CFR 1926 Subpart K

Electrical

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- 1926.403 General requirements.
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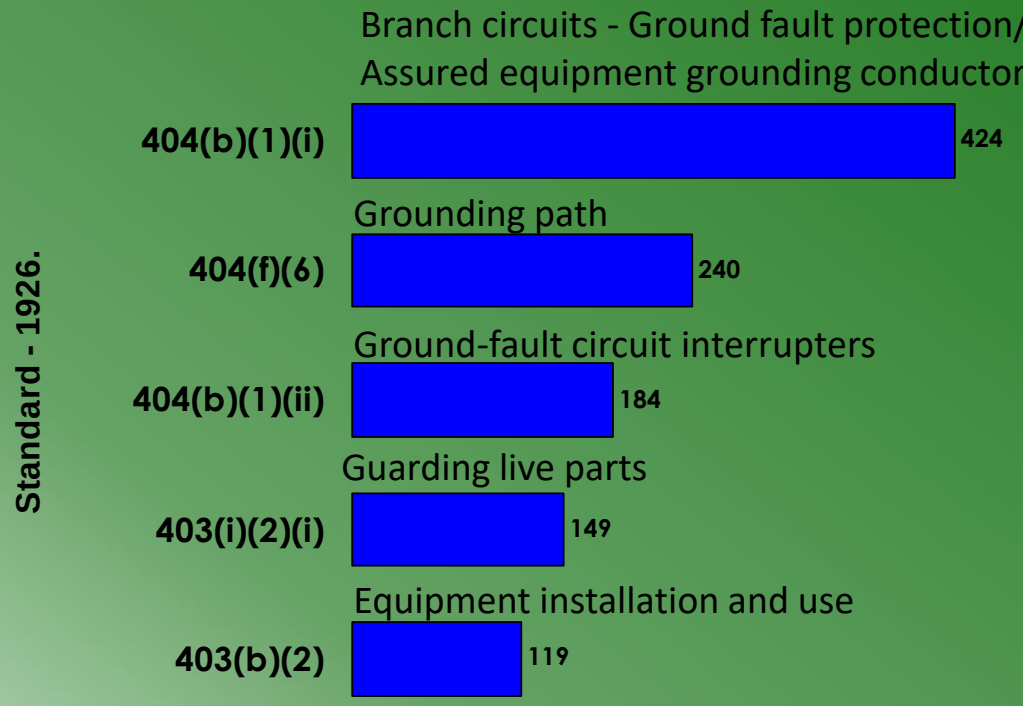
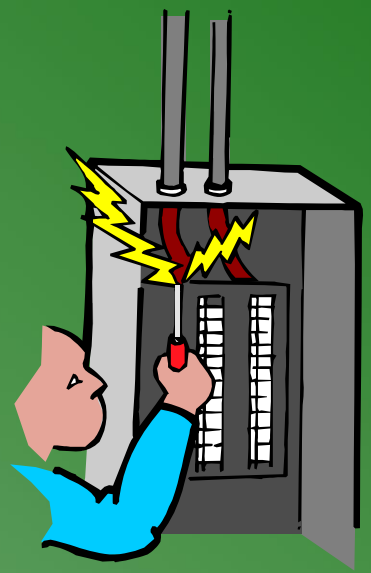
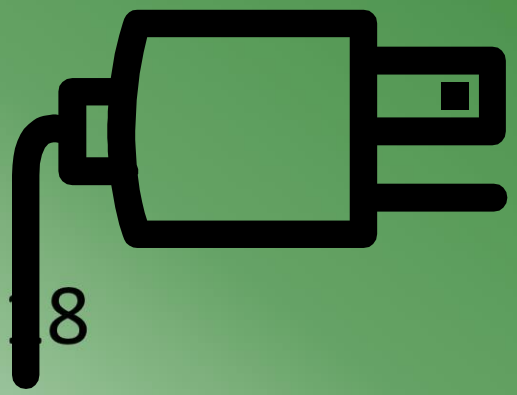
Subpart K - Electrical
(1926.400 - 449)





1926.402 Applicability

- Safety requirements for electrical equipment and installations used to provide electric power and light at the jobsite
- Both temporary and permanent
- National Electrical Code ANSI/NFPA 70-1984



1926.403 General Requirements

- **Free from recognized hazards**

  Determining safety of equipment:

  – Listing, labeling, or certification **REQUIRED, & USED IN ACCORDANCE WITH INSTRUCTIONS**

  – Mechanical strength and durability

  – Electrical insulation

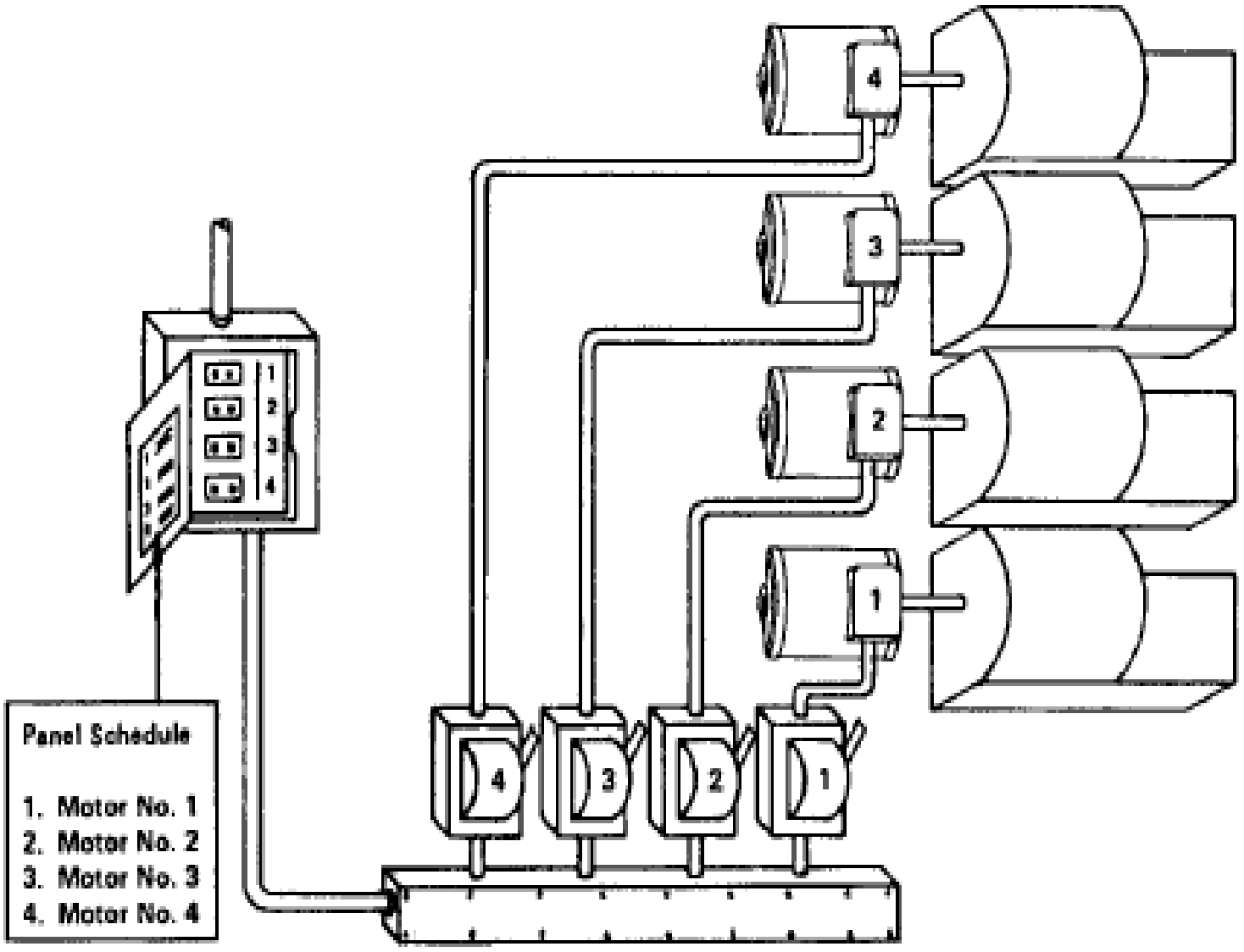
  – Heating effects under conditions of use

  – Arcing effects

  – Practical safeguarding

1926.403 General Requirements

- Electric equipment firmly secured to the surface on which it is mounted
- Arcing parts enclosed
- Proper marking and identification of all electrical equipment
- Disconnecting means identified


4
3
2
1
Panel Schedule
1. Motor No. 1
2. Motor No. 2
3. Motor No. 3
4. Motor No. 4
Motor No. 1 is Controlled by Disconnect No. 1 and Circuit Breaker No. 1

1926.403 General Requirements

- Sufficient working space maintained around equipment (3 to 4 feet required)
- Refer to Table K-1 ‘Working Clearances’

1926.403 General Requirements

- Live parts by cabinets, enclosures
- Prevent access to unqualified persons
- By location
- By elevation (8')
- With warning signs
- If subject to damage must install guards

1926.403 General Requirements

- Lighting outlets arranged that persons changing lamps or making repairs on the lighting system will not be endangered by live parts or other equipment.

