California Vocational Agriculture Curriculum Guidelines Instructional Unit

ELECTRICITY-AGRICULTURAL STRUCTURES

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ELECTRICITY-AGRICULTURAL STRUCTURES

Unit Goal:

To provide the student with the necessary skills and knowledge of electricity to be able to accomplish the basic electrical wiring of 120 volts, and 240 volts, single phase circuits.

Unit Performance Objectives:

Upon completion of this unit the student will be able to:

1. Define electrical terminology.
2. Exhibit safety habits.
3. Interpret an electrical schematic drawing.
4. Describe the electrical flow of 240 volts, 120 volts in wiring.
5. Complete wiring of light and convenience outlets.
6. "Trouble shoot" electrical circuits in a safe manner.

Teaching Outline

I. Introduction - Orientation

A. Rural Electrification

Use of electrical power on the farm has increased considerably in the past few years, basic knowledge of electricity is essential to reduce the hazards of fire and electrocution, and to allow a person the self satisfaction of doing his own work.

B. Job Opportunities

Jobs are available in the public and private sector in the areas of new construction, maintenance, and repair.

II. Electrical Safety & Tools

A. Safety of Grounding

1. Convenience outlets and switches.
2. Power equipment - portable and stationary.
3. Use of testing equipment.
4. Use of hand tools.
5. Live circuits.
6. Area conditions.
7. Use of dielectrical fittings, rods and piping.
8. Wire and screw color code (see TM - 1 & 3).

B. Hand Tools

Voltage tester, continuity tester, screw drivers, pullers, line pliers, needle nose pliers, wire strippers, electrician knife, benders, punches and as per CATA guide.

III. Electrical Terminology

A. Voltage

B. Amperes

C. Watts

D. Ohms

E. Conductors

F. Conduit - rigid, EMT

G. Circuits - series, parallel, hot common, neutral, grounding

	SUGGESTED LEARNING ACTIVITIES	SUGGESTED RESOURCE MATERIAL
I.	1. Study statistical data of electrical usage, demands, trends of population.	1. Pacific Gas & Electric; Southern California Edison; USDA-Rural Electrification.
	2. Explore opportunities.	2. Electrical contractors service and repair companies; utilities; school districts; city; county; and state.
II.	3. Students will complete all safety tests.	3. City, county, state and federal electrical codes; workman's Compensation; casualty underwriters.
	4. Students shall learn to use hand tools.	4. REF Manufacturers Catalog; Farm Mechanics, Phipps, McColly, etc.
	5. Have students demonstrate the use of hand tools pertinent to electrical installation.	5. Contact local electrician.
III.	6. Test students on the proper use and meanings of terms.	6. Electrical codes; trades (unions) acceptance standards; Farm Mechanics by Phipps.

IV. Electrical Material Identification

A. Wire Conductors

1. Copper.
2. Aluminum.
3. Solid.
4. Stranded.

B. Wire Insulation

1. TW, RHW, U.F. Direct Burial.
2. Color coded.

C. Conduit

1. Rigid.
2. Thin wall (EMT).
3. PVC.
4. Flex.
5. Seal tite.

D. Fittings and Appurtenances

1. Convenience outlets - indoors, weatherproof.
2. Long sweep elbows, rigid, PVC.
3. Connectors (wire nuts, many kinds).
4. LB, OLB elbows.
5. Grounding pull bushing.
6. Plastic pull bushing.
7. Chase bushing.
8. Nipples.
9. Grounding clamps.
10. Grounding rod.
11. KO seals.
12. Adapters; rigid, flex, EMT, seal tite, PVC.
13. Couplings; rigid, flex, EMT, seal tite, PVC.
14. Switches, single pole, double pole and double throw.
15. Light receptacles.
16. Panels and safety switches.
17. Fuses and circuit breakers.

	SUGGESTED LEARNING ACTIVITIES	SUGGESTED RESOURCE MATERIAL
IV.	1. Students will identify the various wire conductors.	1. Electrical codes; TM-3.
	2. Have students study wire sizes in relation to voltage drop.	2. Manufacturers catalog.
	3. Students will learn the areas of usage of conduit.	3. Utilities; Farm Mechanics text by Phipps.
	4. Test students on their ability to identify fittings.	4. Number various fittings and place around classroom or shop; manufacturers catalog.

