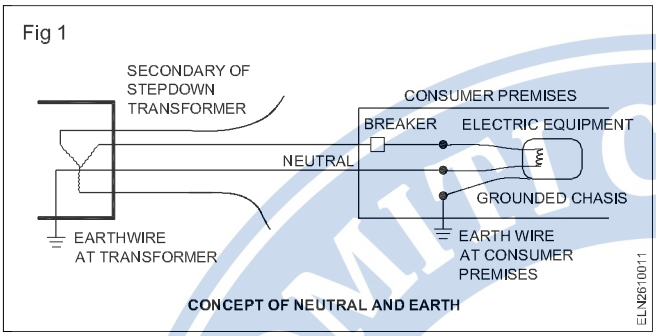
Concept of Neutral and Earth - Cooking range

Objectives: At the end of this lesson you shall be able to
- **state the concept of neutral and earth**
- **explain the domestic appliance**
- **explain the cooking range**
- **explain the parts of electric cooking range.**

Scan the QR Code to view the video for this exercise

Concept of neutral and earth (Fig 1)

Fig 1



Earth point is the point connected to the ground, i.e. earthed locally at the consumer premises while Neutral point is the star point of the secondary stepdown transformer feeding the consumer premises.

The role of Neutral point (Nuetral wire) is to close the circuit and carry the consumer load current (return current) back to the transformer. The earth point (earth wire at consumer premises) shall carry no current in normal situations.

The earth point (earth wire) is used to connect the metallic chassis of consumer equipment with the earth and isolate them from the live wires. Hence, the earth wire is used to ensure safety of equipment and personnel.

The earth wire will carry (short) currents in case of chassis of the equipment becomes electrified, i.e. a bare live conductor touches the metallic chassis. This short current will trip some circuit breaker in the way immediately.

The earth wire will carry (Leakage) small currents due to insulation deterioration, humidity and carbon deposit on the insulator. In this case a special breaker called ELCB (Earth Leakage Circuit Breaker) or RCCB (Residual Current Circuit Breaker) that is calibrated to trip at small currents (of the order of 6-30 mA for residual purposes and 300 mA for industrial purposes). Not all electric codes enforces the uses of ELCBs or RCCBs.

Domestic appliances:

Domestic appliance is an electrical equipment/machine used in houses for the various house hold tasks like cooking, washing and cleaning etc.

Standard safety norms: Trainees may be instructed to refer the international Electrotechnical commission (IECF 60335 -part 2 - section 64) for the standard safety norms related with domestic appliances for the further details.

Cooking range

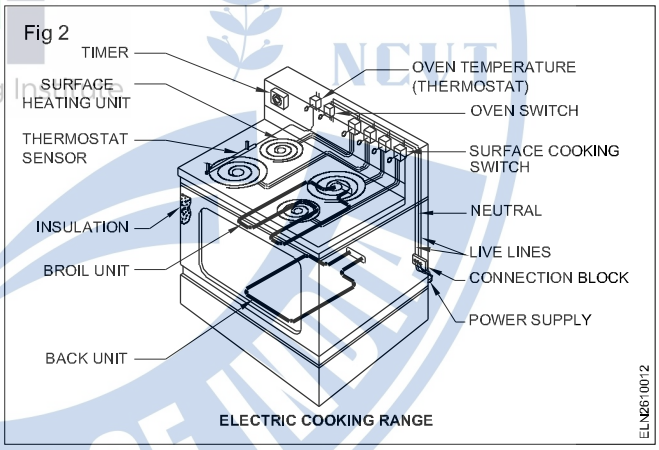
Electric cooking range is the combination of an oven and hot plate. The electric range consist of highly efficient heating elements, it gives better cooking control, has shelf oven, fingertip controls and designs to fit almost every possible kitchen need.

The surface heating units are set in the top of the range, the electric connections for these units are carried in the space between the top of the range (Fig 2). Oven controls are also kept in the top but in separate elevated pedestal.

The parts of a cooking range

Surface heating elements: In present day cooking range the nichrome element is encased in a metal tube with magnesium oxide insulation. This enclosed surface heating element (Fig 2) more efficient, more durable and safe to handle.

Fig 2



Step/Selector switches: A step switch is simply a rotary switch, which can select four or six different heats (wattages) Fig 3 and 4.

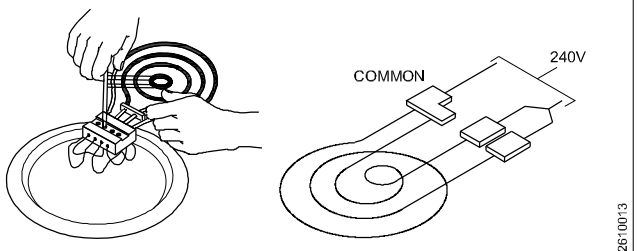
The step switch connected to two or three elements to 240 volts. The total circuit resistance or the voltage is changed to provide different heats.

High heat is obtained by connecting total elements in parallel. For low heat all the coils are connected in series (Figs 3 & 4).

Oven unit: The oven unit consists of two heating elements, an upper element and a lower element.

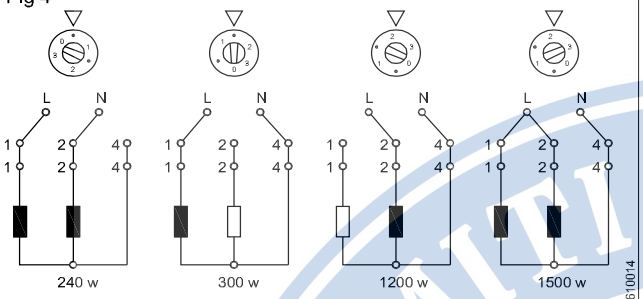
The oven heat is normally controlled by thermostat and timing device.

Fig 3



HEATING ELEMENTS

Fig 4

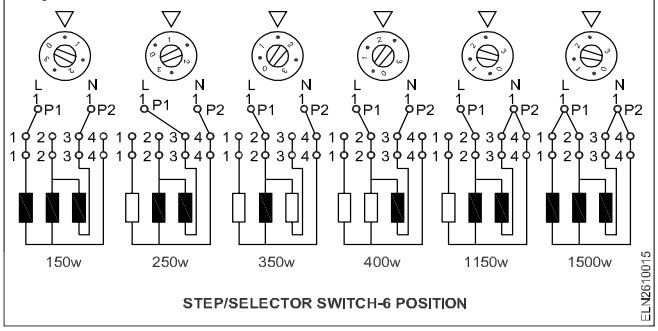


STEP/SELECTOR SWITCH-4 POSITION

In a oven electric circuit, the broil unit is constructed by stringing the element through the frame in two separate coils, whereas the bake unit is strung with only one coil.

Now-a-days instead of thermostat switch, the typical infinite-heat switches are used (Fig 5). This switch operates the internal heater causes the bimetal to open and close the switch that controls the range heater element. This bimetal heater is series the cooking range and must have the correct resistance for the element being controlled.

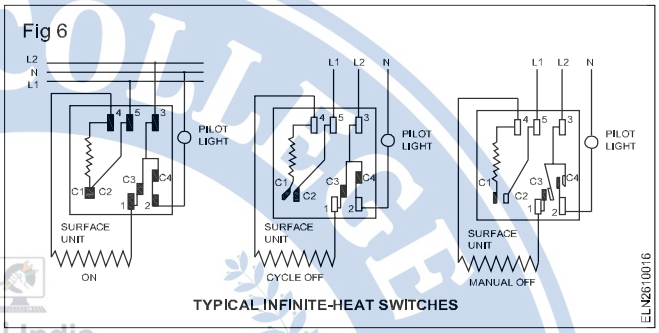
Fig 5



STEP/SELECTOR SWITCH-6 POSITION

A schematic diagram of a typical electric range is given in Fig 6.

Fig 6



TYPICAL INFINITE-HEAT SWITCHES

Geyser

Objectives: At the end of this lesson you shall be able to

- **explain geyser**
- **list the parts of a geyser from the schematic and constructional diagrams**
- **explain the construction and operation of a geyser**
- **explain the possible faults in a geyser and their remedies.**

Geyser

It is an electric water heater which heats and maintains the temperature of the water stored in it.

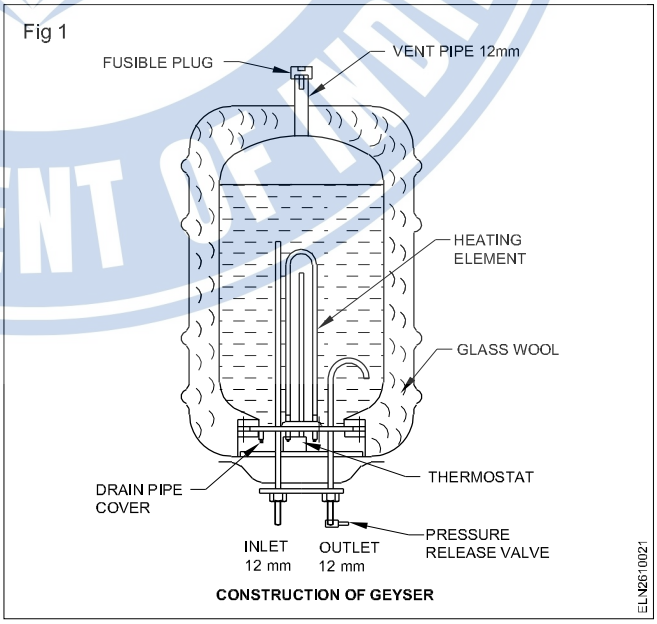
There are several types of water heaters. The most usual one is the geyser, which is more efficient as the hot water can be directly drawn through a tap at different points.