1926.404 Wiring Design and Protection

- All conductors singularly identifiable
- No reversing polarity on conductors

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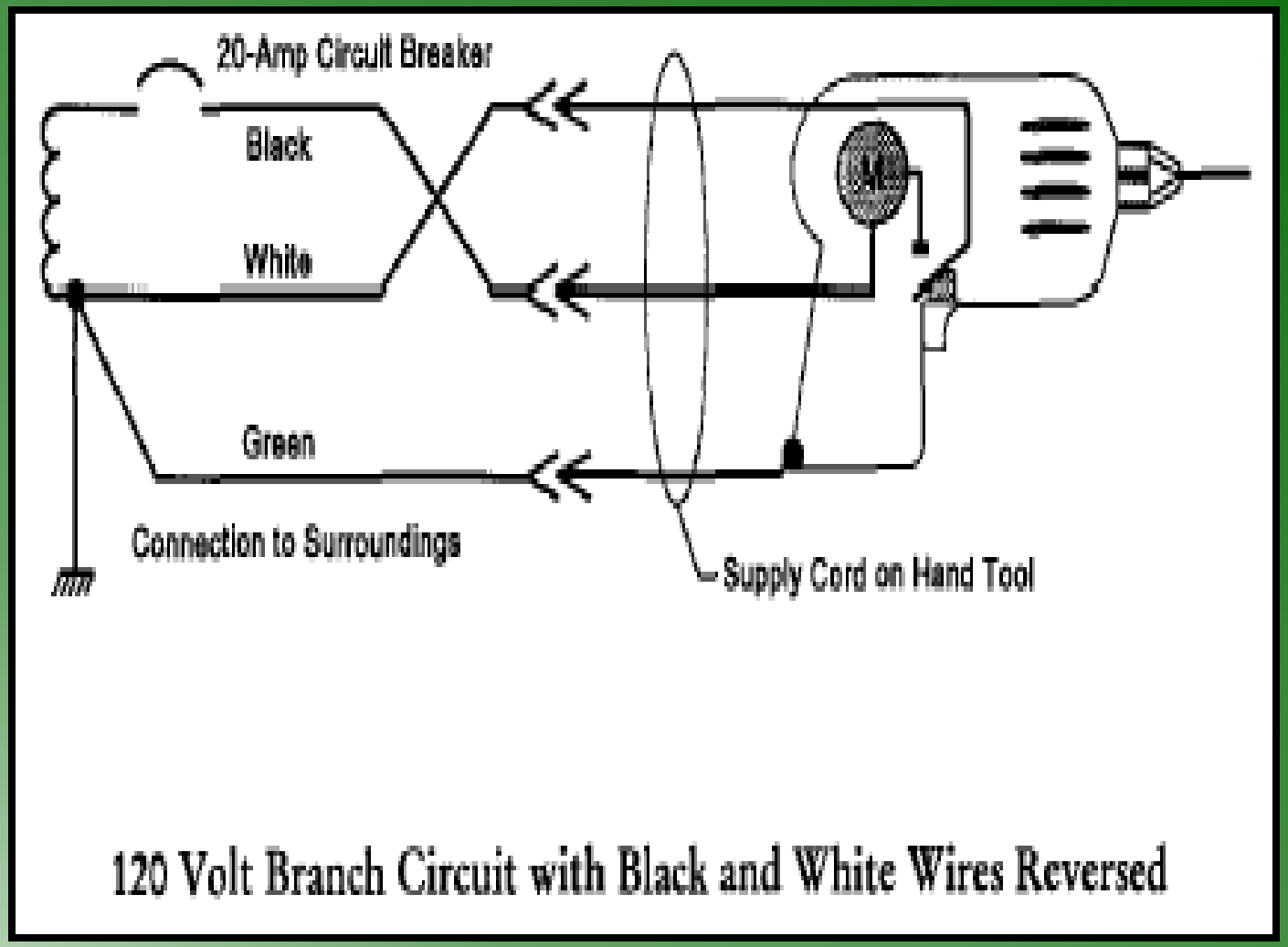
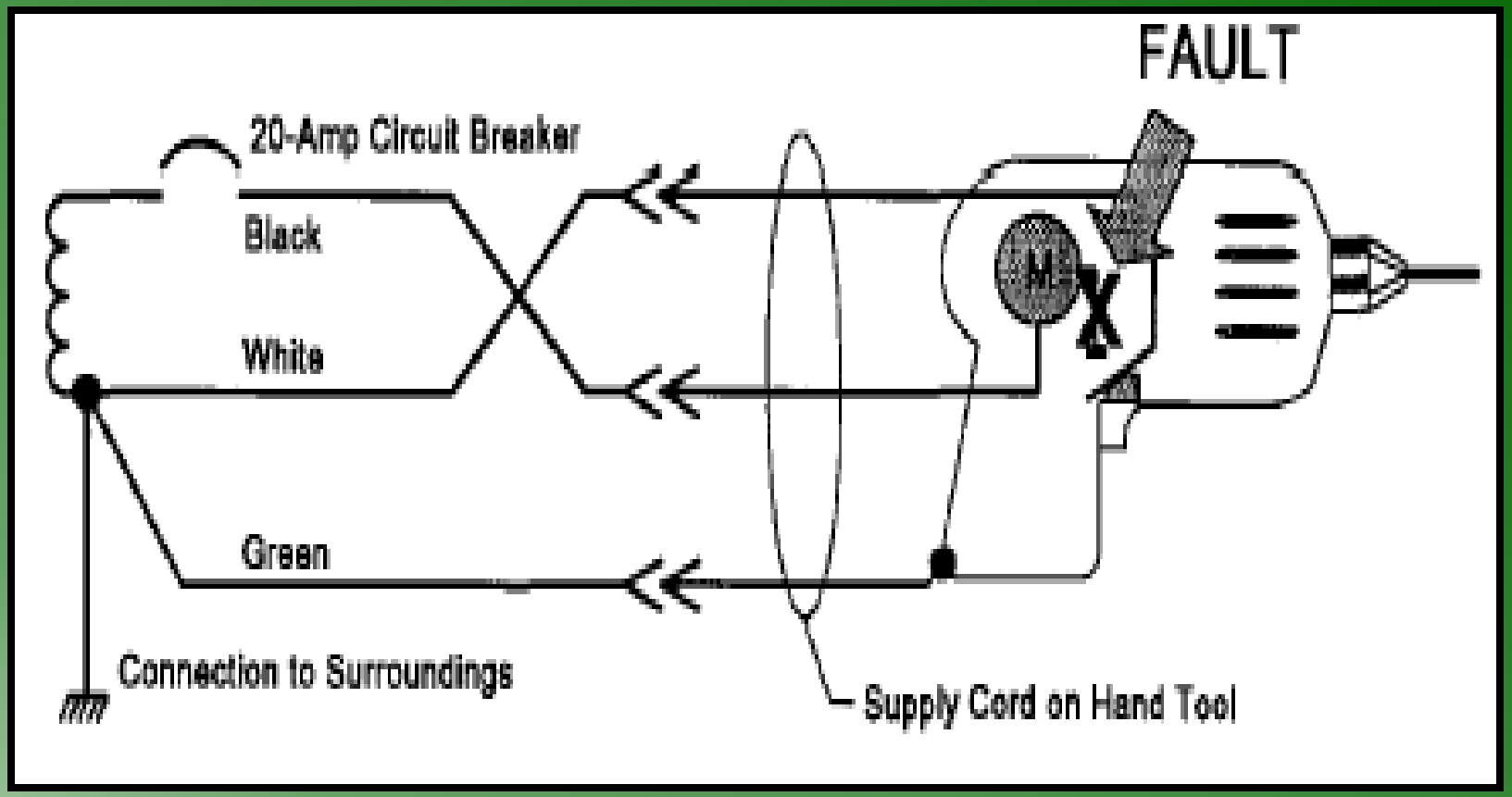
- *Reversed polarity* is a condition when the grounded conductor (neutral) is incorrectly connected to the ungrounded (hot) terminal of a plug, receptacle, or other type of conductor.

