CEW 03

# KRISHNA KANTA HANDIQUI STATE OPEN UNIVERSITY

**Housefed Complex, Dispur, Guwahati - 781 006**

## Six Month Certificate Programme in

## Electrical House Wiring

**BLOCK-3**

## Practical Manual of House Wiring

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## COURSE INTRODUCTION

Practical Manual for Housewiring covers Safety practices, Electrical measurements, wiring practices. This part includes earthing procedure and battery charging and maintenance and also estimating and costing. The whole content is divided into 15 (sixteen) practical experiments. The experiments are carefully designed in such a way that anyone who performs about 10 experiments gets a real life experience and gets the knowledge and confidence to start house wiring jobs.

# PRACTICAL MANUAL

## MANUAL STRUCTURE

1. Experiments : Safety
   - 1.1 Remedy & First Aid Practices in Electrical Injury
   - 1.2 Safety practices on Fire Extinguisher
2. Experiments : Electrical Measurement
   - 2.1 Calibration of Ammeter
   - 2.2 Calibration of Voltmeter
   - 2.3 Calibration of Wattmeter
3. Experiments : Measurements of Different Electrical Parameters
   - 3.1 Measurement of Resistance by Ammeter-Voltmeter Method on DC Source
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   - 6.2 Various Switches and Other Fittings Used in Wiring

# 1. EXPERIMENTS : SAFETY

## 1.1 Remedy & first aid practices in Electrical Injury

To avoid electrical shock and other injury, every body should remember the following points : (Under rule 44 of the Indian Electricity Rules 1956, as defined in clause (m) of section 2 of Factories Act 1948 in which electricity is used and such other places where electricity is used, the following instructions are to be affixed in a place visible to every one.)

1. Electric shocks are easily received. The risk is not always apparent. So always be careful.
2. Proper clothing, hand gloves, rubber sole shoes should be used while you are at electrical work.
3. You must use safety belt and ladder while work on pole or such high rise place. The ladder must be held by another person to avoid slip.
4. Do not tie wire use for cloths drying with an electric pole.
5. During work, if electricity is not a must, put off the switch.
6. Don’t energies any circuit unless you are sure that all is clear and no one is working.
7. You should not tamper unnecessarily any electrical gear.
8. Before replacing a blown fuse, always put-off the switch.
9. Good earthing ensures safety. Hence keep it healthy.
10. Don’t remove a plug by pulling the flexible wire.
11. Be careful when you use table fan, iron, heater etc. Be sure the appliances are properly earthed.
12. Don’t use pliers as hammer.
13. Don’t put a sharp edged tool in your pocket.
14. Don’t use screw-driver, knife etc without insulated handle.
15. Don’t work when you are wet.
16. If an electrician or any other person is in contact with a live wire or equipment, immediately put-off the main switch. If

that is not possible, insulate yourself from the ground by using a wooden chair or stool and then pull him or her from the live wire contact. A wooden stick may be used to knock the victim.

- **First-aid :** If an electrician or any person suffered an electric shock and after that if the victim does not breath, you should give him artificial breathing as follows:

  (Every employee in an establishment is required to be familiar with the instructions given below. These are administered by those who have studied and practiced them before hand.)

  **A. Mouth to nose breathing:**

  1. Place the victim on back.
  2. Clear mouth and throat. Turn head to side and remove any foreign bodies by fingers.
  3. Tilt head back by holding lower jaw as shown in the figure; this opens air passage.
  4. Take deep breath yourself and put your mouth over his mouth or nose. Release the air so that it can go inside of victim's chest. Hold the victim's mouth closed.
  5. Let the victim's chest fall.
  6. Continue this artificial breathing about 12 times per minute until the victim resumes breathing.
  7. In case of children, puff gently.

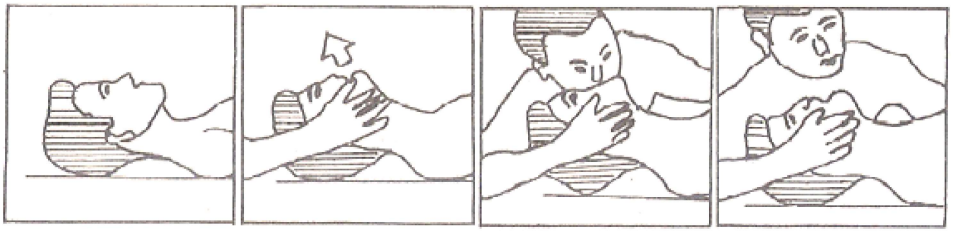


**Fig. 1.1 : Mouse to nose breathing**

**B. Pressure Breathing:**

**First Method :**

1. First place the patient on a bed and turn his or her face and chest downward.
2. Expiration: Kneel over the patient, place your hands flat on his/her back near the lowest rib. Spread your fingers on each side over his/her lower ribs as shown in figure 1.2.



**Fig. 1.2**

Now lean forward gently but firmly over the patient exerting steady pressure downwards still following the diagram shown in Figure 1.2.

3. Inspiration:Take yourself gently backward but don't remove your hands. Keep them in position for the next expiration process. See Figure 1.3.

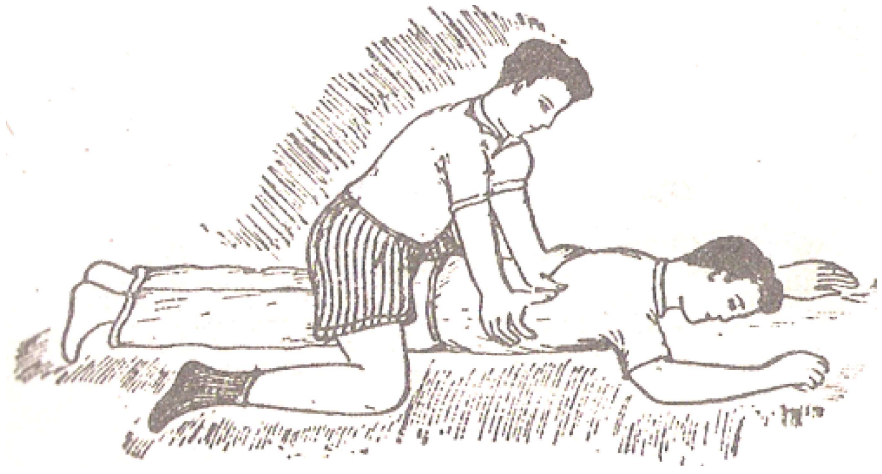


**Fig. 1.3**

Continue these two movements for about 15 times per minute. The process keep expanding and contracting the patient's lungs to initiate slow breathing. The operator may continue his own breathing sequences keeping pace with his forward and backward movement, so that he can adapt to the proper rate of his movement.

Do not cease operation until natural breathing of the patient is re-established. The restoration of breathing may take half an hour or more.

**Second Method :** In this method put the patient on his back, means face and chest upward. Loosen the cloths on chest and stomach. Roll a soft cloth and place it beneath the shoulders of the patient so that the head falls backward as shown in the Figure 1.4

**First Motion :** The operators kneel in the position as shown in the Figure 1.4 Grasp the patient just below the elbows and take his arms over his head in horizontal position for about 2 seconds.

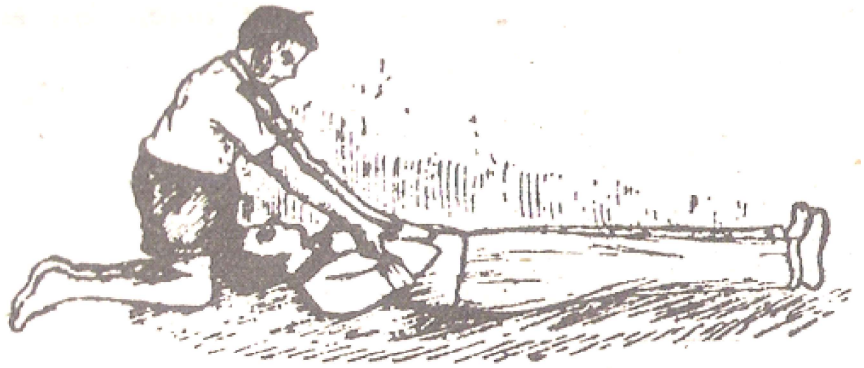


**Fig. 1.4**

**Second Motion :** Next bring the patient's arm down on each side of his chest and press inwards leaning upon his arms so as to compress his chest.

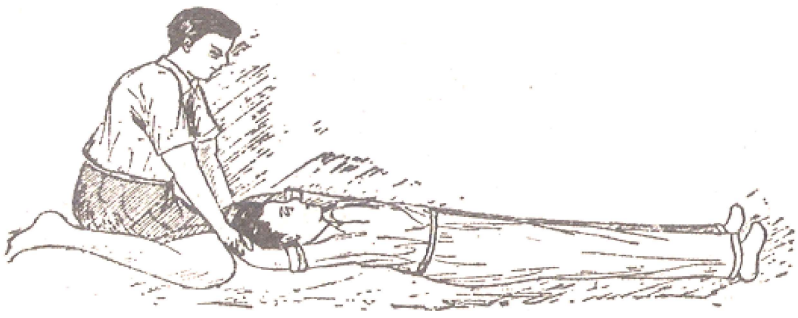


**Fig. 1.5**

Remain in this position for two seconds and then keep repeating both the motions at the same rate.

**First-aid forburnt :** After electric shock, if the patient got burning, then depending on the degree of burning you may give treatment in the following way:

First degree burn :

- Injuries are superficial and mild.
- Swelling and redness occurs in the injured area.
- Pain develops, no blister seen.

Treatment :

- Remove patient from the heat source.
- Remove the burnt clothing.
- Run cool water over the burnt area.
- Gently clean the area.
- Apply anti-biotic.
- Use a sterile bandage to cover burns
- Take tetanus vaccination, if required

Second degree burn :

- Burns extends to middle skin layer, dermis
- Swelling, redness and pain observed
- Burnt area may turn white on touch
- Blisters develop, that ooze a clear fluid
- Scars may develop
- Restricts movement, if injury occurs at joint

Treatment :

- Clean the affected area thoroughly
- Gently dry
- Apply antibiotic cream over affected area
- Make the patient lie down
- Keep burnt body part at a raised level
- Skin graft may be required
- Physical therapy may be essential to aid mobility

If the burnt is more than described above, take the patient to a doctor immediately. It is also advisable that, in all the cases of burnt; the patient should be taken to a doctor for further check-up after the first-aid.

## 1.2 Safety Practices on Fire Extinguisher

Every substance has an ignition temperature at which it burns. Fire means burning of a substance resulting generation of heat and light. Substance having lower ignition temperature is susceptible to fire and need attention for protection of fire. Fire fighting equipment are called fire extinguisher.

Based on different types of fires, fire extinguishers are divided into four categories. Each fire extinguisher also has a numerical rating that serves as a guide for the amount of fire the extinguisher can handle. The higher the number, the more fire-fighting power. The following is a quick guide to help choose the right type of extinguisher.

- **Class A** extinguishers are for ordinary combustible materials such as paper, wood, cardboard, and most plastics. The numerical rating on these types of extinguishers indicates the amount of water it holds and the amount of fire it can extinguish. Geometric symbol (green triangle)
- **Class B** fires involve flammable or combustible liquids such as gasoline, kerosene, grease and oil. The numerical rating for class B extinguishers indicates the approximate number of square feet of fire it can extinguish. Geometric symbol (red square)
- **Class C** fires involve electrical equipment, such as appliances, wiring, circuit breakers and outlets. Never use water to extinguish class C fires - the risk of electrical shock is far too great! Class C extinguishers do not have a numerical rating. The C classification means the

extinguishing agent is non-conductive. Geometric symbol (blue circle)

- **Class D** fire extinguishers are commonly found in a chemical laboratory. They are for fires that involve combustible metals, such as magnesium, titanium, potassium and sodium. These types of extinguishers also have no numerical rating, nor are they given a multi-purpose rating - they are designed for class D fires only. Geometric symbol (Yellow Decagon)
- **Class K** fire extinguishers are for fires that involve cooking oils, trans-fats, or fats in cooking appliances and are typically found in restaurant and cafeteria kitchens. Geometric symbol (black hexagon)

  Some fires may involve a combination of these classifications. Your fire extinguishers should have ABC ratings on them.

