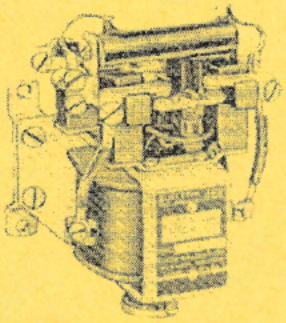
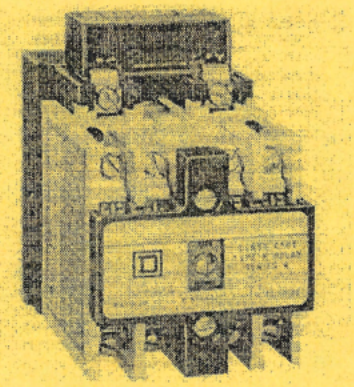
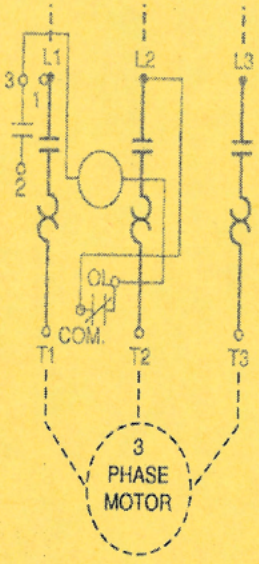
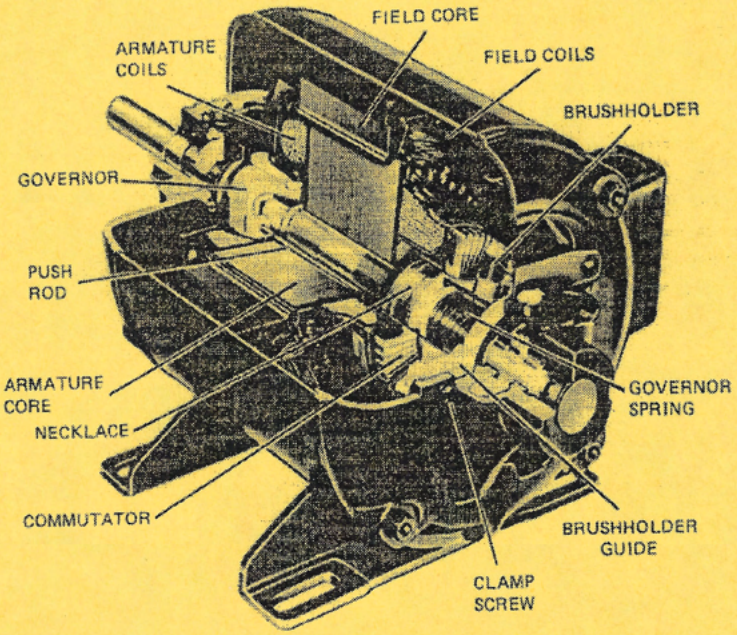
EART – 1285 DC and AC Machines

PART 3 OF 4









EART – 1285 (3 OF 4)

DC and AC MACHINE

Name: _____

HAND IN COMPLETED BY DUE DATE TO THE INSTRUCTOR

The Instructor must date and initial each project upon completion!!

PROJECT NAME & NUMBER	DATE	INITIAL	NOTES
HAND TOOLS			
LAB VOLT # 31			
LAB VOLT #32			
LAB VOLT #33			
TEST EQUIPMENT #1 (CLAMP-ON AMMETER)			SEE FLUKE ON
LAB VOLT #34			
SAFETY 1 – PORTABLE POWER TOOLS			
LAB VOLT # 35			
LAB VOLT # 36			
REPULSION START- INDUCTION RUN #1			SEE ADAMS MOTOR BOOK
LAB VOLT #37			
SAFETY #3 GOOD HOUSEKEEPING			
ELECTRICAL- ACCIDENTS			
LAB VOLT # 45			USE DATE ACQUISITION
LAB VOLT # 46			UNIT & COMPUTER FOR
CORRECTING POWER FACTOR WITH CAPACITORS			ALL DATA NEEDED IN
LAB VOLT # 47			LAB-VOLT EXPERIMENTS
SAFETY # 5 - COLD			# 45 TO # 59
THREE PHASE RULES			
			A CLASS ON HOW TO SET UP THE
			DATA ACQUISITION UNIT &
			COMPUTER WILL BE GIVEN
			BEFORE YOU USE IT

EART – 1285 (3 OF 4)

DC and AC MACHINE

Name: _____

HAND IN COMPLETED BY DUE DATE TO THE INSTRUCTOR

The Instructor must date and initial each project upon completion!!

PROJECT NAME & NUMBER	DATE	INITIAL	NOTES
DYNA MOTOR			BE SURE TO FOLLOW WIRING
IDENTIFY 9 LEAD MOTOR			DIRECTIONS FOR
SAFETY #6 – GFCI			DYNA MOTORS,
TEST EQUIPMENT #4			9 LEAD MOTORS, &
THREE PHASE MOTOR CONNECTIONS #1			3 PHASE MOTOR
LAB VOLT #48			CONNECTIONS. IF IT
LAB VOLT #49			GETS HOT, SMELLS BAD,
LAB VOLT #50			SOUNDS BAD OR SMOKES
LAB VOLT #51			SHUT IT OFF
LAB VOLT #52			IMMEDIATELY & GET
LAB VOLT #53			HELP
LAB VOLT #54			FAILURE TO FOLLOW
LAB VOLT #55			THESE INSTRUCTIONS
SAFETY #7- SWITCHES $ FIRST AID			WILL RESULT IN POINTS
LAB VOLT #56			BEING TAKEN OFF YOUR
LAB VOLT #57			GRADE.
LAB VOLT #58			
LAB VOLT #59			

HAND TOOLS

Care must be taken when selecting pliers, side cutters or diagonal cutters. Pliers or cutters should never be used on nuts or pipefittings. Always hold the pliers or cutters so the fingers are not wrapped around the handle in such a way that they can be pinched or jammed if the tool slips. When cutting short pieces. Never put extensions on tool handles to increase leverage.

When selection a screwdriver for electrical work, be sure that it has a non-conducting handle. The screwdriver selected should be of the proper size to fit the screw and should never be used as a substitute for a punch or a chisel. The points of screwdrivers can be kept in proper shape with a file or a grinding wheel.

Use wrenches only if they are right for the job and only if they are in good condition. An adjustable wrench should be faced so that the moveable jaw is located forward in the direction in which the handle is to be turned.

HAND TOOLS

TOOLS	COMMON DEFECTS	WRONG TOOL FOR JOB	RIGHT TOOL, WRONG USE
Knives	Lack of finger guard, loose, broken, or too short handles, dull or nicked edges or point.	1. Using as screwdriver or pry. 2. Using as a chisel.	1. Using tool with prying or lever action. 2. Using knife without finger guard. 3. Carrying open knife in pocket.
Handsaw	Improper or inadequate set, dull or improperly ground teeth, sprung blades, lose or split blades.	1. Twisting off strips of waste with blade instead of using hand or mallet.	1. Not hanging saw up when not in use. 2. Sawing into nails with a woodcutting saw. 3. Allowing end of saw to strike floor. 4. Cutting insecurely fastened work. 5. Starting the cut improperly, causing the saw to jump.
Screwdrivers	Split or battered handles, chipped or bent blade, bent shank.	1. Using as pry or pinch bar, chisel, punch or draft. 2. Using screwdriver with un-insulated handle around electrical wiring.	1. Using screwdriver with blade tip in screw tip. 2. Using wrong size screwdriver. 3. Using pliers or wrench on shank of screwdriver. 4. Hammer on end of screwdriver.
Wrench	Worn or sprung jaws, rough or sprung handle, worn or broken mechanism.	1. Using as a hammer or pry. 2. Using the wrong type of wrench.	1. Pushing instead of pulling. 2. Using a wrench that fits the nut poorly. 3. Turning adjustable wrench so pulling force is applied. 4. Using pipe to increase leverage.

QUESTIONS:

1. Pliers and cutters may be used on nuts and pipefittings?
   a. True
   b. False

2. Extensions may be used on tool handles in increase leverage?
   a. True
   b. False

3. When selecting a screwdriver for electrical work, be sure that it has a non-conducting handle?
   a. True
   b. False

4. A screwdriver should not be used as a punch or chisel?
   a. True
   b. False

5. Using a file or grinding wheel to keep screwdriver point in proper shape.
   a. True
   b. False

6. An adjustable wrench should be faced so that the moveable jaw is located forward in the direction in which the handle is to be turned.
   a. True
   b. False

7. Name two commo0n defects of chisels and punches.
   1.
   2.

8. Drills may be used as reamers?
   a. True
   b. False

9. A machinist's hammer may be used for driving nails?
   a. True
   b. False

10. Name two common defects of knives.
    1.
    2.

11. Starting the cut improperly causes a handsaw to jump,
    a. True
    b. False

TEST EQUIPMENT
Clamp-on Ammeter

GENERAL INFORMATION

A lot of different types of test equipment is used by electricians in the performance of his job. To become familiar with different types test equipment the following pages are for your information. Read and study each piece of equipment so you become familiar with its operation. You will be using each piece of equipment this quarter. **This equipment is very expensive!** Make sure you understand its operation before using the equipment.

OPERATING INSTRUTIONS:

Amprobe Digital Clamp-on Volt/Amp/Ohmmeter, Model ACD-1

Specifications:

Ranges: 0.1 – 99.9/ 999 Amps AC
0.1 – 99.9/ 999 Volts AC (Input Impedance 10 megohms)
0.1 – 99.9/ 999 Ohms

May also be used to measure DC voltage as explained in instructions.

Ohmmeter Test Voltage:
1.2 V maximum (7ma low range, 0.6 ma high range)

Accuracy: AC Current and Voltage + 2% + 1 LSD* of reading based on 25 – 400 Hz sinusoidal wave form.

Resistance: + 2% + LSD* of reading
See instructions for low resistance measurements.
Least Significant Digit

Power: 1 Mallory No. NM1604, 9V Alkaline Battery (Not supplied)

Fuse: 1 No. 8AC – 361, 1 AMP Fast Blow (Little Fuse)

Operating Temperature and Humidity:

+32 Degrees F to 120 F
0 Degrees C to 49 C
Up to 95% RH

Over- Range Protection: 50% overload for a maximum of one minute when measuring voltage or current. Ohmmeter is fused.

Case Voltage Breakdown Test: 3000 Volts AC

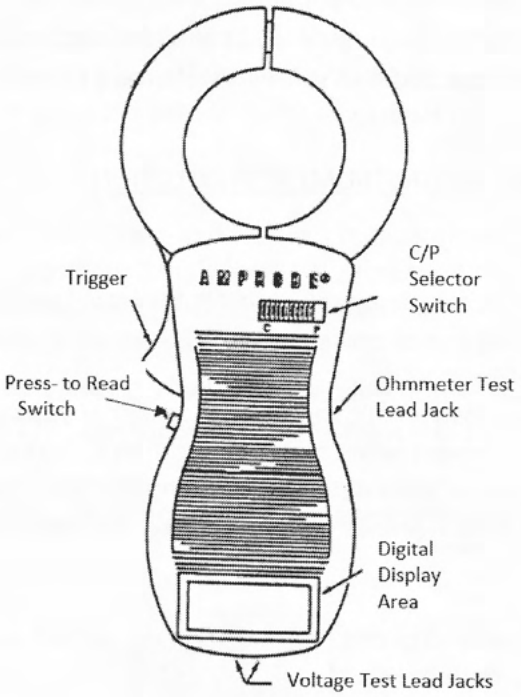


Figure 1

Helpful Hints for Getting Top Performance from you ACD-1....

Make certain the C/P (Continuous/Peak) Selector Switch is moved completely into either the C or the P position.

When measuring resistance, make certain the voltage test lead that is being used is inserted into the voltage test lead that is being used is inserted into the jack marked "COM" on the back of the instrument.

When measuring currents of widely varying values, start with the conductor in which you expect to find the lowest current, then the next highest, etc. To reduce the possibility of retained magnetism in the jaws, open and close the jaws a few times between measurements.

When using the Peak Mode to take and lock in a low current measurement that is to be read away from the conductor, open the jaws slowly and slowly remove them from around the conductor. When measuring resistance, the "C/P" Selector Switch should be in the "C" position. In the "P" position, any accidental opening of the circuit will cause a lock-in, over-range indication unless the Press-to-Read button is released.

The temperature operating range of your ACD-1 is +32 degrees F to +120 degrees F. If the instrument has been in a location where the temperature was lower than 32 degrees F or higher than 120 degrees F, allow the instrument to adjust to within the operating temperature range.

Congratulations! You are now an operator of an AMPROBE instrument. It has been union crafted according to quality standards and contains quality components and workmanship. This instrument has been inspected for proper operation of all its functions. It has been tested by qualified, factory technicians according to the long-established standards of AMPROBE INSTRUMENTS.

PRECAUTIONS FOR PERSONAL AND INSTRUMENT PROTECTION

IMPORTANT!

1. Before using and electrical instrument or tester for actual testing, the unit should be checked on a known live line to make certain it is operating properly.

2. The jaws of a clamp-on instrument should **NOT**, under any circumstances, be used as a device to hold the instrument when taking other than a current reading. When using a clamp-on as a voltmeter or ohmmeter never clamp the jaws around or on to a conductor, box, or anything else conducting or non-conducting, except a test lead. See (Figure #5).

3. Before applying test leads to circuit under test, make certain that test leads are plugged into the proper instrument jacks.

4. Make certain no voltage is present in circuit, before connecting ohmmeter to circuit.

5. Should the instrument accidentally be used to try to measure a voltage or current beyond the range to the instrument, immediately remove the instrument from the circuit. See Over-Range indication.

6. When not in use, keep instrument in its carry case.

7. When instrument will not be used for a period of time, remove the battery from instrument.

DESCRIPTION:

Your Model ACD-1 will directly measure AC current, AC voltage and resistance and provide a digital readout of the value. It can also be used to measure DC voltage as explained under "How to Measure DC Voltage". The instrument is auto-ranging which means that it changes ranges automatically. Below 100, it provides readings to the nearest 0.1 up to 99.9. At 100 and above, it provides readings to the nearest whole digit up to 999.

CONTINUOUS OR PEAK OPERATION:

The ACD- a can be used to continuously monitor a fluctuating variable (current, voltage, resistance) or to measure the peak (surge) value of a variable, such as a motor starting current. Peaks must last at least 0.08 seconds. Motor starting currents normally persist for approximately 0.17 seconds.

The Peak Mode can also be used to take and lock in a measurement when the display cannot be read because of instrument position. Simply keep your finger on the "Press-to-Read" button and remove the instrument to a position where it can be read.

For continuous operation, move the C/P Selector Switch to the left into the "C" position. For peak measurements, move C/P Selector Switch to the right into the "P" position. See (Figure2)

IMPORTANT: When changing C/P Selector Switch position, release "Press-to-Read" button before switching.

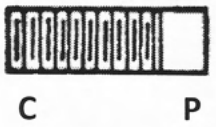


Figure #2

INSTALLING BATTERY AND FUSE:

The ACD-1 uses one No. MN1604 9V alkaline battery. To install:

1. Loosen screw located toward the bottom on the back of the instrument. See (Figure #3).
2. Lift battery compartment cover.
3. Firmly Snap connector battery terminals
4. Replace cover and tighten screws.

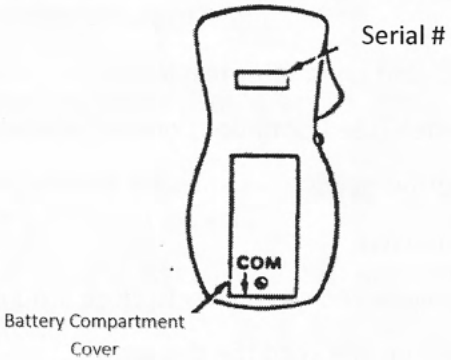


Figure #3

The ACD – 1 uses one No. 8AG-36a, 1-amp Fast Blow Fuse (Little fuse) which installs in the probe handle of the OHB – B ohmmeter battery attachment. To install:

1. Unscrew the top (probe tip) section from the bottom section of the probe handle
2. Insert fuse into top section.
3. Screw two sections together.

LOW BATTERY INDICATION:

Replace the battery when the decimal point at the left end of the digital display comes on (Figure 4) or the display digits do not light up.

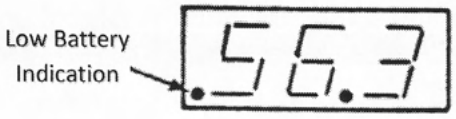


Figure 4

OVER-RANGE INDICATION:

If you attempt to measure a voltage, current, or resistance greater than the instrument's capability, the instrument will signal over-ranger as follows:

a. With C/P Selector in "P" (peak) position, the two right- hand decimals will light up and remain on; balance of display will be back.
b. With C/P Selector Switch in "C" (continuous) position, the two right-hand decimals will light up and remain on and the three digits will flash on and off.

Immediately remove instrument from the circuit.

HOW TO MEASURE AC CURRENT:

1. Disconnect voltage test leads and ohmmeter test leads from instrument.
2. Position the C/P Selector Switch (see Continuous or Peak operation).
3. Press trigger to open transformer jaws.
4. Encircle single conductor with jaws.
5. Release finger pressure on trigger and allow jaws to close around the conductor.
6. Press the "press-to-Read" button and read the display.

HOW TO MEASURE AC VOLTAGE:

NOTE: Because the ACD – 1 is a high impedance voltmeter (10 Megohms) and RF signal exist almost everywhere, it is possible to get a voltage reading even when the instrument is not connected to a circuit. This will not, however, affect your actual voltage measurement.

Figure #5

See Precautions for Personal and Instrument Safety

1. Disconnect ohmmeter test lead from instrument and/or remove transformer jaws from around and conductors.
2. Position the C/P Selector Switch (see Continuous or Peak operation).
3. Insert insulation voltage test lead connectors om voltage receptacle, in bottom of instrument (see Figure #1). Push in against receptacle spring and twist clock-wise to lock in place.
4. Clamp on voltage test lead probe between jaws (see figure #5).
5. With instrument in one hand and the other voltage test lead probe in the other hand, apply test probes to the test pints of the circuit.
6. Press the "Press-to-Read" button and read the display.