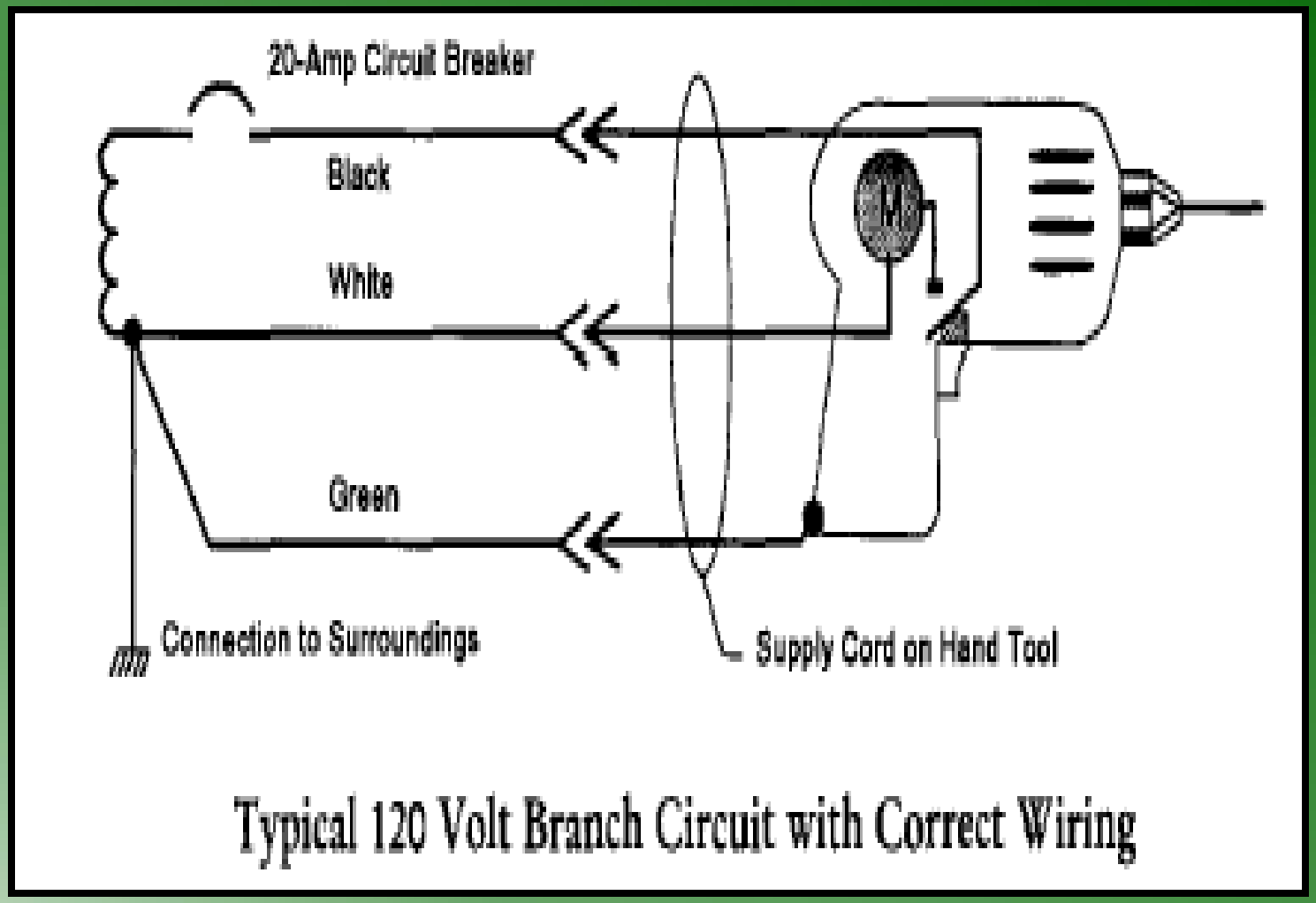


120 Volt Branch Circuit with Black and White Wires Reversed

Reversed Polarity



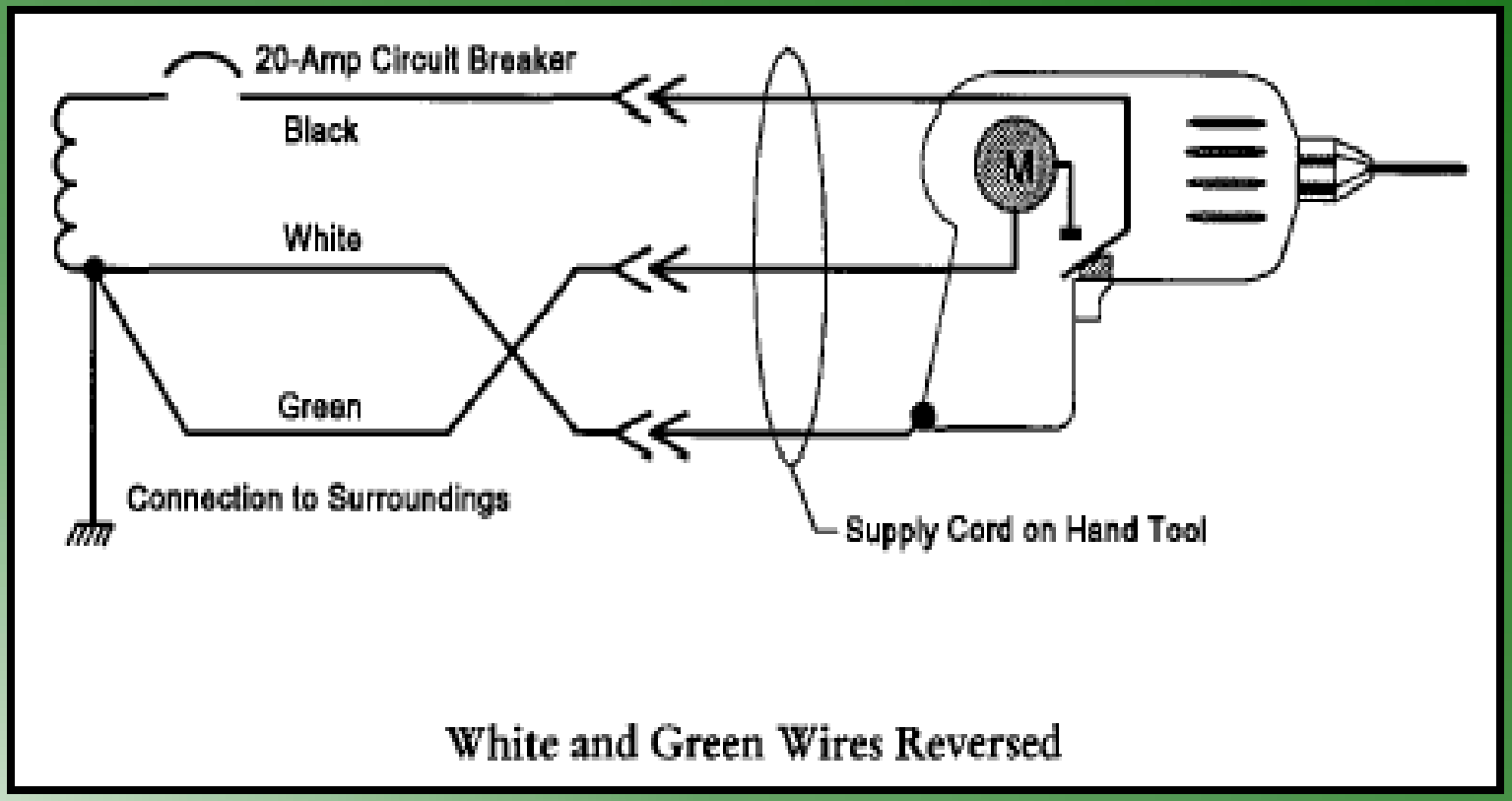
If an internal fault should occur
the equipment would not stop when
the switch is released
or would start immediately as soon as it is plugged in
to the improperly wired outlet