**Here are the most common types of fire extinguishers:**

- Water extinguishers or APW extinguishers (air-pressurized water) are suitable for class A fires only. Never use a water extinguisher on oil or grease fire, electrical fires or class D fires - the flames will spread and make the fire bigger! Water extinguishers are filled with water and are typically pressurized with air. Again - water extinguishers can be very dangerous in the wrong type of situation. Fight the fire if you're certain it contains ordinary combustible materials only.
- Dry chemical extinguishers come in a variety of types and are suitable for a combination of class A, B and C fires. These are filled with foam or powder and pressurized with nitrogen.
  - BC - This is the regular type of dry chemical extinguisher. It is filled with sodium bicarbonate or potassium bicarbonate. The BC variety leaves a mildly corrosive residue which must be cleaned immediately to prevent any damage to materials.

- ABC - This is the multipurpose dry chemical extinguisher. The ABC type is filled with mono-ammonium phosphate, a yellow powder that leaves a sticky residue that may be damaging to electrical appliances such as a computer

- Carbon Dioxide ($CO_2$) extinguishers are used for class B and C fires. CO2 extinguishers contain carbon dioxide, a non-flammable gas, and are highly pressurized. The pressure is so great that it is not uncommon for bits of dry ice to shoot out the nozzle. They don't work very well on class A fires because they may not be able to displace enough oxygen to put the fire out, causing it to re-ignite.



**LET US KNOW**

It is vital to know what type of extinguisher you are using. Using the wrong type of extinguisher for the wrong type of fire can be life-threatening.

- CO2 extinguishers have an advantage over dry chemical extinguishers since they don't leave a harmful residue - a good choice for an electrical fire on a computer or other favourite electronic device such as a stereo or TV.
- These are only the common types of fire extinguishers. There are many others to choose from. Base your selection on the classification and the extinguisher's compatibility with the items you wish to protect.

**Special notes on electrical fire hazards :** Every year hundreds of people die and thousands are injured in accidents involving electrical fires. Most of these incidents can be prevented by following simple electrical fire safety rules. Although some of these fires are caused by electrical system failures and appliance defects, many are caused by the misuse and poor maintenance of electrical appliances, incorrectly installed wiring, and overloaded circuits and extension cords.

**Electrical wiring :** Most electrical fires result from problems with “fixed wiring”, such as faulty electrical outlets and old wiring. Many are caused by cords and plugs, such as extension and appliance cords. In urban areas, faulty wiring accounts for 33% of residential electrical fires. Misuse of electric cords, overloading circuits, poor maintenance of cords, and running cords under rags or in high traffic areas often lead to electrical fires that could have been avoided. Many home appliances consume large amount of electricity and sometimes cause electrical fires. Those most often involved are electric stoves and ovens, dryers, televisions, radios and record players. Always follow the manufacturer’s safety precautions when using an appliance. Many people overlook seemingly-harmless warning signs such as overheating, an unusual smell, short circuits, sparks and sputters. If any of these occur, the appliance should be immediately turned off and unplugged. If the appliance functions well, you may have encountered an electrical wiring problem and should check the wiring.

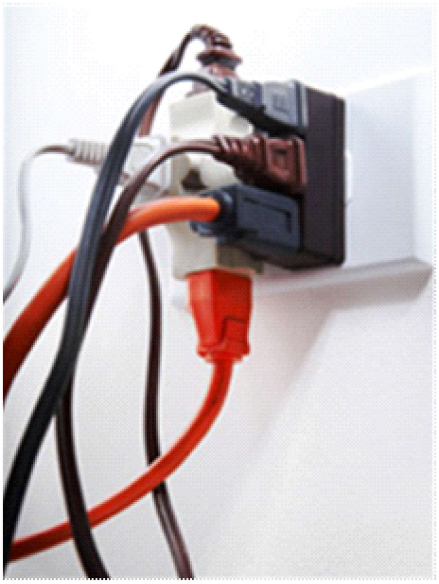


**Fig. 1.6**

**Some Safety Precautions :**

- Routinely check your electrical appliances and your home wiring
- Replace all old, worn out, or damaged appliance cords
- Use electrical extension cords wisely
- Keep clothes, curtains and other potentially combustible items away from all heaters
- Never overload extension cords or wall sockets

**Fuses and circuit breakers :** When a fuse blows or a circuit breaker is tripped, find out what caused it to overload before replacing or resetting it. Correct the problem.

**Warning Signs :** Many electrical problems can be detected before they cause a fire or harm someone. To better ensure electrical fire safety, learn to be alert and pay attention to any irregular electrical function. Some warning signs include:

- A recurring problem with blowing fuses or tripping circuit breakers
- Experiencing a tingle when you touch an electrical appliance
- Discoloration of wall outlets
- A burning smell or unusual odour coming from an appliance or wiring
- Flickering lights

If you notice any of the above warning signs or if an appliance functions oddly, take appropriate measures to prevent an accident. Unplug the malfunctioning appliance immediately. If necessary, cut off power to the problem circuit by disconnecting the fuse or tripping the circuit breaker manually and locate the problem. When in doubt, contact the power company to inspect the electrical connections outside your home. Electrical fire safety is a serious matter and precaution is of utmost importance.

## 2. EXPERIMENTS : ELECTRICAL MEASUREMENT

**Calibration of measuring instruments :** When we use an instrument to measure a physical quantity, we must know whether the instrument gives us correct reading or not. If it does not give correct reading how can we know the actual reading? Answer to this question is calibration.

Calibration means assessing an instrument against a standard instrument for its correctness to measure a physical quantity. It is a practice to ensure correct measurement by an instrument. Calibration process involves a comparison of a particular instrument with either a **primary**

**standard** or a **secondary standard** instrument with a higher accuracy than the instrument to be calibrated or **an instrument with known accuracy**.

After calibration a static error calibration curve is drawn which is used to correct the reading of the instrument. A typical error calibration curve is shown:

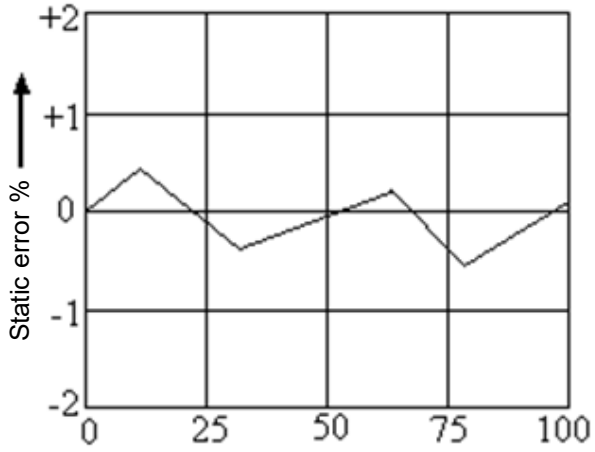



**Fig. 2.1 : Error calibration curve**

## 2.1 Calibration of Ammeter

**Aim :** Calibration of an ammeter by comparison with a standard one.

**Procedure :** The meter to be calibrated is connected with the standard one in series and a variable resistance across a low supply voltage. Low voltage is used to save power. The circuit is shown in Figure 2.2 The standard meter must be selected properly. It should be a moving coil instrument which is already calibrated with the help of a potentiometer.

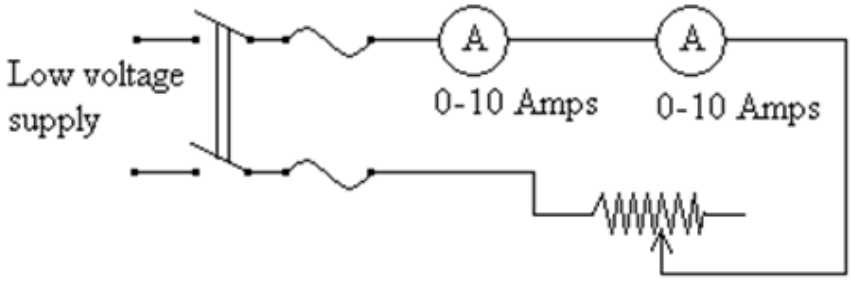



**Fig. 2.2 : Calibration of ammeter**

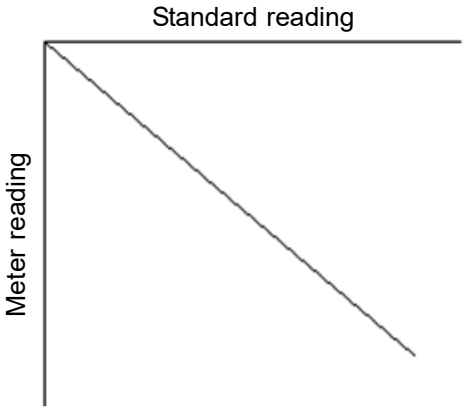



**Fig. 2.3 : Calibration curve**

You can take readings for the whole range of the meter by the variable resistance. Record the readings in the table given below:

| Sl. No. | Reading of the standard meter | Reading of the meter to be calibrated |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |

From the above readings you draw a curve as shown in Figure 2.3 where standard readings are plotted against the readings of the meter under calibration. This curve can be used later to obtain correct reading of current by the calibrated meter when it is used for current measurement in any other cases.

Correction curve can also be used for obtaining correct reading by the calibrated meter, a sample of which is shown in Figure 2.1.

## 2.2 Calibration of voltmeter

**Aim :** Calibration of a voltmeter by comparison with a standard voltmeter.

**Procedure :** The voltmeter under calibration is connected in parallel with the standard one across a supply voltage which is given by a potential divider as shown in Figure 2.4.

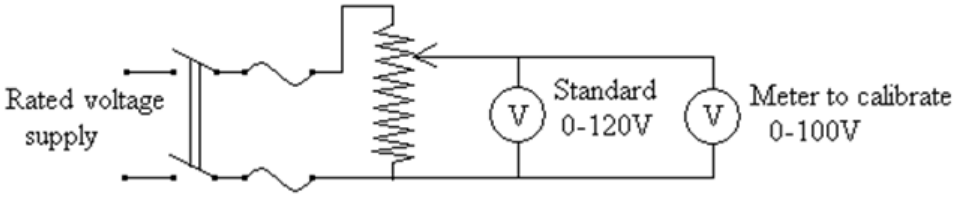



**Fig. 2.4 : Calibration of voltmeter**

In this calibration the standard voltmeter is of higher range than the meter to be calibrated. Take different readings by varying the P.D. across the voltmeters. Tabulate the readings and plot the calibration curve and correction as in the case of ammeter calibration.

## 2.3 Calibration of Wattmeter

**Aim :** Calibration of a watt meter by comparison with a standard ammeter and voltmeter.

**Procedure :** Complete the connection as shown in Figure 2.5. The current coil is connected to a low voltage supply with an ammeter in series and the pressure coil is connected to rated voltage of the watt meter through a P.D. connection. A standard voltmeter is connected in parallel to the pressure coil.

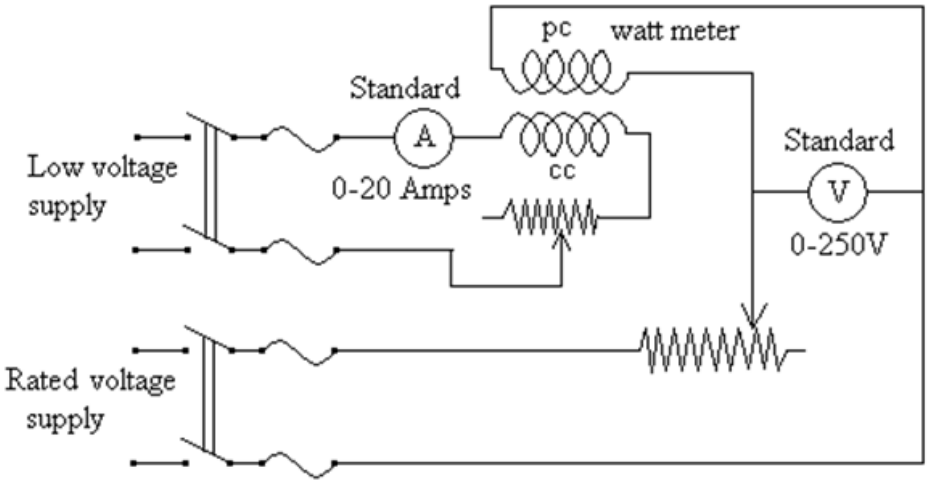



**Fig. 2.5 : Calibration of watt meter**

Take different readings by changing current and voltage and tabulate them in the table given below:

| Sl. No. | V | I | Watt (Standard) = VI | Watt meter reading |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |
| 6 | | | | |
| 7 | | | | |

From the above reading draw calibration curve by plotting Watt (Standard) against the reading of the watt meter to be calibrated. A correction curve may also be drawn.