Construction of geysers: The construction of a hot water geyser or storage water heater is simple (Fig 1).

The outer casing is made of mild steel sheet. The inner tank is made of heavy gauge copper which is tinned to prevent corrosion. The space between the outer casing and the inner tank is filled with glass wool as heat insulation to avoid excess heat losses. Heating elements, thermostat, inlet and outlet pipes are fitted to the tank.

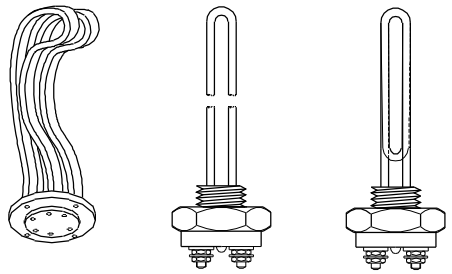
Heating elements are similar to those of immersion heaters but with different shapes to suit the tank sizes and the screw base. Fig 2 shows a few shapes of heating elements.

Fig 1



CONSTRUCTION OF GEYSER

Fig 2



DIFFERENT SHAPES OF HEATING ELEMENTS

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The rating of the heating elements depends on the capacity of the geyser. For up to 25 litres capacity, 1 KW elements are used while for 50 litres capacity 2 KW are used, for 100 litres capacity 3 KW are used.

Thermostats: Thermostats are used in water heaters to control the current to the heating elements and thereby regulate and maintain the water temperature between 32°C to 88°C.

A typical thermostat used in geysers: A thermostat used in a geyser is of tube and rod bimetal type (Fig 3).

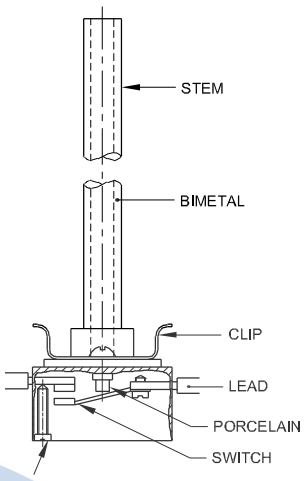
Thermostats are available in sizes of 8 mm diameter with a length of 175 mm, 275mm or 450 mm depending on the height of the geyser. Thermostats are fixed in a tube and are connected in series with the heating element.

The outlet pipe is provided with a `U' bend inside the tank as shown in Fig 1 to prevent complete draining of water from the geyser. A pilot lamp is fitted on the outer case indicating the automatic working of the unit.

A fusible plug is fitted on the top of the unit to protect the inner tank to release the excess pressure that may be developed due to failure of the thermostat.

Working: When a geyser is fitted initially, open the inlet cock, fill the innertank and maintain the water level . When

Fig 3



A TYPICAL TERMOSTAT USED IN WATER HEATER

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switched `on' the heater heats the water. When the temperature of water reaches to a set value the thermostat disconnects the heater from the supply. (Fig 3) The water drawn from the outlet pipe reduces the temperature and hence the thermostat, re-connects the heater with the supply.

Care and maintenance: A geyser requires less maintenance. The scale deposits that may adhere to the inside surface should be removed. It depends on the amount and kind of mineral content in the water. The only care required is not to energise the geyser without initially filling with water.

Troubleshooting of geysers

The following chart lists out complaints, causes and possible remedies.

Troubleshooting in water heaters/geysers

Complaints	Causes	Test and remedy
No hot water	1 Blown fuse. 2 Open circuit. 3 Heater element burnt out.	1 Replace fuse. 2 Check wiring all the way for broken wire or loose connections. 3 Check elements for burn-out.
Constantly/repeatedly blowing the fuse	1 Grounded heating element. 2 Grounded lead wire. 3 Incorrect connections.	1 Check the heater element for ground. 2 Check wiring for grounds. 3 Check electrical connections all the way.
High consumption of power leading to increased electricity bill	1 Leaking faucets (taps). 2 Excessively exposed hot water pipes. 3 Thermostat setting too high. 4 Short to ground in heating element. 5 Scale deposit on heating units.	1 Replace washers in all leaking faucets (taps). 2 Hot water lines should be as short as possible. 3 Reset thermostat. Setting should be 60°C to 65°C. 4 Check element for ground. 5 Remove unit and check.

Washing machine

Objectives: At the end of this lesson you shall be able to
- **explain the washing machine**
- **state the types of washing machines and wash techniques**
- **state the function of mangle wringer for drying**
- **explain the function of drain pump and drive motor**
- **state the points to be noted while placing the washing machine at a suitable place.**

Washing machine

It is a domestic electric appliance which is used to soak, rinse, wash, wringle /dry the cloth/fabrics etc.

Types of washing machines: The modern washing machines can be divided roughly into three main groups according to their function.

They are

– Ordinary

– Semi automatic

– Fully automatic.

i Ordinary type

Ordinary without timer: This machine uses the pulsator type technique in which a disc is fitted to the motor.

It has only one tub and one motor the dirty cloth is loaded in the tub, water is filled manually in the tub, detergent is added. The motor is switched on the pulsator disc moves the cloth around the tub and the time duration of washing is decided by the operator.

Ordinary with timer: Similar to the ordinary type, but added with a clock timer to select the time of wash from 1 to 15 minutes.

ii Semi-automatic type

This type has two tubs. One for washing and rinsing, the other for spin drying the cloths. The washing tub operates at lower speed whereas the spin drier tub operates at a higher speed. The machine may contain either one or two motors.

iii Fully automatic type

In this type, the micro processor enables to programme the wash cycle. There will be only one tub. The machine could be programmed for wash cycle, detergent intake and water input. The machine does washing, rinsing and also dry the cloth and stops.

Further to the above types the washing machine could be further divided by the type of loading i.e. top loading and front loading. In some machines the water used for washing could be preheated with the help of an electric heater.

Types of wash techniques

In addition to the above classification, the washing machine could be catagorised according to the wash technique used as explained below.

The pulsator wash technique (Fig 1)**:** This is the most common type pulsator wash technique, it has disc in concave shape used to rotate the clothes in water. Dirt is removed from the cloth by rubbing against tub wall surfaces and the disc. (Fig 1 & 2)

Fig 1

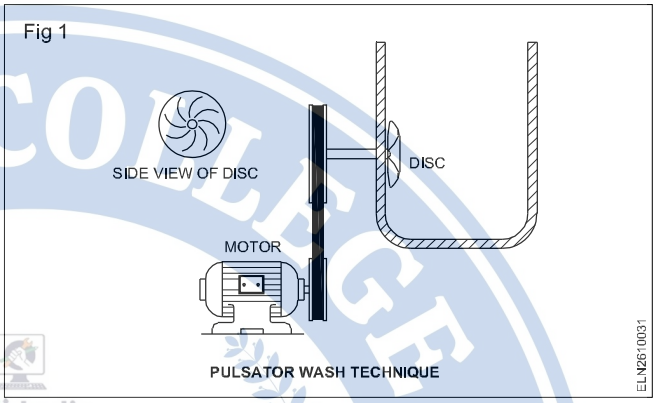
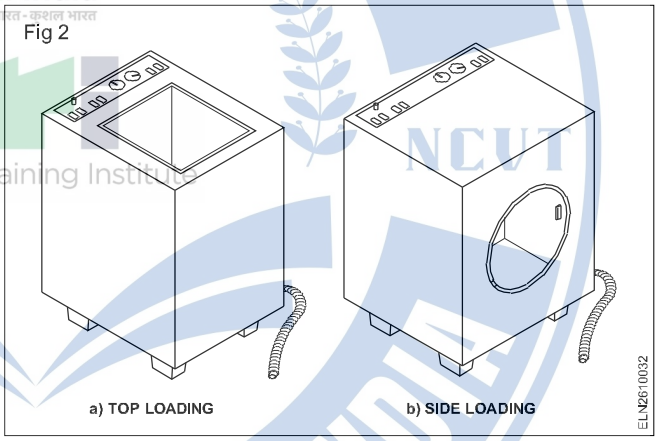


Fig 2



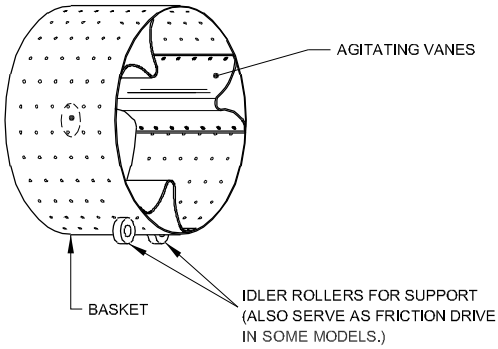
Tumbler type (Fig 3 a)**:** In the tumbler type the washing is carried out by tumbling the cloths with the help of a simple drum. Here the construction is simple and cloths are tumbled around the drum by virtue of the drum itself being rotated by means of a pulley at the rear or the friction drive of the idlers.