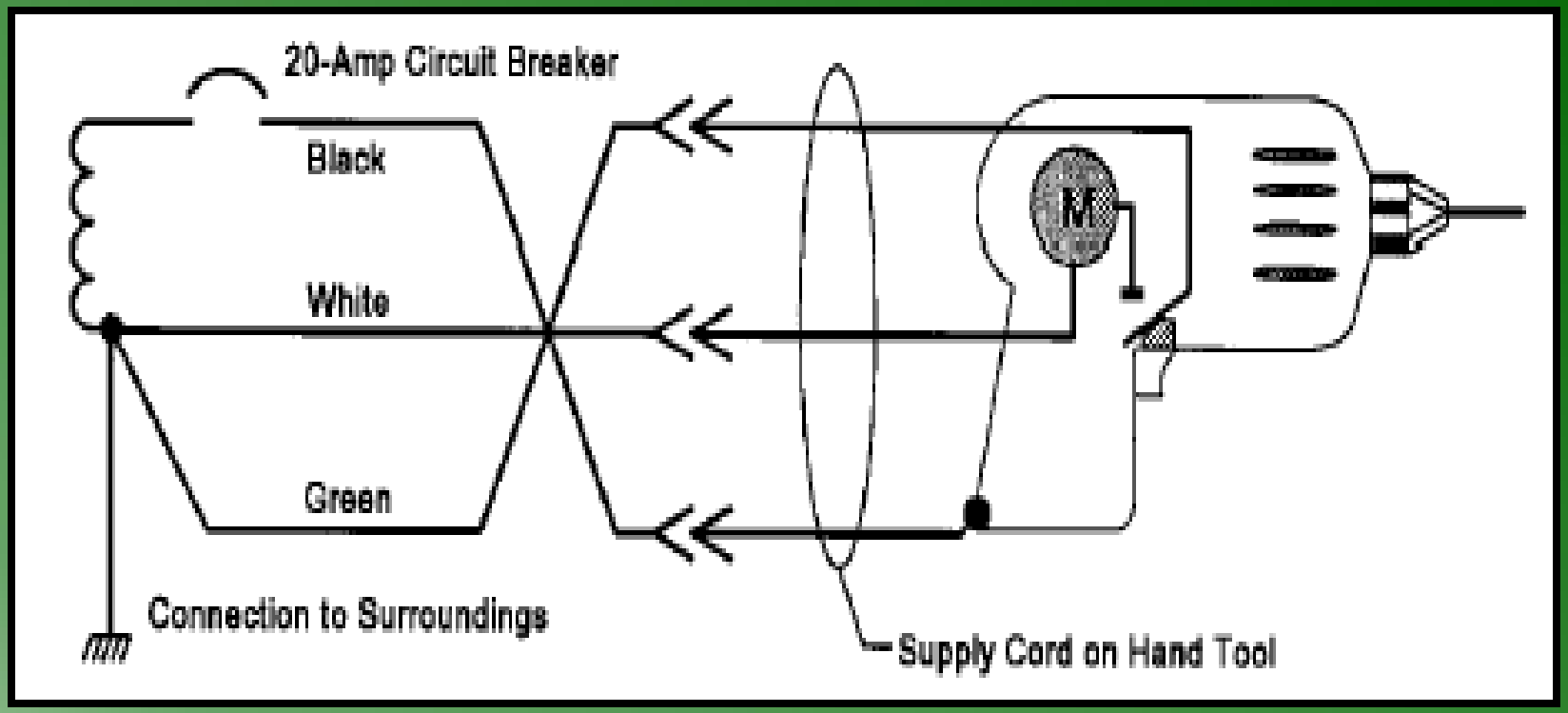
Typical 120 Volt Branch Circuit with Correct Wiring

Correct Wiring

The figure below shows the white (grounded) and green (grounding) conductors reversed. Although it is not fitting, considering OSHA or code terminology, to call this *reversed polarity*, a hazard can still exist. In this case, due to the wiring error, the white wire is being used to provide equipment grounding. Under certain conditions, this could be dangerous.