V. Electrical Schematic Drawing

A. Symbols (See TM-2)

1. Ceiling light outlet.

2. Ceiling light with pull cord.

3. Wall light outlet.

4. Wall light outlet with convenience outlet.

5. Heavy duty outlet, e.g., range, waterheater or motor.

6. Floor receptacle.

7. Single convenience outlet.

8. Double convenience outlet.

9. Double convenience outlet and switch.

10. One-way, single pole switch.

11. Three-way, double throw.

12. Four-way, double throw switch.

13. Ground.

14. Single phase.

15. Electric motors.

B. Circuit Line Reading (See TM-3)

1. A special symbol is used when two electrical lines cross.

2. "Hot" wires are any color except white or green and are the lines that are to be open and closed on an operating circuit.

3. White colored wires are used for the neutral or common line.

4. Green colored wires are used for grounds only. Bare copper may also be used.

C. Completing 120 Volt 1Ø (single phase) Circuit. The students should draw in where the wiring goes. Used also for tracing a circuit.

1. Power source 120 V 1Ø (See TM-4).

2. Silver screws secure common or neutral wire.

3. Brass color screws secure colored except white or green wires ("hot").

4. Complete circuit - lights - 120 V 1Ø (See TM-5).

   Used in a room or shop where it is desired to turn lights on and off from different sides, normally at door entrances or exits.

5. Complete circuit - lights and convenience outlets - 120 V 1Ø (See TM-6).

   Caution: Never use a continuity tester on a live circuit.

	SUGGESTED LEARNING ACTIVITIES	SUGGESTED RESOURCE MATERIAL
V.	1. Have students learn the meaning of symbols used in electrical drawings.	1. Electrical codes; Farm Mechanics text by Phipps, etc., TM-2.
	2. Test students on their ability to make a sketch.	2. Trade standards acceptance.
	3. Have students practice reading schematic drawings before attempting to complete live circuit.	3. TM-2 and TM-3.
	4. Have students determine single and poly phases.	4. Text or examples.

VI. Electrical Circuits

A. 120 V 1Ø - Black (can be any color except white or green), white and green wire.

B. 240 V 1Ø - Black, red and green wires are used.

C. 240 V 3Ø - Black or red wires are used. All wires are "hot."

D. Breaking Down Circuits - Circuit breaker box for many individual circuits, e.g., lights, convenience outlets, small power equipment of either 120 V or 240 V 1Ø.

E. Breaking Down 240 V 3Ø to 240 V 1Ø

1. All wires are "hot," generally all black or all red.

2. 120 V 1Ø electric power cannot be obtained from 240 V 3Ø 3 wire.

3. Transformer has to be installed to get 120 V 1Ø. Ground all metal boxes to ground rod.

4. Never use a continuity tester on a live circuit.

F. Use of Transformer

1. 240 V 3Ø to 120 V 1Ø, or 120 V 1Ø or 24 V 1Ø.

2. 120 V 1Ø to low voltage, 24 V or 12 V.

G. Use of Branch Circuits (See TM-7) - 1, 2, 3 are individually fusible or circuit breaker panels for separate motors.

VII. Electric Controls - All controls have schematic electrical drawing. Only make or break "hot" wire or wires.

1. Pressure switch 120 V 1Ø (See TM-8).

2. Pressure switch 240 V 1Ø (See TM-8).

3. Note: All motor circuits shall have fuses or breakers to protect the overloads. Read thoroughly the manufacturers recommended wiring diagram. Other controls are similar.