The agitator wash technique (Fig 3b)**:** An agitator which is long and cylindrical is installed at the centre of the washing tub. The water and cloths circulate around the agitator, thereby under going a thorough cleaning process. Not suitable for delicate fabric.

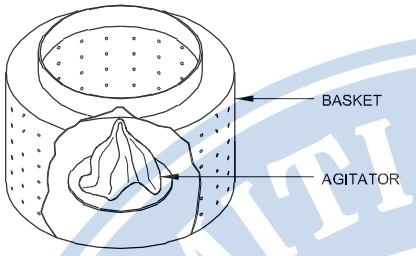
The air power wash technique: This machine uses air bubble technique to wash delicate fabrics smoothly.

The chaos punch wash technique: A multifaceted method of washing, where in water is propelled upwards in the machine to prevent entanglement of garments punching, is done on clothes by forced water.

Fig 3



a) TUMBLER WASHING TUB



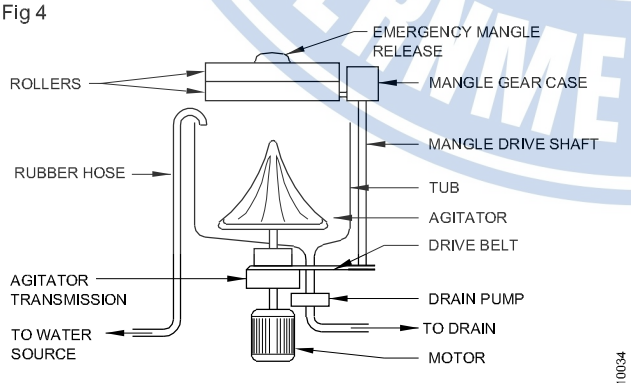
b) AGITATOR WASHING ARRANGEMENT

The water fall technique: This is more or less similar to chaos punch technique. This machine use jets of water which are pumped from below the pulsator in to the tub. The velocity and force of water removes the dirt. Most of the washing machines could be repaired by the electrician but micro processor controlled washing machine repair needs some more training and experience.

The conventional type with mangle wringer for drying: The conventional washing machines are relatively simple in operation and construction. The washing cycle in such a type of machine would consist of the user filling the central tub with water up to the water level mark. Soap and bleach are added.

Depending upon the types of the clothes to be washed the 'ON' time or the wash time of the machine is set and then 'the machine is switched 'ON'. Most machines have the agitator directly driven without any intermediate gears (Fig 4).

Fig 4

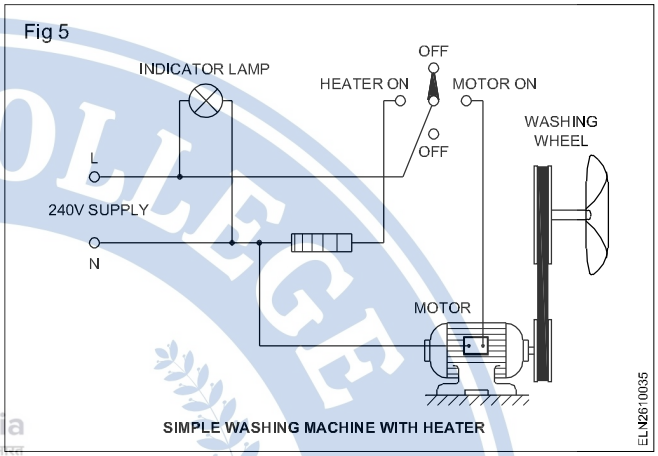


AGITATOR DIRECTLY DRIVEN BY MOTOR

The wash is stopped by the timer setting on the machine. The agitator is brought to a standstill and the drain pump is operated or the valve for gravity draining is activated. For rinsing the clothes the machine is switched 'ON' for a time duration such that all the detergent or soap is removed off the clothes. This cycle is called the rinse cycle. The clothes are then put through the mangle wringer to press and roll out all the water from the clothes.

Some type washing machines having heater, is generally immersion rod type which is permanently fixed in the bottom of the washing machine. The purpose is to produce warm water for loosening stubborn dirt particles of the clothes for quick cleaning. In these types generally heater is not repairable, once found defective it has to be replaced. Fig 5 shows the connection diagram of simple washing machine with heater .

Fig 5



SIMPLE WASHING MACHINE WITH HEATER

Precaution

i **The agitator should be stopped during the drain period, because if it were to continue operating without water in the tub, the required force on the agitator to rotate the clothes in the absence of water would be many times more causing motor to overload.**

ii **The bottom cable should be protected from the damage by the rats by using a rust proof welded mesh.**

The drive motor: The most popular type of motor used in a washing machine is a single phase 240 volts 50 Hz. capacitor start squirrel cage induction motor. These motors may range from 1/3 to 1/2 HP rating. These motors are normally protected from overload and overheating conditions by means of a bimetallic overload relay or a thermal switch. The motor is located in such a way that water leakages do not fall on to these motors.

Locating the machine: The machine should be so located that soft water is freely available, and outlet or water drain arrangement is also easily available. The supply board should have the rated 3 pin socket arrangement with proper earth brought to the 3 pin plug point. The flooring should be in level such that the machine rests properly to avoid unnecessary loading on the machine drum and vibrations.

Pump set

Objectives: At the end of this lesson you shall be able to

- **explain pump set**
- **explain the method of selection of the type of pump and capacity of the motor taking various factor into consideration**
- **explain the types of pumps and use the table for selecting a proper type and capacity for requirement**
- **state how to select a proper location of pump installation and select proper control devices**
- **state troubleshoot in pumps.**

Pump set

Pump set is a combination of an electric motor and a impeller/pump coupled together to pump the water from well (or) bore (or) sump etc.,

Selection of pump : The following points are to be considered before selecting a pump for lifting the water.

– The quantity of water to be lifted

– Height of water to be delivered

– The time for lifting.

Based on the above considerations the pump has to be selected along with the motor to lift the water from a well/ sump.

An illustration is given below to show how to calculate the required HP of the motor to a particular height and quantity of water to be lifted within a specified time.

Example: Calculation of HP for domestic pump set.

A pump driven by a single phase AC motor of 240V, 50 Hz has to deliver 1000 litre to a height of 30 metre within 15 minutes. Find the HP of the motor if the efficiency of the motor is 80%.

Given

Working voltage - 240V, 50 Hz

Quanity of water to be delivered - 1000 litre

Height of the water delivered - 30 m

Efficiency of motor - 80%

Time of delivery - 15 minute

Solution

Work done by the pump / minute =

$$\frac{\text{weight of the water x Height}}{\text{Time}} = \frac{1000 \times 30}{15} \text{ kgm/min.}$$

since 1 litre of water = 1 kg. of water

and 4500 kgm/minute = 1HP

$$\text{Pump output in HP} = \frac{1000 \times 30}{15 \times 4500} = 0.44 \text{ or } 0.5 \text{ HP}$$

$$\text{Input of the pump} = \frac{0.5 \times 100}{80} = 0.625 \text{ HP}$$

Next nearest HP of the motor recommended is 0.75 HP.

Pumps : Pumps can be classified mainly into two categories. They are

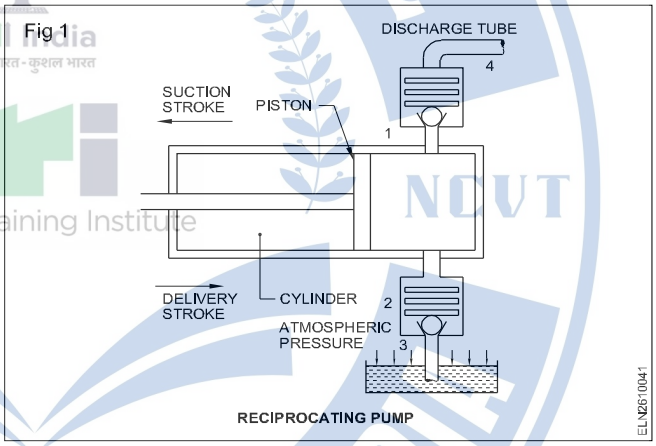
– Reciprocating pumps

– Rotary pumps.

Reciprocating pumps : In this type of pump, the main moving part has reciprocating motion only and hence the name. Fig 1 shows the main parts of a reciprocating pump.

When the piston moves towards left, a partial vacuum is created inside the cylinder. The check valve 1 in Fig 1 closes due to the suction effect of the vacuum, spring action and head of water in the discharge tube 4 but valve 2 Fig 1 opens and allows the water to fill the cylinder through the suction pipe 3 due to atmospheric pressure outside. This stroke of the piston is called suction stroke.

Fig 1



On the other hand when the piston moves towards right ie discharge or delivery stroke the liquid inside the cylinder is pushed out through check valve 1 and delivery pipe 4. During the delivery stroke valve 2 remains closed by the action of spring and the water pressure inside the cylinder.

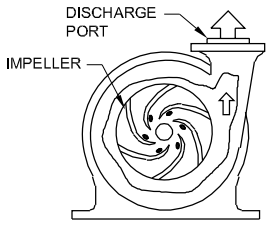
However, as the discharge of water takes place in this type of pump only during the discharge stroke, the pump creates a pulsating flow of water and not a continuous flow. This type of pump is called a piston pump.

