe material restriction -

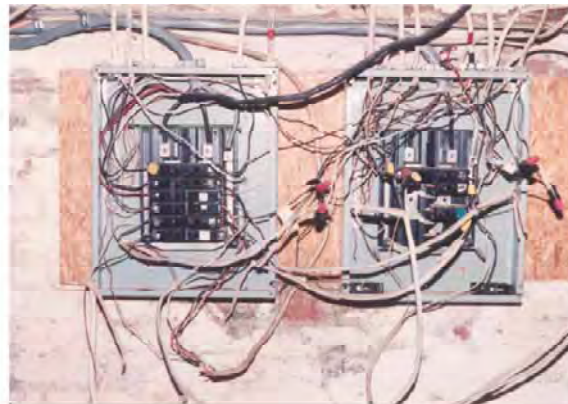
## Remember:

- The “hot” conductors are called ungrounded conductors
- The “neutral” is the grounded conductor (carries current – thus insulated)
- Equipment ground “ground” is the bare wire. Should not carry current **UNLESS** there is a malfunction – it is the emergency path back to the transformer in the event of a fault





## Professional Wiring?





## 200 Ampere Meter



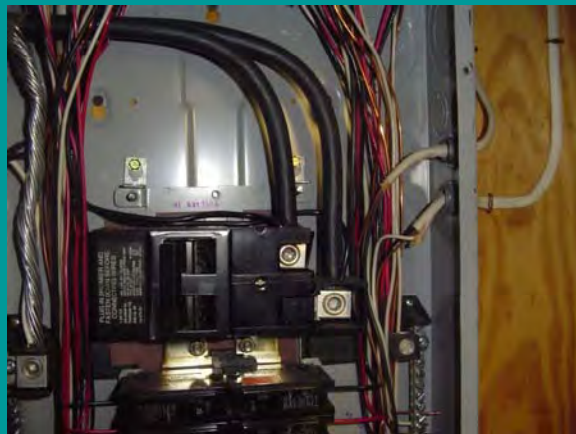
## 200 Ampere Main



## Splices OK in Main Panel (it's a junction box)



## Direct taps not OK in Main Panel



## Working Clearance?



## Working Clearance?



## Working Clearance?



## 30 Amp Service Panel

- Used in homes as the first service panel
- Undersized for today's homes
- Upgrading is required



## **Obsolete Panels**

- **30 Amp Fuse Service Panels**
- **Fused Neutral Panels**
- **Federal Pacific Stab-Loc Fuse Panels**
- **Bull Dog Pushmatic Panels**

## **Problematic Panels**

- **Federal Pacific Stab-Lok Panels**
- **Zinsco/Sylvania Panels**
- **Bull Dog Pushmatic Panels**

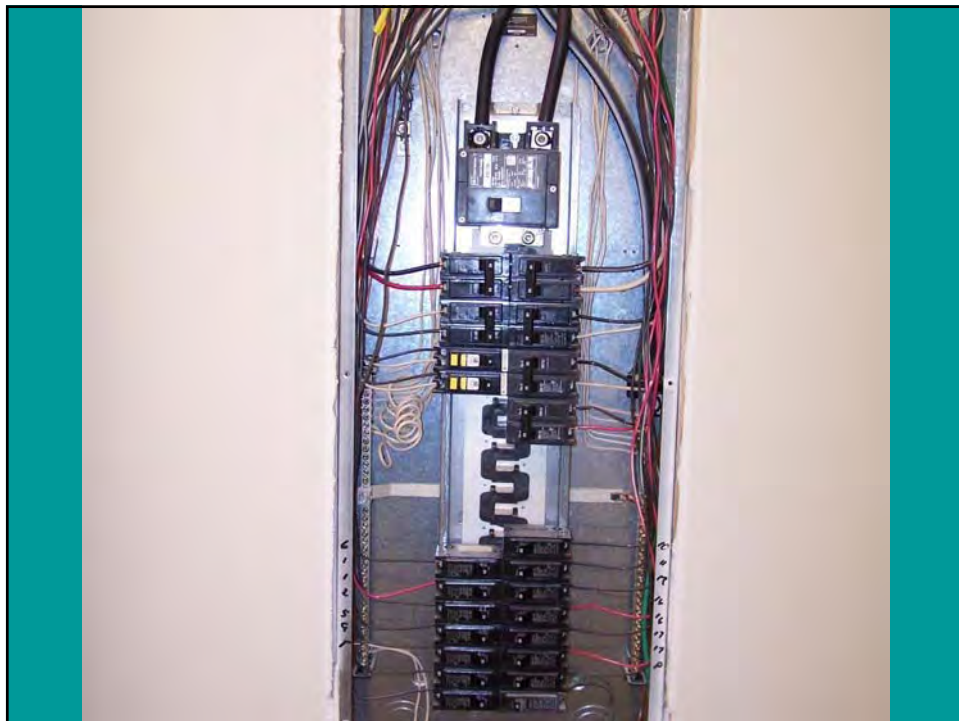
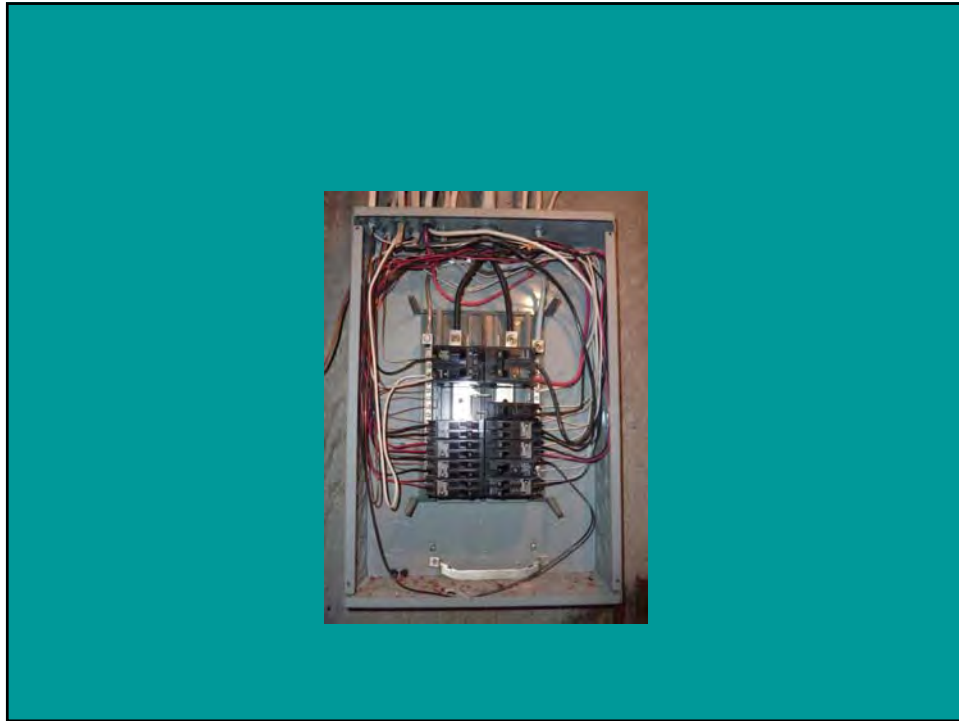
## Modern Panels