VIII. Trouble Shooting

A. Live (Closed) Circuits 120 V - 240 V

B. Dead (Open) Circuits 120 V - 240 V

C. Controls

	SUGGESTED LEARNING ACTIVITIES	SUGGESTED RESOURCE MATERIAL
VI.	1. Have students review the color code of wires in relation to usage.	1. TM-3.
	2. Students will properly wire a simple light switch/light circuit 110 V.	2. Electrical code.
	3. Students will learn how to wire combination light, outlet circuit (and other).	3. Trade standards acceptance; manufacturers guide; Farm Mechanics text by Phipps, etc.
	4. Have student wire cut-outs or relays into a circuit.	4. Materials from ag shop or store.
	5. Have students wire completely from power source to safety switch, to control panel, to circuit controls, to terminal point of lights, outlets, motors, etc.	5. Display board, outlets, tools, etc.
VIII.	6. Have students check live and closed circuits and determine voltage.	6. Trade standards acceptance.
	7. Have students check open and dead circuits and determine location of trouble.	7. Manufacturers guide.
	8. Have students trouble shoot control panels properly and safely.	8. Pacific Gas & Electric representatives.

Student Evaluation

Directions: Students will successfully pass all safety tests and ID test. Students will demonstrate skills of properly wiring agricultural structures. Students will demonstrate skills of properly wiring electrical appurtenances, i.e., switches, panels, motors.

A. After each word or term write in your own words, as briefly as possible, its meaning in application or description of use.

1. Voltage
2. Amperage
3. Ohms
4. Conductor
5. Conduit
6. Hot wire
7. Common or neutral wire
8. Ground wire
9. Wire stripper
10. Continuity tester
11. Voltage tester
12. Wire puller (snake)
13. Benders
14. Open circuit
15. Closed circuit
16. White colored insulation
17. Red, black, blue colored insulation
18. Green colored insulation
19. Bare copper wire
20. Circuit

NOTE: The student evaluation in electricity should feature practical application of the material covered to this end. The evaluation must be designed around the teacher's personal outline and style. Expansion of each area will be at the discretion of the instructor.

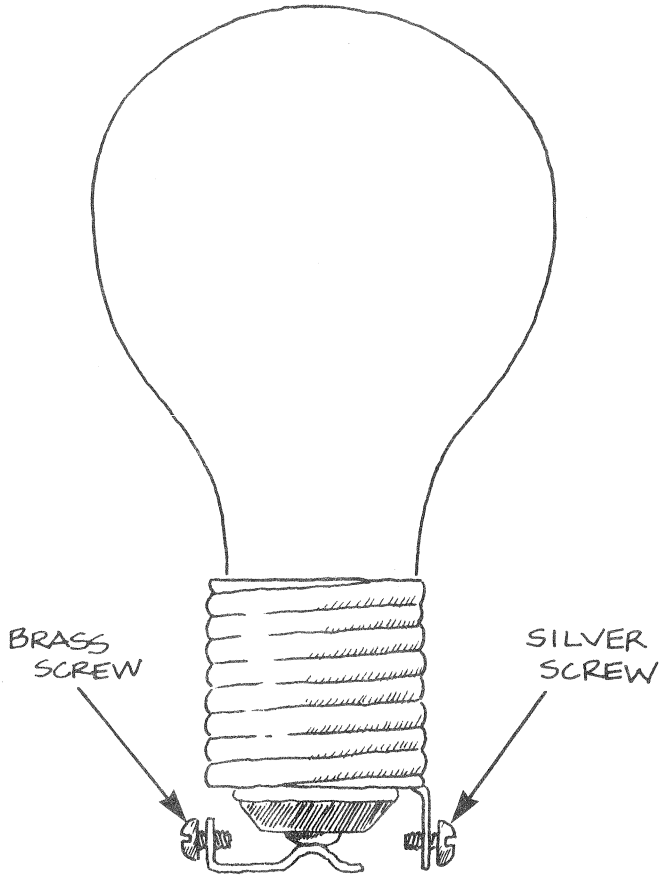
B. Material and tool identification.

C. Schematic drawing reading.

D. Wiring up circuit and controls.

E. Trouble-shooting.

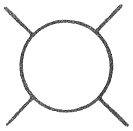
LIGHT SOCKET



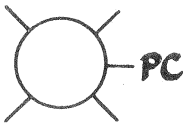
Note: if hot wire is connected to the silver screw, there is a chance of shock when removing bulb.