Rotary pumps : There are very many varieties of this pump in the market. However centrifugal pumps, jet pumps and submersible pumps are the commonly used pumps for lifting water in houses.

Centrifugal pumps : Fig 2 shows the construction and operation of a centrifugal pump.

The operation of a centrifugal pump is based on centrifugal force. As the fluid being pumped enters the inlet or central section of the pump, the rotating action of the impeller vanes forces it to the outside of the pump casing (Fig 2).

Fig 2



FLUID FLOW IN A CENTRIFUGAL PUMP

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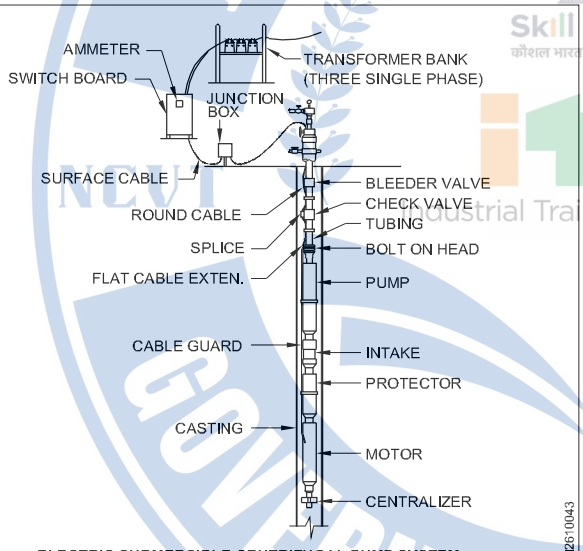
Because the fluid moves faster at the outer edge of the impeller the momentum increases. As more fluid enters the pump, more fluid momentum is built up in the casing that encloses the impeller. This momentum forces the fluid out of the pump discharge port.

The centrifugal pumps are used where large volumes of water are to be pumped at relatively low pressure.

Submersible pumps : This pump also comes under the category of centrifugal pumps and is found in use at places where water is found in great depth.

Submersible pumps have motor and pump in an axial length are submerged in water (Fig 3). Generally such pumps are used for borewells where the volume of water to be lifted exceeds the capacity of reciprocating pumps. The motor used in such types of pumps is of 3-phase.

Fig 3



ELECTRIC SUBMERSIBLE CENTRIFUGAL PUMP SYSTEM

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The cables and motor windings have water proof sealing as they are immersed in water. Such pump sets will have following advantages.

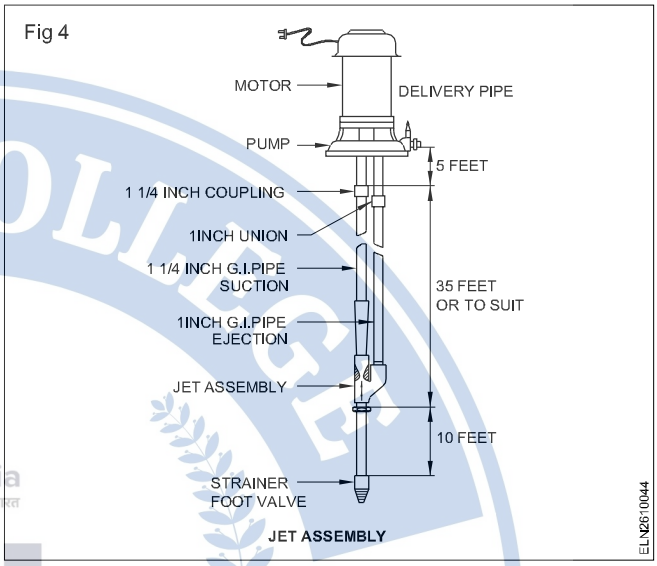
- Diameter is smaller.
- Motor and pump are submerged in water. Hence needs no space on ground level.
- The motor and pump are entirely connected through metal pipes for delivering water.
- Efficiency is more as the motor with the pump will be to the level of water or inside the water.
- Cooling is effectively done by water only.
- Can be used for lifting water from any depth of sump or borewell as suction pipe is not used.

Disadvantages

- Erection cost and initial cost of purchasing will be high.
- In case of any defects, it is necessary to remove entire unit along with the pipe line.
- Requires skilled worker for both erection and maintenance work.

Jet pumps : Another variety of centrifugal pump commonly used in the domestic wells an d borewells is the jet pump. In jet pumps, the motor and pump are assembled together in one block (Fig 4).

Fig 4



JET ASSEMBLY

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The bottom portion of the pump has two connecting pipes. One is called suction pipe and the other is called ejection pipe. A portion of the water is sent through the ejection pipe to the jet assembly and it aids the water in the suction pipe to be lifted upwards by Venturi principle.

Suction, ejection and delivery pipes and motor capacity could be selected with the help of the performance Table 1.

Almost all types of pumps may be independent units to be coupled with an electric motor through belts or couplings or may be single(mono) blocks comprising both motor and pumps.

Location of pump set : The pump should be installed as near as possible to the water source in order to reduce the suction lift and to achieve better performance.

Ample space should be provided around the pump for easy inspection and maintenance whenever required.

Before starting the pump ensure that.

- Shaft rotates freely by hand.
- The gland box is properly tightened.
- The valve, if there is any on the delivery branch, is opened.

Check the following during running condition.

- The direction of rotation is correct.
- Pump is running smoothly.

– Leakage of stuffing box is normal ie., 50 to 60 drops per minute in gland packed pump.

– The ball bearings do not get excessively hot.

Trouble shooting in pumps : In case of trouble in pumps, with the help of the trouble shooting chart (Table 2), locate the fault and rectify the defects.

Table 1

Troubleshooting chart

Sl.No.	Problems	Probable reason
1	Pump does not deliver water.	Pump casing and suction pipe is not primed.
2	Delivered water is not enough.	Delivery head is too high. Suction lift is too high.
3	Not enough pressure.	Impeller/suction pipe choked. Wrong direction of rotation. Leakage in suction pipe. Gland packings/mechanical seal worn out. Foot valve choked/not immersed in water. Impeller damaged. Wearing of shaft sleeve.
4	Pump takes too much power.	Damaged ball bearing. Head is much lower. Mechanical friction is more in the rotating part. Shaft bent. Stuffing box is too tight (gland is too tight).
5	Pump leaks excessively.	Gland packings/mechanical seal worn out. Shaft sleeve worn out. Gland packings/mechanical seal are not in proper position.
6	Pump is noisy.	Hydraulic cavitation. Foundation is not rigid. Shaft bent. Rotating parts are loose or broken. Bearing worn out.

Automatic electric iron

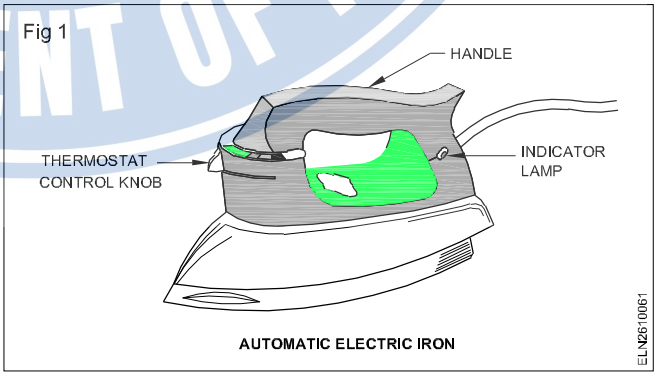
Objectives: At the end of this lesson you shall be able to
- **state the difference between non-automatic and automatic irons**
- **describe the construction of a bimetal thermostat**
- **illustrate the working of an adjustable thermostat**
- **list the possible faults, their causes and corrective action to be taken in an automatic iron.**

Automatic electric iron

The difference between an automatic iron and the ordinary (non-automatic) iron is that the automatic type has a thermostatic device to regulate the temperature. The other parts are more or less the same in both the types of irons. (Fig 1)

Automatic irons are fitted with a thermostatic switch to regulate the heat to a specific predetermined value. The thermostatic switch disconnects the supply when the predetermined value is reached and reconnects the supply when the iron cools down. A turning knob with a dial just below the handle, marked as rayon, cotton, silk, wool etc. can be operated to select the preset temperature.

Fig 1



They are two types of automatic electric iron, they are:

1 Dry Automatic Iron

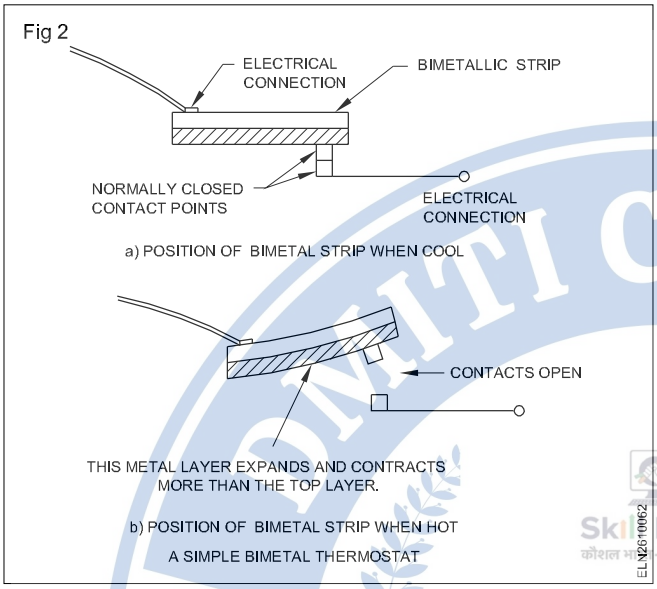
2 Spray/Steam Automatic Iron

Thermostats

A thermostat is a switch which can be designed to close or open a circuit at predetermined temperature. One of the simplest and most dependable components in the modern heating appliances is the BIMETAL THERMOSTAT. It controls the temperature in stoves, toasters, food warmers, irons etc. It serves as a safety device to prevent overheating of the appliances.