HOW TO MEASURE DC VOLTAGE:

CAUTION: Because of polarity, it is possible for instruments to read "0.0". If this happens reverse test leads on test points and read again.

See Precautions for Personal and Instrument Safety

1. Follow steps under "How to Measure AC Voltage".
2. Multiply reading by 1.41 to get DC value.
3. If display reads "0.0" reverse test leads on test points, read again and multiply reading by 1.41 to get DC value.

HOW TO MEASURE RESISTANCE:

(Ohmmeter Test Voltage 1.2V Maximum 6ma Low Range, 0.6ma High Range)

CAUTION: Make certain no voltage is present in circuit before connection ohmmeter to circuit. If ohmmeter is applied to a live line, the ohmmeter fuse may blow, or incorrect readings may be obtained. Also make certain any capacitors in circuit are discharged.

(See Precautions for Personal and Instrument Safety)

1. Insert on insulated voltage test lead connector into the right hand (viewing instrument from front) voltage receptacle at the bottom of the instrument. Looking at the back of the instrument, this voltage receptacle is marked "COM". (figure # 3).
2. Clamp voltage test lead probe between jaws (See figure #5).
3. Plug ohmmeter lead into jack on the right side of the instrument. (See figure #1).
4. Position C/P Selector Switch in the "C" position.
5. Short Ohmmeter test probe tip to voltage test lead probe tip and press the "Press-to-Read" button.
    a. If fuse is good, reading should be below one ohm
    b. If fuse is blown, the two right-hand decima; points will light up and remain on and the three digits will flash on and off.
6. With the instrument in one hand and ohmmeter test probe in the other hand, apply probe tips to circuit or device. Press "Press- to – Read" button.

NOTE:

When measuring low resistances, subtract the resistance value obtained in 5(a) above from the reading obtained in the actual test. Instrument measures its own lead resistance at the same time it measures circuit or device resistance at the same time it measures circuit or device resistance. Subtraction the test lead resistance gives a more accurate resistance measurement. Also, make certain good electrical contact is made with test points. Because of the sensitivity of the ACD – 1, even slight corrosion on the probe tips or test points may cause erroneous readings. To clean probe tips, use fine steel wool.

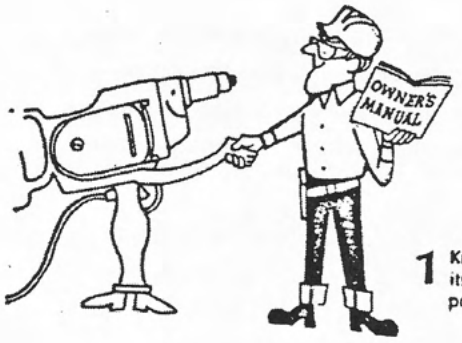
PORTABLE POWER TOOLS

All portable power tools should be inspected before use to see that they are clean, well oiled, and in the proper state of repair. The switches should operate normally, and the cords should be clean and free of defects. The case of any electrically driven power tool should be well-grounded; and sparking electric tools should never be used in place where flammable gases or liquids or exposed explosives are present.

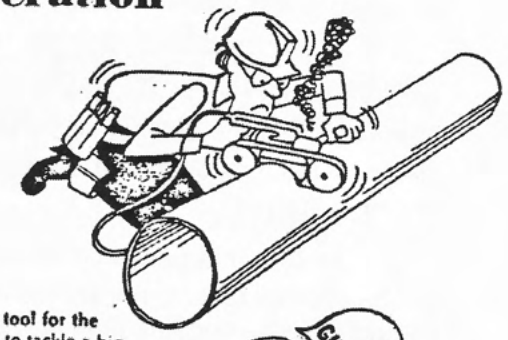
Drill bites must be straight, undamaged, and properly sharpened. Tighten the drill bit securely in the chuck using the key provided; never secure it with plyers or with a wrench. It is important that the drill bet be set straight and true in the chuck. The work should be firmly clamped and if made of metal, a center punch should be used to score the material before drilling is started.

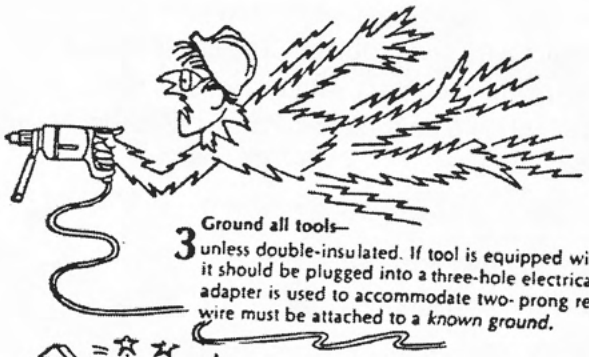
Be sure that power cords do not come in contact with sharp objects. The cords should not be allowed to kink, nor should they be allowed to come in contact with oil, grease, hot surfaces, or chemicals. When cords are damaged, they should be replaced instead of being patched with tape.

Electricians' *On-the-job* *SAFETY RULES* For Power Tool Operation

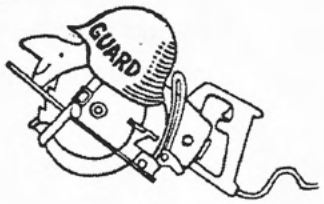


1 **Know the tool you are using**—its application, limitations and potential hazards.





2 **Select proper tool for the job.** Don't try to tackle a big job with an undersized tool—makeshift tools can cause accidents.

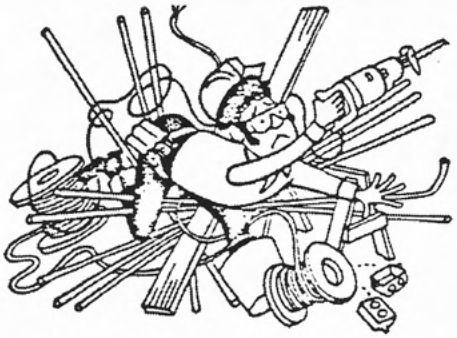


3 **Ground all tools**—unless double-insulated. If tool is equipped with three-prong plug, it should be plugged into a three-hole electrical receptacle. If adapter is used to accommodate two-prong receptacle, the adapter wire must be attached to a *known ground.*

4 **Remove adusting keys and wrenches** before turning on tool.

6 **Keep guards in place** and in working order. Do not remove or wedge out of the way.

7 **Always be alert** to potential hazards in your working environment such as damp locations or the presence of highly combustible materials—gasoline, naptha, etc.

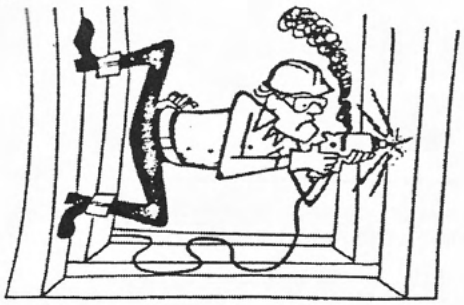


5 **Keep work area free of clutter**—boards, boxes, debris, tools, etc.—that can be tripping hazards.

8 **Avoid accidental startup.** Make sure switch is off before plugging in cord—or when power is interrupted. Don't carry plugged in tool with finger on switch.

9 **Make sure saw blades, drill bits, router cutters, etc. are sharp, clean and regularly maintained.**

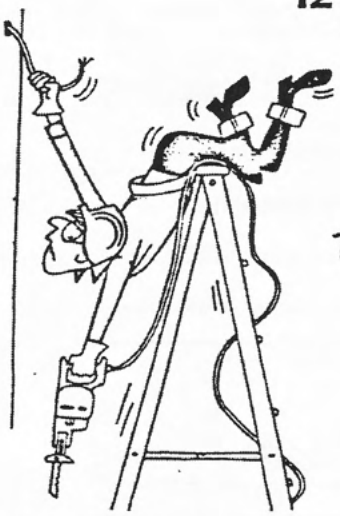
10 **Use only recommended accessories.** Follow manufacturer's instructions.



11 **Do not force tool.** It will do a better and safer job at its designed speed.

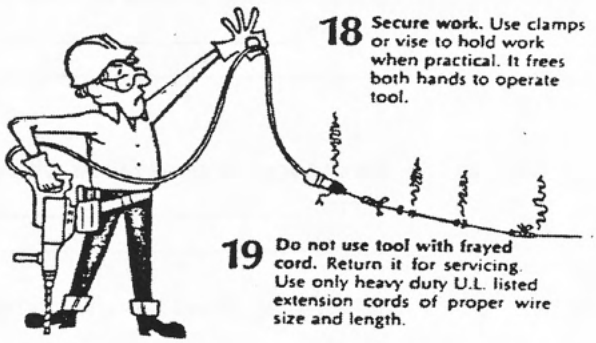
17 **Dress properly.** Avoid loose clothing that could catch in moving parts. Wear rubber boots in damp locations.

12 **Use safety glasses.** Also face or dust mask if operation requires it.



13 **Do not overreach.** Keep proper footing and balance at all times.

14 **Never leave tool running unattended.** Don't leave until it comes to a complete stop and is disconnected from power source.



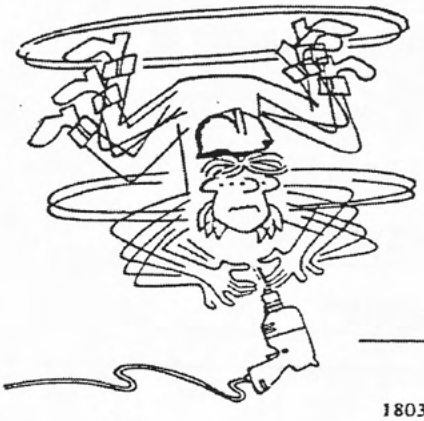
18 **Secure work.** Use clamps or vise to hold work when practical. It frees both hands to operate tool.

19 **Do not use tool with frayed cord.** Return it for servicing. Use only heavy duty U.L. listed extension cords of proper wire size and length.

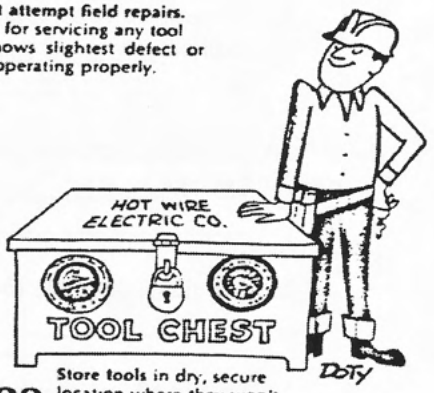
15 **Don't surprise** or touch anyone operating a power tool. The distraction could cause a serious accident.

20 Never brush away chips or sawdust while tool is operating.

16 **Never adjust, change bits,** blades or cutters with tool connected.



21 **Do not attempt field repairs.** Return for servicing any tool that shows slightest defect or is not operating properly.



22 Store tools in dry, secure location where they won't be tampered with.

Material for this article comes
from the **Power Tool Institute, Inc.**
1803 S. Busse Highway, Mt. Prospect, Illinois 60065

QUESTIONS:

1. Under what condition is it unnecessary to ground hand power tools?
   Explain:_____
   _____
2. Is it necessary to remove the key from the chuck before turniong on the power?
   Explain:_____
   _____
3. Should you operate a power tool in a place where flammable gases are present?
   Explain:_____
4. Is is important to select the right size tools for the right job?
   Explain:_____
   _____
5. Should you avoid loose clothing that could get caught in moving parts?
   Explain:_____
   _____
6. Should you use power tools with a frayed or small size extension cord?
   Explain:_____
   _____
7. When using power tools, should you always use safety glasses?
   Explain:_____
8. Should you leave power tools running and unattened?
   Explain:_____
   _____
9. Should you store tools in a dry and secure location where they won't be tampered with?
   Explain:_____
   _____
10. Should all portable power tools be inspected before being used?
    Explain:_____
    _____
11. Should all portable tools be grounded if they have a metal case? Explain:_____
    _____
12. Should all power cords be in good condition?
    Explain:_____

REPULSION START – INDUCTION RUN MOTOR

Project #2

General Information:

Before you start this project, read Pages 217 -221 in your test book INDUSTRIAL ELECTRICITY, Principles and practices by Adam and Rockmaker. You will use a real motor on this project. It is use a real motor on this project. It is a "Singer Sewing Machine Motor". It is the same type of motor you could run into the industry today. It is a dual voltage motor 120/140 volts.

OBJECTIVES:

1. Connect up and run the motor for low voltage.
2. Connect up and run the motor for high voltage
3. Determine the number of poles that the motor has.
4. Reverse the motor.
5. Identify industrial repulsion motor leads.

EQUIPMENT NEEDED:

1. "Singer" motor and "Master motor.
2. A.C. power source 120V – 208 VAC
3. A.C. volt meter 0 – 250 VAC
4. A.C. amp meter 0-5 ACA
5. Tachometer
6. Connection leads

PROCEDURE:

NOTE: **DO NOT** connect up the light circuit (the two brown wires)

1. a. Identify the four motor leads coming out of the motor.

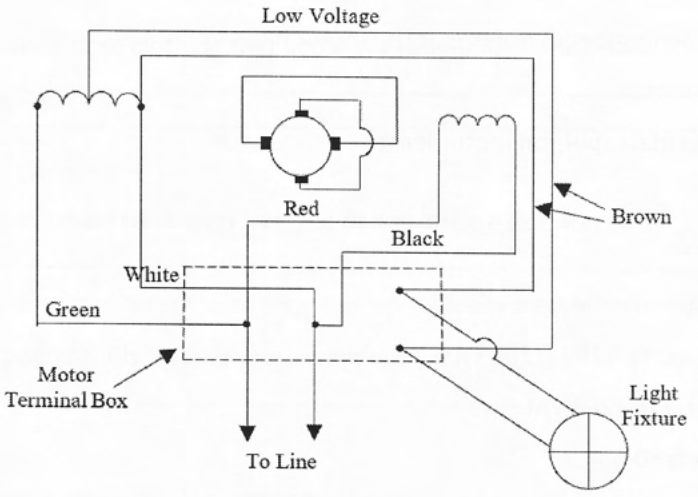
   b.White and green fo to one winding.

   c. Red and black go to the other winding.

   d. How many ohms does the red and black winding have? _____

   e. How many ohms does the white and green winding have?_____

2. NOW connect the motor for low voltage operation. (Figure #1) shows you the proper way to make this connection.
   a. Turn on power and measure and record the RPM.
   b. Measure and record the current in line # L1._____
   c. Measure and record the current in line # L2 ._____
   d. Is there a difference in these 2 currents?_____
      Why?_____
   e. Note what direction the motor turn._____
   f. How many poles does this motor have connected up at the time?_____
   g. Disconnect the power from the motor.



3. Now reverse the motor.

   NOTE: Figure # 2 shows rocker ring set or clockwise in counte rclockwise rotation facing commuter. To reverse the rotation, remove hand hole cover on end bell of motor you get access to motor reverser .

   a. Displace sprinf "C" from notch in long narrow slot of rocker ring (push spring toward center of motor).
   b. Move entire rocker ring and brush assembly by grasping a brush holder and move to next notch.
   c. Release spring so it snaps into the next notch.

4. To rewind or remove brusher, proceed same as above, move rocker ring to position where brush holders are accessible – replace brushes and move rocker ring to notch to give proper rotation.

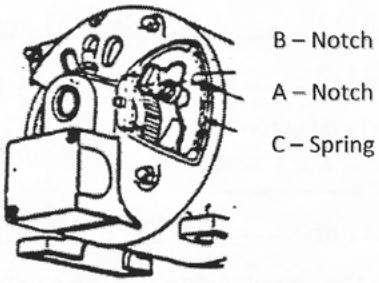


Figure #2

NOTE: Brown leads, if provided, are for low voltage connection. When making these connections a suitable strain relief must be provided. If leads are not connected to a lamp, tamp ends separately. **DO NOT** connect these leads together or to any other leads.

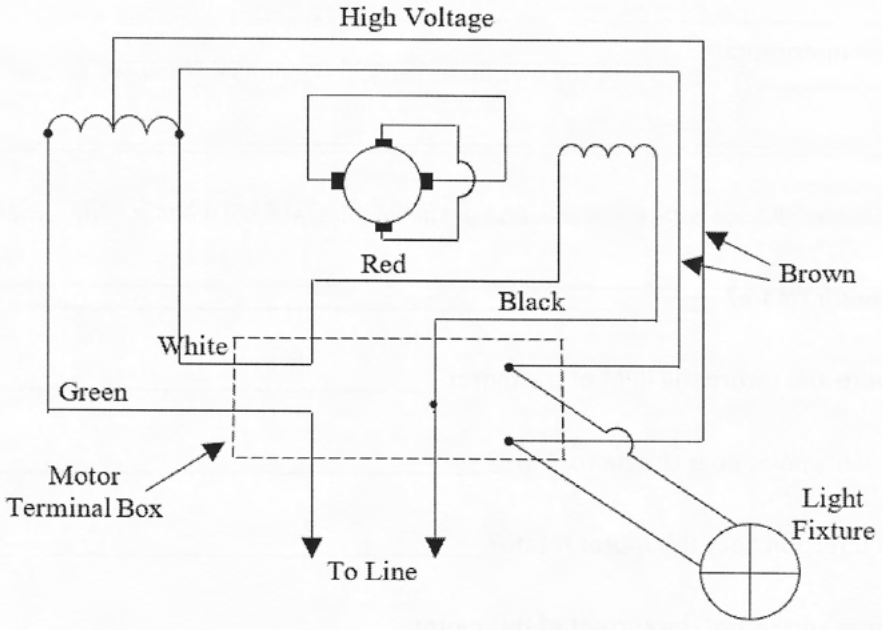


Figure #3
208 V.A.C.

5.

a. Measure and record the RPM of the motor while connected for high volt._____

b. How many people does the motor now have?_____

c. What is the current in line # L1?_____

d. What is the current in line # L2?_____

e. There a difference in these two currents? _____

Why? _____

f. What direction is the motor turn ?_____

g. Disconnect the motor from the power and return the equipment.

6. The "Master" motor has four leads coming out of the motor for connection to a power source. These four leads are not identified by color or by number. This is a two voltage motor, 120/240 volt. It has two windings that have the same resistance in them so they can be connected parallel for 120 volt operation or series for 120 volt operation. You are to identify these two windings so that you know where the lead and go .