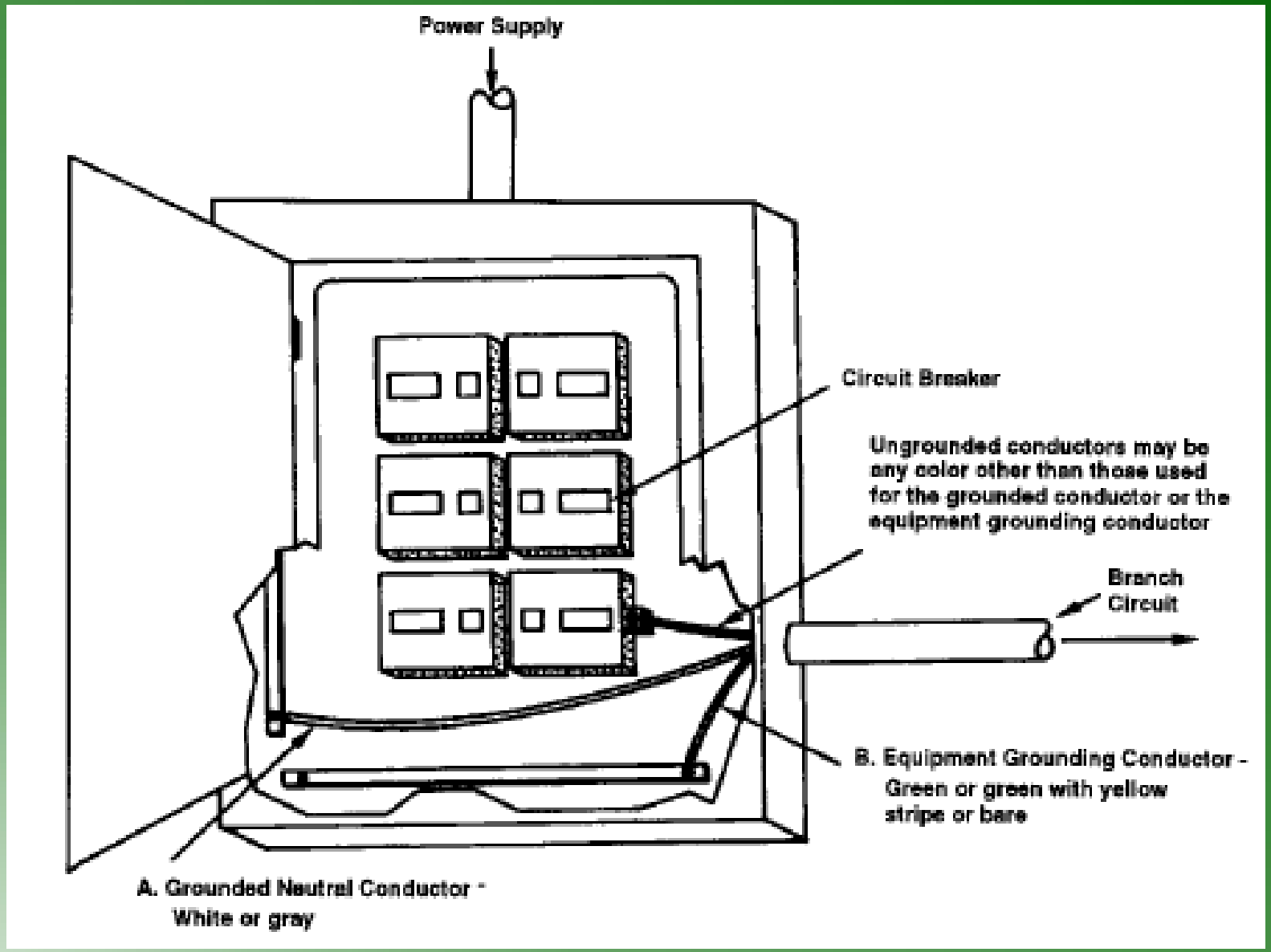


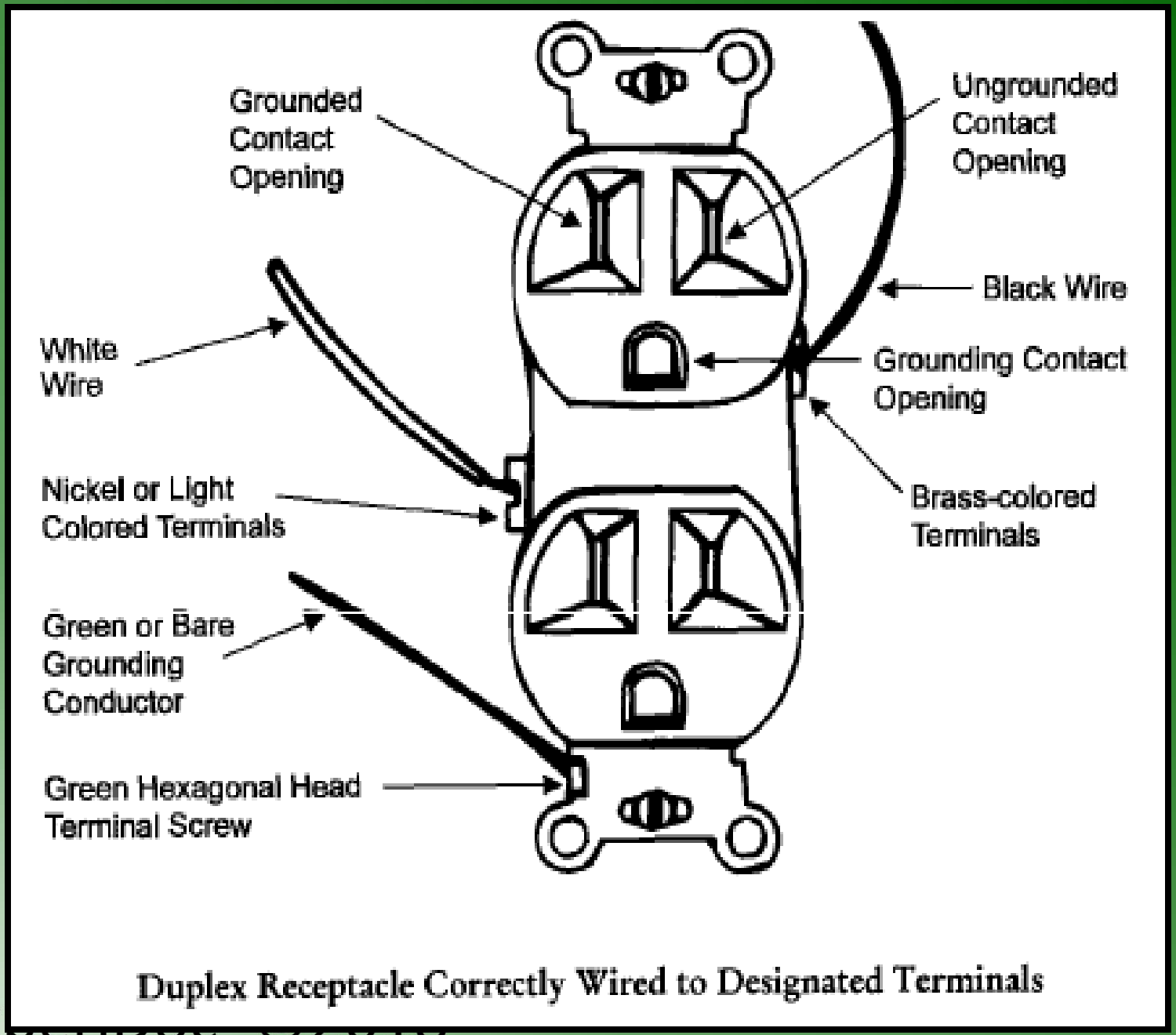
White and Green Wires Reversed



Black and Green wires reversed

This is extremely dangerous
The metal case of the drill is at 120 volts w/ respect to the surroundings
As soon as the drill is picked up and the person touches a conductive surface the will receive a serious or even deadly shock


Power Supply
Circuit Breaker
Ungrounded conductors may be any color other than those used for the grounded conductor or the equipment grounding conductor
Branch Circuit
B. Equipment Grounding Conductor - Green or green with yellow stripe or bare
A. Grounded Neutral Conductor - White or gray



Duplex Receptacle Correctly Wired to Designated Terminals

Grounding

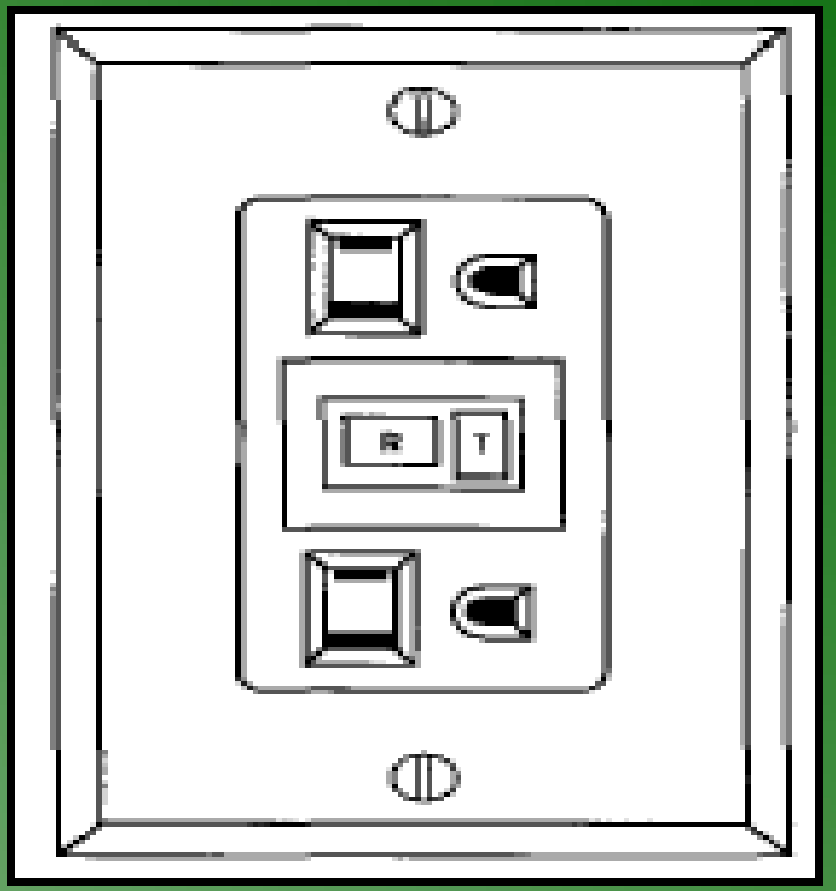
1926.404 Wiring Design and Protection

Branch Circuits:

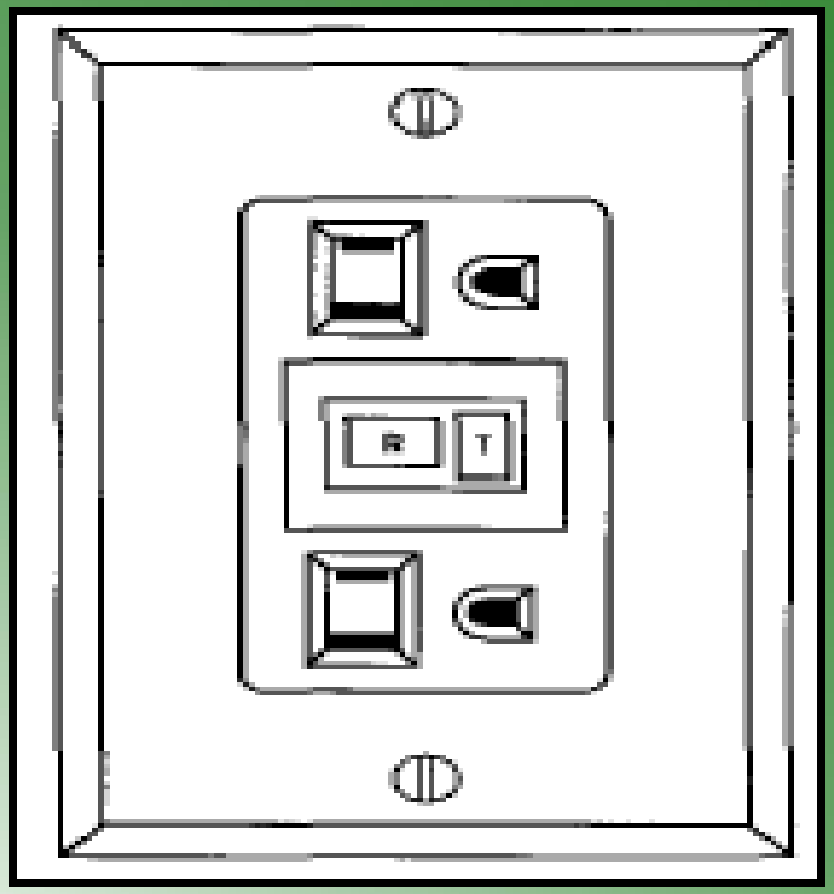
- Either ground fault circuit interrupters or an assured equipment grounding conductor program
  - All 120-volt, single-phase 15- and 20-ampere receptacle outlets on construction sites, which are not a part of the permanent wiring of the building or structure and which are in use by employees, shall have approved ground-fault circuit interrupters for personnel protection.

Ground fault circuit interrupters (GFCI's)

- A GFCI is **not** an overcurrent device like a fuse or circuit breaker.
- GFCI's are designed to sense an imbalance in current flow over the normal path.