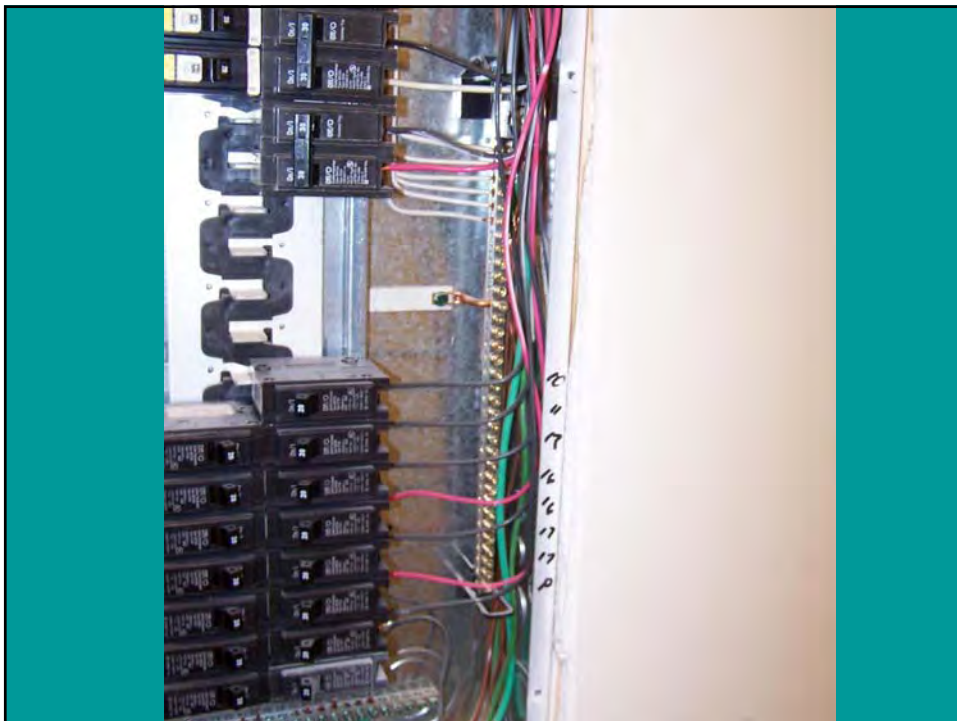
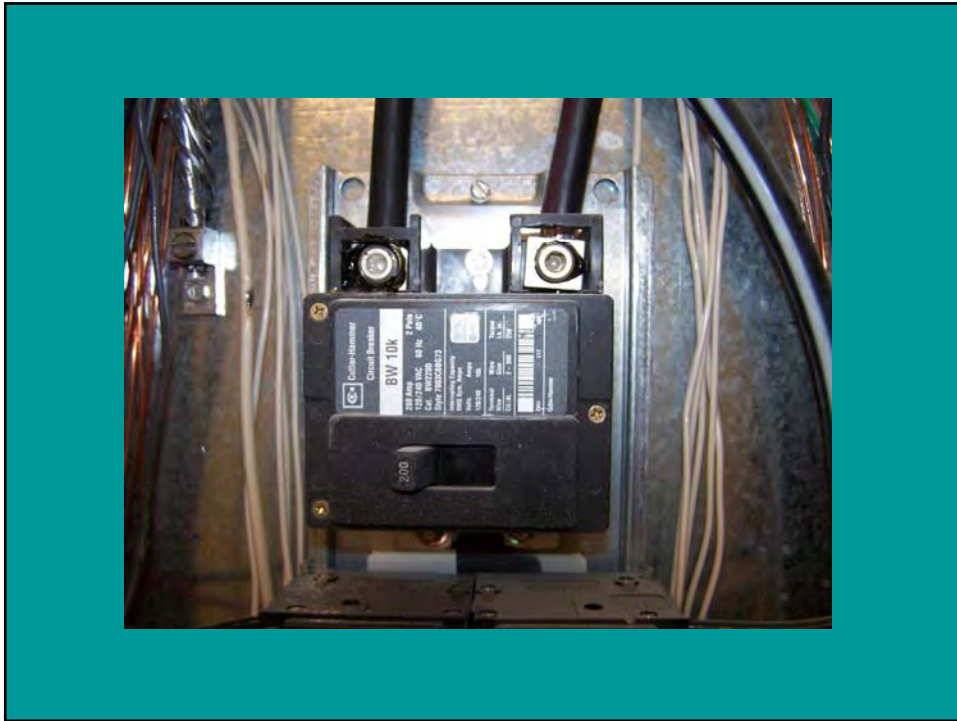
- 100 Amp panels
- 125 Amp panels
- 200 Amp panels