# 3. EXPERIMENTS: MEASUREMENTS OF DIFFERENT ELECTRICAL PARAMETERS

## 3.1 Measurement of Resistance by Ammeter-Voltmeter Method on DC Source

**Aim :** Measurement of resistance by ammeter-voltmeter method.

**Materials :**

1. 1.5 mm sq.wire 5 meters.
2. 5 ampere ON-OFF switch 1 No.
3. Battery, 12 Volt 1 No.

**Tools :**

1. Plier 1 No.
2. Screw Driver 1 Set

**Equipment :**

1. Ammeter 0-5 Amps 1 No.
2. Voltmeter (M.C.) 0-15 V 1 No.
3. Unknown resistance 1 No.
4. Variable Resistance 10 Ohm 1 No.

**Procedure :**

1. Connect voltmeter, ammeter, resistance, battery, switch etc as shown in the circuit diagram in Figure 3.1.

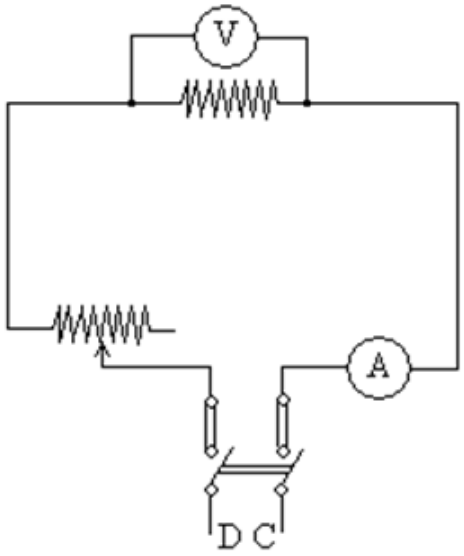



**Fig. 3.1 : Measurement of resistance**

2. Put the switch ON.
3. Take readings of the meters.
4. Vary the current by the variable resistance and take readings.
5. Put the reading in the table given.
6. Find value of resistance by using the formula given.

| Sl. No. | V | I | R = V/I | Average R |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |

## 3.2 Measurement of Resistance by Ammeter-Voltmeter Method on AC Source

**Aim :** Measurement of resistance by ammeter-voltmeter method.

**Materials :**

1. 1.5 mm sq.wire 5 meters.
2. 5 ampere ON-OFF switch 1 No.
3. AC source, 230 V

**Tools:**

1. Plier 1 No.
2. Screw Driver 1 Set

**Equipment :**

1. Ammeter 0-5 Amps 1 No.
2. Voltmeter (M. I.) 0-230 V 1 No.
3. Unknown resistance 1 No.
4. Auto Transformer 1 No.

**Procedure :**

1. Connect voltmeter, ammeter, resistance, auto transformer, switch etc. as shown in the circuit diagram in Figure 3.2.

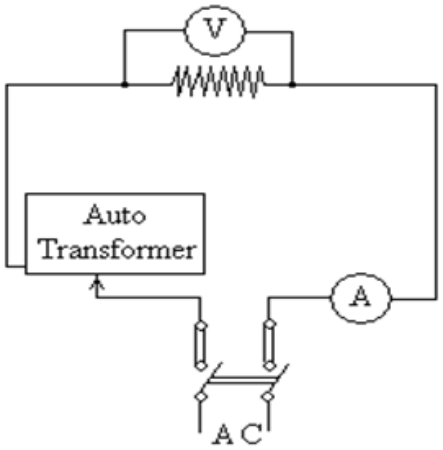



**Fig. 3.2 : Measurement of resistance**

2. Put the switch ON.
3. Take readings of the meters.
4. Vary the current by the auto transformer and take readings.
5. Put the reading in the table given.
6. Find value of resistance by using the formula given.

| Sl. No. | V | I | R = V/I | Average R |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |

## 3.3 Measurement of Frequency, Voltage, Current, Power, Power Factor, Energy in a Single Phase AC Circuit

**Aim :** To measure voltage, current, power, energy, power factor and frequency of a circuit supplied with an A.C. Source.

**Materials, tools and equipment :**

| Materials | Qty. | Tools | Equipments |
|---|---|---|---|
| 1.5 mm sq. wire | 5 mtr. | Screw driver set | Frequency meter – 1 No. |
| 5 Amps ON-OFF | 3 Nos. | Plier | 1 phase, 2 amps, |
| Switch Bulb, | 2 " | Knife | 230V energy meter – 1 No. |
| 100 Watt | 1 " | | 230V single phase |
| Choke 40 W | 2 " | | watt meter – 1 No. |
| Lamp holder | 1 " | | M.I. volt meter – 1 No. |
| Insulation tape | | | M.I. ammeter – 1 No. |
| | | | Frequency meter – 1 No. |
| | | | Potential Transformer |
| | | | ( P.T.) – 1 No. |

**Procedure :**

1. Connect all the meters and load as per the circuit diagram shown in Figure 3.3.

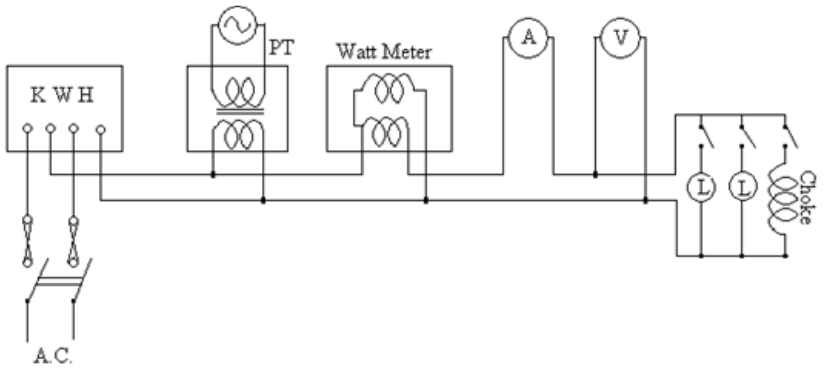



**Fig. 3.3 : Circuit for measurements of electrical parameters**

2. Put the switch ON. Notice the direction of rotation of the energy meter.
3. If the energy meter rotates in reverse direction, inter change the connections of the load and the supply, putting the supply mains OFF.

4. If the watt meter reads back, inter change the connections of the current coil putting the mains OFF.
5. Interchange the connections of voltmeter as well as ammeter if they reads back keeping the mains OFF.
6. Take readings at a particular interval say 10 minutes with the bulbs and choke in the circuit in ON condition.
7. Record all readings in the table given below:

| Sl. No. | Energy meter reading | | Energy Consumed = Final – Initial | Watt meter reading | V | I | F | P.F. = $\frac{W}{VI}$ |
|---|---|---|---|---|---|---|---|---|
| | Initial | Final | | | | | | |
| | | | | | | | | |

8. Repeat the test with a) Bulb only b) Choke only c) Other load.

## 3.4 Test of House Wiring With Megger Insulation Tester

**Aim :** To test a house wiring for its polarity, continuity, insulation between phase & neutral, phase-neutral & ground.



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Before giving electric supply to any installation, it is a must to test it by a megger insulation tester for its polarity, continuity etc as per I.E. Rules. The megger used for this generates 500V when rotated at 160r.p.m. During the test, the main switch is kept in OFF position.

**Materials :**

1. A typical house wiring.
2. A megger.
3. 1.5 mm sq. wire approx. 10 meters.

**Procedure :**

1. **Continuity test :** To test continuity, switch OFF the main switch; close all switches on the switch board. Fix all appliances like bulb, refrigerator, fan etc.In their respective holder, socket etc. Now connect line and neutral to the Megger. Rotate the Megger at about 160 r.p.m.. The megger reading should be zero. Carry on this teat on every branch circuit one by one.
2. **Insulation test between line and neutral :** For this test, switch OFF mains and remove all appliances like bulb, fan, refrigerator etc from their respective holder, socket etc. Switch ON all the switches on the switch board. Now connect the megger between line and neutral. Rotate the handle of the megger at 160 r.p.m. If you get infinite resistance (at least 7 Mega Ohm) then the insulation level is said to be satisfactory.
3. **Insulation test between line and earth :** The procedure of this test is also same as above. Only in this test you have to connect the megger between line and earth. The reading of the megger should also be infinite or at least 7 Mega Ohm.
4. **Insulation test between earth and neutral :** Here also the procedure is same, only the megger should be connected between the neutral and earth. The reading of the megger should be infinite or at least 7 Mega Ohm.
5. **Earth resistance test :** In any domestic wiring every socket has an earthing point which is to be connected to the earthing pipe of the installation. So there should be a continuity from every earth point of socket to the earthing pipe. Now connect one wire from the earth point of a socket to the megger and another wire from earthing point. Rotate the megger. It should show very low resistance, of the order of 1 Ohm. Carry on this test between every socket point and the earthing pipe.

The earth resistance between the earthing pipe and the surrounding soil can be measured by eart tester taking the help of two auxiliary electrodes.

## 3.5 Measurement of Earth Resistance by Electrical Earth Tester

Earth tester is used to measure the resistance between the earthing pipe and the surrounding soil. The earth resistance should be measured periodically for safe electrical operation in any electrical installation. According to ISI specification earth resistance must not exceed 5 Ohm in ordinary soil and 8 Ohm in rocky soil. The diagram below show a battery operated earth tester which runs on 9 volt battery.

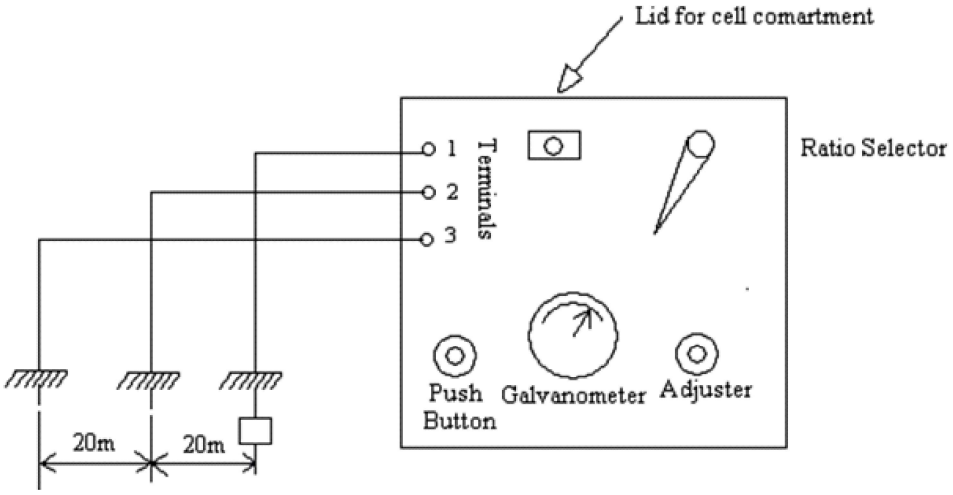



**Fig. 3.4 : Measurement of earth resistance by electric type earth tester**

**Aim :** To measure earth resistance surrounding an earthing pipe.

**Materials :**

1. 1.5 mm sq. wire about 20 meter and 40 meter.
2. Auxiliary electrode

**Procedure :**

1. Connect the earthing pipe to terminal 1.
2. Connect the other two leads to the auxiliary electrodes.

3. Drive the auxiliary spikes in the ground as shown in figure.
4. Select the meter switch.
5. Push the button and bring the galvanometer reading to NULL by the adjuster.

Under this condition, Earth resistance = Resistance adjusted X ratio selected.

## 3.6 Measurement of Earth Resistance by Meggertype Earth Tester

This instrument is similar to a Megger having a handle to rotate to generate voltage. There are four terminals which are connected to the pipe earthing and the two other auxiliary electrodes.