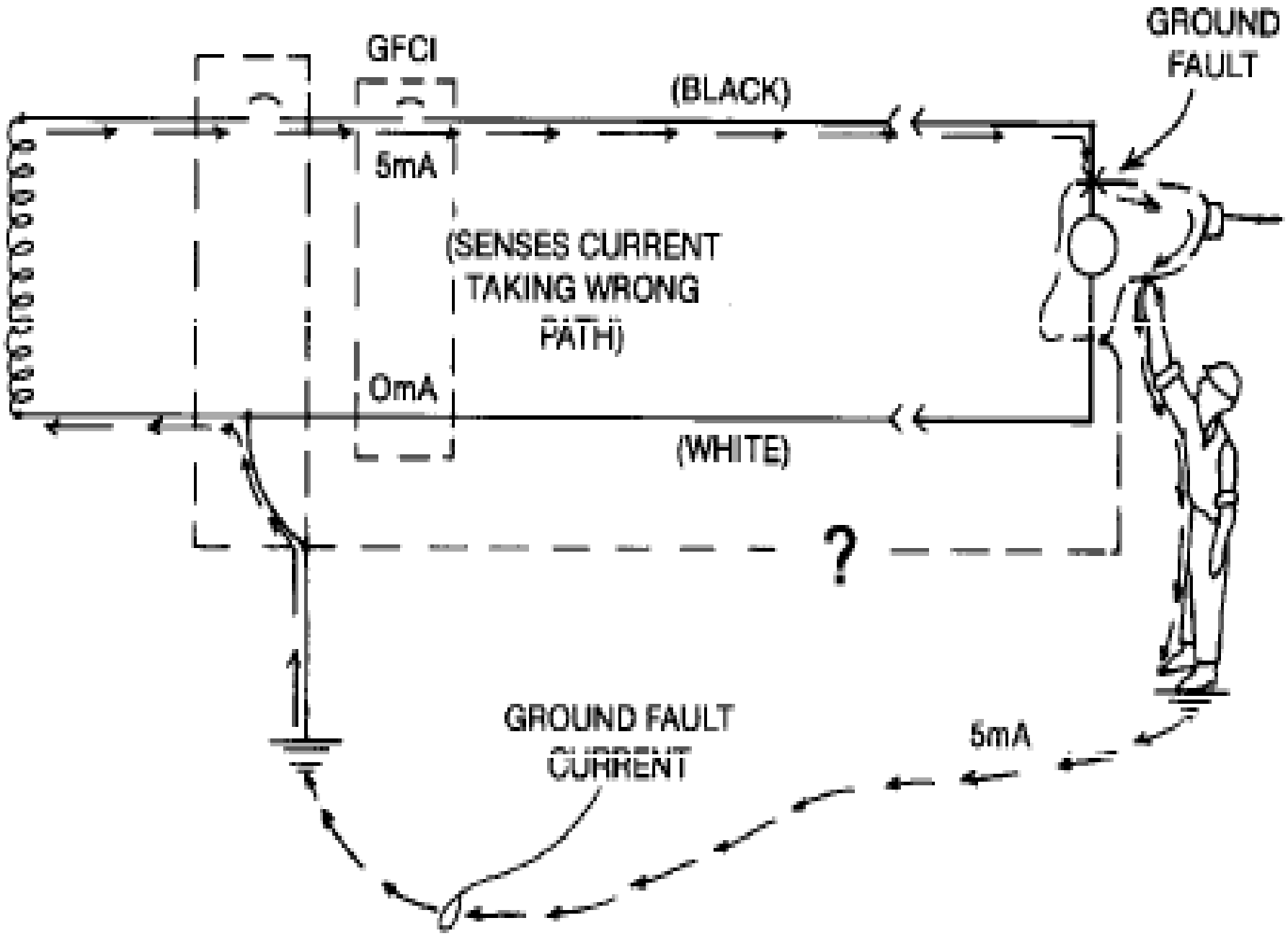
Ground fault circuit interrupters (GFCI's)



- GFCI contains a special sensor that monitors the strength of the magnetic field around each wire in the circuit when current is flowing.
- The field is proportional to the amount of current flow.

Ground fault circuit interrupters (GFCI's)

- If the current flowing in the *black (ungrounded)* wire is within 5 milliampers of the current flowing in the *white (grounded)* all the current will flow in the normal path.
- If the current flow differs by more than 5mA, the GFCI will quickly open the circuit.


GFCI
(BLACK)
GROUND
FAULT
5mA
(SENSES CURRENT
TAKING WRONG
PATH)
0mA
(WHITE)
?
GROUND FAULT
CURRENT
5mA

•Note that the GFCI will open the circuit if 5mA or more of current returns to the service entrance by any path other than the white (grounded) conductor.

•If the equipment grounding conductor is properly installed and maintained, this will happen as soon as the faulty tool is plugged in.

•If this grounding conductor is not intact, and of low-impedance, the GFCI may not trip out *until a person provides the path.*

•In this case, the person will receive a shock, but the GFCI should trip out so quickly that the shock will not be harmful.

Types of GFCI's

- **Circuit Breaker type:**
- Includes the functions of a standard circuit breaker with the additional function of a GFCI.
- Installed in a panelboard and can protect an entire branch circuit with multiple outlets.
- A direct replacement for a standard circuit breaker of the same rating.

Types of GFCI's

- **<u>Receptacle type:</u>**
- Incorporates within one device one or more receptacle outlets, protected by the GFCI.
- Popular and inexpensive.
- Most are of duplex type
- Can protect additional non-GFCI type receptacles connected "downstream".

Types of GFCI's

- **Permanently Mounted type:**
- Mounted in an enclosure and designed to be permanently wired to the supply.
- Frequently used around commercial swimming pools or similar wet locations.

Types of GFCI's

- **Portable type:**
- Some plug directly into non-GFCI outlets.
- Incorporate no-voltage release device which will disconnect power to the outlets if any supply conductor is open.
- Units for outdoor use will be in suitable enclosure.
- Will be listed if for rain use.

Types of GFCI's

- **Cord Connected type:**
- Attachment plug incorporates the GFCI module.
- Protects the cord, and any equipment attached to the cord.
- Attachment has non-standard appearance
- Equipped with test and reset buttons.
- No-voltage release feature

Testing GFCI's

- GFCI's are complex mechanisms, they must be tested on a regular basis.
- For permanently mounted types, once a month testing is recommended.
- Portable GFCI's should be **tested before each use.**
- GFCI's have a test-circuit which imposes an artificial ground fault when the test button is pushed.

1926.404 Wiring Design and Protection

- The employer shall establish and implement an ***assured equipment grounding conductor program*** on construction sites covering all cord sets, receptacles which are not a part of the building or structure, and equipment connected by cord and plug which are available for use or used by employees.

1926.404 Wiring Design and Protection

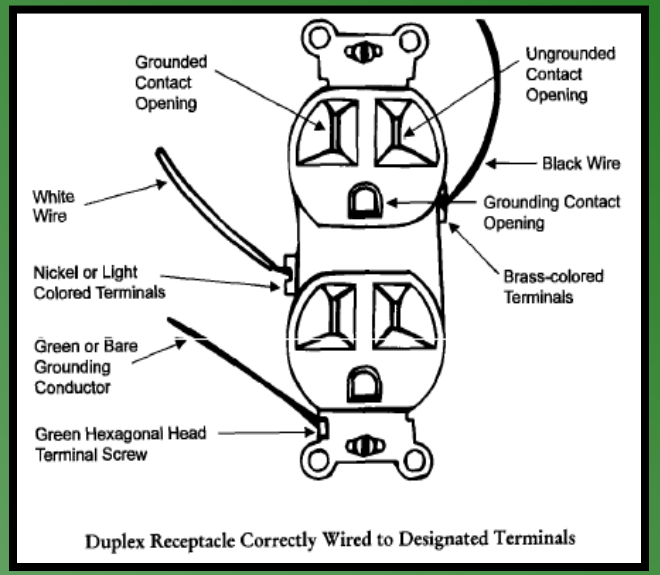
Assured equipment grounding conductor program:

- Written program
- Procedures
- Available at jobsite
- CP to implement
- Cords, plugs, receptacles ***visually inspected daily***
- Damaged equipment not used until repaired

1926.404 Wiring Design and Protection

Assured equipment grounding conductor program tests required:

- Electrical continuity
- Correct attachment of equipment grounding conductor
- Grounding conductor attached to proper terminal



Duplex Receptacle Correctly Wired to Designated Terminals

1926.404 Wiring Design and Protection

Assured equipment grounding conductor program tests performed:

- Before first use
- Before used after repairs
- Before used after any likely damage
- Every three months
- Comply with above or *do not use!*

1926.404 Wiring Design and Protection

Assured equipment grounding conductor program tests performed:

- Tests recorded
- Identifies all items tested that passed
- Includes date of last inspection
- Kept by logs or color coding
- Available at jobsite

Color scheme recommended by the National Electric Contractors Association

- January White
- February White & Yellow
- March White & Blue

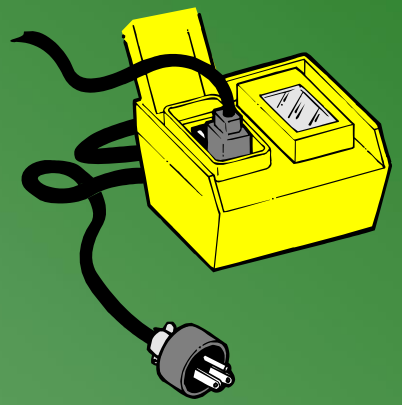
Equipment to be repaired should be tagged in brown

- April Green
- May Green & Yellow
- June Green & Blue

Wrap the appropriate color tape on the end of of the cable after testing

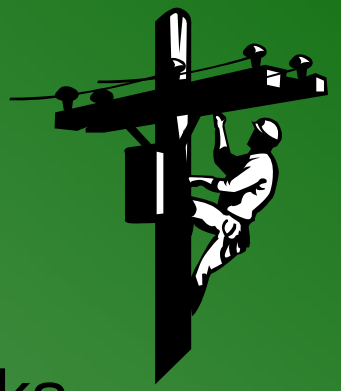
- July Red
- August Red & Yellow
- September Red & Blue

- October Orange
- November Orange & Yellow
- December Orange & Blue



1926.404 Wiring Design and Protection

- Open conductors on poles; provide 24 to 30 inches of horizontal climbing space (see 1926.404 (c)(1))
- Clearance from ground:
  - 10 feet above finished grade, sidewalks
  - 12 feet over vehicular traffic
  - 18 feet over public streets, alleys, roadways



1926.404 Wiring Design and Protection

- Branch disconnects must be provided which are separate from service or entrance conductors
- Clearly indicate whether in ‘Closed’ or ‘Open’ position

1926.404 Wiring Design and Protection

- Warning signs. Signs warning of high voltage shall be posted where unauthorized employees might come in contact with live parts.

