Geyser

Objectives: At the end of this lesson you shall be able to
- **define the geyser**
- **list the parts of a geyser from the schematic and constructional diagrams**
- **explain the construction and operation of a geyser**
- **list the care and maintenance practices specific to the geyser**
- **explain the possible faults in a geyser and their remedies.**

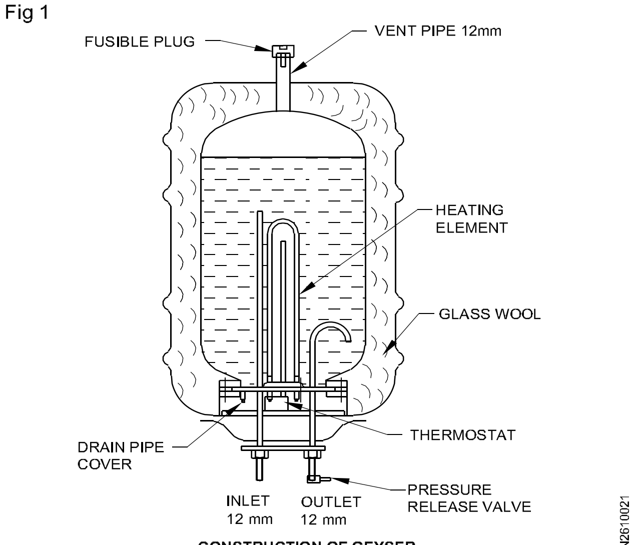
Geyser

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).

Fig 1



CONSTRUCTION OF GEYSER

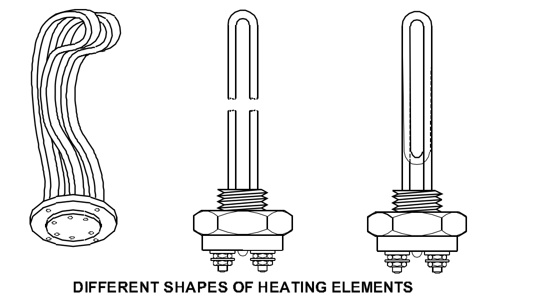
The outer casing is made of mild steel sheet. The inner tank is made of heavy gauge copper which is tinned to prevent corrosion. The space between the outer casing and the inner tank is filled with glass wool as heat insulation to avoid excess heat losses. Heating elements, thermostat, inlet and outlet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

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.

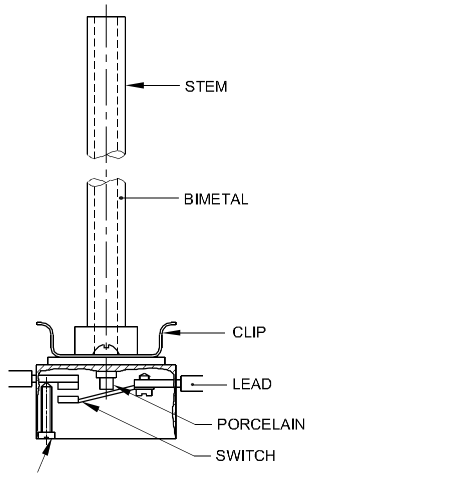
Fig 2



DIFFERENT SHAPES OF HEATING ELEMENTS

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

Fig 3



A TYPICAL TERMOSTAT USED IN WATER HEATER

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 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.	1 Replace fuse.
	2 Open circuit.	2 Check wiring all the way for broken wire or loose connections.
	3 Heater element burnt out.	3 Check elements for burn-out.
Insufficient quantity of hot water and less hot	1 Thermostat setting too low.	1 Check thermostat setting. Should be 60°C to 65°C.
	2 Lower heating element burnt out.	2 Check the lower heating element and replace if burnt out.
	3 Capacity of tank is insufficient for one's needs.	3 Check quantity of water used. Explain to the user if tank capacity is too small.
Constantly/repeatedly blowing the fuse	1 Grounded heating element.	1 Check the heater element for ground.
	2 Grounded lead wire.	2 Check wiring for grounds.
	3 Incorrect connections.	3 Check electrical connections all the way.
Steam in hot water	1 Thermostat improperly connected.	1 Check wiring and correct any improper connections.
	2 Thermostat contacts burnt together.	2 Check thermostat.
	3 Grounded heating element.	3 Check unit for ground.
	4 Thermostat set too high or out of calibration.	4 Reset thermostat.
High consumption of power leading to increased electricity bill	1 Leaking faucets (taps).	1 Replace washers in all leaking faucets (taps).
	2 Excessively exposed hot water pipes.	2 Hot water lines should be as short as possible.
	3 Thermostat setting too high.	3 Reset thermostat. Setting should be 60°C to 65°C.
	4 Short to ground in heating element.	4 Check element for ground.
	5 Scale deposit on heating units.	5 Remove unit and check.
Leaking tank	1 Leakage around thermostat and heating unit flange.	1 Check all points for possible leakage before condemning tank.

Washing machine

Objectives: At the end of this lesson you shall be able to
- **define 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.

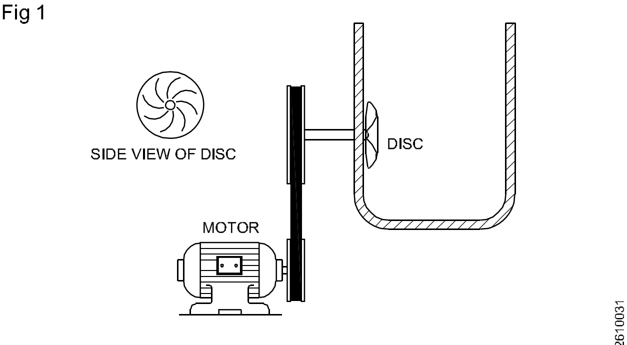
Further to the above types the washing machine could be further divided by the type of loading i.e. top loading and front loading. In some machines the water used for washing could be preheated with the help of an electric heater.

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.