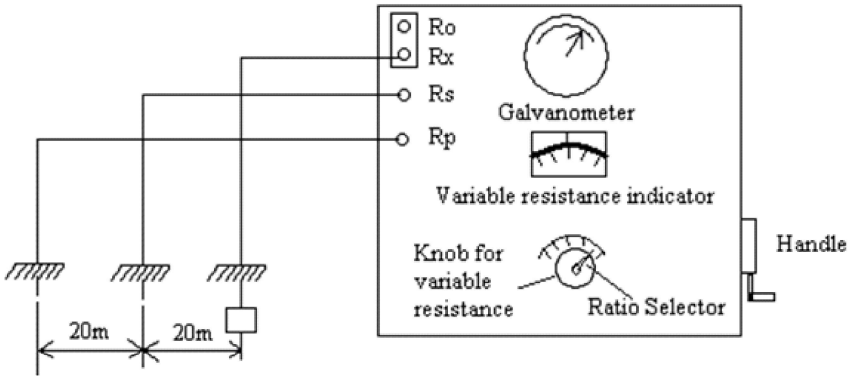



**Fig. 3.5 : Megger type earth tester**

**Procedure :**

1. Short the terminals $R_o$ with $R_x$ and connect it to the pipe earthing.
2. Connect the 20m lead to $R_S$ and 40 m lead to Rp
3. Drive the auxiliary electrodes to the ground.
4. Select the ratio.
5. Rotate the handle.
6. Adjust the resistance in such a way so that the galvanometer shows NULL.

Hence the Earth resistance = Resistance adjusted X ratio selected.

# 4. EXPERIMENTS: ELECTRICAL WORKSHOP HAND TOOLS & CONSUMABLES

## 4.1 Demonstration of Workshop Hand Tools & Consumables

Many different tools and equipment are used to practice house wiring. Some of these are tabulated below and their diagrams are shown in the figures 4.1 to 4.4.

| Sl. No. | Tool | Size | Uses |
|---|---|---|---|
| 1 | Screw driver | 10, 15, 20, 30 cm | Used for tightening or loosening screws. |
| 2 | Pliers | 15, 20, 25 cm | For holding, cutting or twisting wires |
| 3 | Nose pliers | 10 cm | -DO- |
| 4 | Cutting pliers | 20 cm | For cutting wires. |
| 5 | Electrician knife | 10 cm | For removing insulation and cleaning wires |
| 6 | Soldering iron | 10/25/35/60 /125 W | For soldering wires. |
| 7 | Cross peen hammer | 250 gm/ 500gm/ 1Kg/2 Kg | For fixing link clip, making holeon wall. |
| 8 | Ball peen hammer | -DO- | -DO- |
| 9 | Hand saw | 30.5cm/40.5cm | For cutting wooden batten, board etc. |
| 10 | Firmer Chisel | 1.25/1.9/2.54cm | Used for preparing switch board and batten. |
| 11 | Try square | 15/20/30cm | To check right angle. |
| 12 | Cold Chisel | 10/15 cm | For making holes on wall. |
| 13 | Poker | 10/15 cm | For making small hole for fixing of screws. |
| 14 | Gimlet | 10-25 mm | For making hole on wooden board etc. |
| 15 | Hand drill | 3/6/12 mm | -DO- |

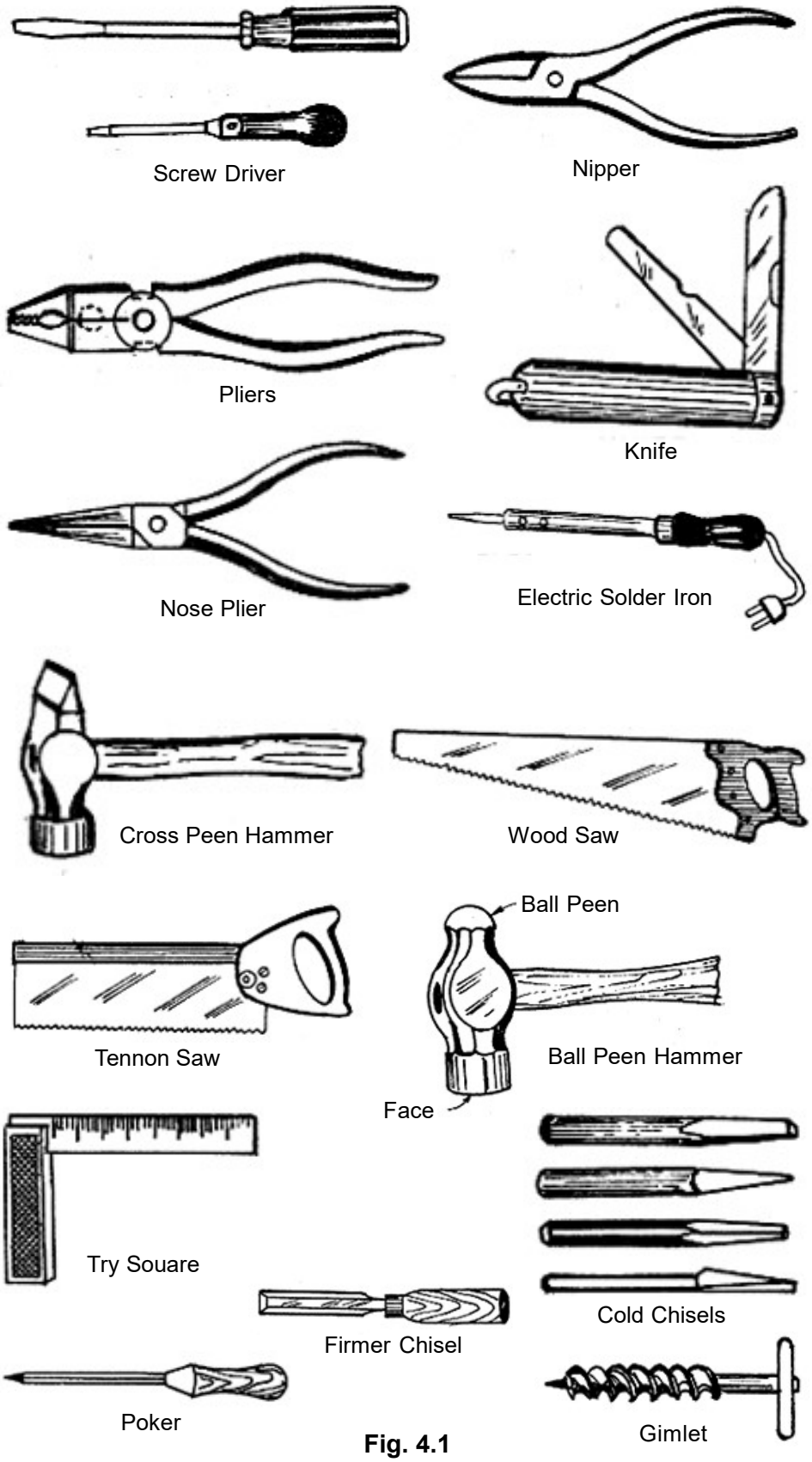

Screw Driver
Nipper
Pliers
Knife
Nose Plier
Electric Solder Iron
Cross Peen Hammer
Wood Saw
Ball Peen
Tennon Saw
Ball Peen Hammer
Face
Try Souare
Cold Chisels
Firmer Chisel
Poker
Gimlet

**Fig. 4.1**

| Sl. No. | Tool | Size | Uses |
|---|---|---|---|
| 16 | Rawal plug tool | 8/9/10 No. | For making holes on stone wall or concrete wall. |
| 17 | Hack saw | 16/20/25/30 cm | For cutting M. S. conduit pipes. |
| 18 | Flat/half round/ round flat | 8 to 35 cm | To smooth surface of any iron board etc. |
| 19. | Ratchet brace | 2.5 cm bit | It is used for drilling. |
| 20 | Auger bit | 6 to 25 mm | For making holes in doors, windows to pass wires. |
| 21 | Plumb bob | ———— | For making vertical lines. |
| 22 | Pin vice | 0.7/1.5/3 mm | For holding small objects like pins etc. |
| 23 | Pipe vice | 25/50/100/150 mm | For holding tightly conduit pipes for thread cutting. |
| 24 | Bench vice | 50/75/100/125/ 150mm | For holding tightly any substance for cutting or filing. |
| 25 | Hand vice | 25/30/50/ mm | For holding wires for making joints. |
| 26 | Centre punch | 100/150 mm | For making punch hole for drilling in metals. |
| 27 | Pipe wrench | 15 to 60 mm | For tightening or opening conduit pipes. |
| 28 | Mallet | ———— | Used as a hammer for soft items. |
| 29 | Blow lamp | 0.5/1/1.5 liter | For heating purposes. |
| 30 | Rasp cut file | 15/20/30 cm | For filing wooden objects. |
| 31 | Spanner set | ———— | Used to tighten and loosen bolts, nuts etc. |
| 32 | Drill Machine | ———— | Used for making holes on wall, ceiling for plastic plugs. |
| 33 | Crimping tool | 1.5, 2.5, 6 mm | Used to fix lugs with wires. |
| 34 | Measuring tape | 10 or 20 mtr. | Used for measuring distances in house wiring. |
| 35 | Wire striper and cutter | ———— | Used to remove insulation of wires. |
| 36 | Neon tester | 500 V | Used to test live wire. |
| 37 | Pipe cutter | ———— | Used to cut conduit pipes. |

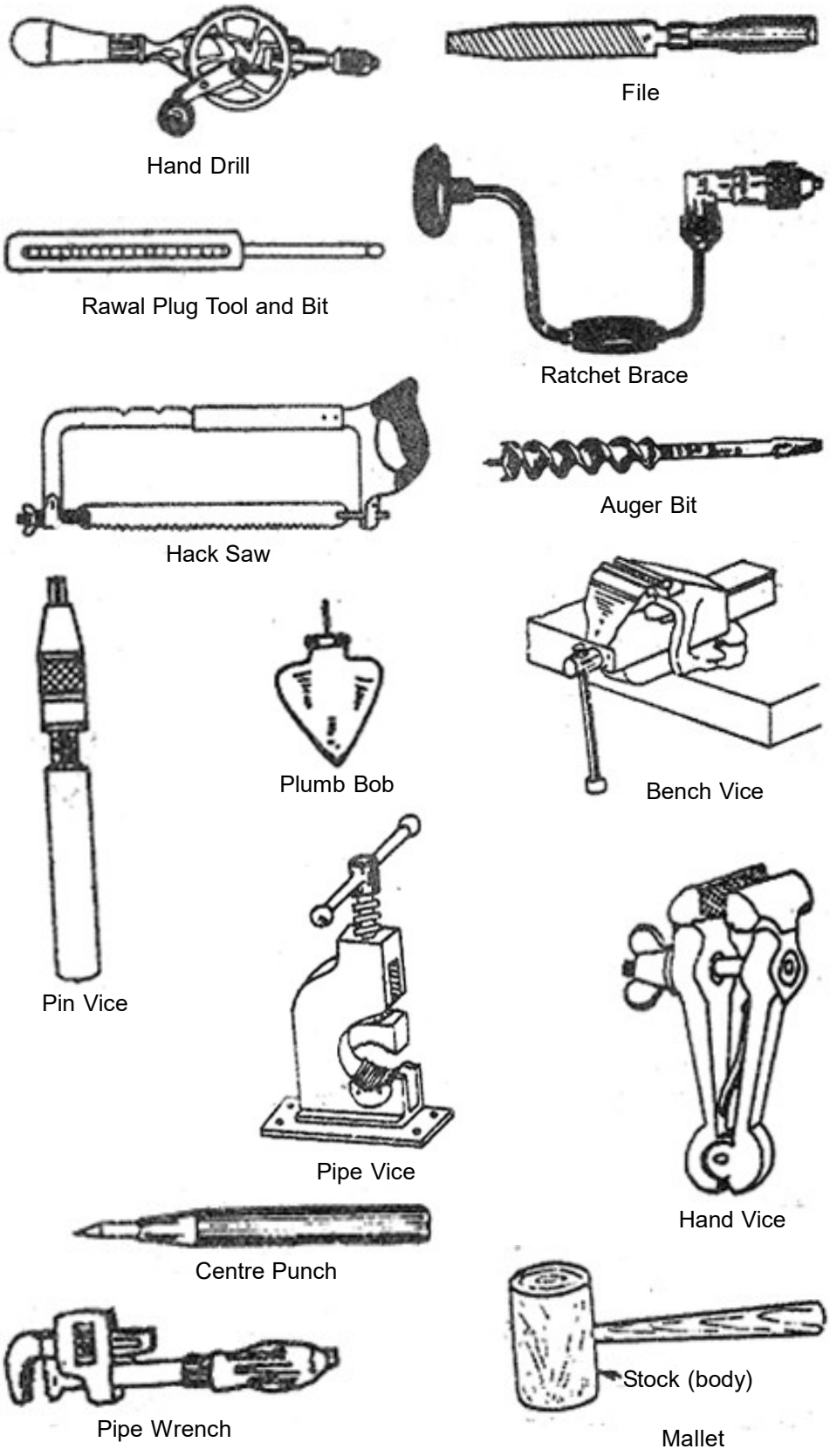

Hand Drill
File
Rawal Plug Tool and Bit
Ratchet Brace
Hack Saw
Auger Bit
Plumb Bob
Bench Vice
Pin Vice
Pipe Vice
Hand Vice
Centre Punch
Pipe Wrench
Stock (body)
Mallet