7. Now connect up the "Master" motor for low voltage and apply power 120 VAC.

a. Did the motor rotate? _____

Why?_____

b. If the motor did not rotate, reverse one of the winding and try it again. Why would this make the motor rotate?_____

c. Measure and record the RPM of the motor._____

d. How many poles does this motor have? _____

e. What direction does this motor rotate? _____

f. Measure and record the current of this motor. _____

8. Now connect up this motor for high voltage and apply 208 single phase. Apply the voltage and note the direction of rotation._____

   a. Measure and record the current._____

   b. Measure and record the RPM._____

   c. How many poles does this motor have?_____

   d. Measure and record the current of this motor._____

CONCLUSION:

1. Does changing the voltage to a repulsion motor changes its speed?_____

2. What determines the speed of the repulsion motors? Explain:_____

   _____

3. Why would a motor be connected or wired for two voltages?_____

   _____

4. Does changing the voltage connected or wired for two voltages? Explain:_____

   _____

5. What determines the current to the motor? _____

   _____

ASBESTOS

"Asbestos" Is the name of a family of minerals which occur naturally as masses of fibers. These fibers have a tendency to break easily into a dust of tiny particles nthat can float in the air, stick to clothes, and may be easily inhaled or swallowed. This dust can be brought into the home on shoes and clothing of workers.

USES:

Asbestos been used Widely in many industries during the past for decades deletion and fire proofing , and in textiles and struck. Ship building has been a major use of asbestos because the substance is good for insulating boilers, steam pipes, hot water pipes and nuclear reactor in ships. Today, about 800,000 tons of Bestias our mind or process you really to make over 3000 different products in the United states. Two-thirds of these are used in the construction industry. Among past and current uses of that asbestos are the following:

*coverings for pipes and surfaces (in new construction of ships, repairs, refittings); insulation in construction, powerhouses and cheical plants, and for engines, hulls and decks of ships; coatings for cables and electric wires; and putties, caulks, paints, and cement.

*floor and ceilings tiles, sealants, pipe covering, and patching tape compounds.

*friction products such as clutch facings, brake linings for automobiles, railroad cars and airplanes; filtration materials, and theater curtains.

*a wide variety asbestos cement material and wallboards

THE PROBLEM FOR WORKERS:

Health hazards from asbestos dust have been recognized among workers heavily exposed in shipping trade, asbestos mines, asbestos manufacturing, in insulation work in the construction and building trades, and among workers who used asbestos products in a variety of other trades.

Since the early 1940, as 11 million American workers may have been exposed do concentration of asbestos dust, including some 4.5 million workers in shipyards during the peak shipbuilding years of World War II.

Exposure to asbestos on the job may increase risk of four serious diseases:

1. Asbestosis- A chronic lung illness which can produce shortness of breath and lung damage. The disease results from inhalation of asbestos dust.

2. Lung cancer there is a close Association between Asbestos exposure and increased occurrence of lung cance.

3. Mesothelioma – A cancer that involves the thin membrane lining of the chest and abdomen. Most mesotheliomas can be traced to prior asbestos exposure.

4. Other cancers - Several studies have indicated a link tween Asbestos exposure in increased occurrence of cancers of the esophagus (the food tube leading to the stomach) , stomach,colon, and rectum.

WHO IS AT RISK?

The best estimates of the increased risks associated with asbestos exposure are based on U.S. Department of Health, Education and Welfare—supported studies of workers heavily exposed to Asbestos before the government began regulate asbestos in the workplace in the late 1960's and early 1970's. As a result of recent government regulation current workers without previous exposure can be expected face smaller risk than those exposed in the past.

There is no evidence that exposure to asbestos dust substantially creases the risk of asbestosis and certain cancers in workers with jobs in or near asbestos contaminated area.

Scientific information now available indicate that workers may not begin to show signs of the disease for 30 or more years.

Recent studies of shipyard workers, including those exposed to asbestos even for a brief period of time (as little as a month or two) indicate the presence, in some, of asbestos-related diseases. Some workers who may not have worked directly with this asbestos, but whose jobs were located near contaminated areas, have developed asbestosis, mesothelioma , or an excess of other cancers associated with the asbestos exposure.

There is also some evidence that members of families of workers heavily exposed to asbestos face an increased risk of developing mesothelioma and perhaps other asbestos related diseases, probably as a result of exposure to asbestos dust brought into the home on the shoes and clothing of workers.

Many workers exposed to asbestos, perhaps most, may suffer no apparent effect. However, others are likely to develop disease related to asbestos.

Asbestos bonded in finished product is not a risk to health, as long as the product is not damage or disturbed in such a way as to free fibers in the air since the fibers are nearly indestructible, a risk exists if fibers are set free. It is known that risk increases with increased of amount of exposure and the length of time a worker is exposed. Once the asbestos particles work their way into the body tissues, they tend to stay there indefinitely.

Some studies have shown that lung cancer has caused up to 25% of all deaths in workers heavily exposed to asbestos in the past , compare to a lifetime lung cancer risk of 4 to 5 percent in the general population.

In these same studies of death records of asbestos workers , some 7% died of a asbestosis.7 to 10% such workers died of mesothelioma, and 4% of these asbestos exposed individuals died of gastrointestinal cancer,(stomach, colon, esophagus), compared to 2% in the general population.

SMOKING:

Well asbestos by itself can increase the risk of lung cancer asbestos and cigarette smoking gather increase lung cancer risk five-fold over the already high risk due to smoking alone. Asbestos workers who also were cigarette smokers have been 30 to 90 times more likely develop lung cancer then an non-expose non-smoker.

There is also some evidence quitting smoking will reduce risk among asbestos - exposed workers, as much as half. So if you were exposed to asbestos on the job anytime in your life, or suspect you were, you should not smoke.

WHO NEEDS TO BE EXAMINED?

If there had been exposed (or suspected you have been) to asbestos dust on the job, or via a family contact, you should consult with your doctor. Regular checkups could mean early detection and may provide a better chance for successful treatment should you become sick .

Your doctor be told of your work history in any symptoms you may have likely to give you a thorough physical exam including chest X Rays and lung function tests. Interpretation if the chest X Ray may require the help of a specialist who is experienced in reading X Rays for asbestos related diseases other test may be necessary depending on your specific situation.

The symptom of asbestos related diseases may not become apparent for many years. If you have any of these symptoms, however, schedule an examination without delays:

*Shortness of breath.

*Cough or change in cugh pattern.

*Blood in the fluid coughed up from your lungs.

*In the chest or abdomen.

*Difficulty in swallow, Or prolonged hoarseness.

*Rapid large weight loss.

TREATMENT:

Deaths from asbestos are due mainly lung infections that attack weakened lungs. These can be treated with the greatest success following early medical attention. Aggressive treatment may be important should you develop a lung infection . As a protective measure, depending on your situation, your doctor may wish to give you one of the currently effective vaccines against influenza and pneumoccal pneumonia.

Treatment of all cancer is individually tailored and may include surgery drugs , radiation combination of these therapies.

HOW CAN CURRENT WORKERS PROTECT THEMSELVES?

Employers are required to follow regulations issued by the Occupational Safe and Health Administration (OSHA) dealing with asbestos exposure on the job.

If you are concerned about asbestos exposure in your workplace , discuss the situation with other employees in your local union. If necessary OSHA can give you more information or make and inspect.

Workers may get a copy of the Standard on Worker Exposure to Asbestos from the office of Information, OSHA, Washington, DC 20210 or from the regional office in Boston, New York, Philadelphia, Atlanta, Chicago, Kansas City (MO), Dallas, Denver, San Francisco, and Seattle.

Information is available for insulation installers who may be exposed to asbestos in a Good PracticeManual available through the Clearinghouse Occupational Safety and Health (NIOSH), 4667 Columbia Parkway , Cincinnati, Ohio 45226. This booklet recommends on the job procedure for those working with asbestos.

Any exposure that me aggravated respiratory ailment should be avoided. Information on possible workplace exposures are available from the NIOSH Clearinghouse.

Recommended work practices for renovation projects also are available in another booklet com Sprayed Asbestos-Containing Materiasl in Buildings , from the Standard Development Branch, US Environmental Protection Agancy (EPA), Research Triangle Park, NC 27711.

Use all protective equipment, work practices, and safety procedures your employer provides if you have questions check with OSHA .

IF YOU SMOKE CIGARETTES, STOP!

1. What is asbestos? Explain:_____

2. What are the two main uses of Asbestos? Explain:_____

_____

3. Name ten uses of Asbestos.

1._____ 6._____

2._____ 7._____

3._____ 8._____

4._____ 9._____

5._____ 10._____

4. What are four of the more common problems for workers of Asbestos?

1._____ 3._____

2._____ 4._____

5. How many years before a worker may show signs of a disease from Asbestos?

Explain?_____

6. The studies show that lung cancer has caused up to _____ of all deaths in workers heavily exposed to asbestos.

7. Asbestos and smoking together increase lung cancer risk _____over the already high risk of smokers alone.

8. The symptoms of asbestos related diseases are:

1._____

2._____

3._____

4._____

5._____

6._____

9. Workers are required to follow regulations issued by?_____

GOOD HOUSEKEEPING

Good Housekeeping is very much a part of your job. Common sense should tell you a neat job is a good indication of safety. Dirt, disorder, and confusion are accident breakers.

Good Housekeeping has a dual person one is the personality individual and two, the personality of the job.

THE INDIVIDUAL :

Personal habits are of prime importance your job and your safety. Do not develop a personal habit that could be offensive to others. Personal neatness is a big asset and goes hand in hand with good housekeeping. Be courteous and considerate always, both to your fellow workmen and school. No work or action or yours should create an unfavorable opinion of the organization you represent. The good housekeeping of your personal appearance, the amount of clutter necessary for you to do the job, and the condition you leave the premises will determine what kind of an impression your good housekeeping habits have left with the customer. If you have made a good inpression on the customer, you have gained man-hours of work for yourself, the contractor you represent, and your fellow craftman.

THE JOB

Ordinarily, it is much harder to be good apprentice than it is a journeyman. The reasons for this is that the journeyman knows exactly what he going to do, How he is going to do it in what will need to do it with the apprentice does not know. Therefore, to become a good apprentice and be a help to the journeyman instead of a hindrance, one of the first thing to do is to study and try to understand what the journeyman is anticipating. Sometimes this is rather hard to do Carol early if you are constantly changing journeyman. However, it can be turned into in advantage if you try to pick all of the good points of each journeymen that you work with and arrange them into work pattern of your own.

Some journey man require lot more attention than others but you will fine that most all of them will insist upon a fairly clean job and under normal conditions, it is up to you to see that the job is kept clean. Save yourself some time by keeping your work up and not let it pile up and have to do it all at the end of the day. When you finish a job, be sure that the tools, material, and equipment are put in their proper place. Do not leave them laying around until quitting time. Many of the tools of the electrical trade that belong to the journeyman (which he made let you use) or belong to the contractor , or to your employer, are quite expensive in the journeyman cancel on you to keep track of them. the loss of a few tools such as an electric drill soldering iron or pipe dies, can mean the difference between profit and loss on a small job. No journeymen is going to tolerate an apprentice working with or for him that he has to constantly remind labor allowed on the job that labor is used up trying track mislaid tool, material, and equipment instead of productive work, the margain of profit is going to be cut dow.

A journeyman wants an apprentice who will help him. Some of the key points to try to learn and anticipate are: what are You going to do next how are you going to do it? What tools and equipment will you need this particular job question my mentally using a job breakdown, you can anticipate the type of tools that are required for a particular job. For example the tools are considerably different then would be needed to install conduit in a slab, compared to a romex installation in a residence . This is also true of material.Getting out material be taken to the work he sure they are the proper materials used for the job to be done. After you have finished with certain tools and they will not be used again that day, take them back to the tool and or source of supply on your next trip back.

Every job has a trailer, a tool box ,or certain area in which tools and material and equipment are kept. Ordinarily, the workmen keep their tool boxes ,their lunch, and their hats and coats in the same area. There is nothing more disgusting than to walk into a trailer or a room to eat lunch and have to kick your way through empty boxes, cartons, newspapers, pieces of scraps of wire and pipe and other materials laying around on the floor. It is up to the apprentice to do this housekeeping. A good apprentice does not need to be told that this room, trailer,or work space should be kept in an orderly manner. If a person had untidy habit of living before becoming an apprentice, they will just have to be corrected if he wants to be a success as an apprentice. When using stocks and dies, oil has to be used, and as oil is cheaper than stocks and die, quite a bit of it is used. Naturally, it drips on the floor. When working in a new building on a clean floor, some provision must be made to catch the oil, otherwise, an oily spot will be found that is inpossible to remove. Would you like to have someone do a job in your home and set up a work bench in the livingroom or kitchen and let oil drip on the floor? To avoid spots on floors, provide a sandbox, or for a short job, a few pieces of paper or cardboard placed underneath the vise to catch the drippings. This will leave the customer in a much happier mood. It is these careless andnegligent pratices that get a lot of journeymen and apprentices in trouble with architects and builders. These small things cause them to lose a lot of time when they could be working.

An electrician with a clean personal habit, coupled with a job with a clean personality, is certainly a clean cut asset to the electrical industry.

HINTS FOR GOOD HOUSEKEEPING

1. Select clothing suitable for people to get the job done well. Wear comfortable fitting clothing.
2. Finger rings are very much a hazard to an electrician.
3. Wear sturdy serviceable shoes. Avoid worn or loose souls and run down heels.
4. Store all tools in a safe place and orderly manner.
5. The deck from rolling scaffolds.
6. Do not let paper , crates, packing material, or scrap cumulate in your work area.
7. Always be careful of storage and spillage of flammable liquids.
8. Stack materials so that the wait is equally distributed.
9. Do not stack material too high.
10. Do not leave nails protruding from packing crate or boxes.
11. Falling or tripping hazards.
12. Do not leave tools where they might fall on someone.
13. Do not leave tools or materials on a ladder, stairway, or passageway.
14. Do not leave loose conduit on the floor or in a passageway.
15. When cutting or spreading conduit, do not drop nipples or scraps on the floor; get a box or a suitable container for the scrap.
16. Use a sandbox or mat under vice or pipe threading equipment to catch oil dripping.
17. Do not leave ladders in stairways or passageways when not in use.
18. Win ladders are not in use, they should be laid down or lashed where they cannot fall or be blown down.
19. Return everything to its proper place.

There seems to be attendance safety is something not so important. You cannot skip a trip to the doctor for a broken bone, but you can prevent it Yourself or a fellow Workman and very possible, through the practice of Good Housekeeping. Do you feel this would be very important accomplished?

The old fashion way of construction was to allow so many deaths of construction worker per floor of a large building. Modern safety practice and safety laws have changed this period let's go modern and build a large building with no accidents. You can do your part to accomplish this my studying and putting into practical application the safety practice and suggestions given in this course.

QUESTIONS:

1. Three accident breeders are:
   a. _____
   b. _____
   c. _____
2. What are the 2 personalities involved in good housekeeping?
   a. _____
   b. _____
3. Walk into a customers place of business or a person's home as an electrician, who do you represent? _____
4. And neat job is a good indication of _____.
5. Altools should be stored in a _____ and orderly manner.
6. _____ the deck for rolling scaffolds.
7. Electrical material should be stacked so the weight is _____ distributed.
8. What are some of the key points in learning to anticipate what a journeyman is going to need? _____
9. What precautions should be taken to eliminate tripping hazards? _____
10. What should be done with the ladder when it is not in use? _____
11. Some of the things that can be done to make cutting and threading conduit a neater job? _____
12. Finger rings are a _____ to an electrician.

TRUE AND FALSE STATEMENTS:

13. An apprentice should only pick up and clean up when he is told to do so? _____
14. All tools should be left out until quitting time in case they might be used? _____
15. The tools of a contractor uses on a job represent sizable investment? _____
16. Good Housekeeping requires continuous attention? _____

ELECTRICAL ACCIDENTS

This has been an exceptionally bad period for electrical accidents. The one ported this time are less than half of those I have received and catalogued. There are many more still in their envelopes waiting to be filed.

Wonder how many more there would have been if it were not for the steady increase in the use of the GFI?

The requirements now in the code for the installation of the guy in the bathroom and then outdoor outlet is bound to cut the toll a great deal for the fortunate people who are moving to new homes. But this is only a fraction of the millions of bath which are not tell me never be brought up to date.

It is such a simple matter to switch a breaker over to a GFI breaker.

Hair dryers and flat irons are increasing very rapidly and the toll of shock is going right along with them. Stop that all by installing the GFI. Code requires GFI in new homes and new constructions and they have for years. GFI's need to be installed in older homes to be brought up to code and to prevent electric shocks in specified areas.

Water Cooler Kills Boy

Coarse Gold , California- June 1977. A 6 year old Sonora boy was electrocuted when he touched a metal water cooler stand at his Aunts home . Michelly Hathaway was standing in a puddle of water, the cooler had been recently installed on was improperly ground.

Unauthorized Pole Climber

Hanapepe Kauai, HI June 1977. In his mid twenties was electrocuted at 1:30 am when he climbed a utility pole and fell or jumped into high tension wires. He had appear despondent earlier,Police declined to identify him until his family have notified on the Mainland.

Light Switch in Hospital

Inglewood, Colorado - June 1977. Dennis Orban, 28 year old Sheriff's Office Caesar was guarding a suspect in Wedish Medical Center. He flipped on the light in the bathroom while pushing the metal handle on the toilet. A 220 - Volt shock knocked him out of the room, across the hall and into a wall. After treatment, he tried to start his car, but the battery was dead. Deputies had some difficulty getting him to admit to his occupation of Electrical Engineer.

Faulty Drill Still With Us

Cape corral, Florida 1977. David J. Burres, 19, was electrocuted while working in the yard of his home with an electric drill. He apparently touch the metal pole grounding the tool. A neighbor disconnected the cord when the young man shouted for help . He died one and a half hours later.

Natrues's Call Shocking

Nottingham, England - June 1977. A dog's visit to a lamp led to an explosion and put a 9 year old boy in the hospital. The dog urinated on an electrical wiring which had exposed by vandals at the base of the post, where seconds later, Michael Robbins leaned hisbicycle. The bike touched the wet wiring causing an explosion. The dogs not hurt.