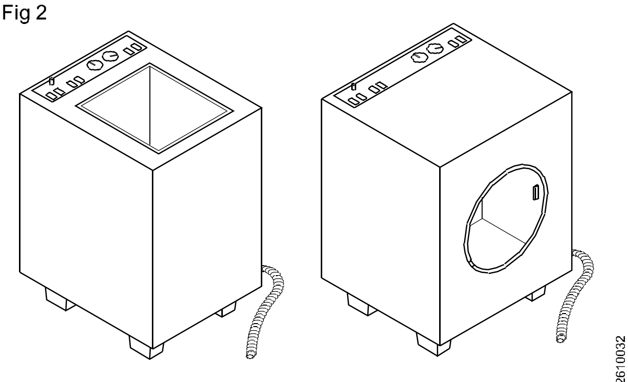
The pulsator wash technique (Fig 1)**:** This is the most common type pulsator wash technique, it has disc in concave shape used to rotate the clothes in water. Dirt is removed from the cloth by rubbing against tub wall surfaces and the disc. (Fig 1 & 2)

Fig 1



PULSATOR WASH TECHNIQUE

Fig 2

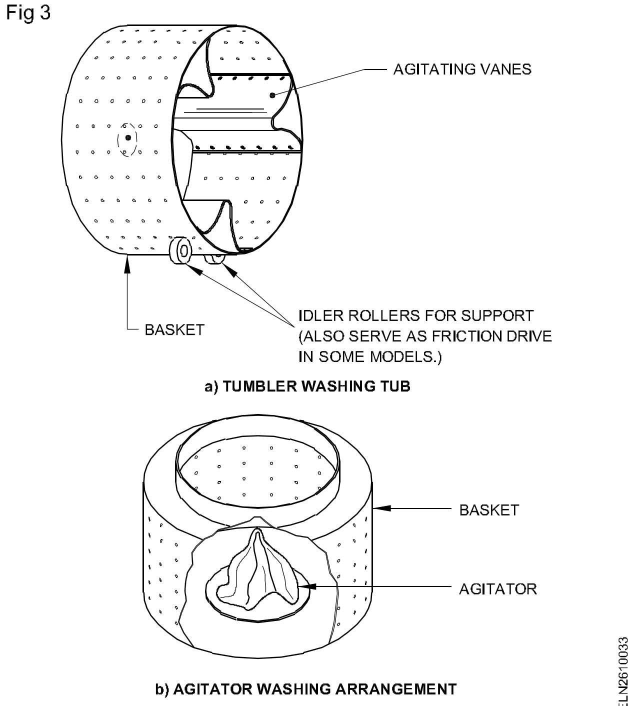


a) TOP LOADING b) SIDE LOADING

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.

Fig 3



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.

The neuro fuzzy logic technique: Machines use this technique uses micro processor for their programming and can make decisions about the type of washing to be used depending upon type of fabric and the extend of dirt.

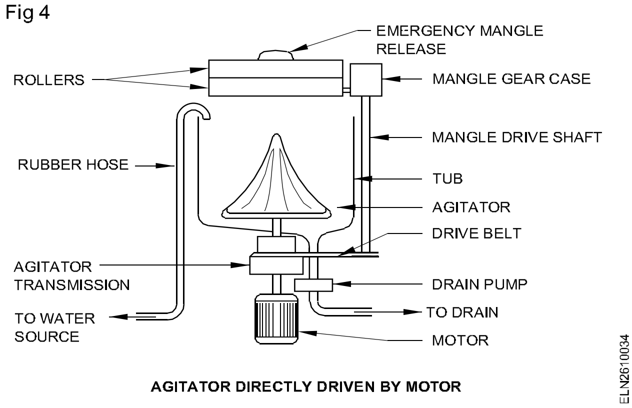
The water fall technique: This is more or less similar to chaos punch technique. This machine use jets of water which are pumped from below the pulsator in to the tub. The velocity and force of water removes the dirt. Most of the washing machines could be repaired by the electrician but micro processor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

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.

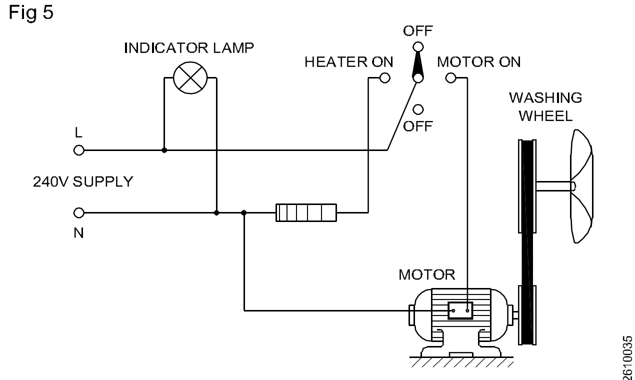
Fig 4



AGITATOR DIRECTLY DRIVEN BY MOTOR

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.

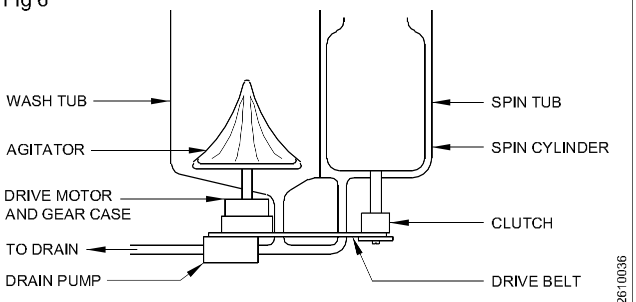
ii The bottom cable should be protected from the damage by the rats by using a rust proof welded mesh.

Twin - tub washing machine

The other type of conventional washing machine available is called the twin tub washer (Figs 6 & 7).