**Fig. 4.2**

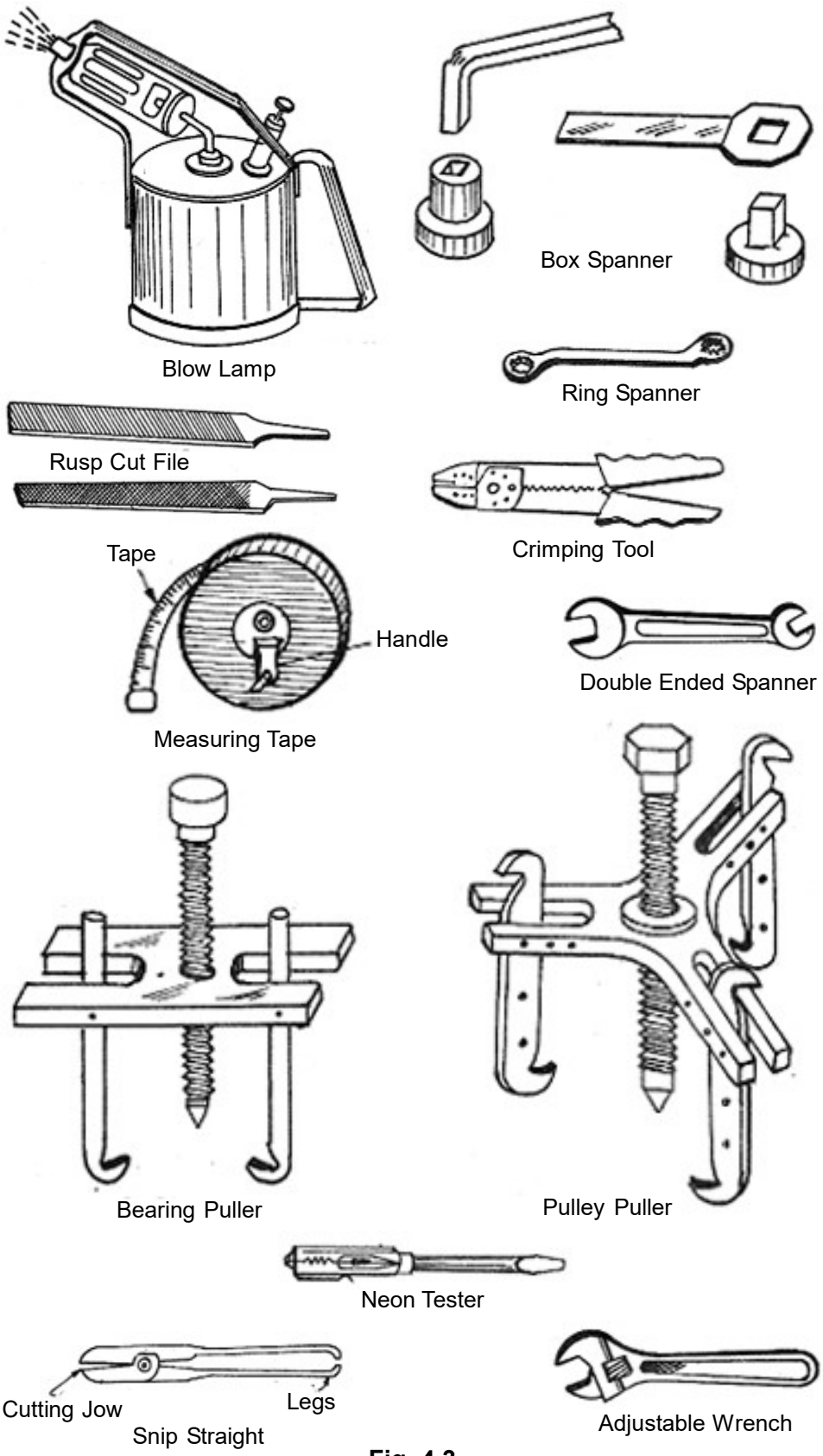

Blow Lamp
Box Spanner
Ring Spanner
Rusp Cut File
Crimping Tool
Tape
Handle
Measuring Tape
Double Ended Spanner
Bearing Puller
Pulley Puller
Neon Tester
Cutting Jow
Legs
Snip Straight
Adjustable Wrench

**Fig. 4.3**

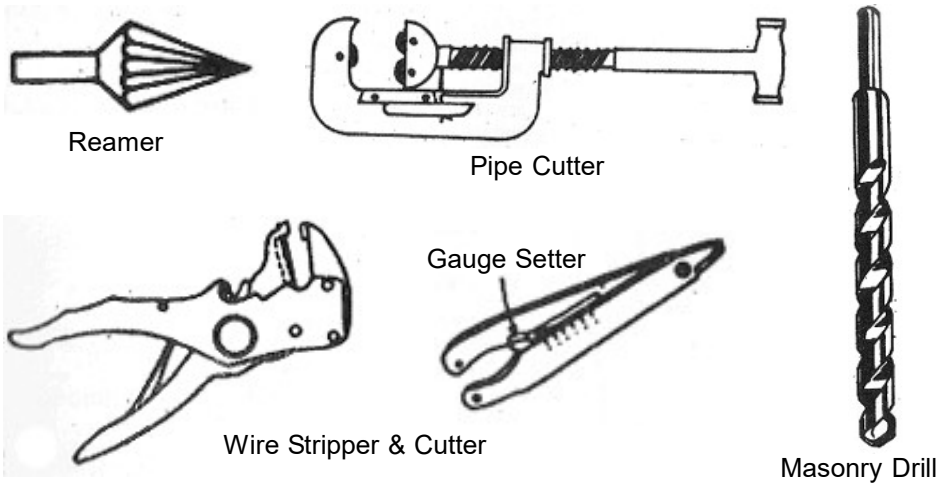



**Fig. 4.4**

## 5. EXPERIMENTS : CABLES & WIRES AS PER IS 732-1963-APP-D & CRIMPING OF THIMBLES & LUGS

**Cables :** Cable means any current carrying conductor either solid or stranded with surrounding insulation. The conducting portion may constitute of one part or multiple part called core. Each core is insulated individually and all the cores are bunched together in one common covering. These are called multi-core cable. A cable consists of– 1. Conductor, 2. Insulation on each core and 3. Overall protective covering against mechanical injury.

**Types of cables :** The cables are classified as–

a) aerial cable and b) under-ground cable.

Aerial cables are laid along the wall, poles and are exposed to air. These are further classified as –

i) V.I.R. cable
ii) P.V.C. cable
iii) Varnish cambric cable

Under-ground cables are laid in ground for carrying current. These are particularly useful in densely populated area, in congested market place etc. These are costly.

**Selection of cable size :** As per load an electrician has to select the size of the cable. Generally a lighting circuit should not exceed 600

watt per way of distribution box or MCB. On a 16 ampere socket line, it may go up to 3000 watt. As for example a geyser may draw 1500/2000/ 3000 watt or an immersion heater may draw 1000/1500 watt when connected to a 16 ampere socket. Therefore the electrician has to decide what would be size of the conductor used for a particular circuit. To decide he must know the specification of commercially available wires or cables such as cross-sectional area, overall diameter, current carrying capacity etc.

Following is a table showing specification of wires used in domestic house wiring which include cross-sectional area of conductor, number of strand, current carrying capacity etc. The table shows the data for SINGLE CORE FR PVC INSULATED COPPER CONDUCTOR (UNSHEATHED) HEAVY DUTY ELECTRIC WIRES IN VOLTAGE GRADE UPTO AND INCLUDING 1100V *(Courtesy: Havell's cable specification published in web site)*

| Nominal cross sectional area of conductor | Number/ Nom. Dia. Of cond. Strands | Thickness of insulation | Approx. overall dia-meter | Current carrying capacity 2 cables, single phase | | Resistance max. per KM at $20^0$ C |
|---|---|---|---|---|---|---|
| | | | | Conduit/ Trunking | Unenclosed clipped directly to a surface | |
| $mm^2$ | mm | mm | mm | Amps | Amps | Ohms |
| 0.5 | 16/0.2 | 0.6 | 2.2 | 4 | 5 | 39.00 |
| 0.75 | 24/0.2 | 0.7 | 2.5 | 7 | 8 | 26.00 |
| 1.0 | 14/0.3 | 0.7 | 2.8 | 11 | 12 | 18.10 |
| 1.5 | 22/0.3 | 0.7 | 3.1 | 13 | 16 | 12.10 |
| 2.5 | 36/0.3 | 0.8 | 3.8 | 18 | 22 | 7.41 |
| 4.0 | 56/0.3 | 0.8 | 4.4 | 24 | 29 | 4.95 |
| 6.0 | 84/0.3 | 0.8 | 5.0 | 31 | 37 | 3.30 |

**Crimping of Thimbles & Lugs :** Sometimes it becomes necessary to connect an electric wire to some kind of terminals. One of such terminal is a lug. For aluminum conductor and sometime for copper conductor also, a lug is connected to the conductor by soldering and by crimping.

But in most of the cases, cables are connected to the conductor by crimping. Figure 5.1 shows various types of crimping pliers and lugs.

## 5.1 Connecting a Lug to a Conductor

**Aim :** To connect a lug to a conductor of size 6 mm square.

**Tools :** Cable crimping plier, electrician knife, cutter, sand paper, cotton-waste.

**Materials :** Aluminium or copper conductor of size 6 mm sq. and a lug of same size.




**Fig. 5.1**

**Procedure :**

1. Take a piece of conductor and remove its insulation up to 1 cm length.
2. Clean the bare part of the conductor by sand paper and cotton-waste.
3. Insert the bare end of the conductor into the lug.
4. Press the lug by the crimping plier. Figure 3.6 shows a cable after crimping.

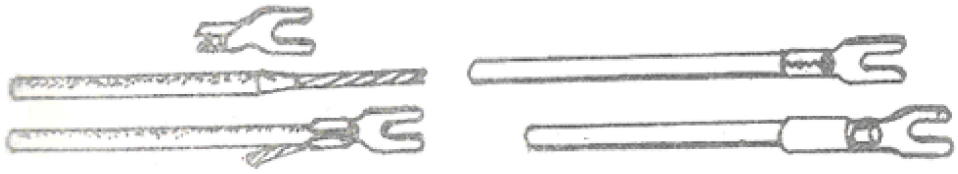


**Fig. 5.2**

# 6. EXPERIMENTS : PRACTICES ON USE OF WIRING ACCESSORIES, T/W, PVC BOARD

## 6.1 Demonstration & Practice of Different Electrical Circuit Connection

**Aim : Demonstration & Practice of different electrical circuit connection :** The circuit connection shown in **Figure 6.1**, **Figure 6.2** and **Figure 6.3** are extensively used in domestic house wiring. So, an electrician must accustom himself with these circuit connections before he practice his profession.

**Tools :**

1. Electrician knife.
2. Pliers of different types.
3. Screw driver set
4. Side cutter
5. Neon tester
6. Test lamp.

**Materials :**

1. Single pole one way, 230V, 5 amps ON-OFF switch.
2. Single pole two way, 230V, 5 amps ON-OFF switch.
3. 230V, 60W Bulb.
4. 1.5 sq. mm PVC wire – 10 m.
5. 230V, 5 amps & 15 amps 3 pin socket.
6. 230V, 5 amps pendant holder.
7. 230V, 5 amps batten holder.
8. 14 SWG, G.I. earth wire – 5 m.

**Procedure :**

1. Make the layout diagram of the circuit.
2. Fix all the circuit elements in place as per the circuit diagram.
3. After completion, check the circuit with neon tester and test lamp.

**Precautions :**

1. All connections should be tight and secure.
2. All ON-OFF switches should be connected in phase wire only, **not in neutral wire.**
3. No bare conductor are exposed; these must be insulated by PVC tap.