Motor Starter

Alberta, Canada – February 1977. An Employee received burns to his face while assisting another employee in removing a 600 VAC 100 – amp motor starter. The other man was a journeyman.

Hurt Replacing Circuit Breaker

Alberta, Canada March 1977. And electrician his hands and face when he attempted to replace a 100 amp three- phase breaker in a 200 amp 120/208 volt panel board. The branch circuit conductor's in the panel shorted to ground when he disturb them.

Grabs Loose Wire As He Falls

Miami, Florida July 1977. Of Miami roofer, unidentified comment about the age of 20, was electrocuted when he fell from a beam and grab a loose wire – a conduit – to break his fall. He died shortly after when rescue attempt failed.

Two Boys Hurt

Summerville, in April 1977. Two boys were shocked and burned when one of them grab several live wires in a parking lot and the other try to rescue him. Ten year old Jeremiah Taylor got ahold of a conduit containing the wires that were in bad shape. He was knocked unconscious. His 16 year old companion was injured when he try to help. He was also in unconscious and in critical condition. The pipe was alongside an old factory.

Electrical Scalpel

Turin, Italy – May 1977. Maria Lisi, 15 , died following an operating room blast that occurred while she was underging minor surgery for warts on her feet. The doctors said an electrical scalpel apparently ignited anesthetic fumes.

Boys in a Tree

Florissant, MO – May 1977. A St. Louis County boy was Electrocuted and a companion was critically injured when they contacted power lines while climbing a tree. The boys were both 7 years of age. Their names were not released.

Eight -year- old Burned

Winn, ME 1977. An eight-year-old boy, Steven Mallory, is recovering from burn Massachusetts General Hospital burn unit. He was playing in a pine tree by the side of the road with him companion, Steven Brown, also eight, when he contacted a 7200 -volt power line. His friend called the mother and she tried to revive him. Eventually I came to and was taken to the hospital.

Well Digger Electrocuted

Hayward, CA – July 1977. Maximiliano Aragon,46, Was electrocuted while digging a well in his backyard. A 30 foot section of pipe he was removing from the well hit an overhead power line. Two companions were jolted away by the shock they received. One of them received severe burn.

TABULATION OF ELECTRICAL FIRES AND ACCIDENTS

		Number of Electrical Accidents		
EQUIPENT INVOLVED		SHOCK	FATAL	FIRES
A	**Air Conditioners**			
1	Window or Through- Wall Types	1		107
2	Central Air Systems Types		1	107
B	**Appliances- Com'l..IND'L**			
1	Business Machines	1	1	22
2	Food Preparation (toaster,mixers,ect.)			89
3	Heating (comfort or Space)		2	102
4	Medical			2
5	Refrigertion, freezers	5		50
6	Tools, Hand	18	1	7
7	Vending Machines	1		20
8	Others,specifty			45
9	Others, specity			11
C	**APPLIANCES – RESIDETIAL**			
1	Clothes Dryers	2		359
2	Clothes Washers	1		165
3	Electric Blankets		1	45
4	Food Preparation (toasters,mixers,etc)			121
5	Hand Tools	4		11
6	Heating (comfort or space)			418
7	Irons	3		68
8	Ranges and Oven	18	2	678
9	Refrigerators and Freezers	1		100
10	Radios (tape recorders, etc.)	1		51
11	Television Sets	3	2	66
	a. black and white	3		94
	b. color	1		176
12	Other – specifty	6		193
D	**CABLES**			
1	Armored			13
2	Non-metallic Sheathed	8		56
3	Service – Entrance			76
4	Other – specify	11		191
E	**CORDS**			
1	On appliances	3		121
2	Circuit extensions	5		163
3	On Portable lamps	2		77
4	Others – specify		2	36
F	**DISTRIBUTION PANELS**			
1	Fuse			145
2	Circuit Breaker	1		114

	EQUIPENT INVOLVED	SHOCK	FATAL	FIRES
G	**FIXTURES – LIGHTING**			
1	Fluorescent (ballast)			768
2	Incandescent - Close to ceiling	1		92
3	Incandescent - Drop cord			31
4	Incandescent - Chain hung (swag)			8
5	Others – specify			18
H	**LAMPS** (bulbs)			
1	Lighting		3	59
2	Heating			46
3	Others – specify			16
I	**LIGHTING**	2		135
J	**MOTORS** (not integral with appliance)			50
1	Fractional			556
2	1 H.P. and over			115
3	Elevator			49
K	**RECEPTACLES**		1	87
L	**SIGNS**			6
1	Cord connected	1		48
2	Fixed wired	1		74
M	**SWITCHES**			
1	Main	1		65
2	Wall type			122
3	Industrial control			21
4	Others – specify			
N	**TERMINATIONS AND SPLICES**			
1	Copper wire			64
2	Aluminum wire			42
3	Copper to aluminum			18
4	Others – specify	2		20
O	**TRANSFORMERS**			
1	Control types			57
2	Distribution type			97
3	Others – specify			29
P	**WIRES**			36
1	In metal raceways	1		36
2	In non-metallic raceways			59
3	Overhead- consumer			59
4	Overhead – Utility	4	6	367
5	Christmas – decorative			33
6	Other – specify	6		233
Q	**POOLS** (swimming- wading-decorative)			
1	Lighting (lights)			2
2	Equipment	1		4
3	Others – specify			
R	**MISCELLANEOUS EQUIPMENT** (Specify)			26
S	**REPORTED ELECTRICAL ORIGIN** (No other details)			50

1. What is a GFI? Explain:_____
2. How many fatal accidents were there with hand tools?_____
3. How many fires were caused by motors of 1HP or over?_____
4. How many people were shocked by extension cords?_____
5. How many people from Utah were electrocuted?_____

CORRECTING POWER FACTORS WITH CAPACITORS

The true nature of reactive power and how it is affected by capacitors is a subject of increasing interest to engineers, contractors, and maintenance personnel.

Transmission losses caused by reactive current flow to serve low power factor loads normally cannot be billed by the utility company to any particular customer. Therefore, many power companies charge a penalty for "excessive" reactive power demand within their customers facilities. This encourages the customers to take corrective action to raise the factor and thus reduce reactive power drawn by their loads. Usually this in-plant correction is accomplished by adding capacitors to the electrical system, either distributed among the various loads or load centers, or centralized in one or more locations. (See the review of power-factors basics on the following pages.)

DISTRIBUTED CAPACITORS

When capacitors are distributed, an individual capacitor normally takes care of an individual piece of equipment - usually a motor. In most cases the capacitors are connected to the load terminals of the motor control or mounted directly at the motor location and tide in at the motor conjunction. Maximum effect against cable losses and other distribution losses can be achieved by such an installation. The drawback, however, is not care must be taken when selecting starting equipment for the motors, because the capacitors will be switched on and off with the motor. This can lead to problems with the motor contactor.

At the instant that the contactor contacts close, the capacitor acts almost like a short circuit. Current inrush is of short duration but is of very high magnitude, possibly up to several thousand amperes if not limited by some external impendences. Because this additional impendence in most cases is an inductive component (such as a coil), a decaying oscillation results, with frequencies typically around 2 kHz.

NEMA standard ICS 2 - 210 deals with contactors used to switch capacitors. It gives the maximum capacitor size of contactor at the most common voltages. The latest addition (Revision 1 to ICS 2 - 210 - 1978 dated April 30th, 1979) has added a new factor that must be taken into account when selecting the contactor size. The concept is of available current ("perspective short- circuit current") at the location essentially at the terminals of the capacitor. Available current depends mainly on the transformer size and its distance from the units in question.

According to the revision, a size 3 contactor for non-motor loads can switch 970 A and handle a maximum of 53 kvar of 3- phase capacitors at 480v when the equipment is far from the transformer. When the available current exceeds 5000 A, a derating factor must be applied. At 22,000 A the contactor is limited to handling only 15 kvar.

In addition to these limitations, the NEMA publication warns about the effect of other capacitors already on the line. They increase the available transient current. If located nearby, special precautions must be taken.

NEMA ICS 2 - 210 also list the cases when capacitors should not be hooked directly motor controller terminals. Separate contractor must be used under any of the following conditions: high inertia loads; open circuit, transition, reduced-voltage starting, wye-delta starting; reversing or frequently jogged motors; multispeed motors. These limitations are further reinforced by NEC sec. 460 - 7 (b), which prohibits connecting capacitors to the load side of the motor controller where the motor is "subject to unusual switching service such as plugging rapid reversals, reclosing, or other similar operations which could generate over – voltages and over-torques".

The 1981 NEC contains an additional rule for connecting capacitors in motor circuits:

460 – 7 POWER FACTOR CORRECTION – MOTOR CIRCUIT.

(a) Total Kilovar Rating of Capacitors that are connected on the load side of a motor controller shall not exceed the value required to raise the no- load power factor of the motor branch circuit to unity.

EXCEPTION: When Motor ratings do not exceed 600 volts, nominal, and 50 horsepower, capacitors not exceeding 50% of the kVA rating of the motor input shall be permitted to be connected on the load side of the motor controller.

CENTRALIZED CAPACITORS

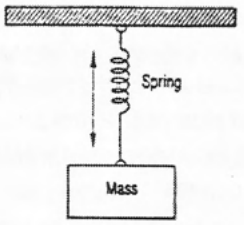
Using the centralized approach, the capacitors or banks of capacitors are sized to correct the entire power factor of the facility or of significant blocks of load within a plant. The latter type often is in the form of a "lumped" capacitor that is sized to correct the power factor of the motor load connected to the lineside main buses is of the MCC and protected by a circuit breaker or fuse disconnected switch.

The disadvantage of the "lumped" of totally centralized capacitor installation is that there is a possibility of over- correction as load varies. In addition to being needless, such over-correction may actually be harmful. Excessive capacitive load tends to increase line voltage beyond desirable limits and cause damage to the connected load. This risk of damage is one of the prime reasons why recommended capacitor sizes are based upon less than 100% compensation and result in a final power factor that is less than unity.

POWER FACTORS BASICS

UNDERSTANDING REACTIVE POWER

Start with a mechanical analogy: Consider a mass hanging on a spring. If the mass is set to osculating up and down, the total energy represented in the system remains constant, but component energies (potential energy and spring tension) are constantly changing, depending on the position of the mass in the spring extension. Mass is at its lowest position; its potential energy is at a minimum and the spring tension is added maximum. The opposite is true when the mass is imparted to start the osculation, the osculation will continue for a long time without additional energy input friction eventually brings the system to a standstill.



This is analogous to an electrical circuit containing both inductance and capacitance. When the momentary energy in the capacitance is at its maximum, the energy in the inductor is at a minimum, and visa versa. Once a capacitor/inductor circuit has been charged, there will be a continuous exchange of energy between these components -- and oscillation. This energy transfer would be go on forever if there were no resistance in the circuit. The resistance corresponds to the friction in the mechanical system and gradually consumes the swinging energy, transforming it into heat. Heat is directly related to real power, while the freely interchange power of the spring and mass represents the reactive power.

UTILITY BILLING PRACTICES

In power systems, the prime purpose is to transfer energy from the power generator to a consumer at a rate suitable both part. Normally equipment so requires active power up the inductive type, largely to satisfy motor loads.

The utility could supply this reactive power either by over – excitation of its generators or through the use of capacitor banks. However, this would require actual transfer of energy between the capacitive generating system and the inductive load in the form of current (amperes) over the utility lines. This is very uneconomical; the extra nonproductive current causes the I_2 R losses in the distribution system to be higher than it needs to be for the load served.

WHAT IS POWER FACTOR?

Definition of terms:

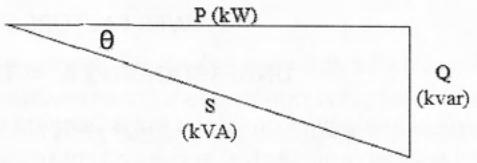
P- Real Power (kW)

Q- Reactive Power (kvar)

S- Apparent Power (kVA)

θ - Power- factor angle (degrees)

PF- Power Factor – Ø



From the trigonometric definition, $\cos\theta$= the side adjacent to the angle θ ÷ the hypotenuse; therefore, PF = $\cos\theta$ = P/S.

The power factor, then, is simply an indication of the amount of power (S) that must be generated to suppl a load made up of real (P) and reactive (Q) components.

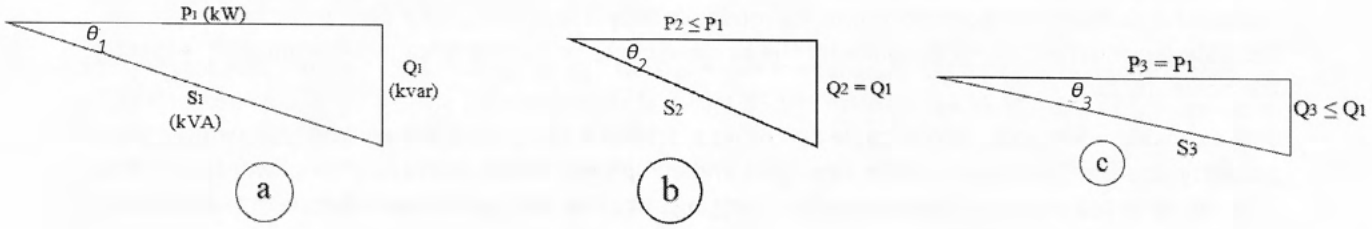
EFFECT OF Q, P AND S ON POWER FACTOR

Consider figure 4(a), 4(b), 4(c), in which one of these three elements is varied. Initial conditions are as shown in drawing (a).

In drawing (b), the reactive component has been kept constant ($Q_2 = \geq Q_1$), but the real power has been reduced ($P_2 \leq P_1$) –say by reducing the number or resistance heaters being used on the system. The power- factor angle is now greater than before ($\theta_1 \geq \theta_2$). This means that the power factor is lower, since the cosine of an angle decreases as the angle increases. Thus, the apparent power has decreased ($S_2 \leq S_1$), but the power factor has worsened.

In drawing (c), the real power had been restored to its original value ($P_3 = P_1$), and the reactive power has been decreased ($Q_3 \leq Q_1$). (In actual installation, this could be accomplished by switching on a bank of capacitors.) In this case, even though the apparent power has decreased ($S_3 \leq S_1$), the power factor has improved ($\cos\theta_3 \geq \cos\theta_1$).

The fact that changes in either the real power (P) or the reactive power (Q) can reduce the apparent power (S) shows that the power factor alone (P/S) does not by itself characterize the magnitude of the demand that may be subject to utility – imposed penalties.



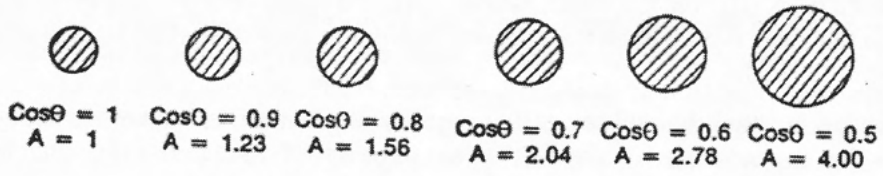
EFFECT OF POWER FACTOR ON EQUIPMENT SIZE[θ]

Most utility demand changes are directly related the apparent-power demand of the customer's load and with good reason. At a given voltage level, the current is proportional to apparent power (S); and apparent power is actually real power (P) increased inverse proportional to the power factor of the load. A utility must, therefore, purchase and install oversized distribution equipment to satisfy low-power-factor loads of its customers. This cost is passed on via penalty charges on electricity bills.

As an example of how power factor affects equipment size, consider the cable needed to feed a load at various power factors, assuming that voltage and real power are kept constant.

For a unit length of cable with cross-sectional area A there is a definite total resistance R associated with it. If current passes through the conductor, a heating effect $P = I^2R$ takes place. The heat must be dissipated through the conductive cross-sectional area of the conductor and then through the insulation to the surrounding ambient.

As current increases, the maximum safe heat dissipation capacity of the cable/ insulation system is eventually reached. Beyond this point, it is necessary to start reducing the resistance R as I is increased to keep the product I^2R constant. For example, if the current doubles, then the value of I^2 is quadrupled, and R must be reduced to a quarter of its original value. Because the resistance of wire is inversely proportional to its cross-sectional area, doubling current would require quadrupling the area of the cable to maintain a constant temperature. In general, then, the required cross-sectional area of a cable for a constant real power output is proportional to the current squared: $A=I^2$. Manipulating this relationship to calculate the relative conductor area needed for different power factors gives the following results:



Since cable weight and price as well as installation cost, are roughly proportional to the conductor cross-sectional area, there are good economic reasons for utility billing charges for poor power factor. Equivalent evaluations could be made for the size and cost of other electrical equipment with respect the power factor.

These consideration apply also to cable and other electrical a equipment installed on the customers property. Loads often outgrew cable capacities and equipment rating. Increasing the power factor of the load can very well remove the necessity for changing out cable and equipment – bonus to the customer beyond the savings in utility charges.

CALCULATING PF CORRECTION

Calculation of the amount of capacitance needed to improve power factor requires reference again to the basic power diagram and development of some additional trigonometric relationships.

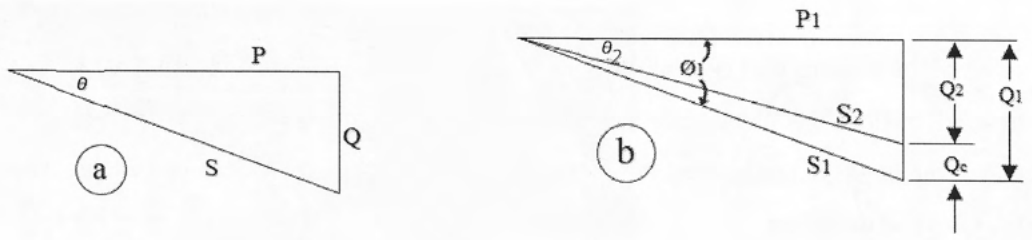
From drawing (a), $\sin\theta = Q/S$ and $\tan = Q/P$. Since $\tan\theta = Q/P$, $Q = P \tan\theta$.

In drawing (b), therefore, $Q_1 = P \tan\theta_1$ and $Q_2 = P \tan\theta_2$.