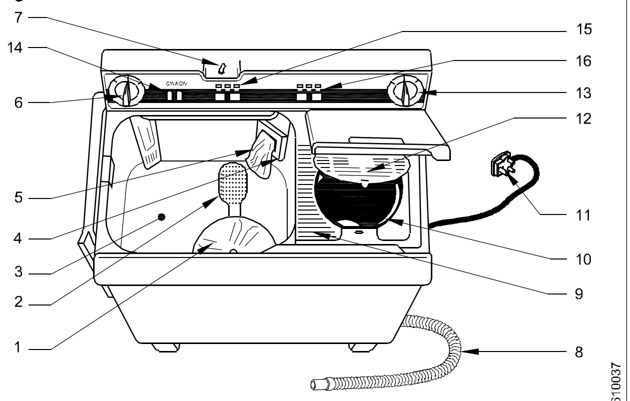
In the twin tub washer an additional tub is present to dry the cloths called a spin tub. Here the clothes after being washed are placed in the spin tub and it is rotated at a high

Fig 6



TWIN TUBS OF WASHING MACHINE

Fig 7



SEMI AUTOMATIC WASHING MACHINE

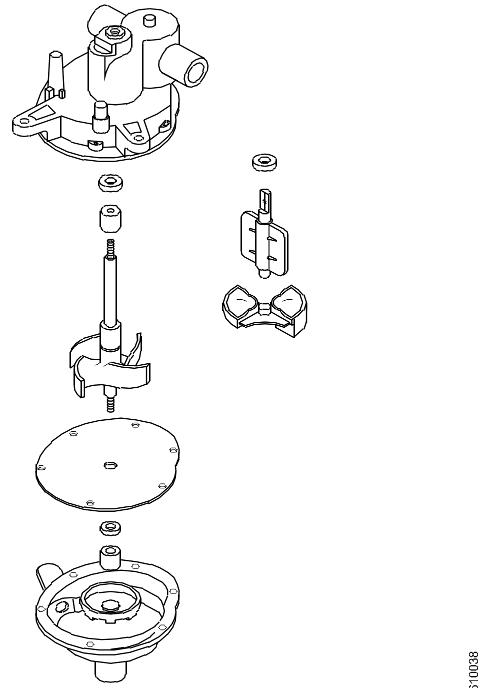
1 - PULSATOR	9 - SCRUBBER
2 - WATER STRAINER	10 - SPIN DRUM
3 - WASH DRUM	11 - 3-PIN PLUG
4 - WATER LEVEL SELECTOR	12 - SPIN DRUM COVER
5 - LINT FILTER	13 - SPIN TIMER
6 - WASH TIMER	14 - AGITATOR DIRECTION SWITCH
7 - WATER INLET PIPE	15 - WATER INLET-OUTLET KNOB
8 - DRAIN HOSE	16 - WATER INLET KNOB FOR SPINING

speed and due to centrifugal action the water from the clothes is removed fully till it is just damp dry. The time duration spin operation may be manual or automatic with the help of a timer depending upon the model.

The mechanical timer: The mechanical timer is a unit that has a spring-loaded gear train reduction arrangement. Normally called as clock timer. In case of defect in the timer it is better to replace it.

The drain pump: Some of the washing machines have a pump for quick removal of water from the drum for fast operation. This may either be gravity drain method or

Fig 8



ASSEMBLY OF WATER PUMP

driven by means of a friction pulley and lever from the main driver or a small sized motor with a water pump (Fig 8).

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.

Installation of a pump set

Objectives: At the end of this lesson you shall be able to
- **define the 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 perform 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.

Example 2: Calculation of HP required.

A pump is to be driven by a 3-phase 415V, 50 Hz induction motor to deliver 45,000 litre of water to a height of 50 metres in 25 minutes. Calculate the HP of the motor assuming the efficiency of the pump is 70% and that of the motor is 95%.

Given

Working voltage - 415V, 50 Hz

Quanity of water to be delivered - 45,000 litre

Height of the water delivered - 50 m

Efficiency of the pump - 70%

Efficiency of the motor - 95%

Time of delivery - 25 min.

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/min = 1 HP

$$\text{Pump output in HP} = \frac{45000 \times 50}{25 \times 4500} = 20 \text{ HP}$$

$$\text{Input of the pump} = \frac{20 \times 100}{70} = 28.6 \text{ HP}$$

$$\text{HP of the motor} = \frac{\text{Input of the pump}}{\text{Efficiency of the motor}}$$

$$\frac{28.6 \times 100}{95} = 30.1 \text{ HP}$$

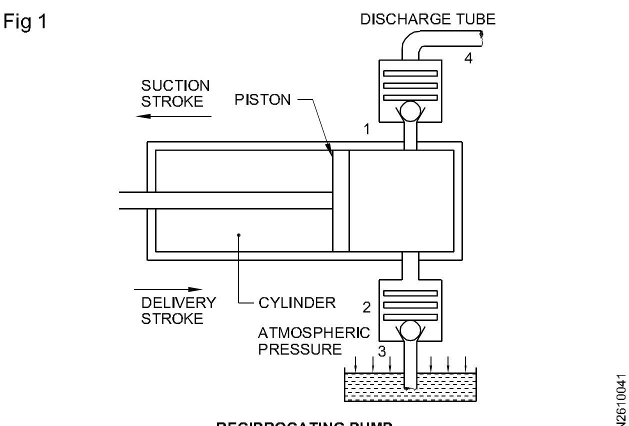
Say approx. 30 HP motor will be suitable.

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



RECIPROCATING PUMP

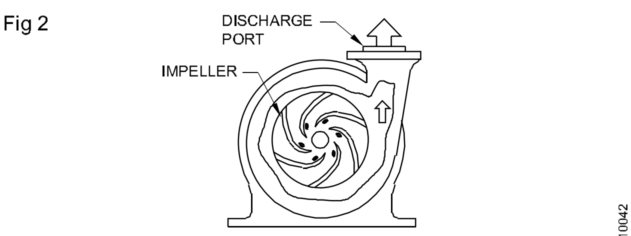
2 Fig 1 opens and allows the water to fill the cylinder through the suction pipe 3 due to atmospheric pressure outside. This stroke of the piston is called suction stroke.