## Enough Panels?

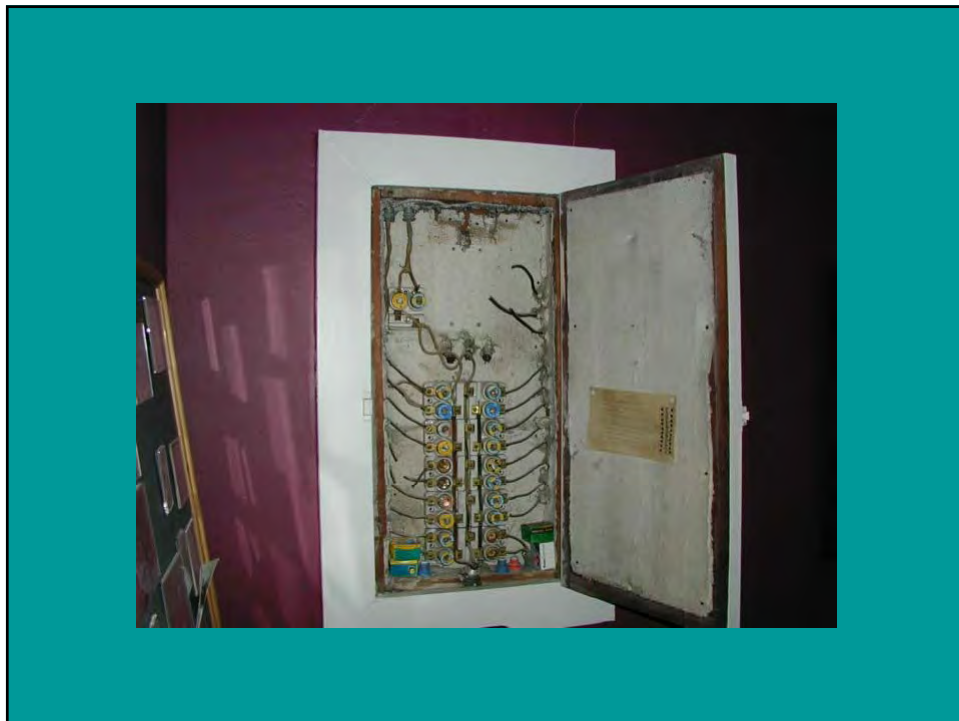
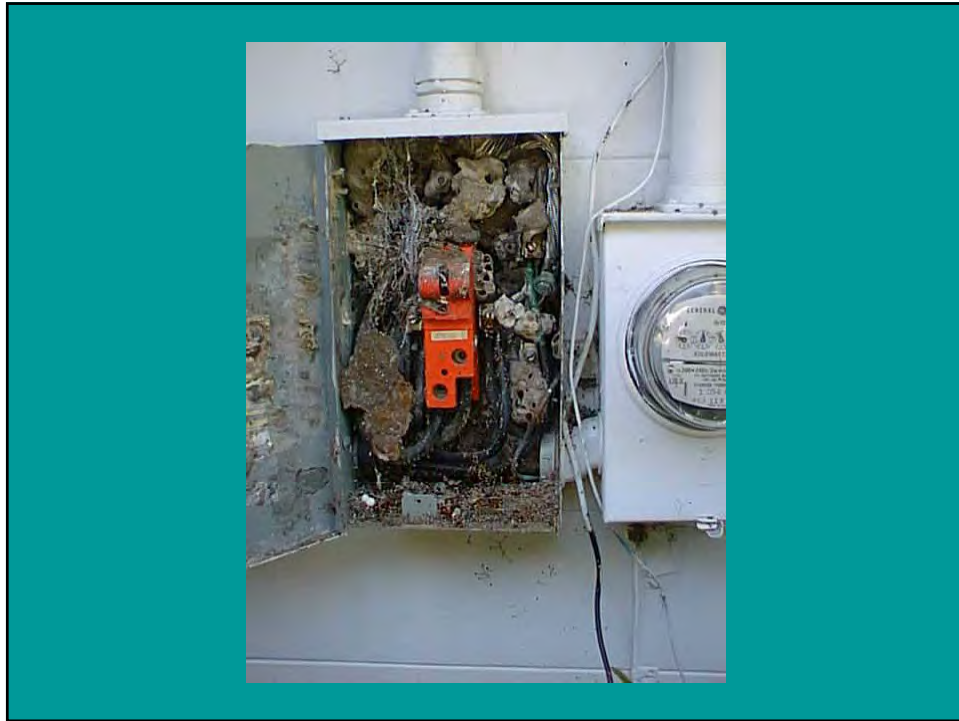