Also (see drawing (b)), $Q_{3c} = Q_1 - Q_2$. Therefore, $Q_c = P \tan\theta - P \tan\theta_2$, or $Q_c = P (\tan\theta_1 - \tan\theta_2)$.

Q_c thus represents the capacitive reactance in kvar that must be added to reduce the inductive reactance from Q_1 to Q_2 and increase the power facto from $\cos\theta_1$ to $\cos\theta_2$.

Tables showing capacitor sizes required to change the power factor from one value to another (normally furnished by capacitor manufactures) are based upon solution to the above equation for Q_c. An example of the use of this equation follows.



Assumption: A manufacturing company has a real power demand of P = 632 kW and an apparent power demand of S1 = 789 kVA.

Problem 1: If the utility penalizes for power factors less than 0.85, what size capacitors would eliminate the penalty? _____

Solution 1: The present power factor P/S is equal to 632/780 = 0.81, which id lower than 0.85 and means that penalties are being charged.

The present reactive load Q_1 is P tanθ_1 or 632 tanθ_1. From trig tables it can be determined that the angle θ whose cosine is 0.81 (the present power factor) is 35.9°. Tanθ_1 = tan 35.9° = - 0.724. Since Q_1 = P tanθ_1, Q_1 = 632 x 0.724 = 458 kvar.

Full power – factor correction – from 0.81 to 1.0 – would be achieved in this case if the full 458 kvar were installed (i.e., 1.0 =0). But this is not necessary since a penalty is assessed only if the power factor is lower than 0.85. To adjust the power – factor correction to 0.85 instead of 1.0 (reactive power = Q_2 instead of Q_1 in drawing (a)), cosθ_2 = 0.85 and θ_2 = 31.8°. Then, using the equation for Q_{c1}.

$$Q_c = P (\tan\theta_1 - \tan\theta_2)$$
$$= 632 (0.724 - 0.820)$$
$$= 65.7 \text{ kvar}$$

Problem 2: What size capacitors would be needed to keep the power factor at 0.85 if 45Kw of lighting having a power factor of 0.62 were added? _____

Solution 2: Additional kilovars (Q3) must be added to bring the power factor of the new load (0.62 up to the desired 0.85). The angle whose cosine is 0.62 is 51.7°, and the tangent of 51.7° is 1.266. Therefore...

$$Q_3 = 45 (\tan 51.7 - \tan 31.8°)$$
$$= 45 (1.266 - 0.62)$$
$$= 29 \text{ kva}$$

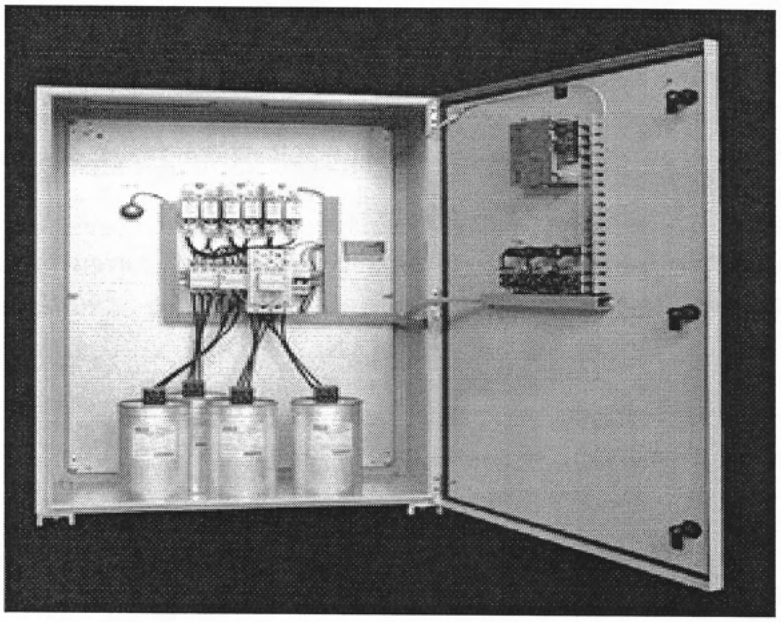
POWER – FACTOR CONTROLS

One of the reasons that centralized capacitor installations are being increasingly recommended is that new, sophisticated controls have been introduced that allow switching capacitance on and off to better match the needs of the system. Power factors close to unity can be achieved while avoiding the possibility of over- correction.

There are several approaches to power-factor control that are valid. Time controllers have been applied where the load is reasonably consistent during working hours and is at another lower level during night time or weekends, etc. This approach suffers when unpredictable variations occur; but where loose penalties limits - such as a power factor of 0.85 - are applicable, this type of control can be used.

Coarse, low resolution compensation can be accomplished by measuring the net reactive power at the income feeder. Here a device similar to the KW our meter is used. The rotating disk is spring loaded to a present position in either direction. Output of the switches are used to control the addition or subtraction of capacitance via a relay or solid-state logic circuit. Inherent in such a system Is time delay caused why the need for the disk to rotate as well as deliberately build in delay to allow for rotation back to the center reference in to eliminate excessive hunting.

Sampled - current controllers are based on the idea of measuring the polarity and magnitude of current at each zero crossing of the respective line voltage (see figure 1). This system is easy to implement with modern electronics. Decisions on whether to switch capacitors on or off are based upon the phase shift and that amplitude of the voltage. The main shortcoming of this system is when using it to monitor a system containing significant amounts of SCR equipment as DC drives. The sample - at - zero voltage method may show a zero result in spite of obvious phase shift. This because SCR loads introduce a phase shift that depends on the control angle of SCR firing (see figure 1 (d).



CENTRALIZED CAPACITOR: Installations, as opposed to distributed capacitors, now have the advantage of better matching the needs of the electrical system of a plant. Sophisticated controls are available that, when packaged with the capacitors, can correct power factor to close to unity without the danger of over-correction.

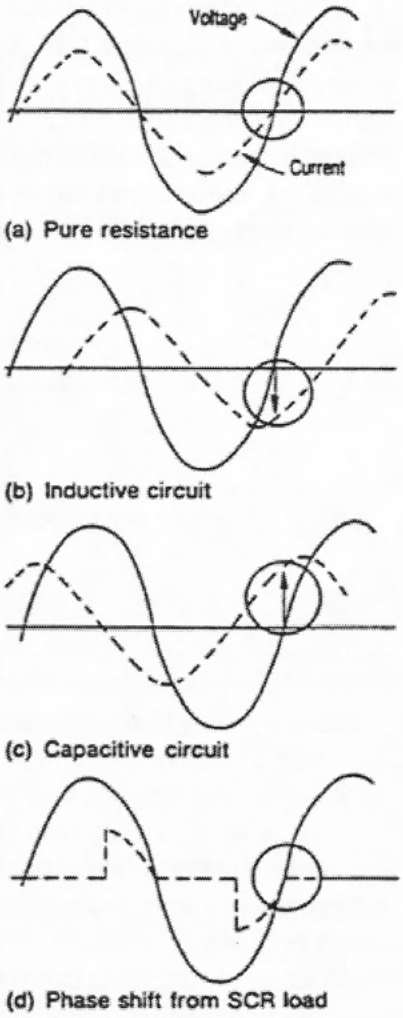


Figure 1

Another method of measuring power factor is by the use of electronic reactive power controllers. As when measuring power with an ordinary watt-meter, the all-important thing is to have correct phase relationships. This is best accomplished by shifting the vault 90°. By electronic relative to the voltage and current magnitudes and the phase shift between them is obtained. This kind of sensor is very tolerant to wave - shape distortion and therefore well suited to modern SCR load.

Fast static compensators are the ultimate in speed of compensation. Where the load variations are large and fast - such as a welding equipment or induction furnaces - this method is recommended. Basically, these compensators are capacitor banks with SCR switch (figure 2). Commonly, the capacitor bank is sized for over- compensation, and the amount of inductive load of a reactor coil is Controlled by anti - parallel SCR's. This solution is complicated however, due to the need to limit inrush current. Either differential - zero - voltage switching or current - limiting chokes must be used, and harmonic filters often are required.

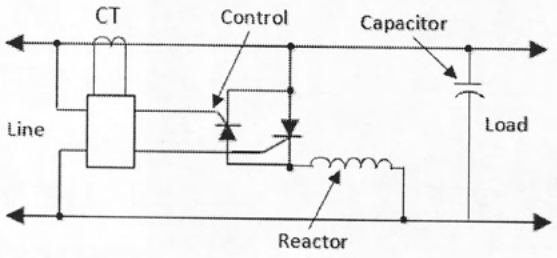


Figure 2

CURRENT AND VOLTAGE COMPONENTS

Although it's fairly common speak of load current, lagging current and leading current, as though they were separate entity, it must be borne in mind that in a generator or feeder circuit only one current can flow, as it must be common to all elements which are in series and the voltage components can then be shown vectors. In parallel circuits the voltage is common to all elements and it is then usually convenient to show current by means of component vectors.

RECTANGULAR REPRENTATION

Power in AC circuits is the product of force (volts) And rate of motion (amperes). In most cases correction factor (power factor) is also necessary.

Although vector representation and analysis on in-phase and quadrature component and accordingly is used in power factor correction problem it is probable the rectangular or sine waves representation provides a better graphic picture of relationship of volts, amperes and watts.

Assume that the voltage wave can be represented by E sin θ and current 1 sine ($\theta - \emptyset$) where $\emptyset$ is phase angle difference. The product of two such sine waves, or the watts, can be represented by the formula:

FORMULA 8:

$W = E1 (\sin 2\theta \text{ cosine } \emptyset - \sin 1/2 \sin 2\theta \sin \emptyset)$

Where
W= watts
E = effective volts
I = effective amperes
θ = angular representation of volts along abscissa
$\emptyset$ = angle of lag of current

Figure 17 represents representation in rectangular coordinate of such a case where E = 3; 1=2 and $\emptyset = 0$.

The power W is represented by the cross hatched area. Figure 18 represents volts, amperes and vote, amperes and watts where the same value apply, except that $\emptyset = 30°$. In the region from 0° to 30°, and 180° to 210°, there is an area representing negative power (shown by area cross-hatched in dark). This negative power and an equivalent amount of positive power cancel out and do not represent net flow of power to load. It is commonly considered as a pulsating power which establishes a magnetic field in the load device during on quarter cycle as the current builds up; this being returned to the power source the next quarter cycle as the current falls to zero. This pulsating power represents a power loss in that the 1^2R losses in conductors and transformers are increased, and to the extent that excitation requirements of generators are increased.

Figure 19,20, 21, represent value with angle of lag ($\emptyset$) value of 45°, 60° and 90° respectively. In the latter case, it will be noted that the positive and negative power area are equal and there is no actual net flow of power to the load.

It will be noted that the double frequency curve representing power (w) is identical in all the above cases, varying only in position, and thus in net value.

As was stated previously and as shown in Table 1, AC power is the product of volts, amperes and power factor.

The formula commonly used to express this is:

FORMULA 9: $W = E1 \text{ COSINE } \emptyset$

However, according to Formula 8, $\emptyset = E1 (\sin 2\ 0 \text{ cosine } \emptyset - ½ \sin 20 \sin \emptyset)$.

Figure 22 illustrates power curves plotted from Formula 8 and 9, with E= 3; 1 = 2: and Ø = 45 and shows that they are equal.

In formula 9, the product of voltage and current is obtained by multiplying their instantaneous product by the power factor (cosine Ø = 0.707). The result is the dashed curve in figure 21.

In formula 8, the instantaneous values are multiplied together and when one element is positive while the other is negative, an area representing negative power is present.

Inspection of Figure 22 will show that the net power represented by the two formulas and the two curves is identical. The area A is common to both curves and B is obviously equal to C; the

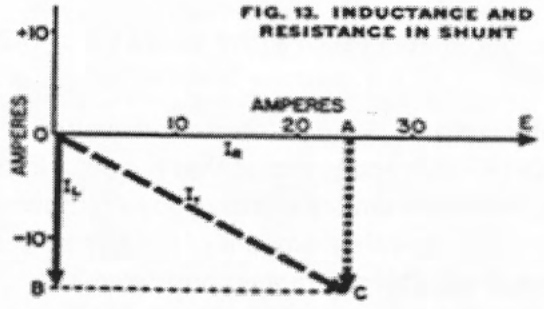


FIG. 13. INDUCTANCE AND RESISTANCE IN SHUNT

FIG. 14. CURRENT VECTOR RELATIONSHIPS

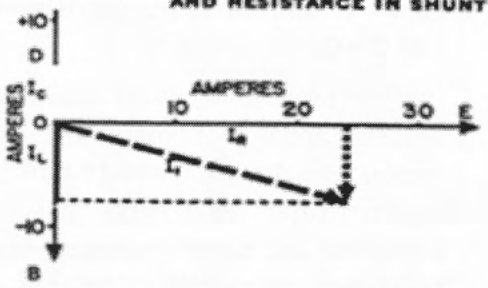


FIG. 15. CAPACITANCE, INDUCTANCE AND RESISTANCE IN SHUNT

FIG. 16. CURRENT VECTOR RELATIONSHIPS

SINE WAVE REPRESENTATION OF VOLTS, CURRENT AND WATTS AT VARIOUS PHASE RELATIONSHIPS BETWEEN VOLTS AND AMPERES

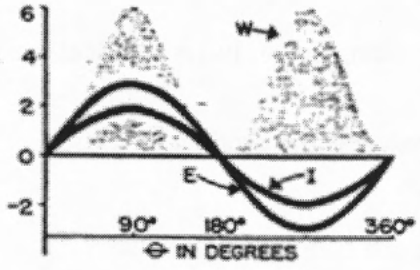


FIG. 17. Ø = 0°

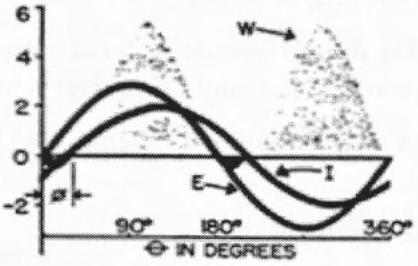


FIG. 18. Ø = 30°

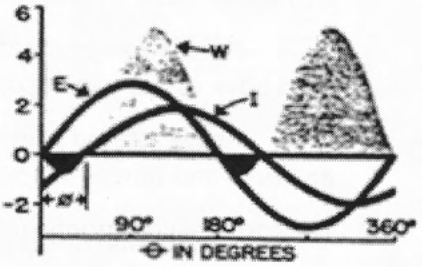


FIG. 19. Ø = 45°

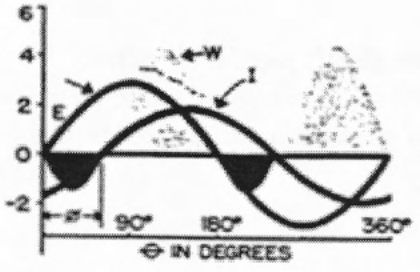


FIG. 20. Ø = 60°

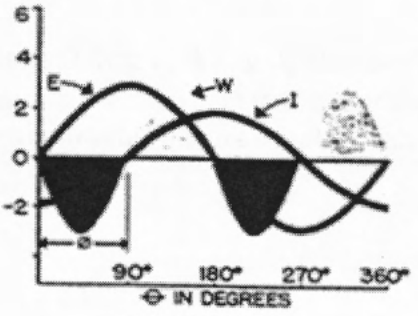


FIG. 21. Ø = 90°

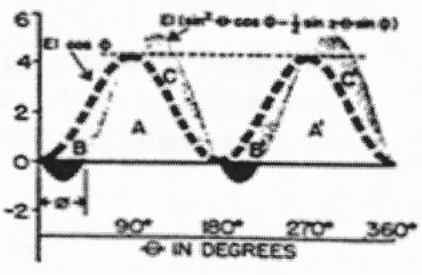


FIG. 22. Ø = 45°

negative area represented in Formula 8 cancelling out an equal positive area above the dotted line.

SAFETY TIPS

HOW COLD IS IT?

Many times, we are required to work in areas that are extremely cold. Because we are naturally warm – blooded, we must see that our body heat is maintained. If it is, through proper protective measures, we can work in rather frigid temperatures. The importance of being properly protected, and taking proper precautions cannot be overemphasized, however, as failure to do so can lead to hypothermia.

Hypothermia results when the body loses heat faster than it can produce it. When this situation first occurs, blood vessels constrict in an attempt to conserve vital internal heat. Hands and feet are first affected. If the body continues to lose heat, involuntary shivers begin. This is the body's way of attempting to produce more heat, and it is usually the first real warning sign of hypothermia. Further, heat loss produces speech difficulty, forgetfulness, loss of manual dexterity, collapse and finally death.

The temperature of the hands and feet can drop as much as 40 50 degrees F (23 to 28 C) below normal body temperature without last harm.

The bodies sense of cold is a relative factor. The how mother me read more than 40 F (4.4 C) and the possibility of hypothermia might seem remote, but many cases of exposure have occurred in temperatures well above freezing. How cold the body gets depends on many factors, not just air temperature. Moisture on skin and clothes can conduct heat away from the body faster than the skin is dry.

WIND-CHILL INDEX

Hair loss from convection is probably the greatest and most deceptive factor in loss of body heat. When the air is still in the temperature is 30 F(minus one C) , the body will feel cool. Given the same temperature and a wind of 25 miles an hour (40 kilometers per hour), it will feel bitterly cold. In essence, the wind blows away the thin layer of air that acts as an insulator between the skin in the outside temperature.

Efforts have been made to develop indices for evaluating cold environments. The wind-chill factor is the cooling effect of any combination of temperature and wind velocity, or wind movement. The wind-chill index should be consulted by everyone facing exposure too low temperatures and wind.

The wind chill index does not take into account the part of the body that is expose to cold, the level of activity with its effect on body heat production, and the amount of clothing being worn. It is important to keep the head, neck, and hands covered in order to keep warm in a cold environment.

The skin is the natural barrier of the body for heat and cold; hence, it's properties are very important, and the skin temperature is an important factor in body thermal control.

CONTROL MEASURES

The dead air space tween the warm body and clothing in the outside air is essential. Usually, no one type of clothing is best for all weather conditions. Denim is relatively loose woven, which not only allows water to penetrate but permits wind to blow away body heat that should remain trapped between the body and clothing. Duck or goose down is good for stopping wind but is of little use when wet. Clear plastic or closely woven nylon is good protection from wind and rain but offers very little insulation against cold.