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.

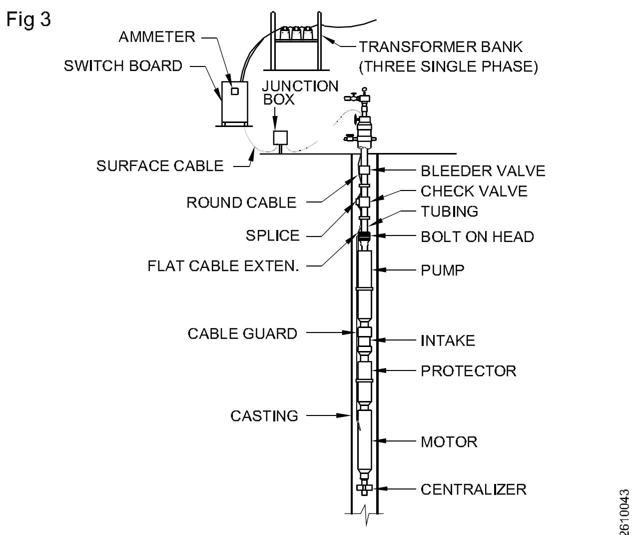


FLUID FLOW IN A CENTRIFUGAL PUMP

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).

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.



ELECTRIC SUBMERSIBLE CENTRIFUGAL PUMP SYSTEM

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.

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).

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.

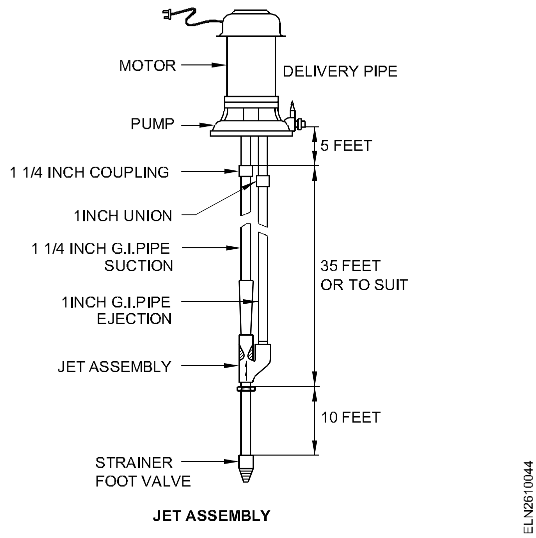
Suction, ejection and delivery pipes and motor capacity could be selected with the help of the performance Table 1.

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.

Fig 4



JET ASSEMBLY

Table 1

Performance with AC 50 Hz, 2880 rpm electric motors for 220/240V single phase and 400/440V 3-phase

Motor rating	Discharge in litres per hour at various suction lifts										Pipe sizes in inches				Minimum
KW (HP)	30'	40'	50'	60'	70'	80'	90'	100'	120'	140'	at discharge pressure of	Suction	Ejection	Delivery	bore diameter (inches)
0.37(1/2) Single phase only	2370	1690	1200	900	700						20 lbs/ Sq.in.	1"	¾"	¾"	3
	2500	1820	1370	1100	820						(46 ft)	1¼"	1"	1"	4" & Well
0.75(1.0) Single phase & 3-phase	3650	2600	2140	1700	1525	1370	1200	1050	700		30 lbs/Sq.in.	1¼"	1"	1"	4" & Well
	3870	2730	2275	1820	1640	1460	1275	1100			(69 ft)	1½"	1¼"	1¼"	5" & Well
1.5(2.0) 3-phase only	4550	3180	2730	2160	1660	1550	1300	1070	910	730	40 lbs/	1¼"	1"	1"	4"
	6350	4460	3550	2900	2460	2260	2000	1730	1370	910	Sq.in.	1½"	1¼"	1¼"	5" & Well
	8400	5700	4800	3800	3200	2910	2460	1820			(92 ft)	2"	1½"	1½"	6" & Well
2.2(3.0) 3-phase only	8900	6000	4840	3820	3250	2960	2530	2180	1820	1250	40 lbs/Sq.in.	1½"	1¼"	1¼"	5"
	10000	7050	5640	4550	4000	3640	3250	2700	2100		(92 ft)	2"	1½"	1½"	6" & Well

NOTE For suction lifts up to 20 feet the pumpsets can work without jet assembly.

Controlling devices

- A switch and starter of a suitable type and capacity may be purchased as per calculated HP of motor.
- Proper size of cable should be used between supply and motor terminals to minimize voltage drop.
- Nuts at connecting terminals should be tightened properly to avoid any chance of the motor burning out.
- Proper double earthing connections should be made at bolts provided for earthing at motor,starter and switch

Operational instructions

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.

To get optimum performance from any pump, the following maintenance schedule is suggested.

Quarterly check.

- Pump noise.
- Pipe connections and nut/bolts.
- Foot valve strainer.
- Moving parts for lubrication.

Yearly check.

- Remove impeller, replace if vanes are worn out totally.
- Replace shaft sleeves, if worn out.
- Replace gland packing, if worn out.
- Replace any other worn out part.
- Replace mechanical seal if damaged.

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 2

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.

Non - Automatic electric iron

Objectives: At the end of this lesson you shall be able to
- **define electric iron and its types**
- **state the function of the parts of an electric iron from the constructional diagram**
- **state the possible faults occured in non - automatic electric iron**
- **explain the method of testing of non - automatic iron.**

Electric iron

An electric iron is a heating device in which the heat is concentrated on a smooth, flat, bottom surface which is applied to the fabrics to be ironed.

The electric iron will probably be the first appliance that an individual will be called upon to repair when entering the appliance servicing field. Inspite of the fact that irons are quite inexpensive, many old irons are in use today.

Types of electric irons : There are three general types of electric irons:

- the non-automatic electric iron
- the automatic electric iron
- the steam iron.

The automatic iron is rapidly replacing the non-automatic iron.