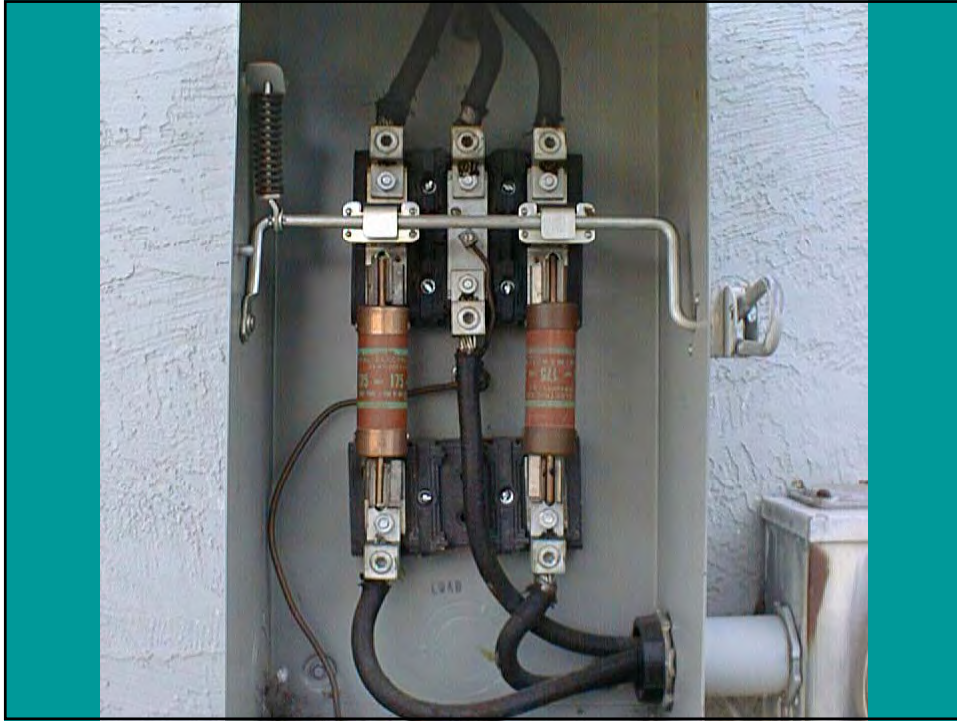




## Subpanel Separation

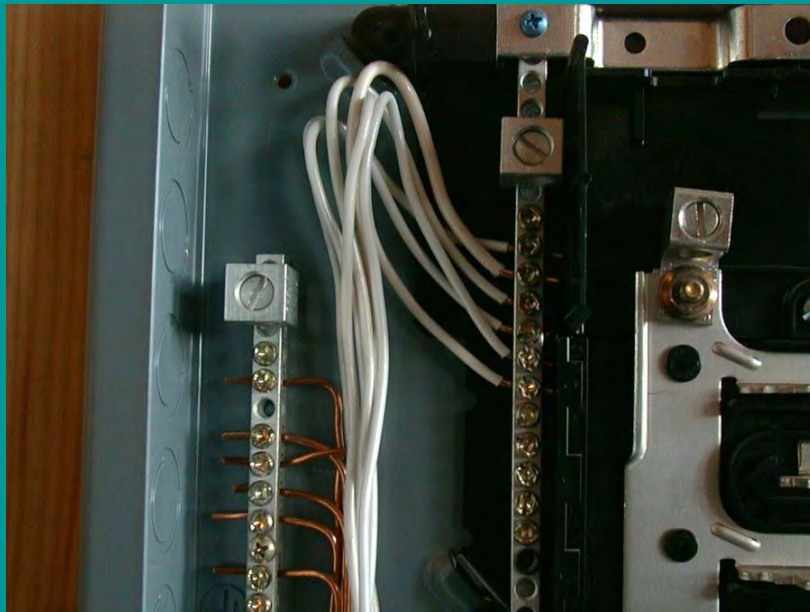






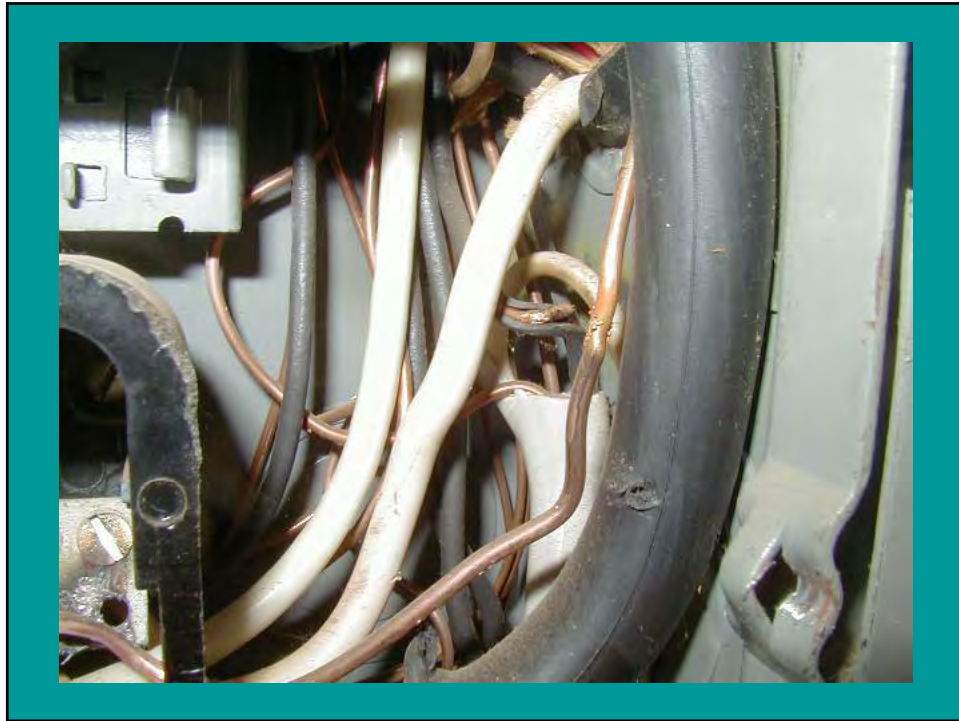


## Subpanel Separation

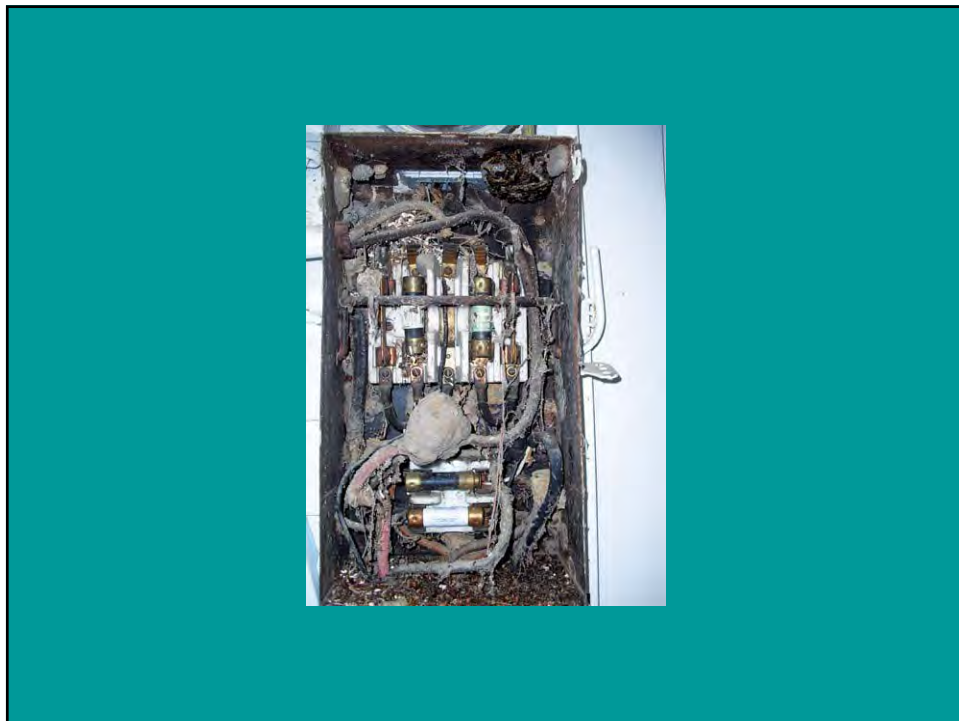


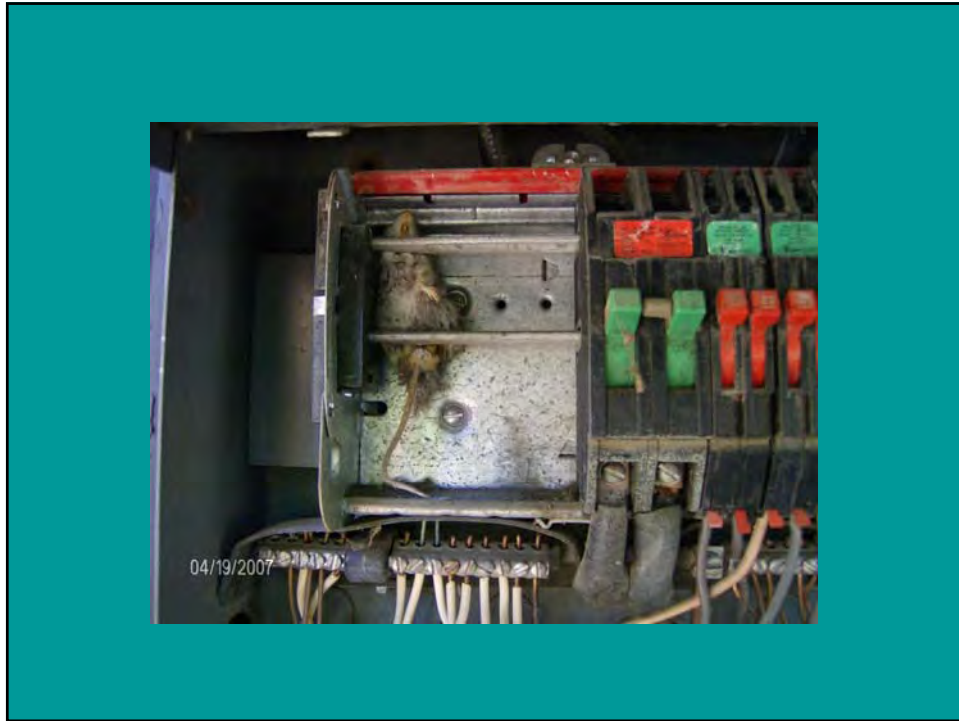