Bimetal thermostat (Fig 2)

Fig 2



In the thermostat there is a bimetal strip made of two strips of metal with different expansion rates welded together. The metal strip expands when heated and contracts when cooled. One metal in the bimetal strip has a high rate of expansion when heated, and the other has a low rate.

When a bimetal strip is heated, both the metals in the strip expand but the one at the bottom with a higher rate of expansion expands faster and forces the upper half to curl up or bend away from the contact point (Fig 2b). The strip curls or bends enough to break the contact, opening the circuit.

As the strip cools, it straightens and restores contact with the stationary point. The bending of the bimetal strip on heating, is towards the side that has the smaller expansion rate.

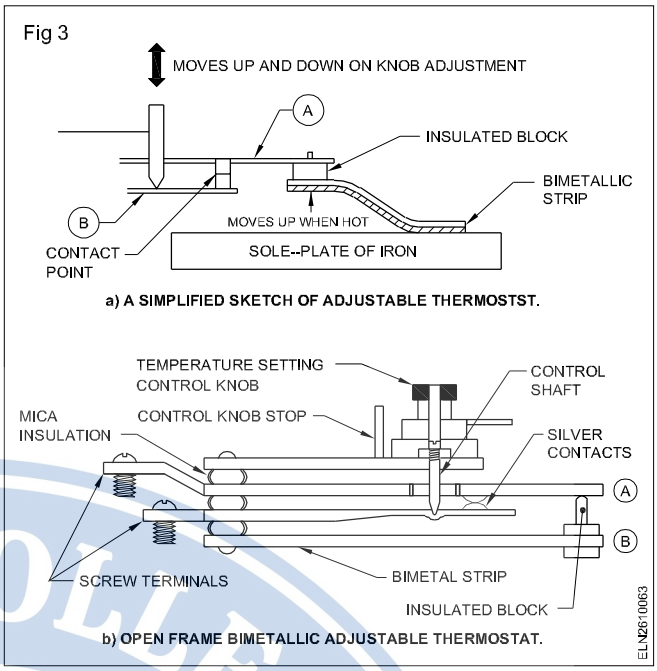
Adjustable thermostat (Fig 3)

The operation of the thermostat is as follows. The strip B (Fig 3 (a) part B) along with the silver contact is designed such that it has upward tension whereas the control shaft moves the strip B either upward or downward depending upon the temperature setting.

The strip A (Fig 3(a) part A) along with its silver contact is designed such that it has downward tension. But its downward movement is restricted by the insulated block.

In the 'OFF' position of the temperature setting control knob, the strips A and B will be away from each other, keeping the silver contacts in an opened condition, thereby, keeping the heating element circuit open.

Fig 3



When the temperature setting control knob is set to minimum position, the control shaft moves up and allows the strip B and its silver contact to move upwards to some distance and make contact with the silver contact of the strip A.

Thus the heating element circuit is closed, the iron heats up. The bimetal strip which is also heated, bends upwards and the insulated block pushes the strip A, thereby, separating the silver contacts and the heating element circuit opens.

When the iron cools down, the bimetallic strip also cools and comes back to the straight position. The downward movement of the insulated block allows silver contact strip A to come in contact with the silver contact strip B; thereby the circuit is closed and the iron heats up.

A lamp fitted near/into the handle of the iron goes off when the desired temperature is attained.

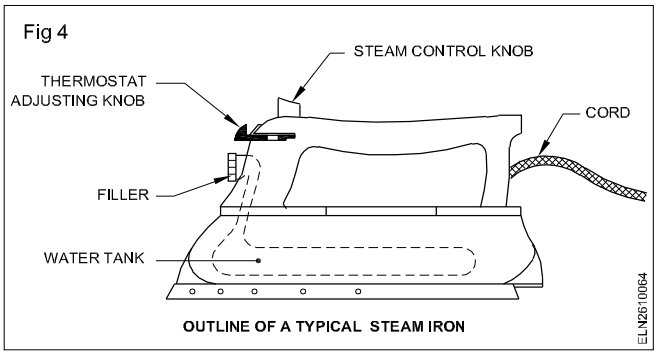
Steam/spray irons (IS 6290)

Electrically there is no difference between steam irons and dry irons. A steam iron has a small reservoir mounted above the heating element. A control valve on this allows the water to drip slowly into recesses in the sole-plate.

A check valve keeps the water from going back up into the tank. When the water hits the hot position of the sole-plate, it is converted to steam and goes out through holes in the bottom of the sole-plate. Fig 4 shows a diagram of the construction of a typical steam iron.

Method of repair

In most of the steam irons, the heating element is sealed along with the sole-plate. When the element is found to be open or shorted, the sole-plate along with the sealed heating element has to be replaced. Apart from defective power cord set and thermostat as found in the irons, the steam iron may develop problems in the water/steam container parts due to the following reasons:



i The consumer might have used tap water instead of distilled water to fill the water tank in steam irons. This may result in deposit of salts in the tank and clog the entry and exit points.

ii The consumer might have left the iron with water for some period resulting in salt and rust formation.

The salt deposit can be removed by filling the tank with diluted vinegar and plugging the iron to the power supply. A number of attempts may have to be made to clear the deposits.

Troubleshooting chart

(Dry Iron)

Trouble	Possible causes	Corrective action to be taken
No heat	No power at outlet.	Check outlet for power.
	Defective cord or plug.	Repair or replace.
	Loose terminal connections.	Check and tighten the terminals.
	Broken lead in iron.	Repair or replace lead.
	Loose thermostat control knob.	Clean and tighten.
	Defective thermostat.	Replace thermostat.
	Defective heater element.	Replace the element if separate. If cast in, replace sole-plate assembly.
	Open thermal fuse.	Replace.
Insufficient heat	Low line voltage.	Check voltage at outlet.
	Incorrect thermostat setting.	Adjust and recalibrate thermostat.
	Defective thermostat.	Replace thermostat.
	Loose connection.	Clean and tighten connections.
Excessive heat	Incorrect thermostat setting.	Adjust and recalibrate thermostat or replace.
	Defective thermostat.	Replace thermostat.
Blisters on sole-plate	Excessive heat.	First repair the thermostat control. Then replace or repair the sole-plate, depending on its condition.
Tears clothes.	Rough spot, nick,scratch, burr on sole-plate.	Remove these spots with fine emery and polish the area with buff.
Iron do not turned off automatically.	Thermostat switch contacts are welded together	Check the thermostat switch contact. Open them by force. The contact points should be in open condition at off position of the control knob.
Sticks to clothes.	Dirty sole-plate.	Clean.
	Excessive starch in clothes.	Iron at a lower temperature. Use less starch next time.
	Wrong setting of the thermostat knob.	Set the knob to correct temperature.
	Iron too hot for fabric being ironed.	Lower the thermostat setting.
Iron gives shock.	Disconnected earth connection.	Check earth connection and connect properly.
	Weak insulation of heating element.	Check insulation resistance of heating element; if necessary replace element.
	Earth continuity with common earth not available.	Check the main earth continuity and connect properly.

Electric kettle

Objectives: At the end of this lesson you shall be able to
- **explain electric kettle and its types**
- **list and state the parts of an electric kettle**
- **describe the method of fitting a new element**
- **state the general care and maintenance.**

Electric kettle

Electrical kettle is a heating device which is used to heat the liquid (like water, milk, etc) poured in it.

There are two types of electric kettles:

– Saucepan type

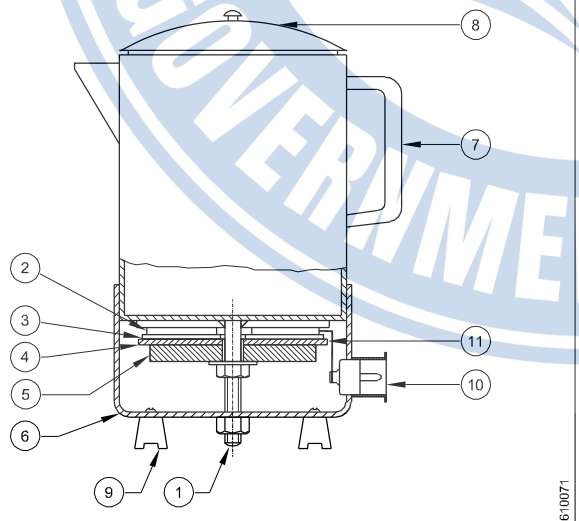
– Immersion heating type.