Parts of an Electric Iron

The flat bottom surface is called the sole-plate.

The sole-plate is heated by an element made of resistance wire or ribbon (Nichrome), placed in or on the sole-plate. Thus, the iron converts electricity into heat at the sole-plate, where it can be utilized to iron clothes.

Figure 1 shows the component parts of an ordinary electric iron. The power cord (1) delivers power from the house electrical circuit to the iron. A cord sleeve (2) reduces flexing of the electrical wires as they enter the handle (3).

The cord, cord sleeve and plug cause more iron troubles than any other part or parts of an iron. The cover (4) serves mainly a decorative purpose to hide the unsightly parts below and to keep one's hands away from the electrical terminals. It also serves to keep the heat where it belongs. A pressure plate (5) clamps the heating element (7) to the sole-plate (9) with an electric insulator (8) in between. The asbestos sheet (6) placed in between the pressure plate and the heating element provides heat insulation and reduces the heat being transferred upwardly towards the cover and the handle. The heel plate (10) allows the iron to be tilted back on its handle when the iron is not in use.

Modern irons use a permanently attached cord rather than the detachable cords which can be misplaced easily. One advantage of the permanent cord is that the wall plug is the only electric disconnecting point in the circuit.

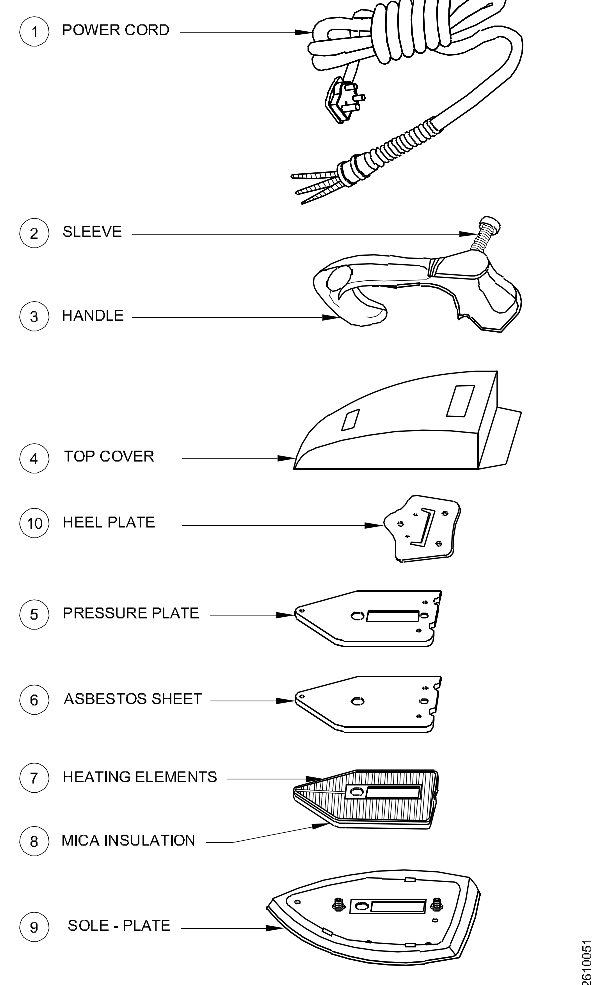
With detachable cords, resistive oxides may form at the iron connector. The resistive oxides formed will in course of time reduce the current input to the heating element.

The electric circuit of any iron is very simple. In many irons it is nothing more than a heating element with a cord and plug attached to connect it to an outlet.

Note that the only troubles possible in this circuit are short circuits and open circuits. Figure 2 shows the four possible parts of the circuit which may be defective. This is an electric diagram of the simple non-automatic type of iron and does not show other non-electrical parts such as the handle cover and sole-plate.

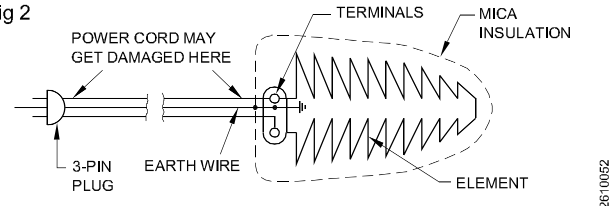
There are six basic steps you should follow to effect an efficient, prompt repair.

Fig 1



PARTS OF AN ELECTRIC IRON

Fig 2



CIRCUIT OF AN ELECTRIC IRON

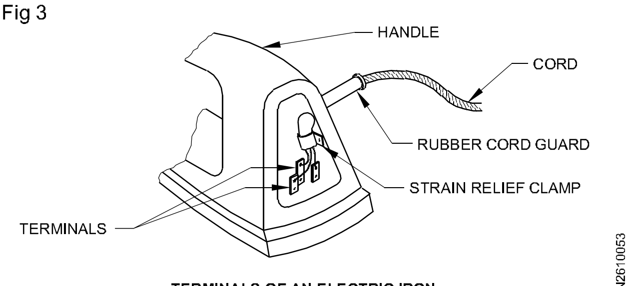
- Conduct a visual examination.
- Listen to the customer's complaint.
- Conduct preliminary tests.
- Repair the iron.
- Make final tests.
- Prepare the iron for delivery.

These basic steps, while not necessarily rigid, provide a good working procedure for the repair of all types of electrical appliance.

General parts: Before you study the method of servicing electric irons, it would be good to learn the names of their principal parts.

Cords: Cords are insulated with asbestos to protect them from the high temperatures produced by the iron. They are covered with braided cotton or nylon (Fig 3). Eyelets or lugs connect a permanent iron cord to the electrical circuit of the iron. A strain relief clamp is firmly fastened to the cord. Any pulls or yanks on the cord are absorbed by this clamp rather than the eyelets.