SYMBOLS USED IN ELECTRICAL SCHEMATIC DRAWING

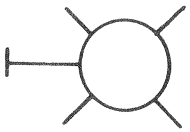
TM 2



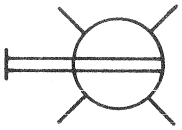
Ceiling light outlet



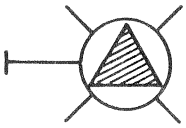
Ceiling light with pull cord



Wall light outlet

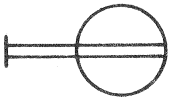


Heavy duty outlet with convenience outlet



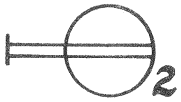
Heavy duty outlet e.g., range, water-heater or motor

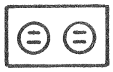
Floor receptacle



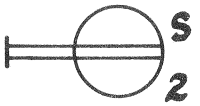
Single convenience outlet

Electric motors

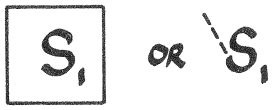




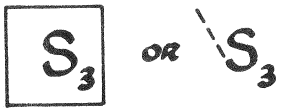
Double convenience outlet



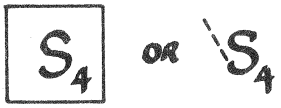
Double convenience outlet and switch



One way-single pole switch



Three way switch



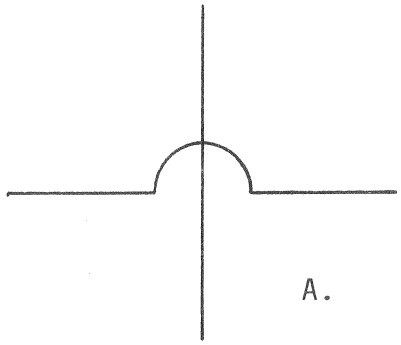
Four way-switch

Ground

Single phase

Three or poly phase

CIRCUIT LINE READING



A.

H

B.

N

C.

Gr

D.

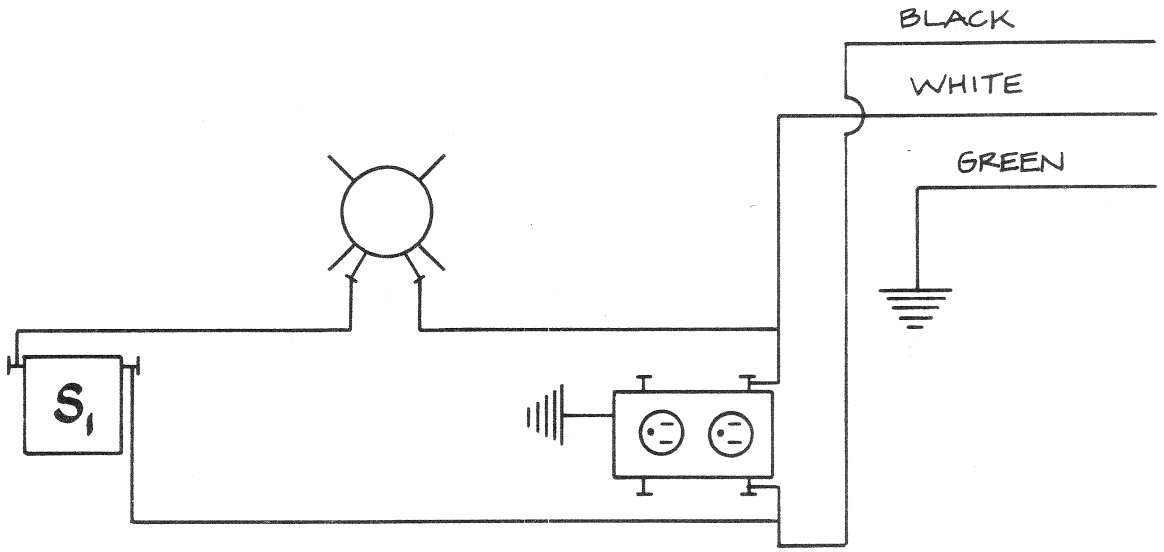
A. Used when two electrical lines cross.