Saucepan type: The construction of the sauce pan type kettle is given in Fig 1. The parts are as follows.

1 Bolt, nut and washer holding bottom cover
2 Heating element
3 Asbestos sheet
4 Sole-plate
5 Pressure plate
6 Bottom cover
7 Handle
8 Top lid
9 Ebonite leg
10 Outlet socket
11 Brass strips

Bottom cover: The bottom cover is fitted to the central bolt of the body by a nut and washer. (Fig 1).

Fig 1



CONSTRUCTION OF SAUCEPAN TYPE KETTLE

Heating element: In its general construction, the heating element is made of Nichrome ribbon. The Nichrome ribbon is wound over mica. This is placed between two circular mica pieces, so that the Nichrome wire may not come in contact with any metallic part of the kettle. The two ends of the elements are connected to the outlet socket terminals of the kettle through two brass strips.

Asbestos sheet: This is placed below the element and mica insulation to serve as a heat insulator. It reduces the heat loss in the kettle in addition it gives increased insulation.

Sole-plate: The sole plate is a cast iron plate neatly ground to have a flat surface and its main function is to keep the element in close contact with the container and to avoid deformation of the element when heated.

Pressure plate: This is made of cast iron and fitted by a nut on the middle bolt. The pressure plate holds the sole plate in position.

Method of fitting new element: Dismantle the kettle by the following steps.

– Invert the kettle and loosen the bottom cover holding nut. Take out the nut and remove the bottom cover.

– Remove the brass strip connections of the elements at the socket terminal sides.

– Remove the terminal socket by loosening the fitting screws.

– Open the nut of the pressure plate.

– Take out the pressure plate, sole-plate, asbestos sheet and then the heating element.

– Replace with a new heating element having the correct size and rating.

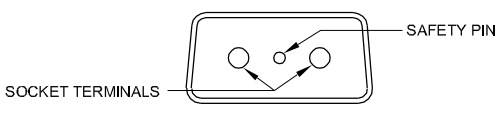
– Reassemble the kettle.

– Test the insulation resistance for any earth fault and insulation failure.

Immersion type: The heating element in this type is of tubular immersion heating design. In some kettles an ejector type safety device is incorporated in the socket terminal side.

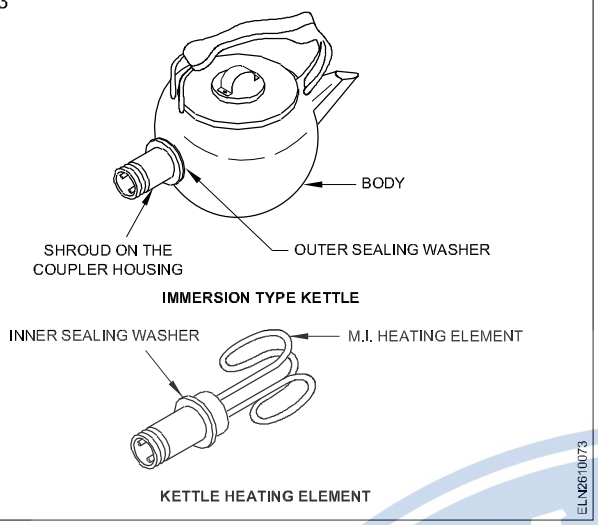
In case the kettle is switched ON without water the safety pin (Fig 2) which is soldered against a spring which is under tension comes out and pushes the plug out. This safety pin can be placed in position by soldering. The heating element is concealed inside a hollow tube and mineral insulated (Fig 3).

Fig 2



SOCKET WITH SAFETY PIN

Fig 3



New elements can be fitted to most types of kettles without difficulty.

Fitting a new element: A new element should be fitted in the following manner.

– Hold the element in one hand and unscrew the shroud on the coupler housing.

– Slide out the outer fibre sealing washer.

– Twist the element assembly inside the kettle and pull it out gently through the top.

– Take the old element to an electric shop to make sure that the replacement is of the exact design and wattage.

– Remove stubborn scales inside the kettle with a blunt knife without knocking the metal surface.

– Put an inner sealing washer, usually made of fibre, on the new element.

– Take care to fit new washers at the coupler housing in the correct order. Reassemble.

Care and maintenance

– Never empty a kettle while it is still switched 'ON'.

– Remove the plug from the socket before carrying out maintenance or repairs.

– Never pour water into a kettle which has just boiled dry, which apart from danger to the users, may damage the element.

– The metal portion of the kettle should be earthed using a 3-pin plug and a 3-pin appliance socket.

– Replace cracked or damaged sealing washer.

– Check for the good condition of asbestos sheet. Replace with a new one, if damaged during removal.

– Immediately replace the defective plug, socket or cable, if once noticed.

– Earth clips of the appliance power cord plug should snugly fit into the inner side of the appliance socket to have perfect earth connection. Check for proper fitting and cleanliness.

Induction Heater

Objectives: At the end of this lesson you shall be able to
- **explain induction heater**
- **explain construction, advantages and disadvantages of induction heater.**

An induction heater uses an electromagnetic field to heat food. When the heater is turned on, an electric current passes through a coil of metal, creating a magnetic field. This magnetic field then penetrates the metal of a cooking pan, inducing a current in the pan. The current then dissipates energy in the form of heat, cooking the food in the pan. (Fig 1)

Fig 1

What is induction?

Electromagnetic induction, which is often referred to simply as induction, signifies the production of an electric current across an electric conductor, caused by a changing magnetic field. Electricity and magnetism are not two disjointed things; they are two entities originating from the same underlying phenomenon - electromagnetism.

Due to this, a change in a magnetic field leads to the generation of electric current. Similarly, a change in the electric field across a conductor produces a magnetic field. The latter is the working principle behind induction heater, which is pretty much all you need to know to understand the working of induction cooktops.

Induction heater

Inside view of an induction heater (Fig 2)

An induction heater looks like any other ceramic cooktop, with different zones for placing pans and pots of varying sizes. It consists of a tough, heat-resistant glass-ceramic plate on which the user places pots and pans that need to be heated. Directly underneath the plate there is an electromagnetic coil of metal that is electronically controlled. This is the main component responsible for heating the vessels kept above the heater.

When you switch on the power supply of the heater, an electric current passes through the coil. The electric current passing through the coil produces a magnetic field in all directions around the coil, including directly above it (where pots and pans are placed). (Fig 3) Note that until this point, no heat is generated, as the magnetic field being produced doesn't produce any heat unless a third object - the cooking pan - is introduced into the mix.

Fig 2

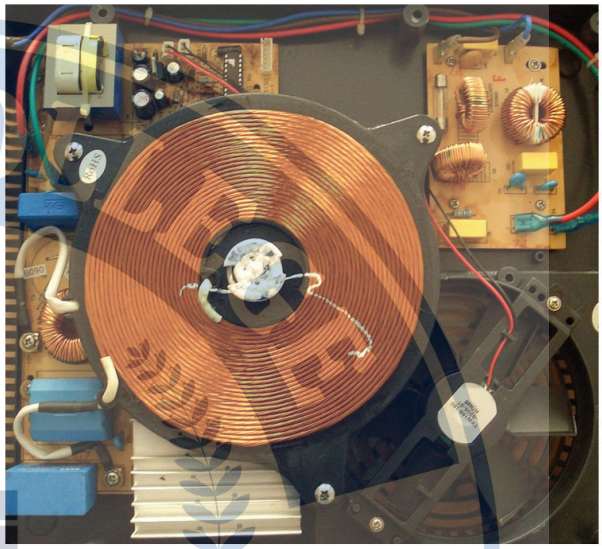
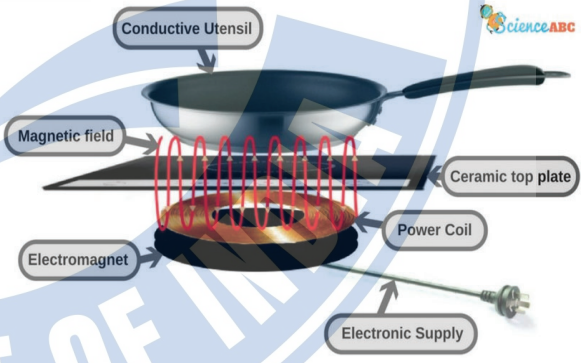


Fig 3



When a heater pan (made of a suitable material) is placed on the cooktop, the magnetic field produced by the coil penetrates the metal of the pan too. This fluctuating magnetic field now causes an electric current to flow through the material of the pan too. The current 'induced' on the surface of the pan in this way is called an eddy current, which is different from the electric current flowing through wires. Eddy currents are actually loops of electric current that are induced in a metallic field due to a changing magnetic field nearby.

This induced current travels around the metallic structure of the pan, dissipating some of its energy in the form of heat. This is the heat that raises the temperature of the pan placed on the cooktop and cooks the food inside the pan by heat transfer through conduction and convection.

Advantages and disadvantages of induction heater

1 Induction heaters are very energy-efficient, in that they transfer most of the energy to the cooking pan with minimal loss of energy. (Fig 4)

2 Also, induction cooktops heat stuff up very quickly, unlike regular stoves, which lose a great deal of energy to their surroundings.