Many layers of relatively light clothing, with an outer shell of wind proof material, maintain body temperature much better than a single heavy outer garment worn over ordinary indoor clothing. The more air cells each of this layer has, the more affective it insulates against body heat loss.

Make sure the clothing allows some venting of perspiration. Because wet skin will freeze more rapidly than dry skin, use all feasible means to keep as dry as possible. Make full use of windbreakers and avoid exposing skin to direct effects of the wind.

If exposed skin begins to sting or tingle, rub the area to stimulate the circulation. However, if the exposed area is numb, do not rub it. Especially, do not use snow; this will only make the injury more serious. Warm the affected parts in warm water 102 to 105 F (39 to 41 C) or other suitable means.

Thermal type respirators are available for those bothered by breathing very cold air. At temperatures much lower than -49 F (minus 45 C), lung issues may start freezing unless the air is warmed before breathing. Because metal will conduct heat way from the body quite rapidly, be very careful that skin does not come in contact with metal objects. If possible, use tools with non-metallic handles.

When stranded during a storm in a vehicle, it is better to stay with the vehicle. The engine can furnish heat, while the vehicle itself can act as a shelter from outside elements. Care should be taken however, to prevent a buildup of carbon monoxide gas in the closed vehicle. For additional warm, insulation can be taken from a vehicle seat and stuff in clothing. If travel is in areas where storms are frequent, emergency supplies should be carried to meet any weather condition.

Cooling power of wind expressed as an equivalent chill temperature (under calm conditions)												
ESTIMATED WIND SPEED (IN MPH)	**ACTUAL THERMOMETER READING (F)**											
	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
	EQUIVALENT TEMPERATURES (F)											
Calm	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
5	48	37	27	16	6	-5	-15	-26	-36	-47	-57	-68
10	40	28	16	4	-9	-24	-33	-46	-58	-70	-83	-95
15	36	22	9	-5	-18	-32	-45	-58	-72	-85	-99	-112
20	32	18	4	-10	-25	-39	-53	-67	-82	-96	-110	-124
25	30	16	0	-15	-29	-44	-59	-74	-88	-104	-118	-133
30	28	13	-2	-18	-33	-48	-63	-79	-94	-109	-125	-140
35	27	11	-4	-21	-35	-51	-67	-82	-98	-113	-129	-145
40	26	10	-6	-21	-37	-53	-69	-85	-100	-116	-132	-148
Winds greater than 40 MPH have little additional effect.	LITTLE DANGER (for properly clothed person) Maximum danger of false sense of security.				INCREASING DANGER Danger from freezing of exposed flesh.			GREAT DANGER				
	Trench foot and immersion foot may occur at any point on this chart.											

WIND CHILL INDEX CHART

To use the chart, find the estimated or actual wind speed in the left-hand column and the actual temperature is found where these two intersect. For example, with a wind speed of 10mph and a temperature of -10° F, the equivalent temperature is -31 ° F. This lies within the zone of increasing danger of frostbite, and protective measures should be taken.

1. Define Hypothermia_____
2. What does it mean when a person begins to shiver? Explain:
   _____
3. How cold can the hands and feet yet without lasting harm? _____
4. Heat loss from_____ is probably the greatest and most deceptive factor in loss of body heat.
5. It is important to keep what part of the body covered in order to warm in a cold environment? _____
6. Is denim of good material for the cold weather? Explain:
   _____
7. What is the best type of clothing to wear? Explain:
   _____
8. What affect does perspiration have on body temperature? Explain: _____
   _____
9. When is it OK to rub the skin?
   _____
10. When stranded during a storm in vehicle you should do what? Explain: _____
    _____
11. What is the equivalent temperature of 30° with a wind of 30 mph? _____
12. What are some temperatures that expose flesh could freeze? _____

RULES FOR 3 PHASE MOTOR AND TRANSFORMERS

STAR CONNECTION

Line Voltage – Phase Voltage X $\sqrt{3}$

Phase Voltage = Line Voltage ÷ $\sqrt{3}$

Line Current = Phase Current

Total Circuit Current = Line Current X $\sqrt{3}$

DELTA CONNECTION

Line Current = Phase Current X $\sqrt{3}$

Phase Current = Line Current ÷ $\sqrt{3}$

Line Voltage = Phase Voltage

Total Circuit Current = Line Current X $\sqrt{3}$

1. Draw a Single 120/240-volt pole transformer below:

2. Draw all the following transformation connections:
   (WYE-WYE, WYE-DELTA, DELTA-WYE, DELTA-DELTA)

DYNA MOTOR

SELECT THE RIGHT SIZE AND TYPE FOR THE JOB YOU WANT DONE

Nos. 16 or 18 extension cords are usually fine for lamps or smaller appliances. Cords for heavy motors and high-wattage appliances must be heavy enough to carry a much larger load. Overload cords overheat (can be dangerous!), waste current, often fail to deliver enough power to run motors at top efficiency.

Types and usage of extension cords.

Ordinary Lamp Cord	Type POSJ SPT	Wire Size No. 16 or 18	Use In residences for lamps or small appliances.
Heavy-duty --with thicker covering	S, SJ or SJT	No. 10, 12, 14 or 16	In shops, and outdoors for larger motors, lawn mowers, outdoor lighting, etc.

Ability of cord to carry current (2 or 3-wire cord)

Wire Size	Type	Normal Load	Capacity Load
No. 18	S, SJ, SJT or POSJ	5.0 Amp. (600W)	7 Amp. (840W)
No. 16	S, SJ, SJT or POSJ	8.3 Amp (1000W)	10 Amp. (1200W)
No. 14	S	12.5 Amp (1500W)	15 Amp. (1800W)
No. 12	S	16.6 Amp (1900W)	20 Amp. (2400W)

Selecting the length of cord set

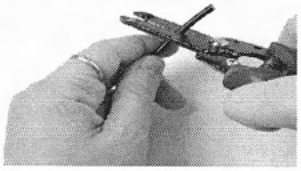
Light Load (to 7 amps)	Medium Load (7-10 amps)	Heavy Load (10-15 Amps)
To 25 Ft - Use No. 18	To 25 Ft. - Use No. 16	To 25 Ft. - Use No. 14
To 50 Ft - Use No. 16	To 50 Ft. - Use No. 14	To 50 Ft. - Use No. 12
To 100 Ft - Use No. 14	To 100 Ft. - Use No. 12	To 100 Ft. - Use No. 10

The Meaning of "Voltage Drop"

Every size wire has a maximum allowable current carrying capacity (see above). But—the longer the length of extension cord used, the greater the current loss of "voltage drop". Long runs of cord waste current, reduced efficiency of the appliance in use.

Moral: it is always a good idea to plan a wiring system with plenty of convenient outlets. This will provide for easy plug-in of all appliances.

What to do about damaged cords and how to repair them.



You've undoubtedly met Jerkers. Yanking a cord out of a wall plug by force, rather than grasping the plug itself, can loosen connections or even break the wires. Rough handling is probably the greatest single cause of extension cord mortality.

Damaged cords are a fire hazard. Repair or replace them immediately to prevent short circuits and blown fuses. If cord is frayed, throw it away.

Exception: If frayed or damaged only at on end, it may repairable (see the picture). Sometimes a cord that looks good won't work... perhaps a broken wire, or the prongs may be bent, or wires may have become disconnected from the terminal screws. Whenever a cord is damaged or broken close to either end, just cut wires and outer cover as shown. Disconnect plug from damaged piece of cord and connect terminal to the long piece.

Round attachment plugs usually provide enough space to allow use of Underwriter's knot to help secure wires.

Circuit Wire Sizes for Individual Single- Phase Motors

Horsepower of Motor	Volts	Approximate Starting Full Load Current Amperes	Approximate Full Load Current Amperes	LENGTH OF RUN IN FEET from Main Switch to Motor								
				Feet	25	50	75	100	150	200	300	400
1/4	120	20	5	Wire size	14	14	14	12	10	10	8	6
1/3	120	23	5.5	Wire size	14	14	14	12	10	8	6	6
1/2	120	22	7	Wire size	14	14	12	12	10	8	6	6
3/4	120	28	9.5	Wire size	14	12	12	10	8	6	4	4
1/4	240	10	2.5	Wire size	14	14	14	14	14	14	12	12
1/3	240	10	3	Wire size	14	14	14	14	14	14	12	10
1/2	240	11	3.5	Wire size	14	14	14	14	14	12	12	10
3/4	240	14	4.7	Wire size	14	14	14	14	14	12	10	10
1	240	16	5.5	Wire size	14	14	14	14	14	12	10	10
1 1/2	240	22	7.6	Wire size	14	14	14	14	12	10	8	8
2	240	30	10	Wire size	14	14	14	12	10	10	8	6
3	240	42	14	Wire size	14	12	12	12	10	8	6	6
5	240	69	23	Wire size	10	10	10	8	8	6	4	4
7 1/2	240	100	34	Wire size	8	8	8	8	6	4	2	2
10	240	130	43	Wire size	6	6	6	6	4	4	2	1

Type PM, three-phase, single voltage, two speed, two winding, (Squirrel cage-induction motor) with neutral lead from each winding.

GENERAL: This motor is a special purpose motor with normal starting current characteristics.

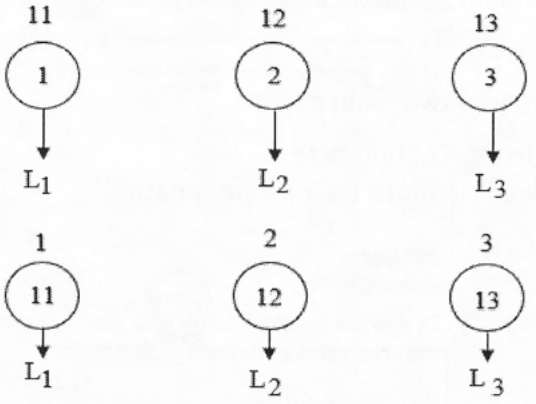
INSTALLATION AND MAINTENANCE:

1. Examine this motor carefully to be certain that no damage has been incurred during shipment.
2. Rotate the motor shaft by hand, it should rotate freely and smoothly.
3. Connect to a power source of the same voltage, within 10%, and the same frequency as indicated on the nameplate. Use the wire size given in the table on the back of this card and connect in accordance with the diagram below.
4. Where no connection is indicated, leads must be insulated.
5. The rotation may be changed in interchanging any two of the line leads.
6. The bearings in this motor are factory lubricated for a normal lifetime of service; however, on some motors, special fitting is provided for bearing relubrication if it is found desirable.
7. Be sure the motor is protected with fuses according to the National Electric Code.

AWG Wire Size	Max. Amps Type R Insulation	Max. Amps Type RH Insulation	AWG Wire Size	Max. Amps Type R Insulation	Max. Amps Type RH Insulation
14	7	7	300	240	285
12	11	11	350	260	310
10	18	18	400	280	335
8	30	30	500	320	380
6	46	46	600	355	420
4	70	74	700	385	460
3	80	93	750	400	475
2	95	115	800	410	490
1	110	130	900	435	520
0	125	150	1000	455	545
00	145	175	1250	495	590
000	165	200	1500	520	625
0000	195	230	1750	545	630
250	215	255	2000	560	665

DYNA MOTOR

CONNECTION DIAGRAM



DO NOT CONNECT

LOW SPEED

DO NOT CONNECT

HIGH SPEED

8. Connect up the Dyna Motor for high speed and note. _____
9. How fast was the motor turning? _____
10. How many poles does this motor have? _____
11. Now connect up the motor for low speed and note the direction of rotation.

    _____
12. How fast is the low speed? _____
13. How many poles are connected up for low speed? _____
14. Is this motor connected for consequent pole operation? _____

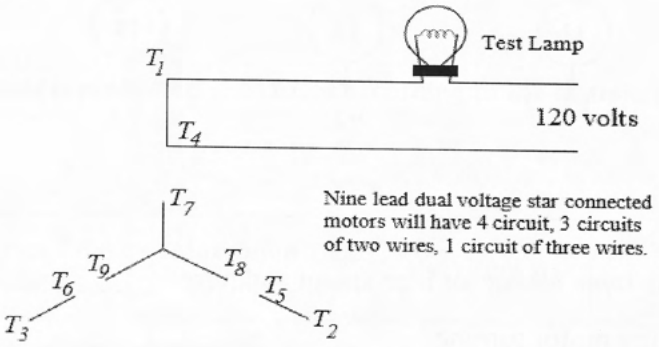
HOW TO IDENTIFY THE NINE LEADS OF AN UNTAGGED THREE- PHASE, DUAL-VOLTAGE, STAR-CONNECTED AND DELTA-CONNECTED MOTORS

The following equipment is used for this:

1. An a.c. voltmeter, Scale up to 460 volts.
2. A source of three-phase current, either 208-220, or 230 volts.
3. A circuit tester, a test lamp or buzzer and batter, or ohmmeter.

The test may be broken down into two main parts:

1. Testing for the four circuit, Continuity test.
2. Connecting the two-lead circuit to their proper phase.



Testing each circuit for continuity

Figure 1

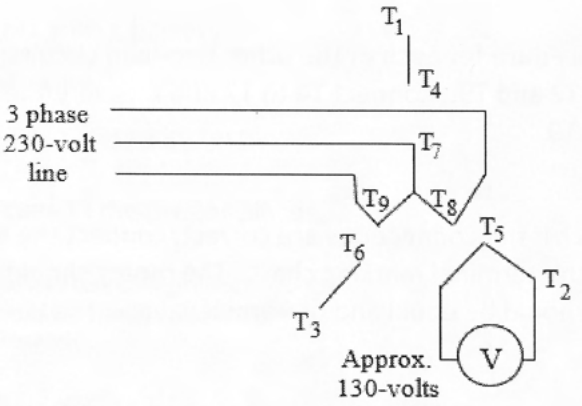
A. TESTING FOR FOUR CIRCUITS

Step 1: Refer to (Figure 1). Test the nine leads for complete circuits using the buzzer, lamp, or other circuit tester. If there are four circuit – three of two leads and one of three leads, this motor must be star (wye) connected. Note that the circuit will be T7, T8, T9- the internal star; T1 – T4, T2 – T5, T3 – T6. If the test had shown three circuits of three leads each, this would have been a delta-connected motor. Assuming a star-connected motor, continue with the next step.

Step 2: Tag the circuits. Use T7, T8, T9 permanently for the three-lead circuit. Temporarily tag the three-lead circuit. Temporarily tag the three two-lead circuit T1 – T4, T2 – T5, T3 – T6. We are not certain at this point that the three-two lead circuits are marked correctly, and our main problem is to locate and mark them correctly.

B. CONNECTING THE TWO-LEAD CIRCUIT TO THEIR PROPER PHASE

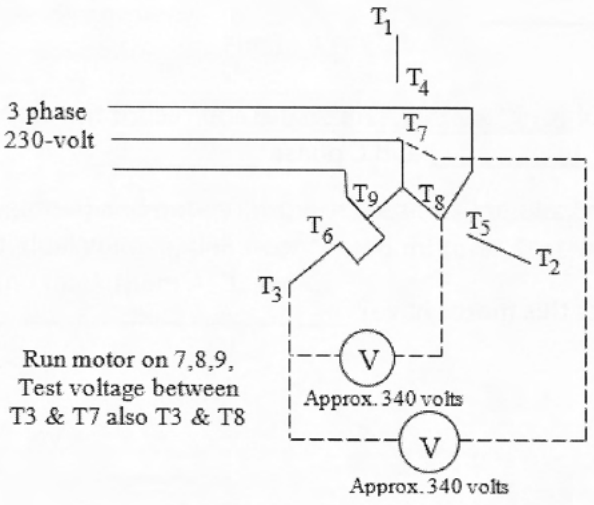
Step 1: Assuming a three – phase 230-460-volt motor is in good condition; apply the lower voltage (230) to leads T7, T8, T9. The motor should run without load. The other leads must remain open.



Run motor using 230 volts 3-phase across T7, T8, T9 to test voltage across each section.

Figure 2

Step 2: Measure the voltage across each of the two lead sections. This voltage should be 230/$\sqrt{3}$ or approximately 130 volts. (see figure 2).



Testing for correct connection in each phase

Figure 3

Step 3: With the motor running, connect temporarily marked T6 to T9 and measure the voltage across T3 and T7 and across T3 and T8 (figure 3). If these voltages are equal and approximately 340 volts, the connection of T3 to T6 is correct and should be tagged permanently. If equal readings of approximately 130 volts are recorded, reverse T6 and T3. If the voltages are unequal, try the connections with another two-lead section until approximately 350 volts is obtained.

Step 4: Repeat this procedure for each of the other two-lead circuits; for example, connect T5 to T8 and test between T2 and T9. Connect T4 to T7 and measure the voltage between T1 and T8 and between T1 and T9.

Step 5: In order to check if the connections are correct, connect the motor for low-voltage operation according to the terminal marking chart. The motor should be able to pull a normal load, and line amperes should be equal and of normal value.

All of the above tests may be done by using test lamps as a substitute of the voltmeter. It is necessary, however, to use the correct number pf lamps in series and to note the brilliance of each light in each circuit to determine the voltage of the circuit tested.

Step 6: Now connect up the motor for high voltage, measure and record the current in A phase _____, B phase _____, and C phase _____.

Also record the speed _____.

Step 7: Connect up the motor for low voltage, measure and record the current in A phase _____, B phase _____, and C phase _____.

Also record the speed _____.

Step 8: How many poles does this motor have? _____

UNTAGGED DUAL – VOLTAGE DELTA-CONNECTED MOTOR

The following equipment is used for this test:

1. An AC voltmeter. Scale up to 460 volts.
2. A source of three-phase current – 230 volts.
3. An ohmmeter.
4. A test lamp or buzzer with a battery.