B. "Hot" wires are any color except white or green. Usually they are black, red, blue in color.

C. White wires are used for the neutral or common line.

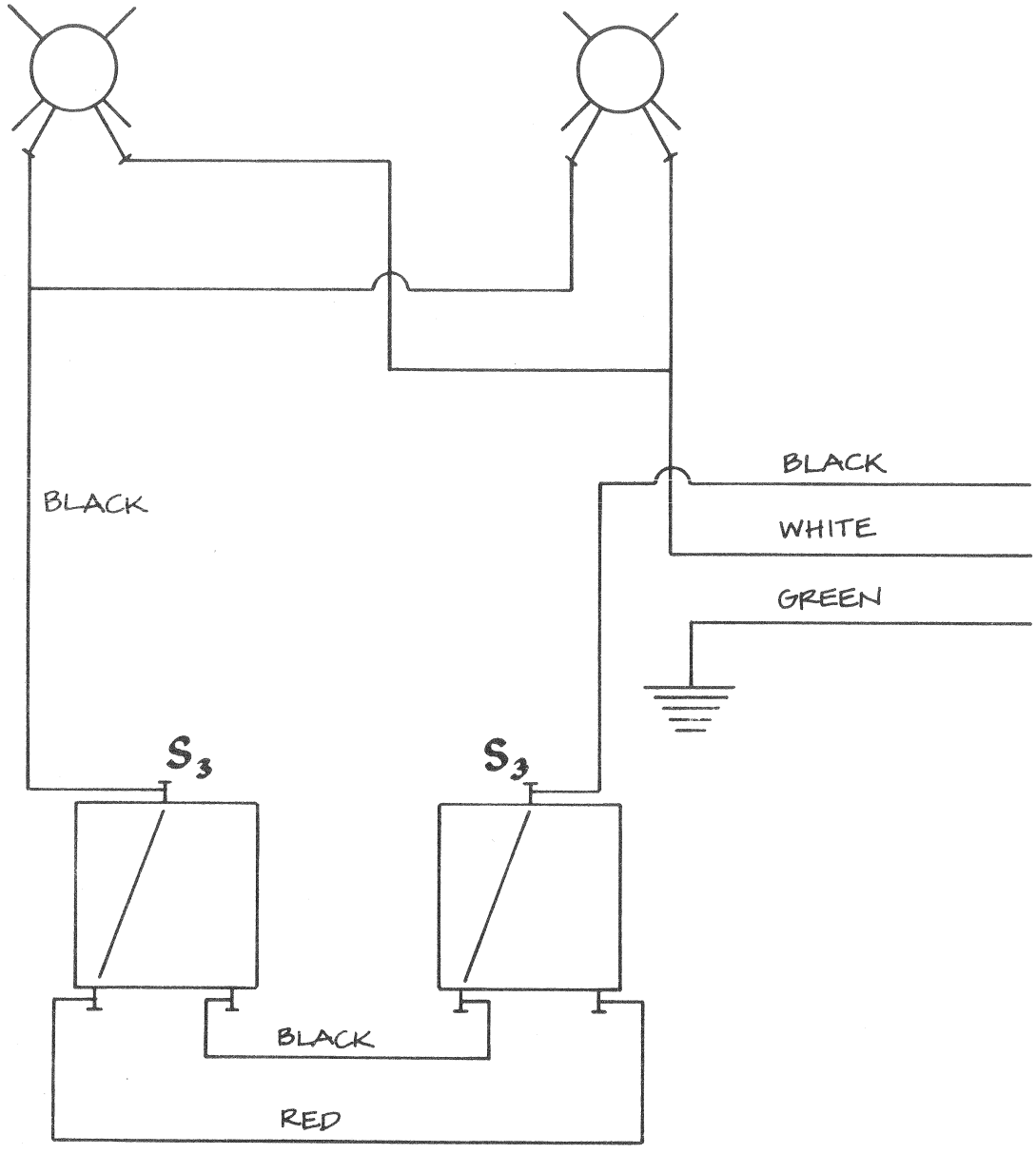
D. Green or bare copper wires are used for grounds.