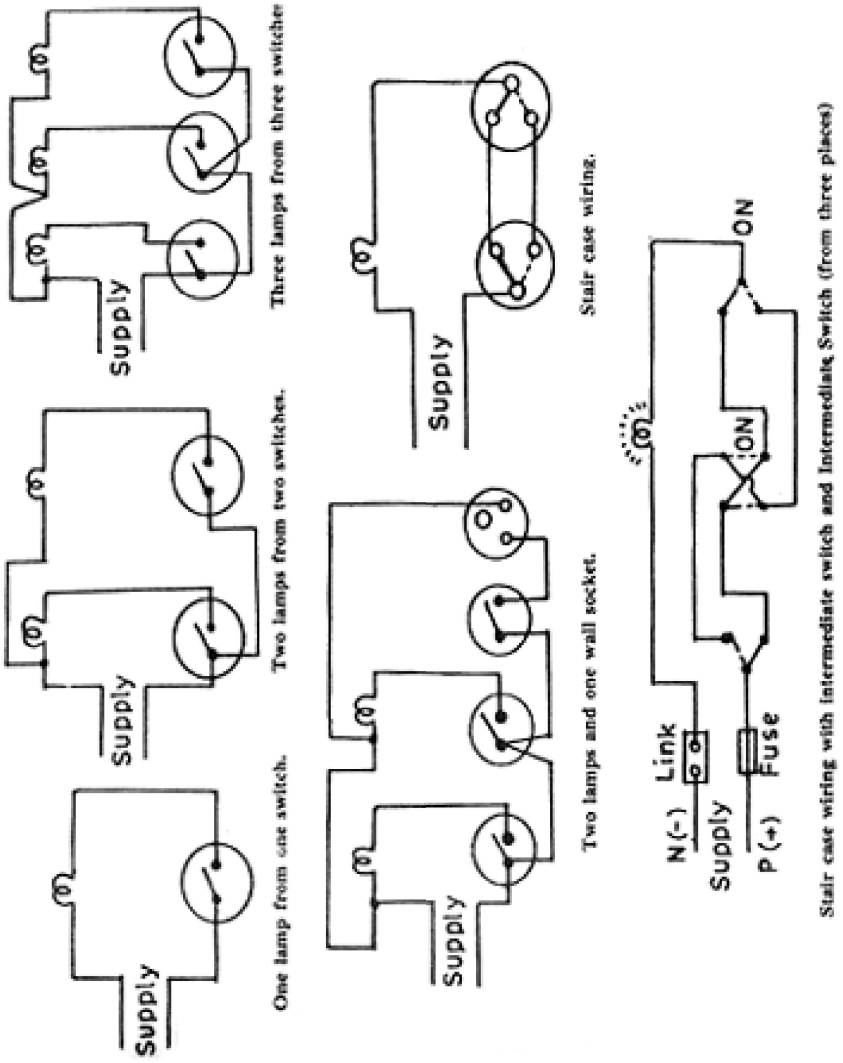
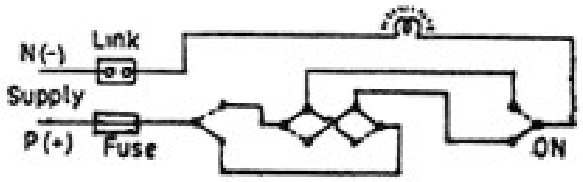
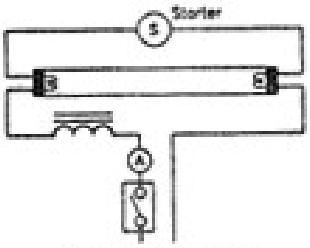


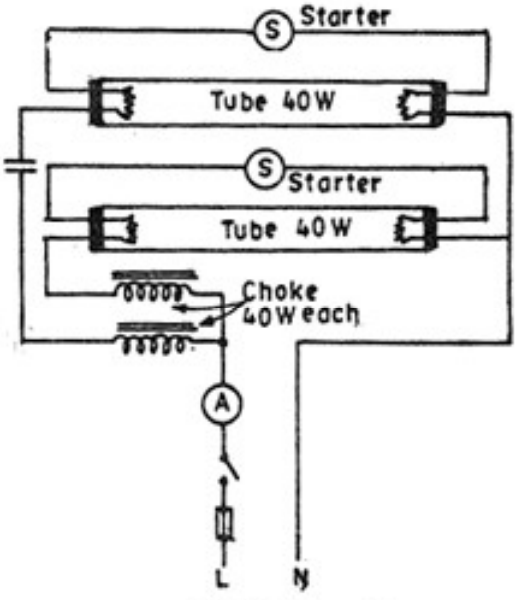

**Fig. 6.1**



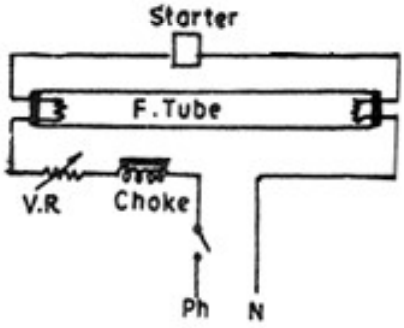

Stair case wiring with two way switches (from three places).




*F.* Tube Connection.




Two *F.* tube in parallel.




Tube circuit on D.C. supply.

Electric circuit connections.

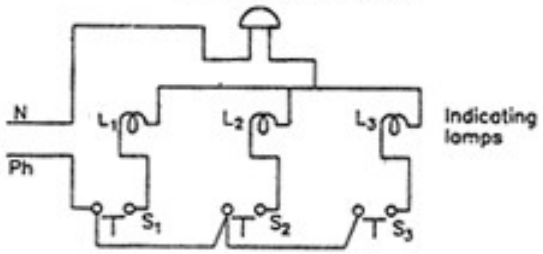
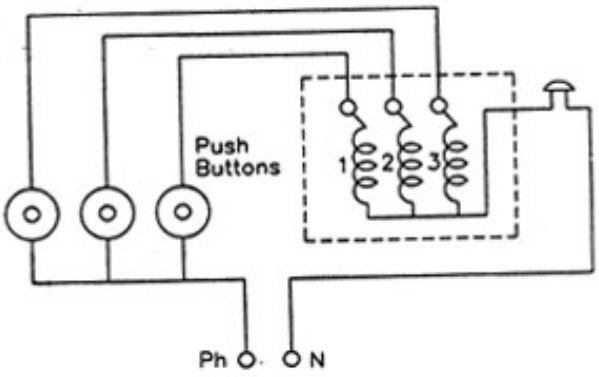
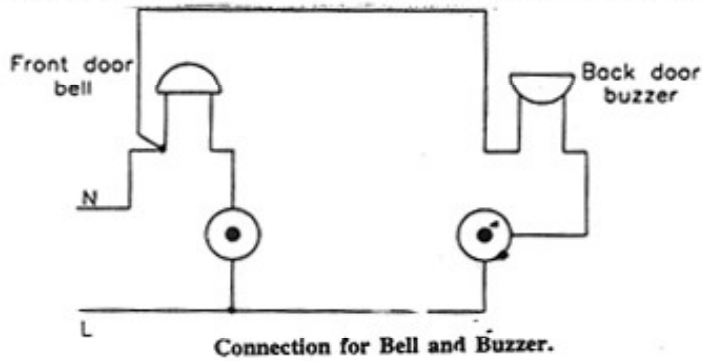



**Fig. 6.2**




One bell controlled from three places with 3 way magnetic bell indicator.




Connection for Bell and Buzzer.

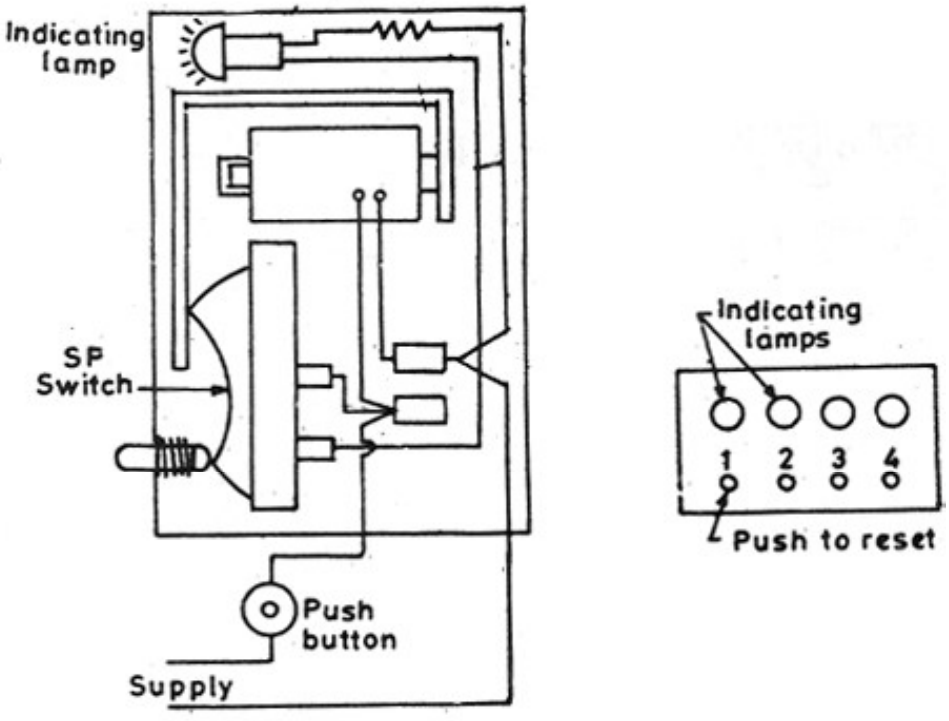



**Fig. 6.3**

## 6.2 Various Switches and Other Fittings Used in Wiring

Following are some switchgear and other lighting accessories a wireman use.