The test consists of the following:

1. Test for three circuits. Continuity test.
2. Identify center tap.
3. Connecting the circuits in the proper places.

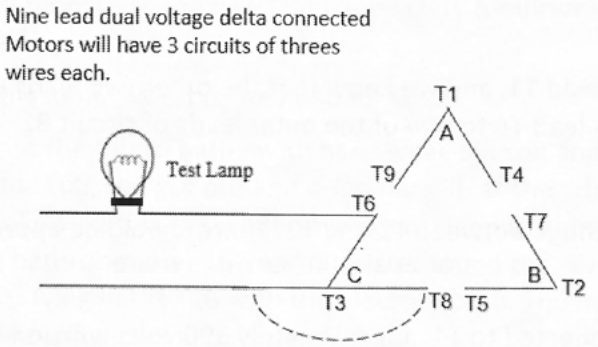
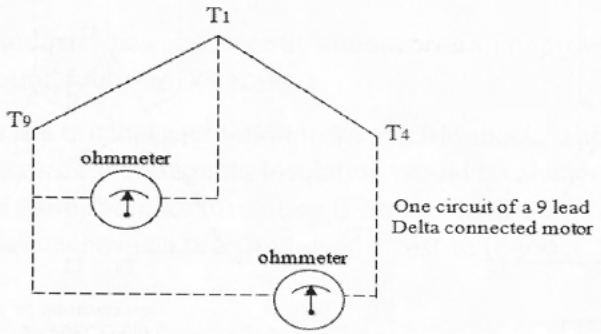


Figure 4

A. TESTING THE THREE CIRCUITS

Step 1: Refer to (figure 4) and note that there are three circuits of three wires each. This is true of all nine-lead, dual voltage, delta-connected motors. Test with buzzer or lamp to identify the three circuits, and mark them A, B, and C.



Measuring resistances with ohmmeter resistance between T9 and T4 = 2 times that of T9 and T1.

Figure 5

B. IDENTIFYING THE CENTER TAP

STEP 1: Use an ohm meter for this test and measure the resistance between Leeds of this three- lead circuit. The two leads showing the highest resistance should be mark temporarily as T4 and T9. The other lead is mark T1 permanently and is the center tap. Refer to (figure 5) and note that the resistance between T4 and T9 is twice that between T1 and T4 or T1 and T9.

STEP 2: Repeat this test for the other TWO circuits, B and C. (see figure 6)

C. CONNECTING THE CIRCUITS IN THE PROPER PHASE

STEP 1: Connect circuit a 2 other 3 phase 2:30 Volt line. The motor should run without a load as an open Delta motor (see figure 6).

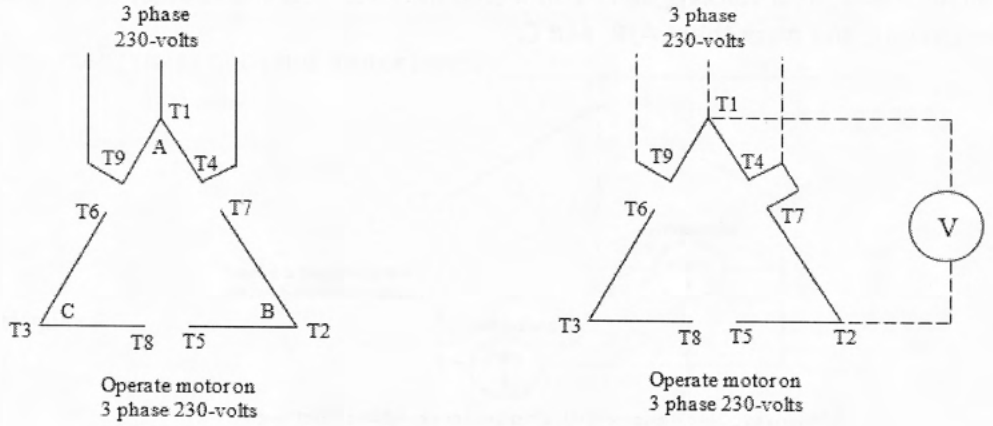
STEP 2: Since we know lead T1, and we know that the other two leads are T4 and T9, we connect what we think is lead T4 to one of the outer leads of circuit B.

STEP 3: Measure the voltage between T1 and T2. There should be approximately 460 volts.

STEP 4: If lead T5 is connected to T4, approximately 390 volts will be obtained. This, of course, is wrong. It will be necessary to use the trial-and-error method until the proper voltage is recorded**. Stop the motor when making lead changes.**

STEP 5: Repeat the above procedure with all the circuits and work the leads according to the terminals showed in (figure 6).

You will use a 12-lead motor for this part of the lab.



Connecting circuits to their proper phase.

Figure 6

GFCI – STRAIGHT TALK

Since the introduction of GFCI's in 1967, the discussion of GFIC's has been anything but dull. The immediate recognition of this heretofore attachable level of protection from the electric shock hazard stimulated rapid Inclusion GFCI protection in the National Electrical Code. This in turn triggered an explosion of technology development rarely seen in the electrical industry.

With every explosion a certain amount of fallout is created. So, it is with the explosive growth in the application of GFCI's.

There are those in the construction industry who consider a building's electrical system an insignificant component, which is hidden in the walls and crawl spaces. As the electrical system is out of sight, they consider it of minimum value to the purchaser of the home. Each advance in safety is challenged by this segment of the construction industry, and the electrical industry is required to demonstrate the need for each safety requirement added to the National Electrical Code.

This raises the Question, "What is the need for GFCI?"

A mother one day got into the tub to bathe with her 3-year-old son and 4-year-old daughter. Leaving the children in the tub, she got out and dried herself, at the adjacent vanity with an electric styling comb. Following this she went downstairs clean clothing the children. She heard trying from the upstairs bathroom. Her 15-year-old sister found the 4-year-old crying in the tube. The 3-year-old was lying in the tub with the electric comb. The boy was pronounced "dead on arrival" at the hospital.

An analysis of a recent Underwriters Laboratories Inc. study of 92 residential electrocutions reveals that at least 75% of the residential electrocutions occur in the bath, outdoor living area, basement or garage, and in the kitchen.

Of the remaining 25% some may well have occurred in these areas, but the accident data was not sufficiently detailed to specify the exact location of the fatality. Certainly, these fatal accidents need to be prevented, and this is, in part, justification for GFCI protection in these areas.

When evaluating the need, we must analyze the effectiveness of GFCI's as compared with other protective systems.

The electrical industry has consistently endeavored to improve the methods for protection against ground fault shock hazard.

Insulation was the original protection from electric shock. Shock hazard would not be a problem if we could assure that adequate insulation would be always present. Unfortunately, we cannot make this assumption, for insulation is subject to abuse, misuse, and deterioration. Those frayed cords that we have all seen and used attest to this fact.

In recognition of insulation's limitations, the National Electrical Code has specified additional methods of protection. One such method is grounding. A properly installed and maintain equipment grounding system has historically been an effective means of protection against most types of shock hazard. However, for grounding you be affective, the grounding system must be reliable and continually connected and capable of caring current to ground.

Very simply, grounding systems are not always maintained. As a matter of fact, frequently they are deliberately circumvented. A break can occur grounding system at any time without notice to the user. No alarm rings if the grounding connection in extension cords to connect 3-wire ground tool.

Even though grounding type receptacles are required on new electrical installation many buildings still contain receptacles without provision for ground this condition may tempt the user to circumvent the grounding system. This is done simply by the improper use of an adapter or worse yet, by breaking off the grounding blade of an attachment plug.

In some instances, the very presence about grounding tool may contribute to a ground fault hazard. A frayed cord exposing an energized conductor at the attachment plug can be grasped as the user holds the tool. In this case, the very fact that the tool was properly grounded contributes directly to the resultant accident.

A third type a protected recognize by the National Code is double insulation. As the name would suggest, double insulated tools and appliances have two levels of insulation. These two levels of insulation are physically separated and so arranged that they are not simultaneously subjected to the same deteriorating influences in the same degree. Obviously, double insulation, with its two levels of insulation, provides for increased safety.

However, double insulation has it short coming as well. Double insulation of a tool itself does not protect the user against shock hazards caused by defective chords, or attachment plugs. Double insulation may not protect the user when the tool is wet.

The UL analysis of 92 electrocutions occurring the residential living area indicates that 54.3% of the electrocutions could have been prevented had an effective equipment ground system been utilized.

One must, therefore, conclude that neither grounding nor double insulation can effectively be relied upon to prevent the electrocutions that continue to take place in the residential living environment.

This UL analysis of electrocutions indicated that 96.7% could have been prevented through the use of a ground fault circuit interrupter.

ELECTROCUTIONS INVOLVING PORTABLE ELECTRIC PRODUCTS WITHIN RESIDENTAL LIVING AREA

LOCATION	TOTAL ACCIDENTS REPORTED	NUMBER OF REPORTED ACCIDENTS THAT COULD HAVE BEEN AVOIDED IF AN OPERATIVE PROTECTIVE SYSTEM HAD BEEN EMPLOYED SUCH AS:		
		DOUBLE INSULATION	EQUIPMENT GROUNDING	GFCI
BATH	25	4	6	25
OUTDOORS	27	19	20	26
GARAGE/ BASEMENT	11	6	7	10
KITCHEN	6	4	1	6
OTHER	23	15	16	22
TOTAL	92	48	50	89
SYSTEM EFFECTIVENESS		52.2%	54.3%	96.7%

This Data was extracted from an analysis of Newspapers articles prepared by Underwriter's Laboratories.

Table 1

It might be well for us to review the basic functioning of the GFCI. Really, a GFCI is not a mysterious box whose black magic is beyond comprehension. However, it is important that each of us understands what makes GFCI trip in order to understand better how to install them to assume the desired performance.

Essentially a GFCI can be pictured as a vectorial adding machine, constantly summing the current flowing through it to a load and then subtracting the amount of current returning through it from the load. A circuit free from leakage current will register "0". However, if a portion the current leaks out of the circuit, as would occur with the ground fault, the return current will not equal the outgoing current. The amplitude of this differential or ground fault current is measured. When this differential current exceeds the trip threshold the GFCI interrupting mechanism is open.

Class A Ground Fault Circuit Interrupted listed by Underwriters Laboratory have a trip threshold of five milliamperes, plus or minus on milliampere. Five milliamperes is an uncomfortable amount of current to have passing through your body. Obviously, it would be desirable to calibrate the trip threshold of the GFCI as low as possible. However, standing leakage exists on all circuits and on all circuits and on all electrical tools and appliances. Consequently, the Underwriters Laboratories trip threshold of five milliamperes, plus or minus one milliampere, was established as a level offering maximum shock hazard protection, yet essentially free from unwanted tripping resulting from the cumulative standing leakage of the various components of the electrical system being protected.

Let's look at some of the leakage values that we have to be concerned with: (see Table 2).

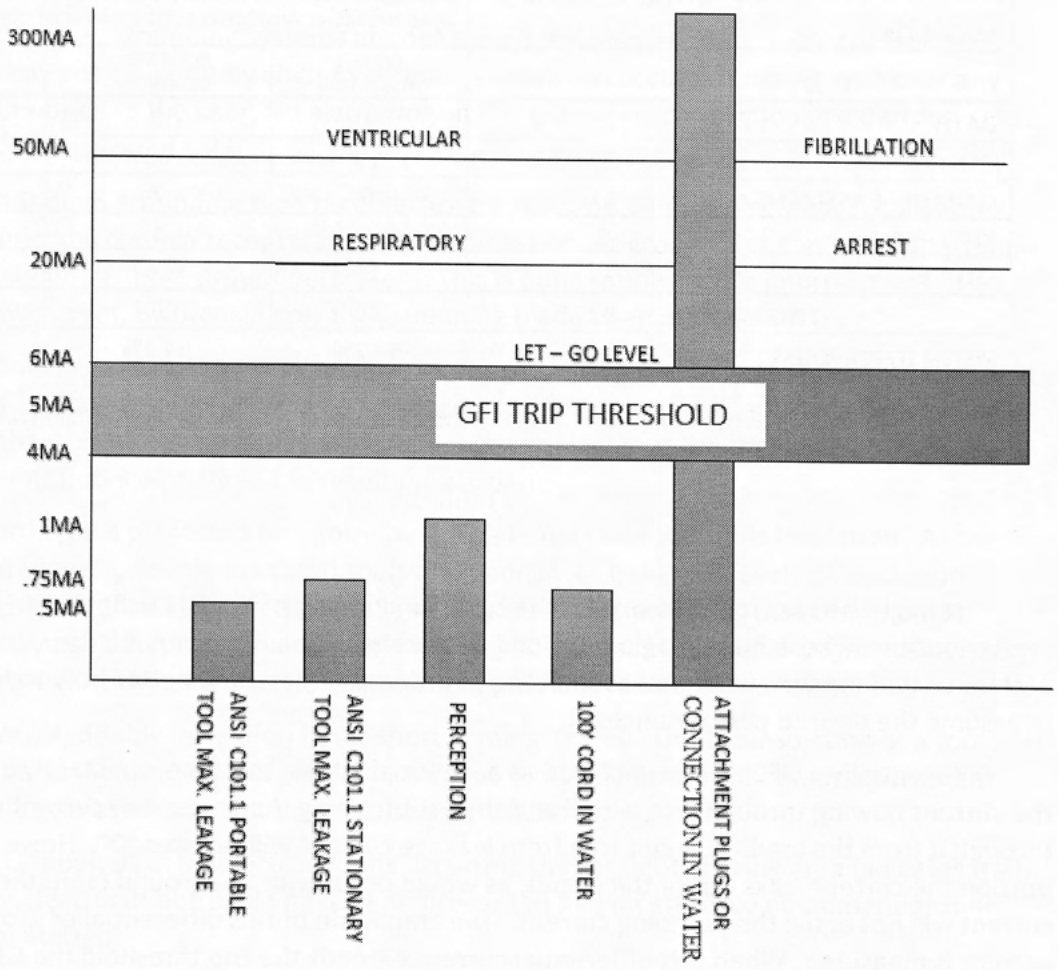


Table 2

1. Probably this single most important value of leakage current that we must concern ourselves with is that which would represent a hazard to the user. Six milliamperes is recognized as the minimum leakage current which will cause a person to be frozen to the circuit. This is the point at which the current is sufficient to cause an individual to lose voluntary muscular control, thus he is unable to free himself from the circuit. Therefore, any value above the let-go level can be considered hazardous. Any level below the let-go level can, under normal circumstances, be considered non-hazardous.

2. All appliances and tool have a certain amount of leakage current even when they are new. Underwriters Laboratories require new portable cord and plug connected tools to have a leakage value not exceeding .5 milliamperes. Similarly, new stationary cord and plug connected tools or appliances are required by Underwriters Laboratory week less than .75 milliamperes. As you can see, these levels of current leakage permitted by Underwriters Laboratories are well below the six milliampere level which would be considered hazardous. As a matter of fact, most people will not even perceive electric current below the one milliampere level and consequently, the leakage permitted on new tools and appliances will not even be sufficient to be felt by the user. Studies reveal that in practice the measured leakage on new tools and appliances is generally well below the maximum value permitted by Underwriters Laboratories.

3. Investigation by Underwriters Laboratories indicates the codes laying in water contributes a minimum amount of leakage to the system. Measurements would indicate the codes under such conditions could be expected to leak as much as .435 milliamperes per 100 fee.

4. On the other hand, Underwriters Laboratories test indicate that attachment plugs and connectors laying in water have been shown to represent a severe potential shock hazard. Leakage measurements of 6 to 310 milliamperes were recorded when such devices were immersed in impure water similar to that found on construction sites. Workers Contacting such wet devices are consequently exposed to potentially lethal current leakage.

5. Other appliances utilization equipment such as fluorescent lighting fixtures or exhaust fans commonly found in bathrooms all contain various levels of standing leakage. The current leakage values are generally substantially below that which, by themselves, would cause a GFCI to trip.

As you can see, the Underwriters laboratories 5 plus or minus one milliamperes trip threshold is designed to offer a maximum shock hazard protection by being below that point at which a person could become frozen to the circuit. Yet, the trip threshold is well above the leakage value that one could normally expect from well-maintained tools, appliances, or portable chords. For example, it would take 8 portable tool each leaking the maximum 0.5 milliamperes permitted before the minimum trip value of for milliamperes would be reached.

Now, let's talk about the two words without which no conversation concerning GFCI's would be complete.

NUISANCE TRIP

Do GFCI's nuisance trip? Certainly, they do. However, before we throw the baby out with he bath water. Let's just consider what a nuisance trip is, and what we can do about it.

I believe all would agree that if a GFCI trips because a single tool or appliance or wiring device or other than enough current to cause a person to become frozen to a circuit, a hazard exists, and such a trip is not a nuisance trip. Under these conditions, the GFCI is doing exactly what it is intended to do, namely protect people from leakage currents that can be hazardous to them.

This means that if an attachment plug and connector are laying in a puddle of water on a construction site, leaking several hundred milliamperes of current causing a GFCI to trip, this isn't a nuisance trip. No one would want to be the construction worker standing in that puddle of water bending over and picking up that attachment plug or connector.

Equally important in maintaining a true perspective of the "nuisance trip" problem is recognizing some trips do occur simply because the GFCI's have not been properly installed.

For example, one contractor states that he instructed all of his wiremen to place the bare equipment grounding conductor on the side of the receptacle opposite the hot terminal screws. His intentions were certainly valid for it, when shoving the device into the box, the bare equipment grounding conductor had accidentally contracted the hot screw, a short circuit would have occurred.

A GFCI is required to trip if the neutral in the load side of the GFCI becomes grounded. Consequently, this contractor reported several "nuisance trips" merely because the bare equipment grounding conductor came in contact with the neutral screws on the receptacle when it was shoved back into the box. Certainly, this was a nuisance to the contractor, but in fact the GFCI was doing exactly what it is required to do. Parenthetically, grounding the neutral at the receptacle is a Code violation.

Another example of an improper installation, resulting in a nuisance trip, is when a single-pole GFCI circuit breaker is installed to protect a portion of a multi-wire circuit. For example, a 3-wire,120/240V multi-wire circuit using a common neutral. A single-pole 120-volt GFCI circuit breaker is installed to protect that half of the circuit feeding the outdoor receptacle, and a conventional single-pole, 120-volt circuit breaker is installed to protect the other half of the circuit. Unfortunately, the GFCI circuit breaker detects the current on that half of the circuit, which it is not protecting, because of the shared neutral. Consequently, the GFCI breakers trip. Again, this may be a nuisance to the contractors. However, single-pole GFCI circuit breakers are not intended to protect a portion of a multi-wire circuit, and their installation instructions so state.