COMPLETING 120 VOLT 1 Ø (SINGLE PHASE) CIRCUIT

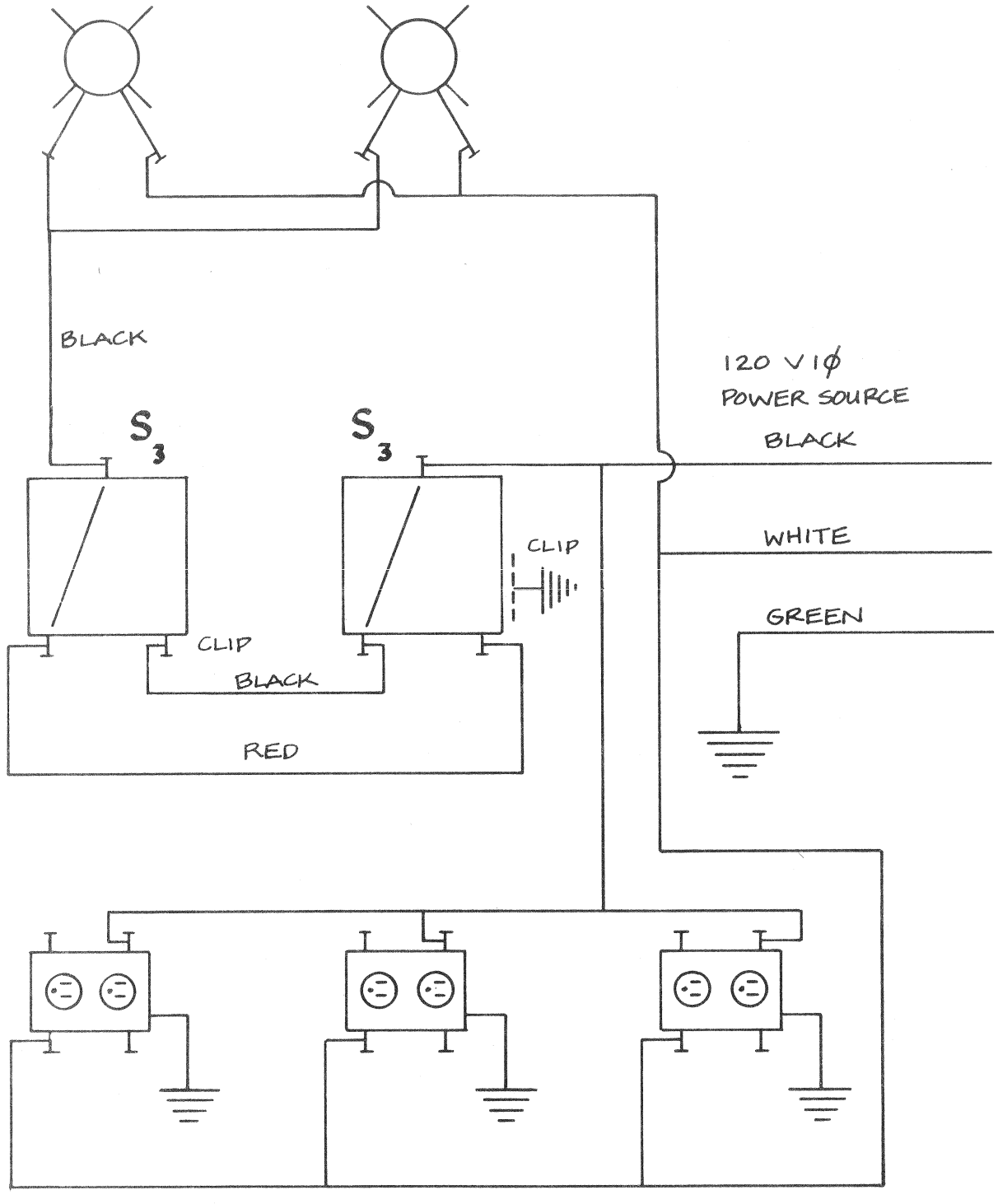


POWER SOURCE 120 V 1ϕ