## Subpanel Separation Missing



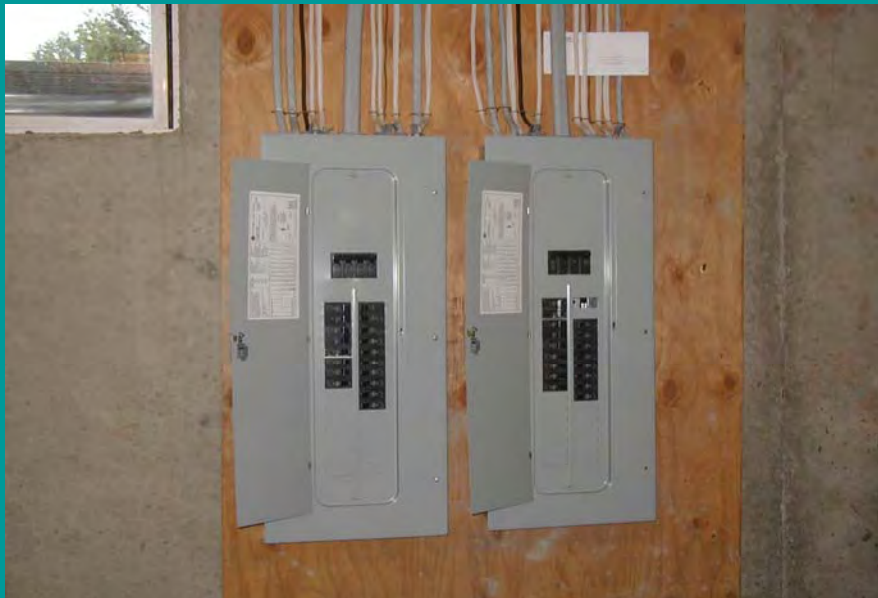


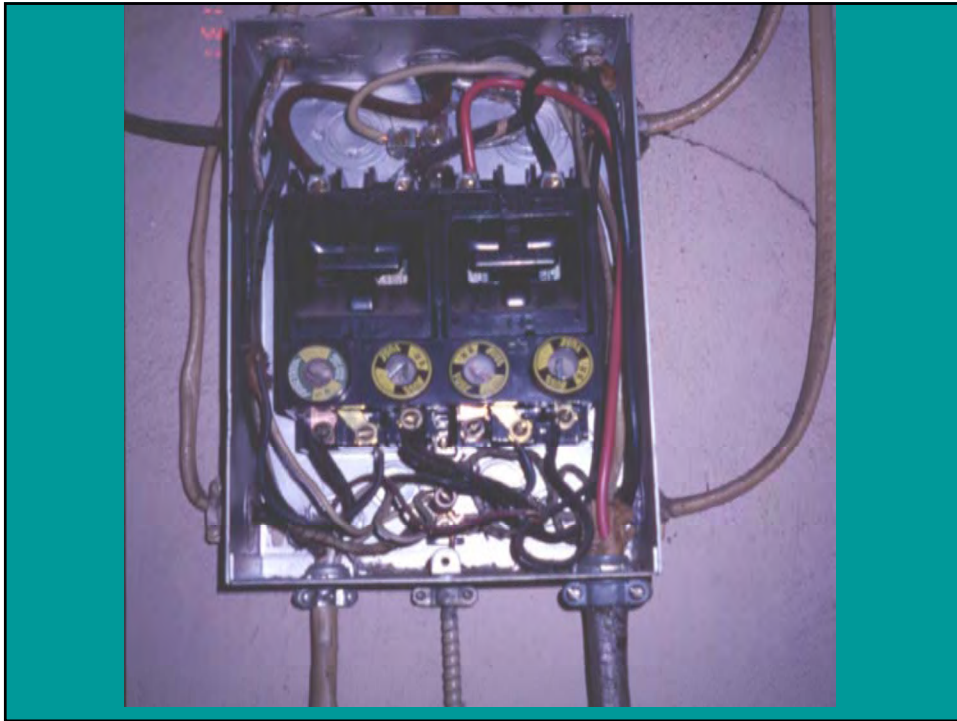


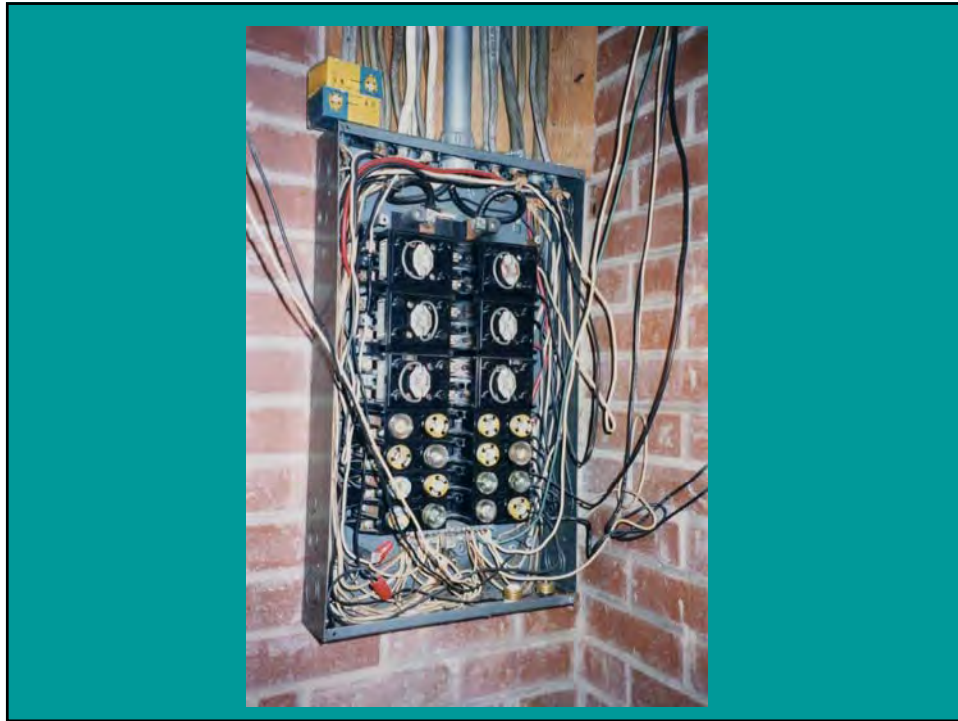




**400-Amp Service (2-200 Amp in parallel 400-amp meter)**



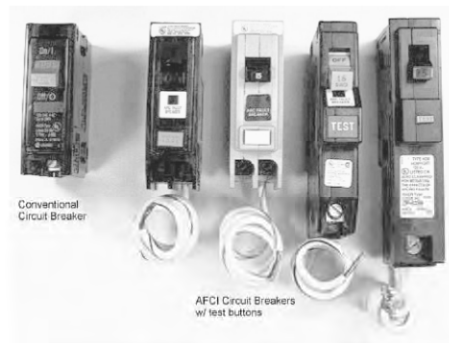




## AFCI

### Arc Fault Circuit Interrupters (AFCIs)

By 1997, residential circuit breakers with arc fault protection were becoming commercially available



## Combo AFCI



## AFCI

- From the GE web site:
- Branch/Feeder AFCI

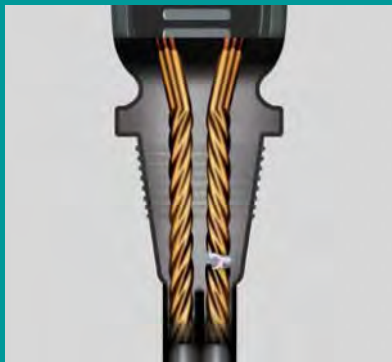
A Branch/Feeder AFCI has the ability to detect and neutralize a parallel arc fault, which is the unintentional flow of electricity between two separate wires. There are three types of parallel arc faults: line-to-line, line-to-ground, and line-to-neutral. The Branch/Feeder AFCI is permitted by the 1999-2005 NEC® Code.