This is not to say that you are prevented from using multi-wire circuits where you are required to have GFCI protection. Several GFCI circuit breaker manufacturers offer double-wire circuit and achieve GFCI protection.

You can maintain the cost economy of using a multi-wire circuits by using GFCI receptacles in one of two ways. First, you can use a non-feed through type GFCI receptacle, installing it virtually any place on a multi-wire circuit. This type of GFCI receptacle protects only that equipment which is plugged into it and offers no downstream protection of additional receptacles. If such downstream protection is desired, then you can use a multi-wire circuit for the home run and install a feed through type GFCI receptacle after a junction is made and a separate neutral from the junction run to that part of the circuit protected by the GFCI receptacle.

GFCI's can be applied to multi-wire circuits without causing nuisance tripping. However, equipment which is best suited to the circulating of the particular insulation must be selected.

Let's assume for a minute that a contractor is wiring a college resident hall. Consider the manner in which he could install GFCI protection to protect the receptacle outlets in the bathrooms as required by Section 210-8. Most likely a 208Y/120V distribution system is being used. This enables the use of a 4-wire multi-wire circuit with a common neutral serving the three-phase conductors.

First, one must remember single-pole GFC I circuit breakers cannot be installed to protect one phase with a common neutral. Consequently, in order to use a GFCI circuit breaker, it is necessary to pull a separate neutral with each phase protected by a GFCI circuit breaker.

Now just to keep things simple, let's assume that the bathrooms are stacked one on top of each other in this dormitory. Probably the easiest way to circuit the bathrooms would be to catch the bath on the first floor in then run upstairs, catching the bath on the second floor, and on up to the third floor. Remember, a separate neutral is run with the phase conductor.

The GDCI breaker is installed, tested and everything operates satisfactorily. Three months later the building is occupied by freshmen coed, each equipped with a hot comb. At 6:00am on the first day of the semester, a coed on the third floor drops her hot comb in the sink. The GFCI circuit breaker trips. I think we would all agree that the GFCI has done exactly what is was intended to do.

Unfortunately, those coeds on the floor first floor and on the second floor who have just had the electricity in their bathroom turned off will consider this a "nuisance trip".

I suspect that even the house mother will consider it a nuisance to have three rooms full of freshmen coeds pleading with her to get their electricity turned back on, so they can dry their hair. Very likely, the maintenance man will consider it a nuisance to receive a 6am from the housemother asking him to come over and unlock the circuit breaker panel board so that the breaker can be reset. The contractor may even consider it a nuisance when he is called and asked what he is going to do about it because the school can't afford to have it happen again.

In fact, it need never to have happened in the first place. Had a non-feed through type GFCI receptacle been installed in each of the bathrooms, the hot comb falling in the sink would have tripped only the GFCI into which it was plugged. Furthermore, it would have been a very simple matter for the coed to reset the GFCI receptacle once she had removed the hair dryer from the sink. It might well have been less expensive to use the three separate GFCI's since you could have used a common neutral and would not have had to pull a separate neutral with each phase conductor in order to utilize a GFCI circuit breaker.

I would like to remind you of two earlier statement. First, a GFCI acts as an adding machine. Second, the leakage currents in a single, well maintained tool or appliance are not sufficient to cause a GFCI to trip.

If several poorly maintain tools or appliances are installed on circuit protected by a GFCI, the GFCI adds up the current leakage of the conductor plus the current leakage of this circuit may exceed the trip value of the GFCI. This would result in what I think we would all agree is a nuisance trip. A trip that may cost the contractor a call back.

Some contractors have found that the easiest way to avoid these troublesome call back is to install a separate circuit dedicated only to those receptacles that the Code requires to be GFCI protected. If you think about it, that's not very good economics. Depending on the links of the circuit, this extra circuit Can be quite expensive. By planning this circuit, placing those appliances that represent potential leakage current on the unprotected without the expense of running a separate current.

For example, you want to protect the bathroom receptacles in two bathrooms, as well as an outdoor receptacle. Each of the bath have, in addition to the receptacle outlets, a lighting fixture and an exhaust fan. The lighting fixture and the exhaust fan or both permanently installed and grounded. Neither is likely to fall into the sink or bath. The Code does not consider them a shock hazard requiring GFCI protection. However, if the lighting fixture happens to be a fluorescent type, you can expect them to have some standing leakage. Furthermore, those of you who have cleaned out your exhaust fans can attest to the amount of dust, consequently moisture, that can accumulate in the fan. This results in current leakage in the fan.

Protecting a lighting fixture and an exhaust fan bathroom with a single GFCI may well result in nuisance tripping. However, using a GFCI receptacle you can wire these fixtures and appliances on the load side of the GFCI receptacles.

Using GFCI receptacles in this manner avoids the cost of running an extra circuit, merely to prevent the GFCI from nuisance tripping. Installing GFCI protection in this manner will thus avoid the cost of extra over-counter device, extra conductor, extra fittings, an extra installation labor. It will also place the GFCI in a location that is convenient for resetting, avoiding than necessity of the homeowner going to the basement to reset the circuit breaker.

There are some factors, beyond the immediate control of the contractor that may cause a GFCI two trip. Under unusual combination of circumstances, external conditions such as lightening, or radio transmitted signals have caused GFCI's to trip. These conditions have not been ignored. Manufacturers have developed extensive production testing program to assure a high level of immunity to such influence.

The National Association of Home Builders reports that the average selling price of a typical single family detached home is $37,300 in 1974. It's reported that 94% have dishwashers 88% have disposal; 72% have more than one bathroom. The cast of the plumbing (excludes heating and appliances) is $1,558.96, 4.2% of the $37,300 selling price. Excluding lighting fixtures and apply is $658.13, or 1.8% sent of the total selling price of the house. Since these NAHB figures were compiled prior to the general adoption of the GFCI requirements for bathrooms, GFCI's were probably not reflected in the $658 worth of electrical work. Assuming a %54.00 retail price for the GFCI, with no additional work. Assuming a $54.00 retail price for the GFCI, with no additional labor required only $1/10^{th}$ of 1% would be added to the cost of the house.

In view of the fact that GFCI's can prevent approximately 96% of the electrocutions occurring in the home today while other protective systems such as grounding or double insulation are only about half as effective, doesn't the electrical industry have an obligation to convince the builders and state and local legislators that the value added by installation of a GFCI is at least comparable to that of a dishwasher.

1. What percent of electrocutions occur in the bath, outdoors, basement or garage, and in the kitchen? _____
2. Is insulation the best insurance against electrical shock?
   _____
3. Does the alarm sound and light flash when the ground is broken?
   _____
4. Will double insulation always protect proper when the tool is wet? _____
5. What percent of electrocutions can be prevented by using the ground fault circuit interrupter? _____
6. The GFI will trip on _____
7. What is the minimum current that a person can let go of the circuit?
   _____
8. Underwriters Laboratories will allow a leakage current on new portable tools of
   _____
9. What is nuisance tripping? _____
10. Can you use a GFCI on a multi-wire circuit of 129/240 volts? Explain:
    _____
11. Can lightening cause the GFCI to trip? _____
12. The GFCI adds _____to the total cost of the home.

THREE PHASE MOTOR

CONNECTIONS

GENERAL INFORMATION:

The squirrel-cage Motor can be connected up in several different ways. Each connection offers the motor certain characteristics which shall learn.

OBJECTIVES:

1. To connect up the 36 coil three-phase squirrel-cage motor.
2. Star, Delta, Single Circuit, 2 Circuit, 9 lead, High HZ, 4-pole, and 6 pole.

DISCUSSION:

In the third quarter lab, is a 3 phase 36 coil motor with the start and finish lead of each coil brought out for connecting the different type of motor connection. This is the same type of motor that is called talked about in your text book, (Industrial Electrical Principles and Practices). Read the information in your text book, on page 234-245 (Chapter # 16) before you start this project.

Then you start this project Measure each coil with the megohmeter to make sure that the coils art in good condition, also check each coil to the frame of the motor for ground. Use the information on using a megohmmeter general radio company #1862-B. Serial #1310. The 50-volt scale and set the multiplier on X 100. Check each oil with its adjacent coil and check each coil to the frame of the motor. If all coils read good, continue to connect up the motor project.

NOTE: If any of the coils are bad let your instructor know. If you burn out any coils in making your connection, you will rewind them!!

EQUIPMENT:

1. Three phase squirrel-cage indication motor with 36 coils.
2. Clamp on ammeter (Amprobe)
3. Tachometer
4. Connection Leads

PROCEDURE:

1. Now connect up a star, 4-pole, single circuit motor. You can see (figure #16-10) a and b, 16-14 a and b, (Adams Industrial Electricity) to help you understand how the circuit makes up. In (figure 16-14) a, you should connect FA, FB, and GC together to form a star point. The power then should connect to SA – A phase, and SC-C phase. When you turn on the power listen for an unusual noise, **if heard shut off power at once!!** You should also have a clamp on ammeter and measure the current in each line. This current should be under 5 amps and the same phase A, B, and C. If the motor has an unusual noise and the currents are not the same, you should turn the power off and recheck your connections. Measure and record current.

   A _____ B _____ C_____ R.P.M._____

2. Now connect up the motor as a single circuit, 4 -pole, Delta (figure 16 – 32a) (Adams) measure and record current.

   A _____ B _____ C_____ R.P.M._____

3. Now connect up the motor as a two circuit, 4-pole, star (figure 16-26-a) (Adams). Measure and record current.

   A _____ B _____ C_____ R.P.M._____

4. Now connect up the motor as a dual voltage, 4 pole, single circuit, star. Tape (masking) or mark all 9 leads of the motor. (Figure 16-31-a) (Adams). Connect it up for high voltage and run it on 208,30. Measure and record current.

   A _____ B _____ C_____ R.P.M._____

****Before connecting this circuit up, check with your Instructor.**

5. Now connect up the motor 4-pole, 9 lead, star connected, dual-voltage, single circuit, 1746 RPM. (Figure 1) Connect this motor for high voltage and run it on 208,30. Measure and record current.

   A _____ B _____ C_____ R.P.M._____

   This type of winding can be connected as a consequent pole motor by reversing the current between the two poles, 1 and 4, 2 and 5, 3 and 6. You can do this by placing A phase power on the wire marked 4, B phase power in the wire marked 5, and C phase power on the wire marked 6. Then tie the wire marked 1 to 7, 2 to 8, and 3 to 9.

   Turn on the power. Measure and record current.

   A _____ B _____ C_____ R.P.M._____

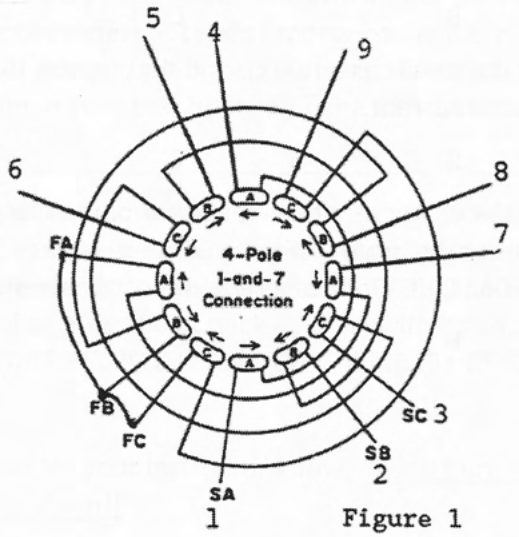


Figure 1

6. Now connect up the motor 4-pole, single circuit, star, high voltage. We will now give you 120 cycles 30 voltage.
   Measure and record current.

   A _____ B _____ C_____ R.P.M._____

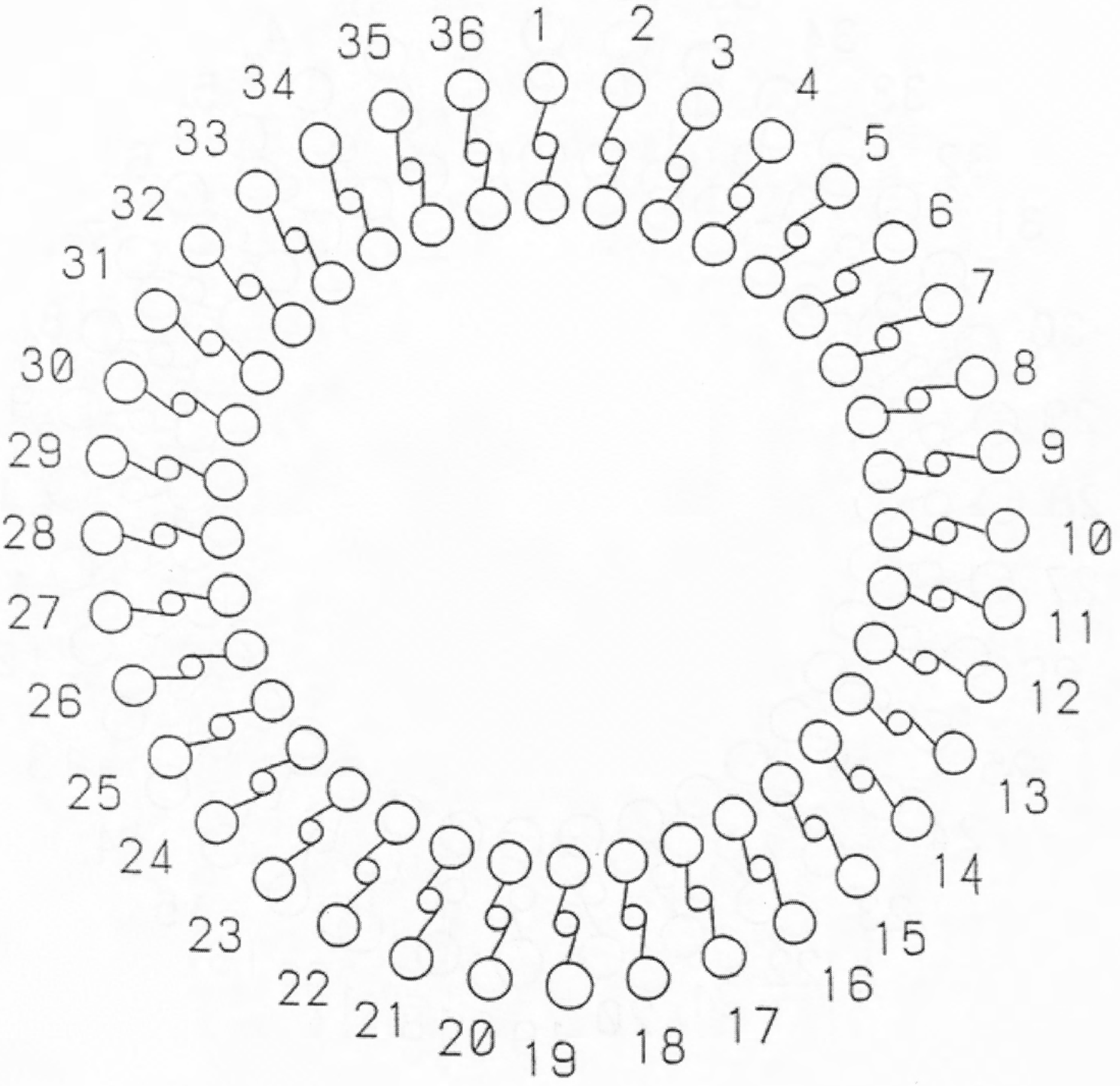
7. Connect up the motor as a 6 pole, single circuit, star, 208 volts,30.

   Measure and record current.

   A _____ B _____ C_____ R.P.M._____

8. Connect up the motor as a 2 pole, single circuit, star, 208 volts, 30.
   Measure and record current.

   A _____ B _____ C_____ R.P.M._____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SAFETY FIRST WHEN OPENING SWITCHBOXES

A sudden rash of reported accidents involving switch boxes and simple disconnect switches indicate that many of our members these devices for granted and overlooking some of the hazards that exist.

It has often been said that the familiarity brings neglect, and with this neglect comes injury. Usually this is caused not just my familiarity, however, due to a lack of adequate training potential hazard that exist.

The Construction Safety Council of Ontario in their publication "The Counselor", recently reported the following:

> Two electricians were sent to restore power in the building. Upon entering the switch-room, they found that the switch box door would not open as the interlocking mechanism did not release when the switch was turned off. One of the men tempted to use a screwdriver to "Jimmy" the door open. Apparently, the tip of the screwdriver inadvertently made contact with one of the energized terminal or fuses. In the ensuring explosion, the 2 men were so grievously burn that they died soon afterwards. Two other men standing about 10 feet from the switch were also critically injured. One man ran out of the room with his clothes so badly burned off that he was wearing only his boots and his belt.

Disconnect switches have been known to flash-over and then explode when someone touches the switch box door. Unless a person opening a box takes precautions he could be burned, blinded or killed before realizing the switch was faulty. A loose connection or a conductor pressing against a sharp or energized surface, causing the heat building up, can erupt when it is disturbed.

With switch box explosions, it is not always possible to predict when an accident will occur, but protection can be used to prevent possible serious injuries.

SAFE OPENING OF A SWITCHBOX

Anyone opening a disconnect switch box should:

- **Make sure the switch is in the "OFF" position before opening the box latch.**
- **The door in direct line between his face and the inside of the box.**
- **Never directly expose his face to the box until the door has been completely opened.**
- **When finished, fasten the latch before turning switch box to the "ON" position.**
- **Always wear eye protection to prevent eye injuries case of an explosion.**

FIRST AID STEPS

In the event, that a switch box explosion occurs, it is important that first aid be quickly given. Flash burns are extremely painful. The surface of the skin will be fiery red and hot to touch.

Apply cold water directly to the burn area using a running tab or hose. Direct the water on and unaffected area so it can flow over the burn. Continue application as long as practicable or until pain subsides. Cover with a sterile bandage in get the victim to the doctor.

Where the burn has gone through the three layers of skin to the nerve, the nerve ends will be destroyed, and the victim will not have the same sensation of pain. If the victim's clothing restricts treatment of the burn, remove it and cover the burn with a cool, wet sterile bandage.

But do not remove clothing if it is stuck to the skin. Get the victim medical aid immediately. Never put a greasy sticky substance on a burn. This delays treatment as it has to be scrubbed off causing more pain to the victim.

The case of a flash burns to the eyes, flush the victim's eyes with cold water and ensure he receive prompt medical attention.