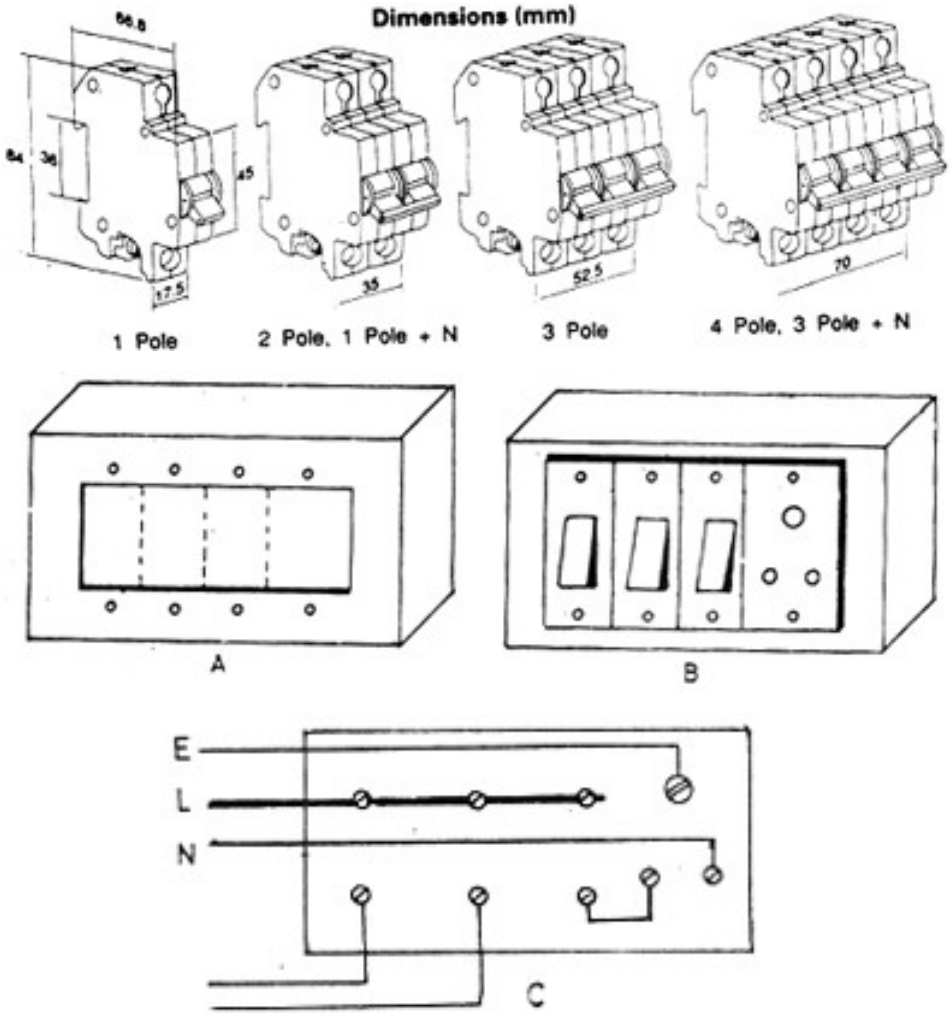



**Fig. 6.4 : MCB, Isolator, Switch**

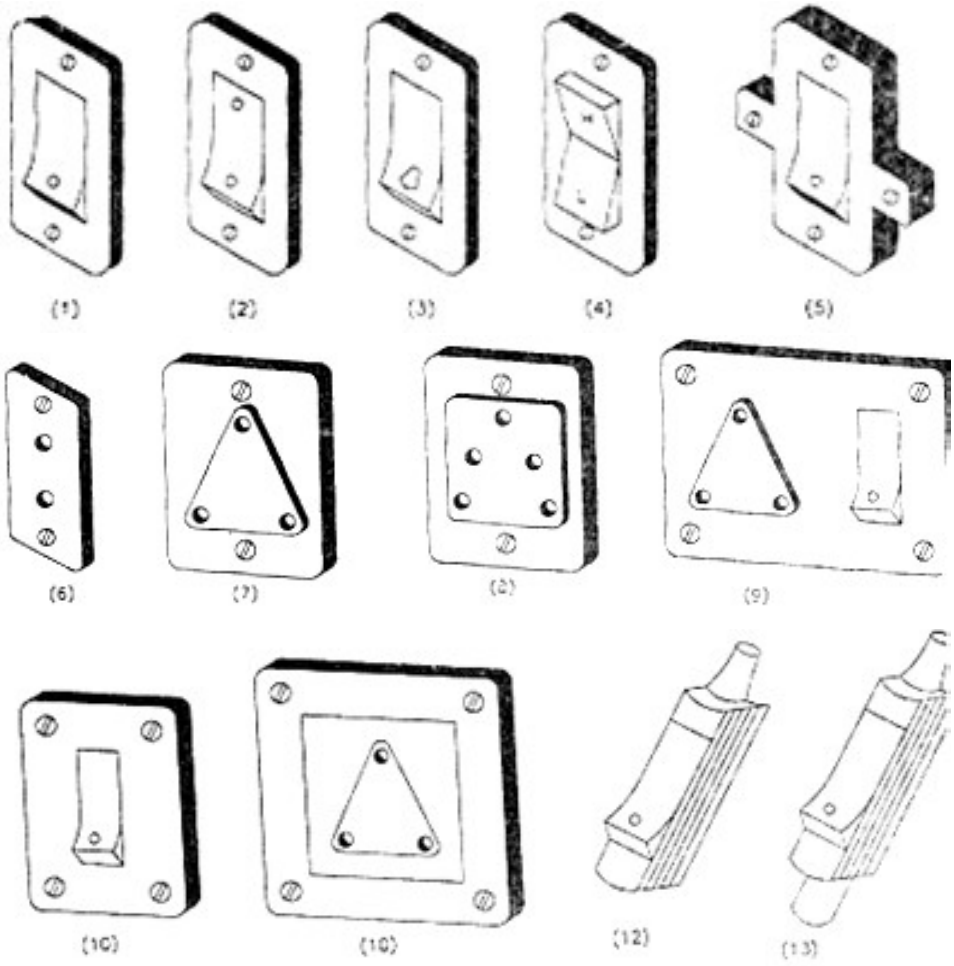



**Fig. 6.5 : Various Switches and Sockets**

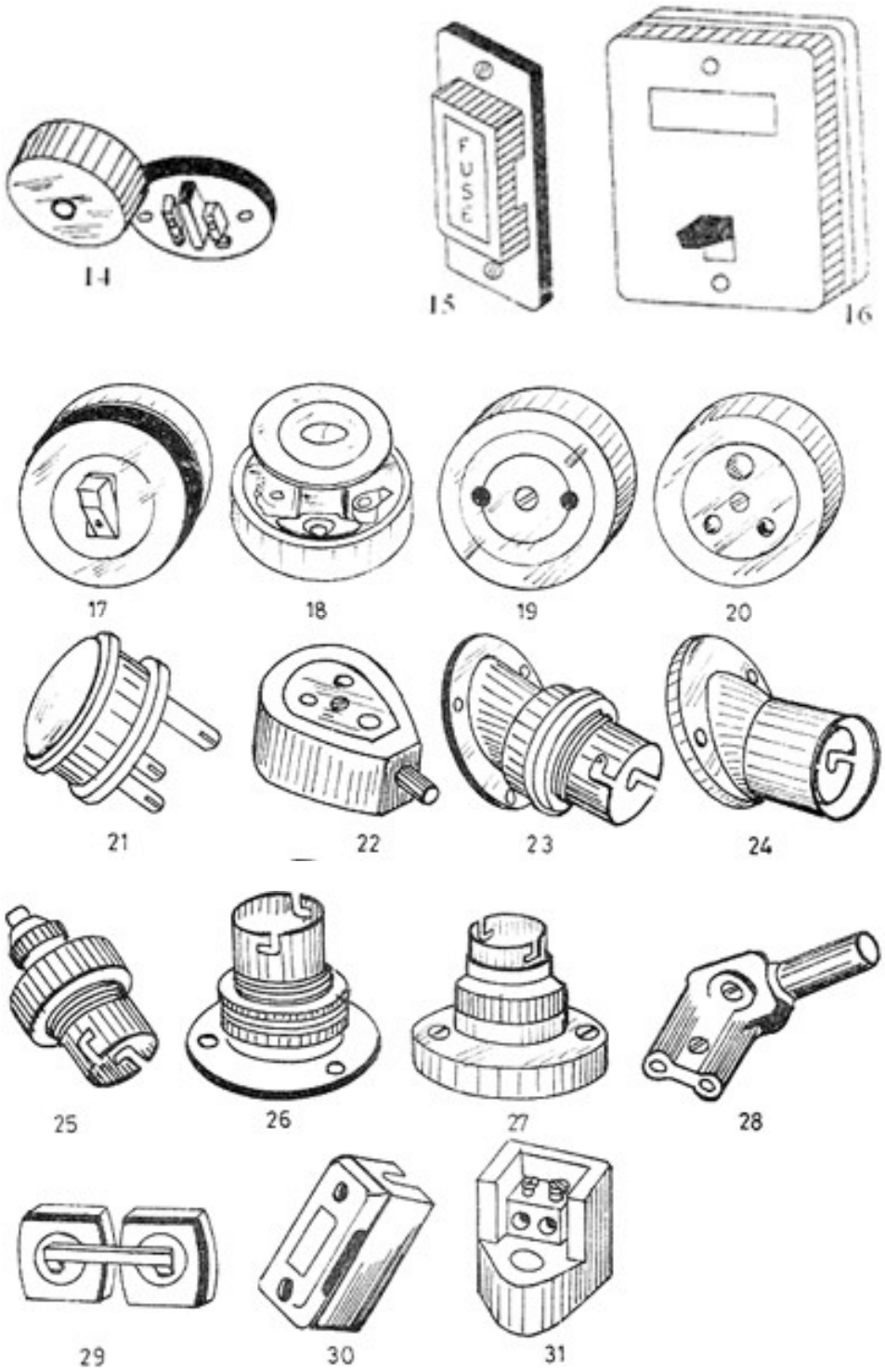



**Fig. 6.6 : Various Sockets, Plugs, Holders, Kit-kat fuseetc**

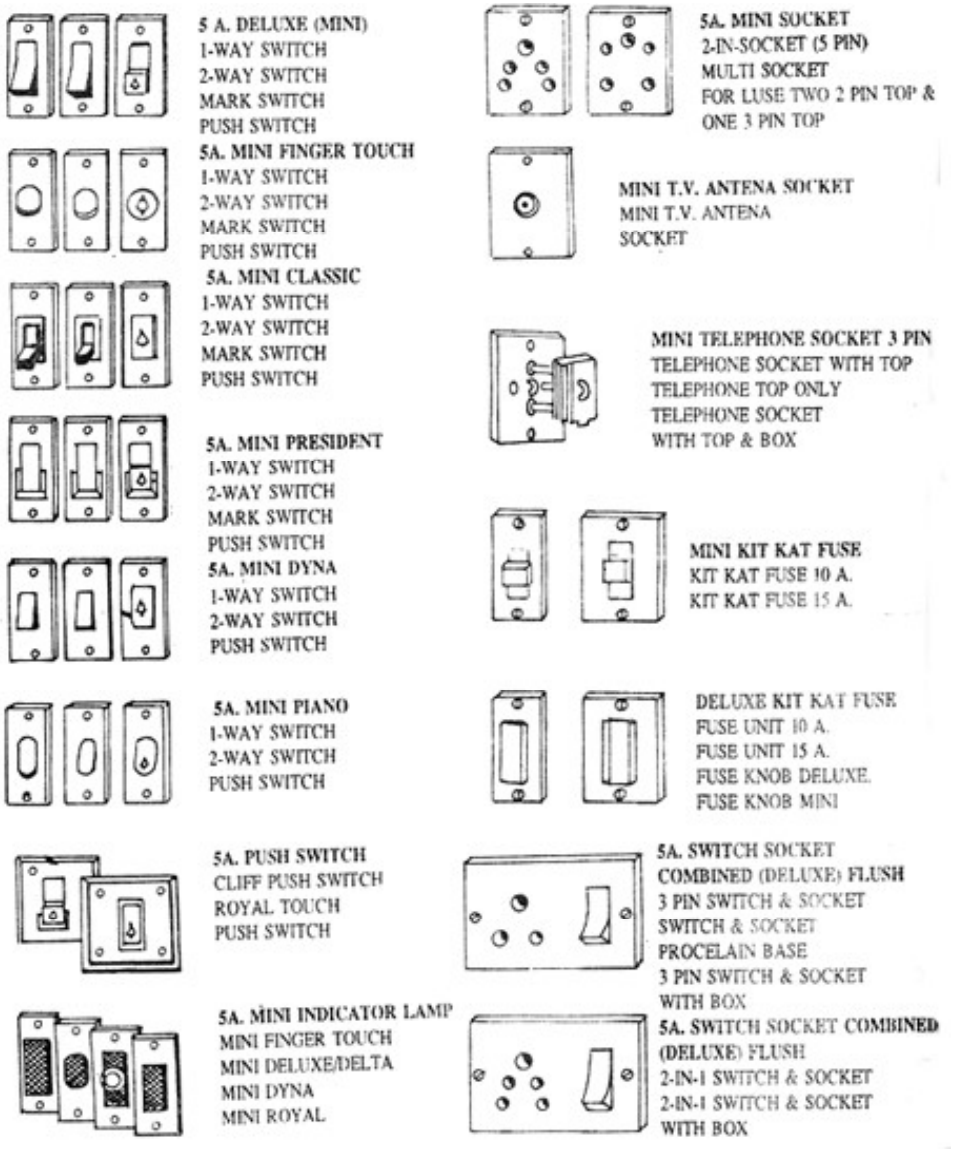

5 A. DELUXE (MINI)
1-WAY SWITCH
2-WAY SWITCH
MARK SWITCH
PUSH SWITCH
5A. MINI FINGER TOUCH
1-WAY SWITCH
2-WAY SWITCH
MARK SWITCH
PUSH SWITCH
5A. MINI CLASSIC
1-WAY SWITCH
2-WAY SWITCH
MARK SWITCH
PUSH SWITCH
5A. MINI PRESIDENT
1-WAY SWITCH
2-WAY SWITCH
MARK SWITCH
PUSH SWITCH
5A. MINI DYNA
1-WAY SWITCH
2-WAY SWITCH
PUSH SWITCH
5A. MINI PIANO
1-WAY SWITCH
2-WAY SWITCH
PUSH SWITCH
5A. PUSH SWITCH
CLIFF PUSH SWITCH
ROYAL TOUCH
PUSH SWITCH
5A. MINI INDICATOR LAMP
MINI FINGER TOUCH
MINI DELUXE/DELTA
MINI DYNA
MINI ROYAL
5A. MINI SOCKET
2-IN-SOCKET (5 PIN)
MULTI SOCKET
FOR LUSE TWO 2 PIN TOP &
ONE 3 PIN TOP
MINI T.V. ANTENA SOCKET
MINI T.V. ANTENA
SOCKET
MINI TELEPHONE SOCKET 3 PIN
TELEPHONE SOCKET WITH TOP
TELEPHONE TOP ONLY
TELEPHONE SOCKET
WITH TOP & BOX
MINI KIT KAT FUSE
KIT KAT FUSE 10 A.
KIT KAT FUSE 15 A.
DELUXE KIT KAT FUSE
FUSE UNIT 10 A.
FUSE UNIT 15 A.
FUSE KNOB DELUXE.
FUSE KNOB MINI
5A. SWITCH SOCKET
COMBINED (DELUXE) FLUSH
3 PIN SWITCH & SOCKET
SWITCH & SOCKET
PROCELAIN BASE
3 PIN SWITCH & SOCKET
WITH BOX
5A. SWITCH SOCKET COMBINED
(DELUXE) FLUSH
2-IN-1 SWITCH & SOCKET
2-IN-1 SWITCH & SOCKET
WITH BOX