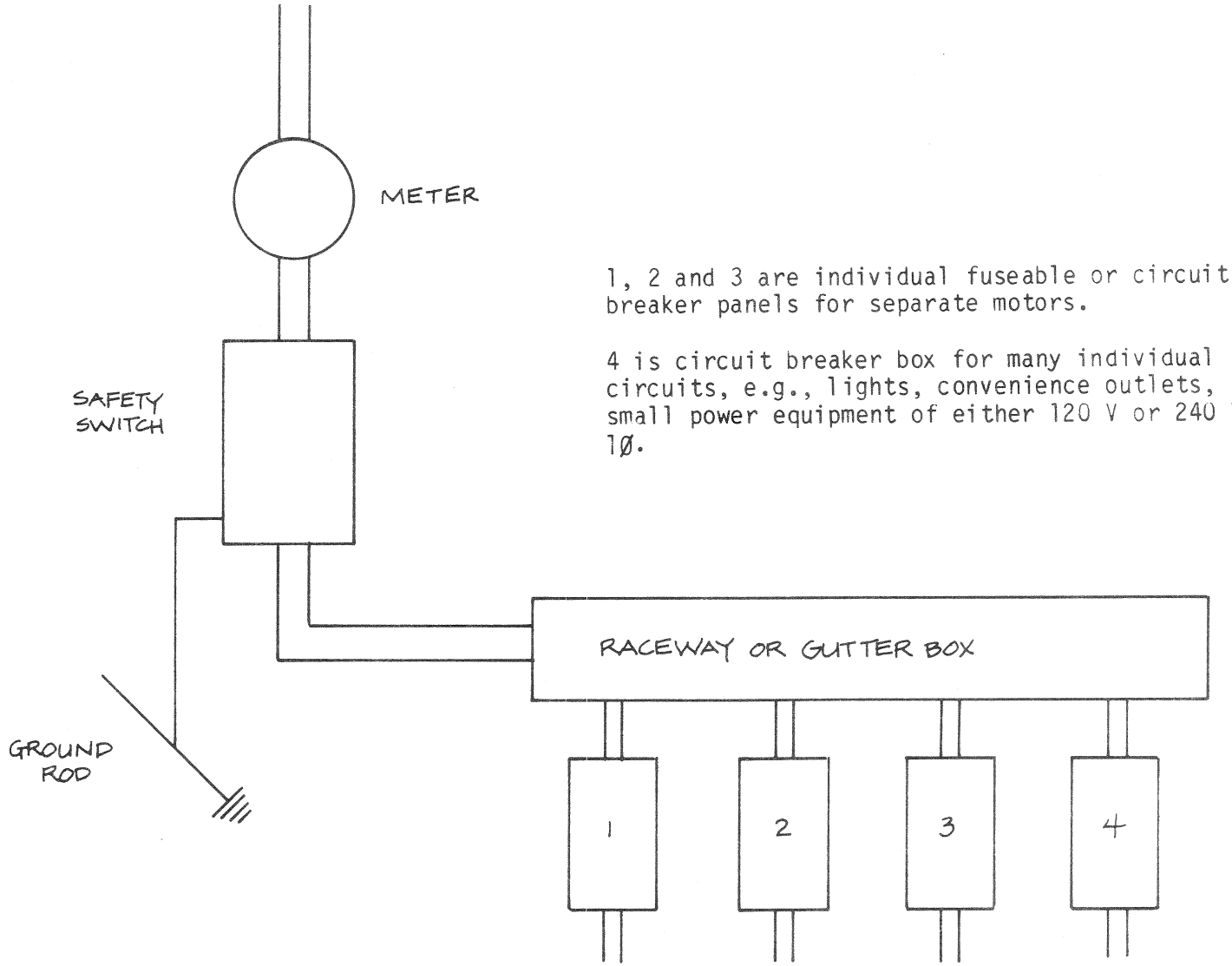
120 VOLT 1 Ø LIGHT CIRCUIT
(with two 3-way switches)