1926.404 Wiring Design and Protection

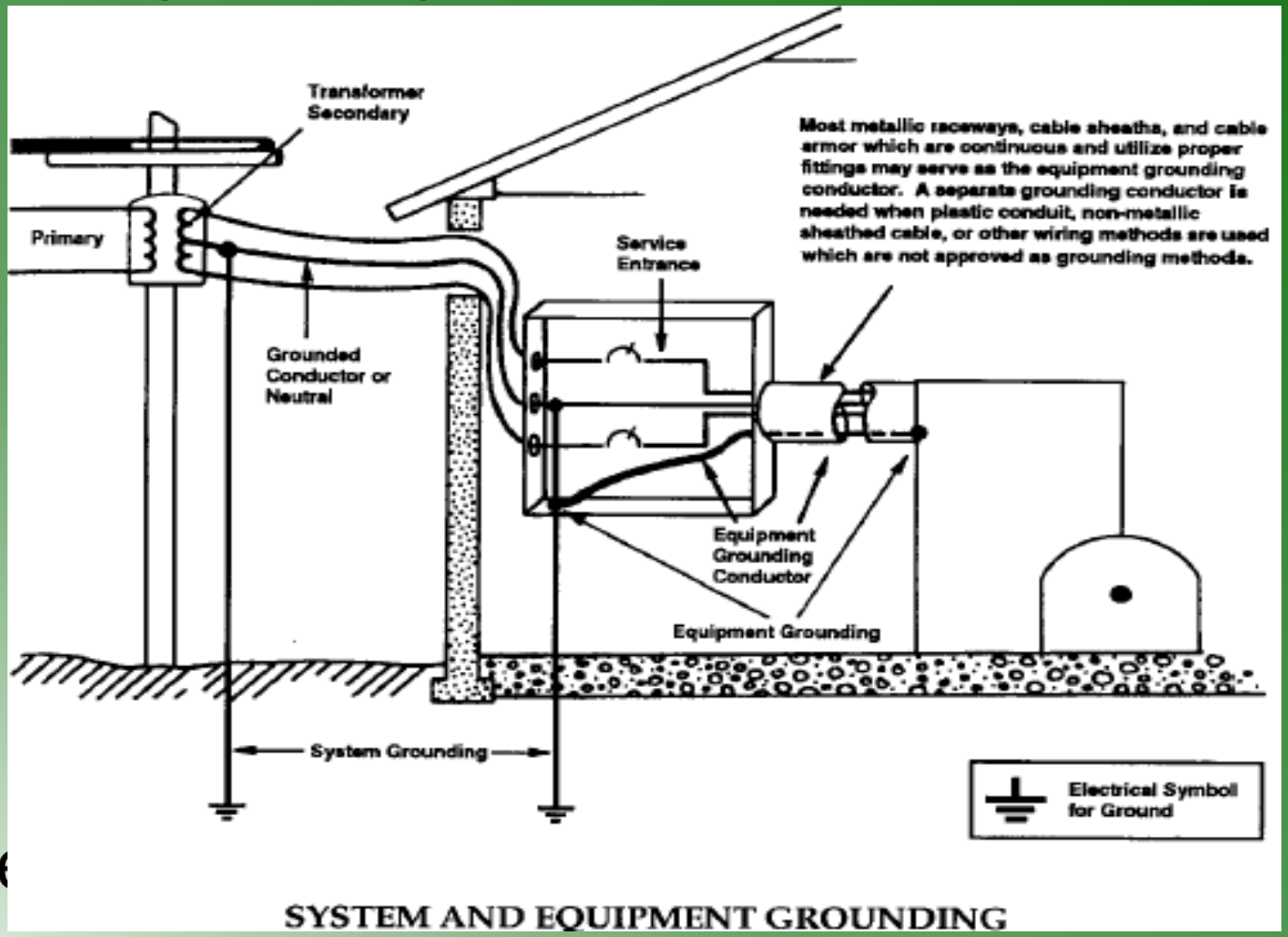
- Cartridge fuses which are accessible to other than qualified persons provided with disconnecting means.
- Overcurrent devices must be readily accessible

1926.404 Wiring Design and Protection

- Circuit breakers must clearly indicate open or closed position
- Should identify what they control

1926.404 Wiring Design and Protection

- Path to ground permanent and continuous



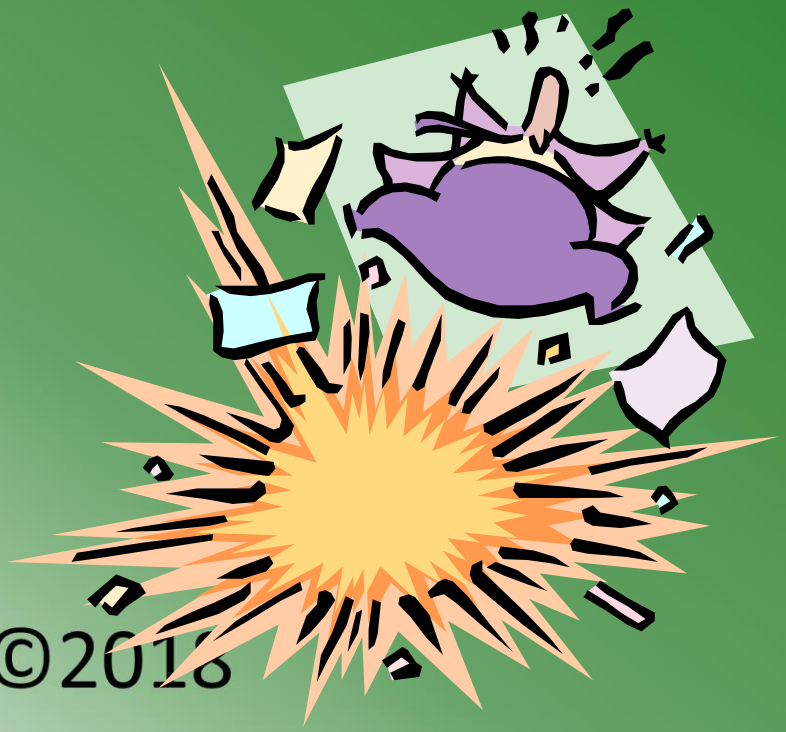
SYSTEM AND EQUIPMENT GROUNDING

1926.404 Wiring Design and Protection

- Hand-held motor operated hand tools and portable lamps must be grounded

1926.405 Wiring methods, components, and equipment for general use.

- No wiring in ducts used to transport dust or vapor removal



1926.405 Wiring methods, components, and equipment for general use.

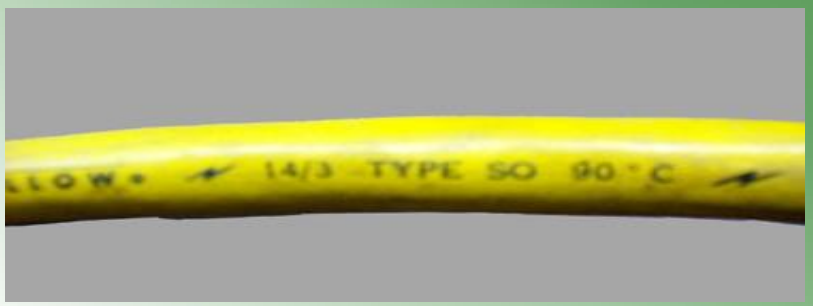
- Receptacles shall be of the grounding type