- Combination AFCI
  - GE's Combination AFCI delivers 5 kinds of protection:
    - Parallel protection – Just like its Branch/Feeder counterpart, Combination AFCI can detect and neutralize parallel arc faults
    - Series Protection – A series arc fault is the unintended flow of electricity over a gap within a single wire. These arc faults were not detectable until advanced technology allowed the development of the Combination AFCI breaker.
    - Ground protection – Arcing between a single conductor and a ground line
    - Overload protection
    - Short circuit protection
  - The 'old' AFCI only detected an arc between two wires, line-ground, line-line, and line-neutral. The new ones detect an arc within a single wire (loose connection).

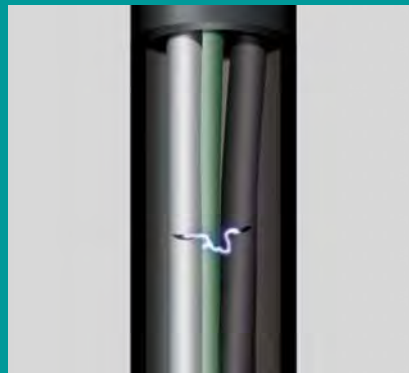
## AFCI

- 2008 NEC brought significant changes into the AFCI world, concerning device itself and expanding greatly areas of its application. Instead of AFCI breaker, combination type Arc Fault Circuit Interrupter is now required, and this is not a GFCI – AFCI combination.
- The new type of AFCI breaker is required to detect line-to-neutral, line-to-ground, neutral to ground, and series arcing (the previous AFCI detected only first three).
- Examples:
  - *Line to neutral* - the nail you drive into the electric conduit compromises neutral and hot wire, and the arc forms between the two damaged wires
  - *Line to ground* – the nail you drive into the electric conduit penetrates ground and hot wire, which causes arcing
  - *Neutral to ground* - the nail you drive into the electric conduit penetrates ground and neutral wire
  - *Series* – the nail you drive into the electric conduit compromises only one wire and arcing forms between the two separated wire sections

## Common Causes of Electrical Fires



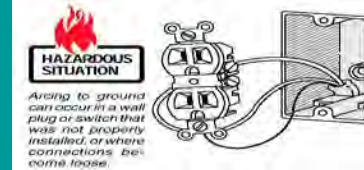
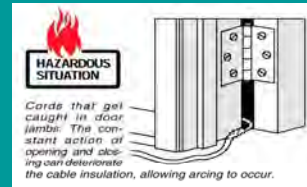
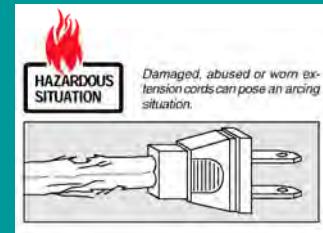
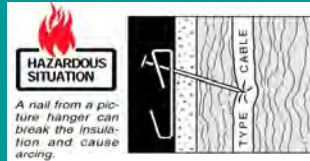
Series Arc Fault



Parallel Arc Fault

Source: SquareD.com

## Common Causes of Electrical Fires



## AFCI

- Where are the AFCI breakers required (2008 NEC):  
All 120-volt, single phase, 15 & 20 amp branch circuits that supply power to the outlets located in
- family rooms
- dinning rooms
- living rooms
- libraries
- dens
- parlors
- bedrooms
- sunrooms
- recreation rooms
- closets
- hallways
- similar rooms or areas

## GFCI Breakers AKA Residual Current Device outside of North America

- An unintentional electric path between a source of current and a grounded surface (like metal plumbing) is referred to as a "ground-fault." Ground faults occur when current is leaking somewhere, in effect, electricity is escaping to the ground. How it

## GFCI

Current path to  
Transformer is metal  
plumbing when  
bonded to the  
grounding system



Appliance malfunction –  
fault to chassis (case)

## **GFCI Breakers AKA Residual Current Device outside of North America**

- **GFCI breakers monitor current flow for imbalance. If 4amps is going out 4amps must return. If not, there is a leak (ground fault) and the device reacts at 4 milliamps or greater.**
- **New GFCI devices have lockout protection and will not reset if Line**

## **Open Domain Information available at [cpsc.gov](http://cpsc.gov)**

### **Consumer Education Materials**

- Videos - Four old homes inspected and improved (Washington, DC; Atlanta, GA; St. Louis, MO; and Redlands, CA)
  - Demonstrations of incremental wiring repairs
  - Affordable steps to remove gross hazards
- Consumer videos - *Wired for Safety*
- *CPSC Guide to Home Wiring Hazards*
- *CPSC Home Electrical Safety Audit Room by Room Checklist*
- Nationwide distribution of over 1000 sets of materials to state and local fire and electrical officials

## The End

Session Over – Thank you!!!

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