LIGHTS AND CONVENIENCE OUTLETS



USE OF BRANCH CIRCUITS



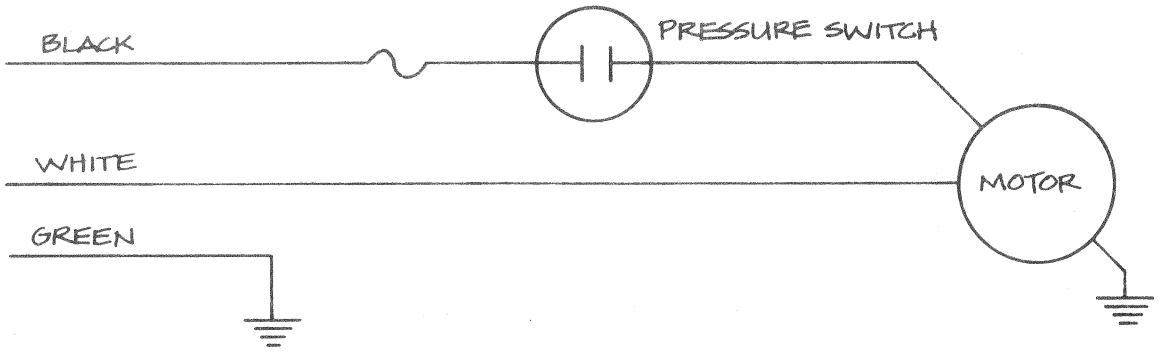
1, 2 and 3 are individual fuseable or circuit breaker panels for separate motors.

4 is circuit breaker box for many individual circuits, e.g., lights, convenience outlets, small power equipment of either 120 V or 240 V 1Ø.

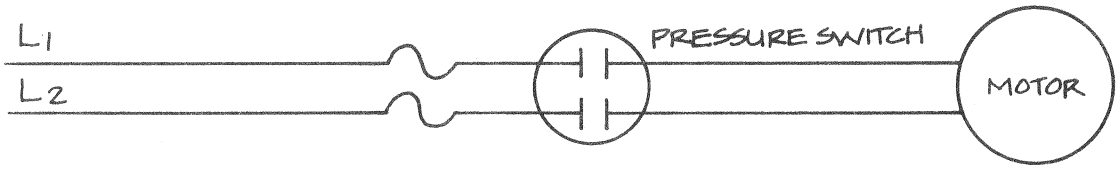
ELECTRIC CONTROLS

TM 8

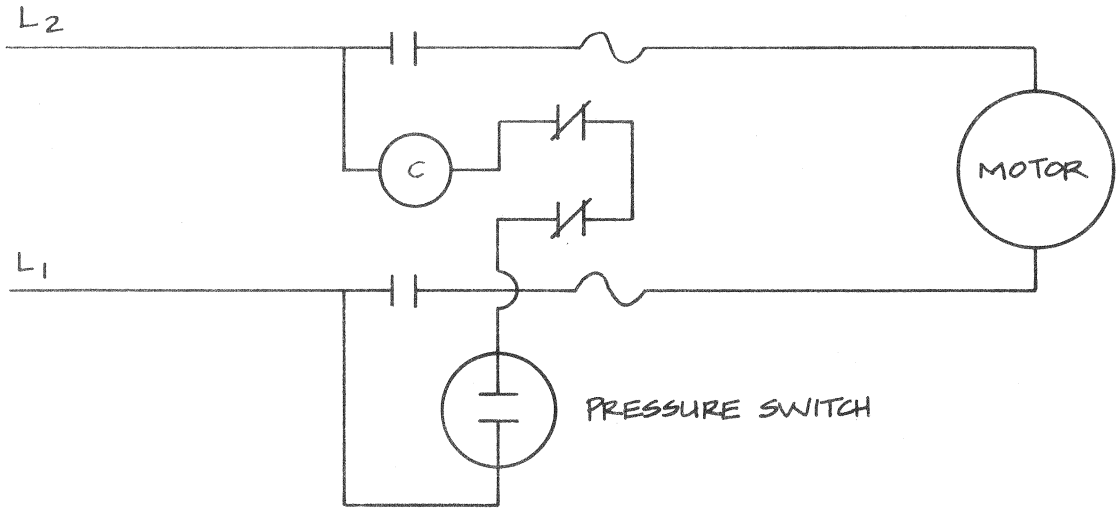
A. Pressure switch 120 V 1Ø



B. Pressure switch 240 V 1Ø, 1-2 hp



C. Pressure switch with magnetic starter



General References

Richter & Schwan, Practical Electrical Wiring, McGraw Hill

Richter, Wiring Simplified, Park Publishing, Inc.
P.O. Box 8527, Minneapolis, Minn. 55408

Simplified Electric Wiring Handbook, Sears or Wards

Phipps, Farm Mechanics Text, Interstate Publishers, Danville, Illinois