1926.405 Wiring methods, components, and equipment for general use.

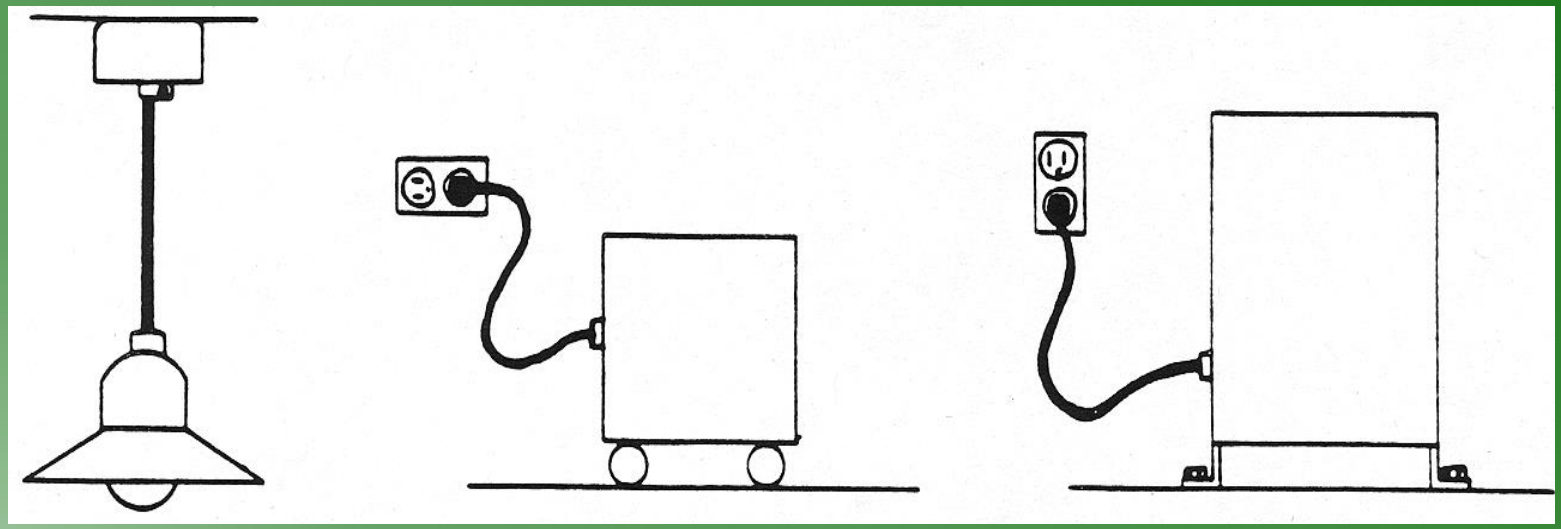
- All lamps for general illumination protected from accidental contact or breakage
- Portable lights used in wet locations operated at 12V or less or GFCI
- Temporary lighting must be on its own circuit

1926.405 Wiring methods, components, and equipment for general use.

- Flexible cords protected from damage
- Avoid sharp corners
- Extension cords 3-w
- Hard or extra-hard duty



Permissible Uses of Flexible Cords
Examples



Pendant, or Fixture Wiring

Portable lamps, tools or appliances

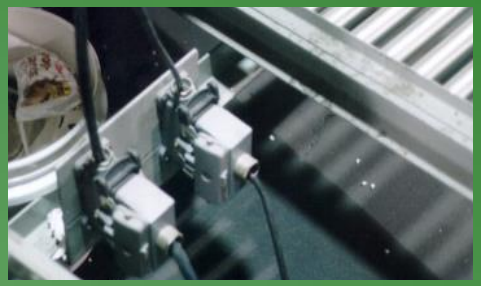
Stationary equipment- to facilitate interchange

1926.405 Wiring methods, components, and equipment for general use.

- Conductors entering boxes, cabinets, or fittings protected from abrasion, and openings through which conductors enter shall be effectively closed.
- Unused openings in cabinets, boxes, and fittings shall also be effectively closed.

1926.405 Wiring methods, components, and equipment for general use.

- Flexible cords not used as:
  - substitute for the fixed wiring;
  - Where run through holes in walls, ceilings, or floors;
  - Where run through doorways, windows, or similar openings
- Must be used in continuous lengths with no splices
- Must have strain relief



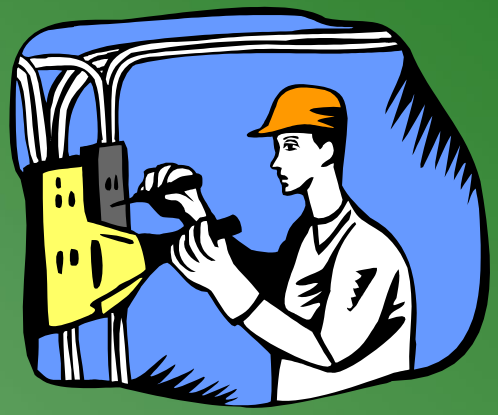
1926.406 Specific purpose equipment and installations

- A readily accessible disconnecting means provided between the runway contact conductors and the power supply.

1926.407 Hazardous (classified) locations

- Hazardous Locations
  - Class I - gas or vapor
  - Class II - dust
  - Class III - fibers and flying debris
- Kinds of Conditions
  - Normal
  - Abnormal

Safety-Related



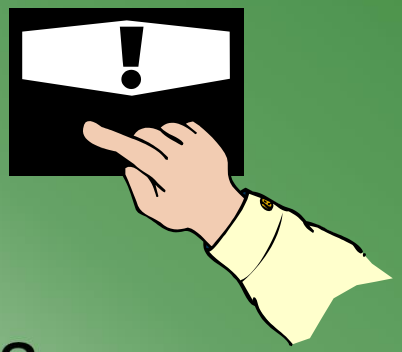
Work Practices

1926.416 Safety-related work practices

- In work areas where the exact location of underground electric powerlines is unknown, employees using jack-hammers, bars, or other hand tools which may contact a line ***provided with insulated protective gloves.***

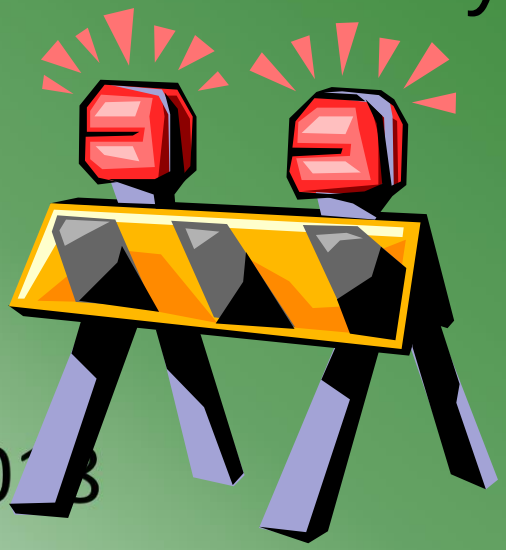
1926.416 Safety-related work practices

- Warn employees if work could bring them into contact with power circuit
- Advise employees of locations, hazards and protective measures



1926.416 Safety-related work practices

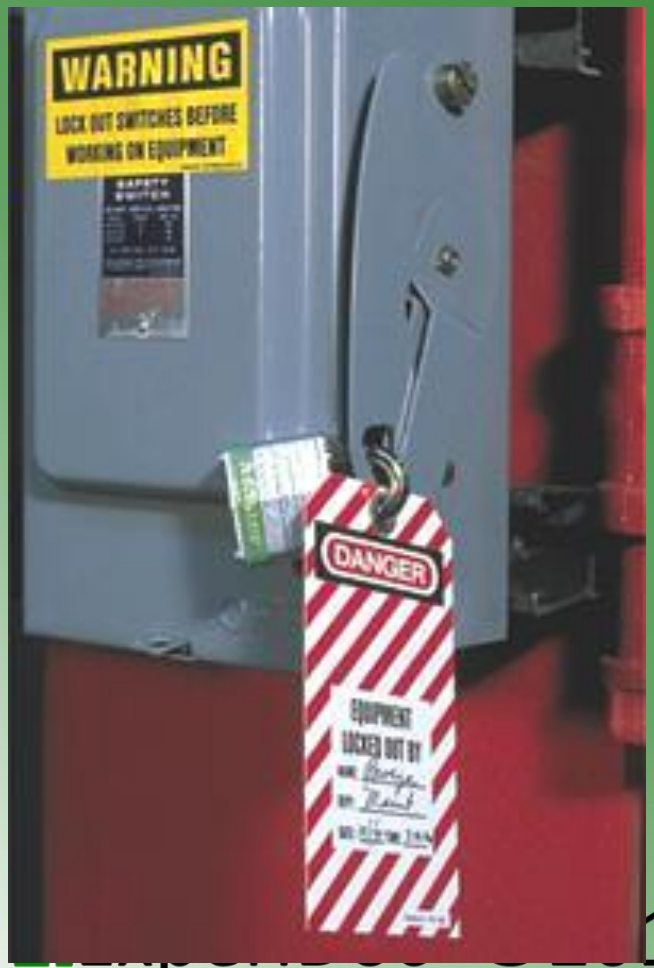
- Barriers provided to ensure that workspace for electrical equipment will not be used as a passageway when energized parts of electrical equipment are exposed.
- Keep cords clear of walkways and work spaces



1926.416 Safety-related work practices

- Worn frayed cords prohibited
- Extension cords shall not be:
  - Stapled
  - Hung from nails
  - Suspended by wire

1926.417 Locking and tagging of circuits



- Controls that are to be deactivated during the course of work on energized or deenergized equipment or circuits shall be tagged.
- Placed at all energy source locations

1926.432 Environmental deterioration of equipment.

- Unless listed or identified for use no conductors or equipment located in:
  - Damp or wet locations
  - Harmful chemicals, fumes or vapors
  - Excessive temperatures

1926.441 Batteries and battery charging.

- Provide ventilation to diffuse gases
- Acid resistant floors unless protected against acid accumulation
- Face shields, aprons & rubber gloves
- Eyewash/safety shower within 25 feet
- Flushing and neutralizing

1926.441 Batteries and battery charging.

- Battery charging installations located in areas designated for that purpose
- Charging apparatus protected from damage by trucks

CFR 1926 Subpart K

Electrical

 The End