**Fig. 6.7**

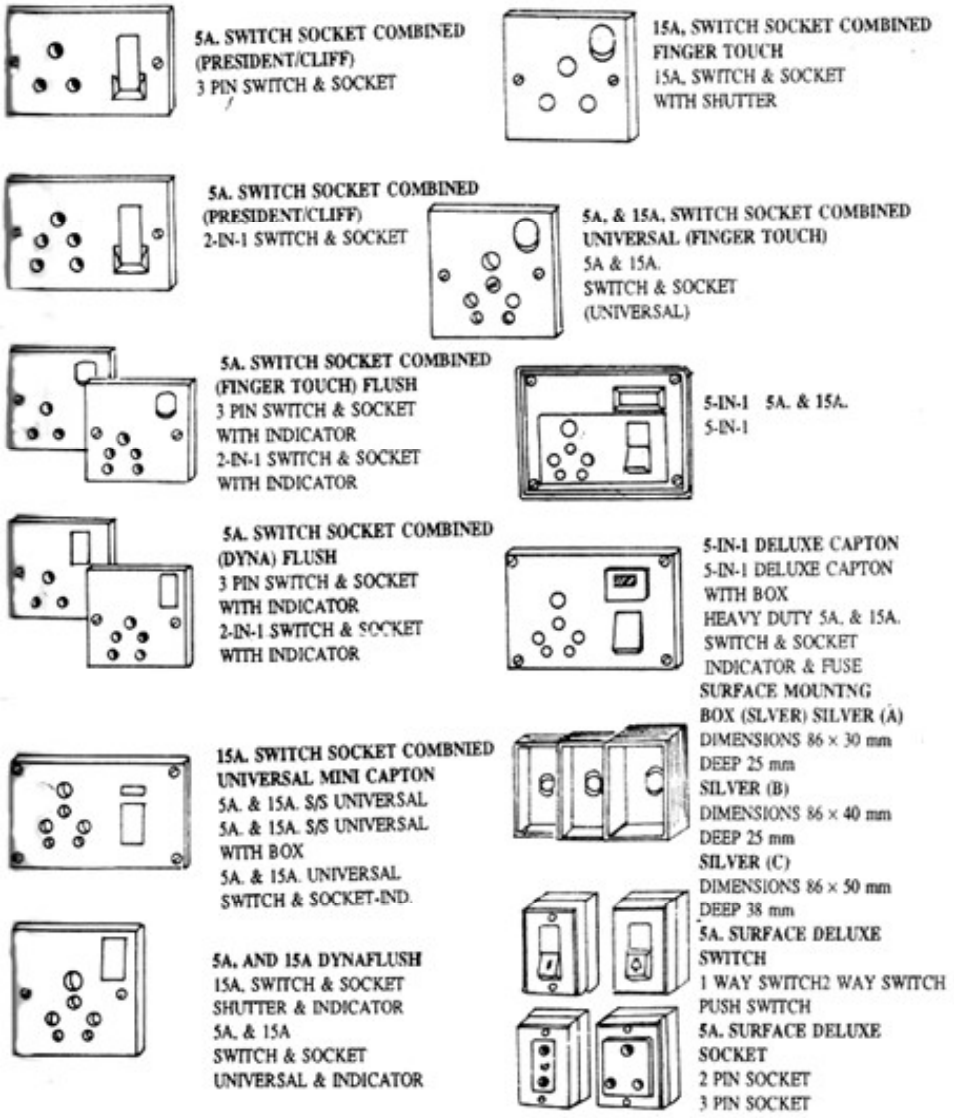

5A. SWITCH SOCKET COMBINED
(PRESIDENT/CLIFF)
3 PIN SWITCH & SOCKET
15A, SWITCH SOCKET COMBINED
FINGER TOUCH
15A, SWITCH & SOCKET
WITH SHUTTER
5A. SWITCH SOCKET COMBINED
(PRESIDENT/CLIFF)
2-IN-1 SWITCH & SOCKET
5A, & 15A, SWITCH SOCKET COMBINED
UNIVERSAL (FINGER TOUCH)
5A & 15A.
SWITCH & SOCKET
(UNIVERSAL)
5A. SWITCH SOCKET COMBINED
(FINGER TOUCH) FLUSH
3 PIN SWITCH & SOCKET
WITH INDICATOR
2-IN-1 SWITCH & SOCKET
WITH INDICATOR
5-IN-1 5A. & 15A.
5-IN-1
5A. SWITCH SOCKET COMBINED
(DYNA) FLUSH
3 PIN SWITCH & SOCKET
WITH INDICATOR
2-IN-1 SWITCH & SOCKET
WITH INDICATOR
5-IN-1 DELUXE CAPTON
5-IN-1 DELUXE CAPTON
WITH BOX
HEAVY DUTY 5A. & 15A.
SWITCH & SOCKET
INDICATOR & FUSE
SURFACE MOUNTNG
BOX (SLVER) SILVER (A)
DIMENSIONS 86 × 30 mm
DEEP 25 mm
SILVER (B)
DIMENSIONS 86 × 40 mm
DEEP 25 mm
SILVER (C)
DIMENSIONS 86 × 50 mm
DEEP 38 mm
15A. SWITCH SOCKET COMBNIED
UNIVERSAL MINI CAPTON
5A. & 15A. S/S UNIVERSAL
5A. & 15A. S/S UNIVERSAL
WITH BOX
5A. & 15A. UNIVERSAL
SWITCH & SOCKET-IND.
5A. SURFACE DELUXE
SWITCH
1 WAY SWITCH2 WAY SWITCH
PUSH SWITCH
5A. SURFACE DELUXE
SOCKET
2 PIN SOCKET
3 PIN SOCKET
5A, AND 15A DYNAFLUSH
15A, SWITCH & SOCKET
SHUTTER & INDICATOR
5A, & 15A
SWITCH & SOCKET
UNIVERSAL & INDICATOR

**Fig. 6.8**

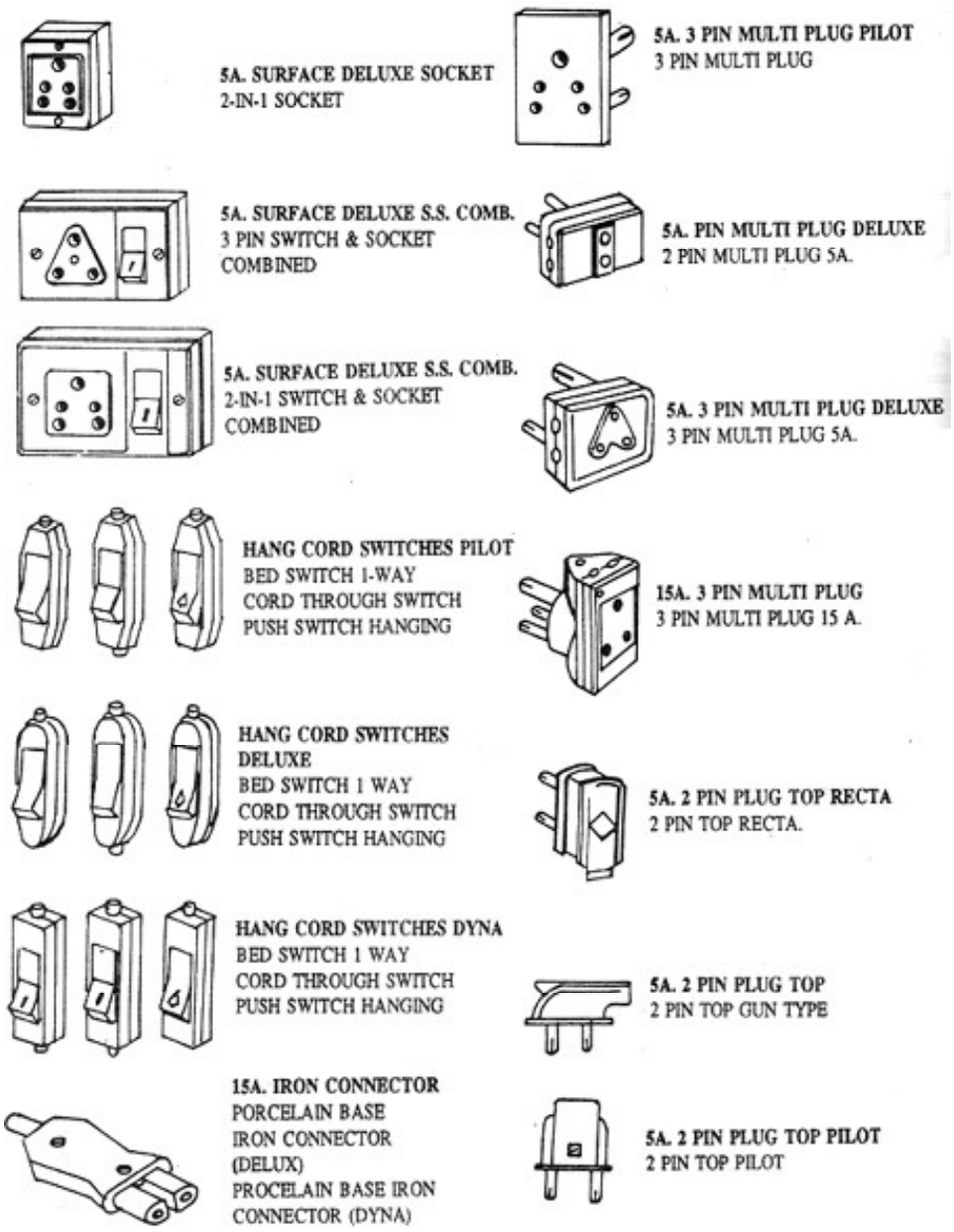

5A. SURFACE DELUXE SOCKET
2-IN-1 SOCKET
5A. 3 PIN MULTI PLUG PILOT
3 PIN MULTI PLUG
5A. SURFACE DELUXE S.S. COMB.
3 PIN SWITCH & SOCKET
COMBINED
5A. PIN MULTI PLUG DELUXE
2 PIN MULTI PLUG 5A.
5A. SURFACE DELUXE S.S. COMB.
2-IN-1 SWITCH & SOCKET
COMBINED
5A. 3 PIN MULTI PLUG DELUXE
3 PIN MULTI PLUG 5A.
HANG CORD SWITCHES PILOT
BED SWITCH 1-WAY
CORD THROUGH SWITCH
PUSH SWITCH HANGING
15A. 3 PIN MULTI PLUG
3 PIN MULTI PLUG 15 A.
HANG CORD SWITCHES
DELUXE
BED SWITCH 1 WAY
CORD THROUGH SWITCH
PUSH SWITCH HANGING
5A. 2 PIN PLUG TOP RECTA
2 PIN TOP RECTA.
HANG CORD SWITCHES DYNA
BED SWITCH 1 WAY
CORD THROUGH SWITCH
PUSH SWITCH HANGING
5A. 2 PIN PLUG TOP
2 PIN TOP GUN TYPE
15A. IRON CONNECTOR
PORCELAIN BASE
IRON CONNECTOR
(DELUX)
PROCELAIN BASE IRON
CONNECTOR (DYNA)
5A. 2 PIN PLUG TOP PILOT
2 PIN TOP PILOT

**Fig. 6.9**