Fig 3



TERMINALS OF AN ELECTRIC IRON

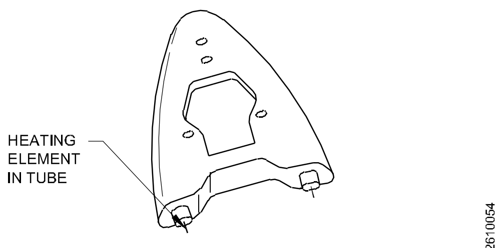
Handles: Handles are made of wood or plastic. In modern irons, plastic handles are made in large units combining the handle and brackets in a single unit mounted directly on the cover. Sometimes handles are split to provide access to the terminal covering and an entrance for the cord. When disassembling an iron for repair, the handle and its part are usually the first to be disassembled.

Cover: This part covers the heating element's internal connections of the iron. It also serves as a shield to protect one's hands from the generated heat and electric terminals.

Pressure plate: The purpose of the pressure plate is to keep the heating element firmly against the sole-plate. Often the pressure plate has an asbestos insulation sheet of the same shape.The asbestos sheet is placed just above the heating element. The pressure plate must be a good fit. (Fitted with two nuts)

Heating elements: There are two types of heating elements. One is made of a ribbon resistance wire wound around a sheet of mica. This type of element is placed on the top of the sole-plate. The other type of element is made up of a round resistance wire, coiled on a ceramic form and cast directly into the sole-plate (Fig 4). The flat type element is easily replaceable. The other type has its element casted into the sole-plate is replaced fully by installing a new sole-plate.

Fig 4



SOLE PLATE WITH SEALED ELEMENT

Sole-plate: The transfer of heat from the heating element within to the material being ironed is done by the sole-plate (Fig 4). The material being pressed can be easily damaged if the sole-plate is not smooth and free from scratches. If the sole-plates are scratched, they can be buffed and polished.

Heel - plate: The purpose of the heel-plate is to supply a resting point when the iron is tilted back on the rear of its handle. The heel plate is not intended to reach a high temperature. The figure shows the other type of heel plate used for resting the iron.

Terminals: The terminals are the point at which the heating element of the iron is connected to the cord (Fig 3).

Electric irons are available for operation on 240V domestic electric supply, and are of different wattages, 450W, 500W, 600W, 750W and 1000 W.

Possible faults

1 Disconnection of element strips from the terminals.

2 Breakage in the element.

3 Breakage in the cord, disconnection of wires in the plug top or connection.

4 Strips at the terminals may touch together which may cause a short circuit.

5 Any part of the element or strip at the terminals may touch the metal body of the iron which may cause earth fault.

6 Porcelain cleats may be broken.

7 Mica and asbestos sheet may be damaged.

Repairs

1 Open circuit fault

Connect the broken element or disconnected strips. Connect the wire ends in the plug top or connector. If there is breakage in the cord. check it and connect the broken wires if possible, otherwise replace the cord.

2 Short circuit fault

It the strips of the element, wires in the plug top or connector are touching together, separate them and insulate them. If the cord is too old and the current is leaking through the insulation, replace the cord.

3 Earth fault

If any part of the element or strips of the element are touching the metal part of body, separate them from the body and insulate them.

4 Leakage fault

If the insulation has become weak and the current is leaking, then add some more insulating material or replace the insulating material.

5 Other faults

If the cleats are broken, get these replaced. If the mica and asbestos sheets are damaged, replace them also.

Precautions at the time of fitting

1 There should be no gap between the pressure plate and the sub-plate, otherwise the element will be damaged soon.

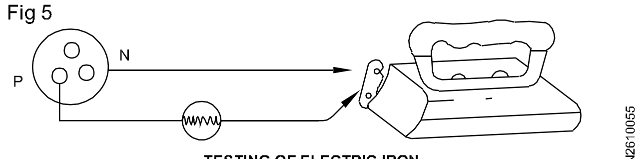
2 Place the asbestos sheet between the pressure plate and the upper side of the element.

3 Fitting of the components should be made fully tight.

Testing

To find out the fault, use the test lamp (Fig 5).

Fig 5



TESTING OF ELECTRIC IRON

Connect two ends of the testing leads to the terminals of the iron. If the lamp gives dim light, it means that the element is in working order. If the lamp does not light up, there is breakage in the element or disconnection of the strip from the terminal.

If the lamp gives full light, it means there is a short circuit. For earth testing, connect one lead to one terminal and the other lead to the body of the iron. If the lamp lights up, it means that there is an earth fault.

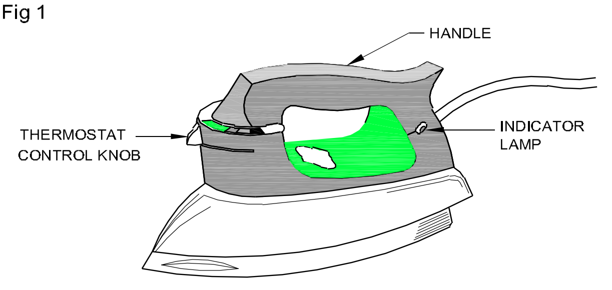
Automatic electric iron

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)

Fig 1



AUTOMATIC ELECTRIC IRON

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.

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

1 Dry Automatic Iron

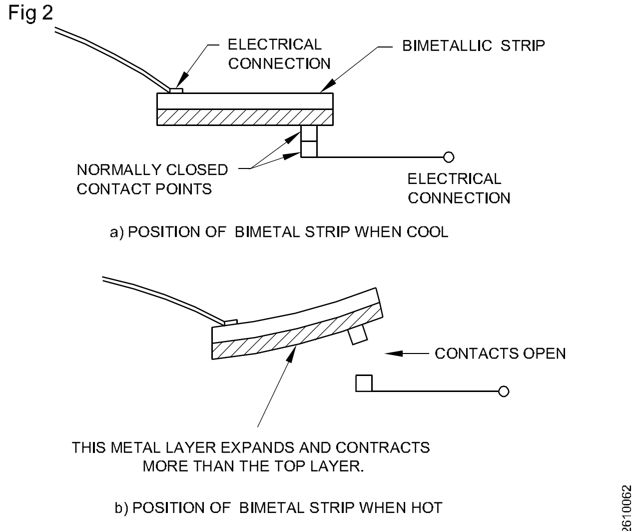
2 Spray/Steam Automatic Iron

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



A SIMPLE BIMETAL THERMOSTAT

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.