3 They are also pretty easy to clean and operate and safe to use.

Fig 4

Disadvantages

A major drawback of induction heater is that they only work with pans and pots that are 'compatible' with them. The containers and vessels placed on the cooktop should contain iron in some form (e.g., stainless steel), as it's the only metal that efficiently produces eddy currents and generates heat through magnetic fields. Therefore, glass, aluminium and copper cookware cannot be used on induction heater.

In a nutshell, using an induction heater is a smart thing to do if you care about electrical efficiency, speedy heating, better cooking control and higher levels of safety. As for the suitability of your existing cookware for induction cooktops, just try sticking a magnet to them. If it sticks, then the pan/pot is fit to be used.

Food Mixer

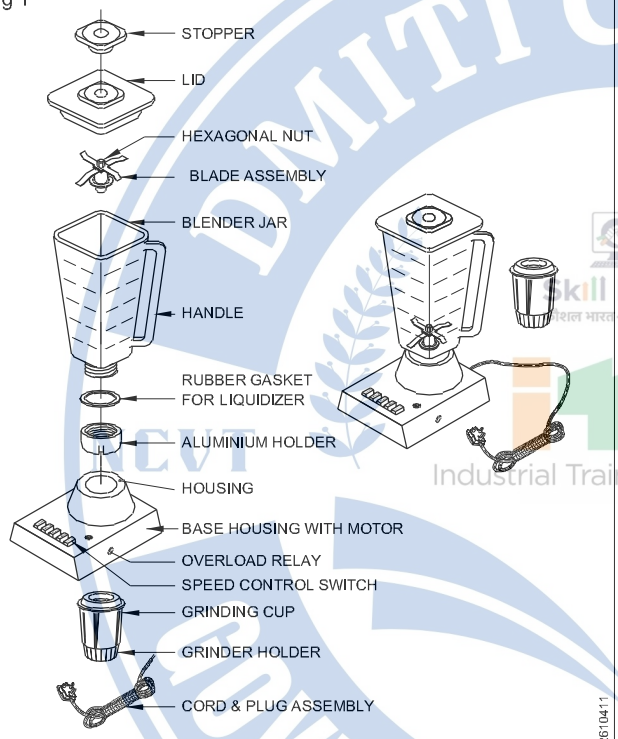
Objectives: At the end of this lesson you shall be able to
- **explain the food mixer and its features**
- **state the maintenance and service procedures of mixer**
- **list their common problems, causes and suggest remedial measures.**

Food mixer

It is an electric domestic appliance which is used to mix, juice, grind and blend the fruits and food grains.

A medium sized universal motor is used in it. Fig 1 shows an exploded view of a mixer.

Fig 1



EXPLODED VIEW OF A FOOD MIXER

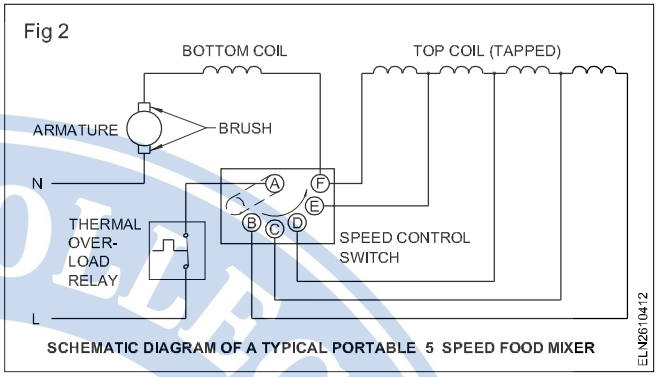
Features of the food mixer

The motor housing differs widely depending on the manufacturer. Special care to be taken for vibration-free running. Safety features such as overload trip, jar mounting lock (fixing) and proper lid closing are included in the appliances.

An AC universal motor is housed in the base. The jar contains the cutting knives which is the heart of the blending action. Fig 2 shows a schematic diagram of a typical mixer.

A food mixer power rating ranges from 100 to 750 watts. The revolution of the food mixer is 3000 to 14000 revolutions per min. The desired speed is selected on the control switch.

Fig 2



SCHEMATIC DIAGRAM OF A TYPICAL PORTABLE 5 SPEED FOOD MIXER

The time rating of running the mixer varies from 1 minute to 60 minutes depending upon the type. A tapped field coil enables speed selection through a rotary or push button switch. The food mixer normally runs at 3 speeds.

Maintenance and servicing of a food mixer: The manufacturer's service manual, if available, read it a number of times and follow the instruction. First listen to the complaint from the customer and make a note of it. Visually check the mixer right from the plug to the speed selector switch connections and enter the details in the maintenance card.

Test the mixer with and without the power cord for the continuity and insulation resistance. The insulation resistance value for the individual part should not be less than 1 Megohm. the power cord should be 3-core and the plug and socket should be of 3-pin/socket type with effective earth.

But double insulated (PVC body) mixers may have two core cable and 2-pin plug type. A damaged plug or power cord should be replaced. Check the brush tension and make it normal. Check the brush length; if found short by 2/3rd of its original length, replace it with the same specification brush or a brush obtained from the manufacturer of the mixer.

Check the switch for its proper function. Better to replace a faulty one with a new one having the same specification. Before opening the motor assembly, check the couplings for their proper form. Check the ply of the shaft and vertical movement to get an idea of the condition of the bearings.

Tight bearing may be due to misalignment, bend in the shaft, dried grease or lubricant, dirt, damaged commutator or due to damaged bearing.

Check the winding for burnt smell or discoloured look. Ascertain through the tests whether the winding is shorted, open or has lost its insulation resistance value. If required rewind or get the rewinding done from outside agencies.

While tightening the screws on the motor housing, spin the armature with your fingers at intervals during the assembling process to ensure that it is not getting bound.

Fix the jar/container on the drive coupling.

Connect the supply cord as per the circuit diagram.

Test the mixer for continuity and insulation resistance. Minimum acceptable insulation resistance value is 1 Megohm.

Connect the supply, and test for its working.

Repairs

Some of the common troubles encountered in the repair of mixers are given in the Table 1 which also gives the possible causes and their remedies.

Table 1

Trouble Shooting Chart

Problem	Possible cause	Corrective action
Mixer does not run.	a) Overload trip might have tripped.	a) Reset the overload relay and advice the customer not to overload the mixer in future.
	b) No power at the outlet.	b) If the mixer is running in your shop but not running at the customer's house ask the customer to get the socket repaired.
	c) Defective power cord or plug.	c) Test, repair or replace the power cord/plug.
	d) Locked shaft.	d) Unplug the supply and try to rotate the shaft by hand. Clean the bearings; lubricate the bearings as advised by the manufacturer. If the shaft is still tight, recondition or replace the bearings. The shaft might have got bent. Replace the shaft or armature assembly.
	e) Worn out brushes.	e) Replace the brushes and loose springs
	f) Open circuited.	f) Check the field and armature windings. If found defective get it rewound or replace.
Blows fuse when switched on.	a) Shorted power cord.	a) Replace the cord.
	b) Locked shaft.	b) As in 'd' above.
	c) Defective armature or field coils.	c) Test the windings for short. If short is found, rewind or replace.
	d) Poor insulation resistance.	d) Check, test and repair.
	e) Low capacity fuse.	e) Check the capacity of the fuse against the mixer rating. Replace if required.
Mixer runs but becomes hot.	a) Overloading of mixer.	a) Bring down the load in the mixer or advise the customer to go for a higher capacity mixer.
	b) Time rating of mixer is exceeded.	b) Check the duration the mixer is switched on by the customer and compare with the mixer rating. Advise accordingly.
	c) Bent shaft and rotor is rubbing the stator.	c) Check, repair or replace if required.
	d) Improper coupling.	d) Check, repair or replace if required.
	e) Shorted winding.	e) Check, test and rewind if required.
Bad sparking at motor brushes.	a) Struck or worn out or loose brushes.	a) Check, reshape the brushes, replace the springs or reposition the brushes for proper tension.
	b) Pittings or uneven commutator surface.	b) Use sand paper or turn the commutator on a lathe.

Problem	Possible cause	Corrective action
Mixer gives shock.	a) Water leaking and coming in contact with live terminals. (Double insulated mixers with plastic body and two pin plug. No earth connection).	a) Check the drain hole in the coupler head assembly for blockage. Check the jar examine for leakage due to loose shaft or worn out bearing, ebonite washer breakage. Repair or replace.
	b) Vent hole in the mixer body clogged.	b) Clean the vent hole.
	c) Damaged power cord.	c) Check and replace if required.
	d) Absence of earth connection.	d) Check the earth connection in the mixer motor, power cord and at socket. Repair and re-do the earth connection if required.
	e) Live parts coming in contact with metal body.	e) Check with a Megger and take corrective action if required.

Wet grinder

Objectives: At the end of this lesson you shall be able to
- **explain the wet grinder**
- **state the different types of wet grinders**
- **explain the parts of a wet grinder**
- **explain the possible faults in wet grinders and their remedies.**

Wet grinder

It is a domestic electrical appliance, which is used to grind the wet grains.

Types: There are three types of wet grinders

– Conventional (regular) wet grinder.