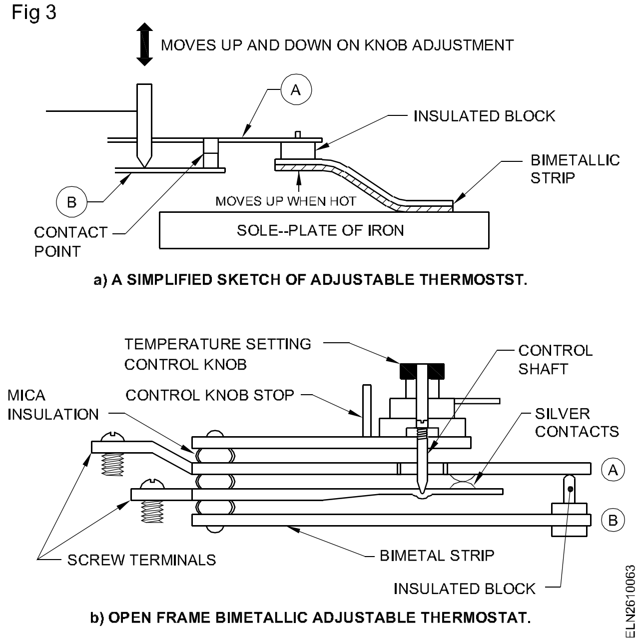
As the strip cools, it straightens and restores contact with the stationary point. The bending of the bimetal strip on heating, is towards the side that has the smaller expansion rate.

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.

Fig 3



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.

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.

Troubleshooting chart

(Dry Iron)

Trouble	Possible causes	Corrective action to be taken
No heat	No power at outlet. Defective cord or plug. Loose terminal connections. Broken lead in iron. Loose thermostat control knob. Defective thermostat. Defective heater element. Open thermal fuse.	Check outlet for power. Repair or replace. Check and tighten the terminals. Repair or replace lead. Clean and tighten. Replace thermostat. Replace the element if separate. If cast in, replace sole-plate assembly. Replace.
Insufficient heat	Low line voltage. Incorrect thermostat setting. Defective thermostat. Loose connection.	Check voltage at outlet. Adjust and recalibrate thermostat. Replace thermostat. Clean and tighten connections.
Excessive heat	Incorrect thermostat setting. Defective thermostat.	Adjust and recalibrate thermostat or replace. Replace thermostat.
Blisters on sole-plate	Excessive heat.	First repair the thermostat control. Then replace or repair the sole-plate, depending on its condition.

Trouble	Possible causes	Corrective action to be taken
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.

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.

This cycle goes on and off in that setting

At the highest temperature setting, the distance between the strip A and the insulated block of the bimetal strip will be more and it takes more time to switch OFF the heater element, and, thereby, the temperature of the iron will be more.

The knob adjustment does not determine the amount of current that flows into the appliance but usually controls the ON-OFF cycle of the unit; thereby, increases the heat required for wool or reduces the heat for rayon.

Bimetal thermostats open and close slowly and as a result the contacts are prone to arcing.

The mica insulation between the two strips A & B act as a condenser and the arc is suppressed by the condenser action. Sometimes, the mica gets deteriorated and allows the arc to exist between the contacts. Each time the contacts open, they cause a small arc which leaves a deposit of oxide on the contact surface.

Corroded contact points increase the arcing and lose electrical conductivity. Eventually the contacts no longer allow the current to flow. This can occur even though they may seem to be touching each other.

Generally, a good thermostat will show zero ohms resistance, or at most a few ohms. When a thermostat indicates high resistance or infinity, it should be replaced. Do not try to bend the strips A or B unless otherwise you know what you are doing is correct.

Troubleshooting in an automatic iron

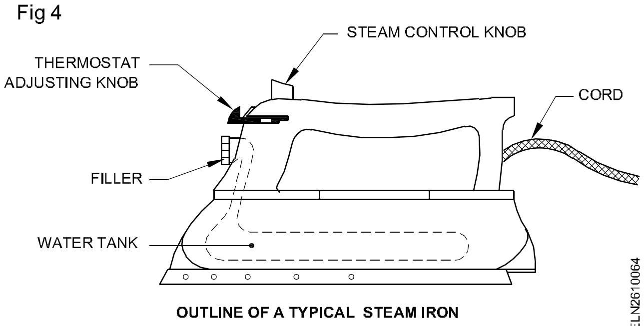
Follow the troubleshooting chart to repair an automatic iron.

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.

Fig 4



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.

Electric kettle

Objectives: At the end of this lesson you shall be able to
- **define 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.

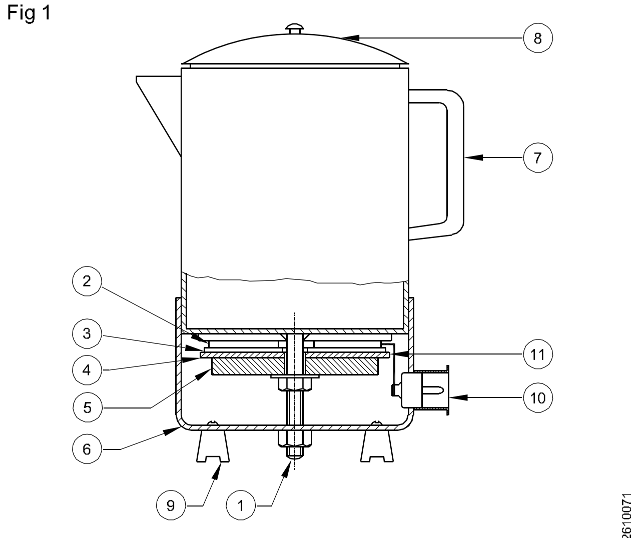
Saucepan type: The construction of the sauce pan type kettle is given in Fig 1. The parts are as follows.

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. On removal of the bottom cover, ready access is made to the terminal and heating element assembly (Fig 1).

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.

Fig 1



CONSTRUCTION OF SAUCEPAN TYPE KETTLE

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. If this pressure plate is loosely fitted, the sole plate and the element become loose. This leads to expansion and contraction of the element during working and the element will get damaged.

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.

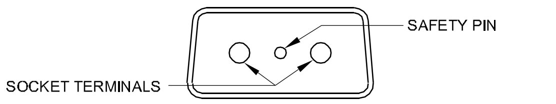
– Reassemble the kettle.

– 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.

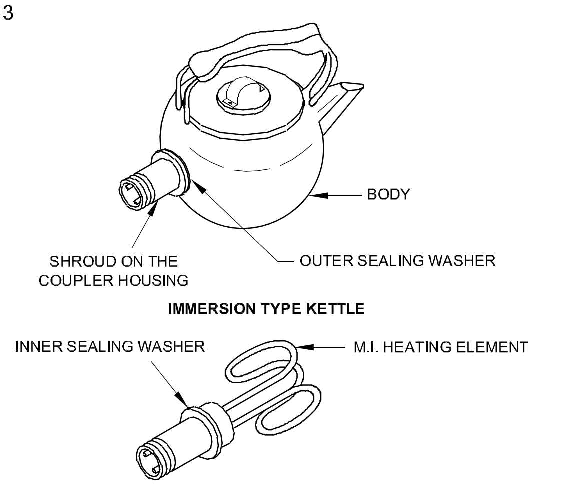
In case the kettle is switched ON without water the safety pin (Fig 2) which is soldered against a spring which is under tension comes out and pushes the plug out. This safety pin can be placed in position by soldering. The heating element is concealed inside a hollow tube and mineral insulated (Fig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

Fig 2



SOCKET WITH SAFETY PIN

Fig 3



KETTLE HEATING ELEMENT

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.

Calculation of heater efficiency

Objectives: At the end of this lesson you shall be able to
- **define heat unit and joule's law**
- **list the method of heat transfer**
- **solve problem related to efficiency of heaters.**

Heat Unit

The kilocalorie (kcal) is the unit of heat in the MKS system. It is defined as the amount of heat required to increase the temperature of one Kg of water through 1°C. It has been experimentally proved that, if 4187J of electrical energy is completely converted to heat, it produces one kilocalorie of heat energy, i.e. 1 kilocalorie = 4187J.

Joule's Law of heating : This law states that whenever the current flow through a conductor the heat is generated in the conductor and it is proportional to the square of the current value, the resistance of the conductor and the time for which the current flows.

The above law can be expressed in the form of an equation as follows :

$H = I^2 Rt$ watt - seconds or joules

where I = current in the conductor in amperes

R = resistance of the conductor in Ohms

t = time for which the current flows in seconds

H = quantity of heat developed in joules.

If current 'I' ampere flows for 't' seconds through a resistance of R Ohms, then the electrical energy consumed (I^2 Rt joules) is converted into heat so that we have.

$H = I^2 Rt$ joules or watt - seconds

or

$$H = \frac{I^2Rt}{J} \text{ calories}$$

where J is joule constant

Mechanical equivalent of heat J = 4.2

because 4.2 joules = 1 calorie

Then one joule = 0.24 calories, and

4187 joules = 1 K calories

$$\text{Thus } H = \frac{I^2Rt}{4187} \text{ K Cal.}$$

Methods of heat transfer : Heat energy is generally transferred from one place or object to another by one of the following three methods: conduction, convection and radiation.

The heat generated by the heater is not fully utilised for our purpose and some losses are taking place. The efficiency of the heater is therefore less than 100%. The efficiency of the heater is the ratio between the heat actually utilised and the heat produced by the heater.

$$\text{So, efficiency} = \frac{\text{Heat utilised}}{\text{Heat generated}}$$

- Therefore, the percentage efficiency

$$= \frac{\text{Heat utilised}}{\text{Heat generated}} \times 100$$

- The heat generated is calculated using Joule's law. Accordingly we have,

$$H = \frac{I^2Rt}{j} \text{ calories}$$

or $0.24\, I^2Rt$ calories

where I is current in amperes

R is resistance in ohms

t is time in seconds

j is the mechanical equivalent of heat = 4.2.

The bigger unit of heat is the kilo-calorie.

Calorie: It is the amount of heat required to raise the temperature of one gram of water to one degree celsius.

1 Calorie = 4.2 joule or watt second

Heat obtained by a substance

$= ms(T_2 - T_1)$ calories

where m - mass in grams

s - specific heat of the substance

$(T_2 - T_1)$ - raise in temperature (degrees celsius).

Example

An electric heater is marked 1000 W 240V. It is found to take 8 minutes to bring 1 Kg of water from 20°C to boiling point (100°C). Determine the efficiency.

Given data

where m	-	mass in grams
Mass of water m	=	1 Kg or 1000 grams
Initial temperature T_1	=	20°C
Boiling temperature T_2	=	100°C
Raise in temp$(T_2 - T_1)$	=	100°C–20°C = 80°C
Time t	=	8 minutes = 480 sec.
Heater wattage	=	1000 W
Heater voltage	=	240 V

Specific heat of water is 1.

Heat utilised by water = $ms(T_2 - T_1)$

= mass x sp. heat x $(T_2 - T_1)$

= 1000 x 1 x 80

= 8000 calories.

Heat generated = 0.24 x I^2Rt calories

= 0.24 x 1000 x 480.

(where $I^2R = 1000$)

Therefore, efficiency $= \frac{\text{Heat utilised}}{\text{Heat generated}} \times 100$

$= \frac{8000}{0.24 \times 1000 \times 480} \times 100$

= 70% (approximate).