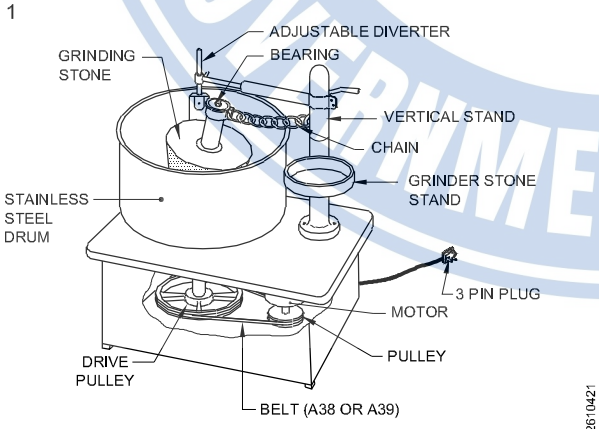
– Table top wet grinder.

– Tilting wet grinder.

Conventional (regular) wet grinder (Fig 1)

The most common wet grinder used in houses is the container rotating type wet grinder.

Fig 1



CONVENTIONAL WET GRINDER

Parts

The important parts of a wet grinder are :

– Motor

– grinding stone

– container

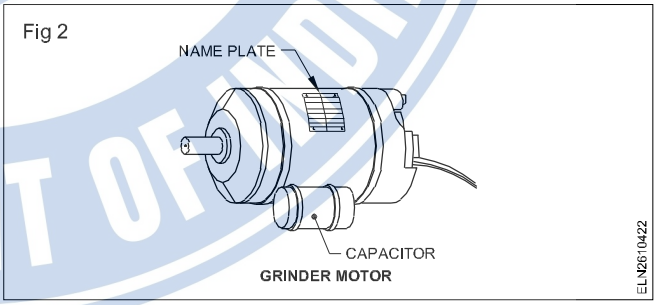
– pulley

– belt

– frame and stand

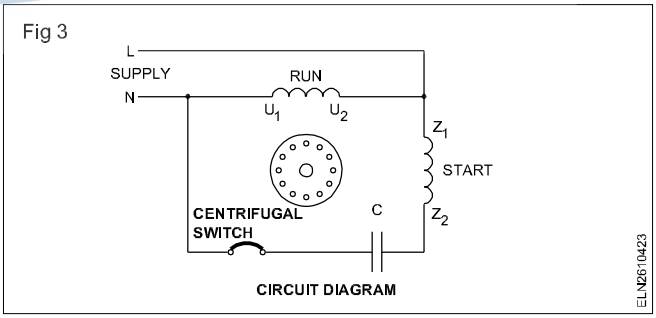
Motor: The motor used in the wet grinders is usually the capacitor start-induction motor (Fig 2 & 3). It has two windings. Both the starting and running windings are energised to start the motor, when the 70 to 80 % of the rated speed is reached, the starting winding is switched off by the centrifugal switching system. The motor then operates only on running winding.

Fig 2



GRINDER MOTOR

Fig 3

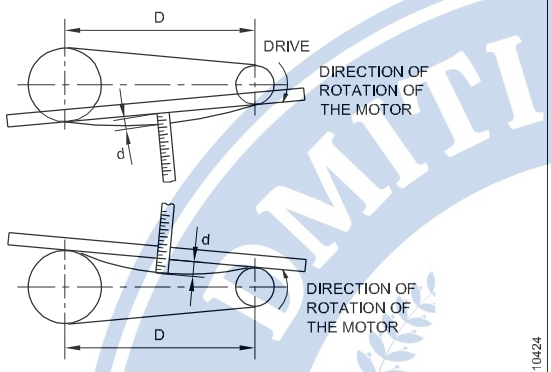


CIRCUIT DIAGRAM

Stone: The grinder stone consists of two parts of stones. One male and one female. The male part grinds the grains during rotation against conical cavity in the base (female stone). This female part is actually attached to the stainless steel container which rotates when the motor is energised. Both the stones are manufactured with hard granite which is usually whitish black in colour.

Pulley: The drum speed is lower than the motor speed, normally 500 to 600 r.p.m. The motor speed is normally 1450 r.p.m. and the speed of the drum is reduced by using a larger diameter pulley than the driven pulley, usually in the ratio of 1:3. The transmission of force between the driver pulley and the driven pulley is through a V belt of type No A 36 or A 39 (Fig 4).

Fig 4



ARRANGEMENTS OF PULLEY AND BELT

Frame and stand: The grinding stones, motor pulleys are all housed in a rectangular frame with sunmica or stainless steel covering or plastic moulding for decoration as well as safety. A separate vertical stand is provided on one side of the grinder for holding the male grinding stone. If the MS frame is used, it is usually to be chromium plated.

Wet grinder- maintenance and servicing: In wet grinders, the trouble may be classified into two types. Electrical faults and Mechanical faults. Some mechanical faults create electrical faults too.

Some common problems and their rectifications are given in the Table 1.

Safety measures

- Make sure power is turned off before working on electrical equipment.
- Plug to be removed from the socket.

Maintenance practices: An electrical machine or appliance to be maintained according to the programme already made. Certain maintenance practices to be observed are,

– Daily maintenance
– Monthly maintenance
– Yearly maintenance

Table 1

Sl.No.	Complaints	Causes	Test and remedy
1	Motor does not start	Short-circuited windings. Grounded winding. Open circuited windings. Broken wire from line cord to windings. Defective capacitor. Blown fuse. Excessive load. Defective centrifugal switch.	Rewind the windings. Rectify or rewind the windings. Solder the joints; if not possible rewind the windings. Solder the broken wire in the line cord or change the line cord. Replace the correct capacitor. Find the cause and replace the fuse. Reduce the load. Rectify or replace the defective switch.
2	Motor starts but heats up rapidly	Centrifugal switch not opening. Short-circuited winding. Grounded winding.	Rectify or replace the centrifugal switch. Rewind the windings. Rectify or rewind the windings.
3	Motor runs too hot	Short circuited windings. Grounded winding. Bearing too tight. Short capacitor. Worn out bearings.	Rewind the windings. Rectify or rewind the windings. Clean and relubricate the bearing. Replace the capacitor. Replace the bearings.
4	Motor runs slow.	Insufficient lubrication or foul lubrication that tends to bind the motor shaft.	Clean and re-lubricate the bearing.
5	Motor runs intermittently	Intermittently open line cord.	Repair or replace the line cord.

6	Motor is noisy	Worn out bearings. Excessive end play. Bent shaft. Unbalanced rotor. Burrs on shaft. Loose parts. Worn out belts. Misalignment. Worn out centrifugal switch. Rotor rubs stator.	Clean and lubricate or replace the bearings. If necessary, add additional end play washers. Straighten or replace the shaft. Balance rotor. Remove burrs. Tighten the parts. Replace the belts . Align pulleys correctly. Replace centrifugal switch. Find the cause and rectify.
7	The user gets a shock	Contact between live parts and body of the motor. Broken ground strap. Poor ground connection.	Rectify isolation between body and the live parts of the motor. Replace ground strap. Inspect and repair ground connection.
8	Motor fuse blows	Grounded or short-circuited windings. Low capacity of fuses Grounded near the switch end of the winding.	Rectify or rewind the windings. Replace with proper capacity of fuses. Repair or rewind the winding.
9	Smoke from motor (motor burnt out)	Overload. Shorter windings. Faulty centrifugal switch. Frozen bearing. Short capacitor.	Reduce the load. Rewind the windings. Repair or replace the centrifugal switch. Clean and lubricate or replace the bearing. Replace the capacitor.
10	Rotor rubs stator	Dirt in motor. Burrs on rotor or stator. Worn out bearings. Bent shaft.	Clean the motor. Remove burrs. Replace the bearing. Straighten or replace the shaft.
11	Excessive bearing wear	Belt too tight tension Dirty bearings Insufficient lubrication Thrust over load Bent shaft	Correct the mechanical condition. Clean and lubricate or replace the bearing Lubricate with appropriate lubricant. Reduce thrust load Straighten or replace the shaft.
12	Motor does not start but will run in either direction when started manually	Defective capacitor. Contacts of centrifugal switch not closed. Starting winding open.	Replace the capacitor. Clean the contacts of the centrifugal switch and check for operation. Replace, if found defective. Solder the open joints or rewind the winding.
13	Motor slows down and runs with insufficient power under working condition.	Short circuited windings. Open circuited windings. Shaft bent.	Rewind the windings. Solder the joints; if not possible, rewind the windings. Straighten or replace the shaft.
14	Reduction in power of the motor. Gets too hot	Short-circuited or grounded windings. Sticky or tight bearings Interference between stator and rotor.	Rectify or rewind the windings. Clean and re-lubricate the bearings. Install new bearings.
15	Radio interference	Faulty ground Loose connections Defective suppression	Rectify poor ground connections. Tighten loose connections. Check filter, capacitors, chokes, if possible or replace the complete filter unit.

Daily maintenance: The parts are to be cleaned with cloth and the stone bearing is to be oiled. Inspect the belt tension and vibration.

Monthly maintenance: Oil and grease the main shaft of the grinder. Insulation test is to be carried out and recorded in the sheet provided.

Yearly maintenance: The electrical machine must be removed and overhauled. Insulate the winding by applying varnish. Check all the mechanical parts and rectify the defects, if any.