

FOOD GRAIN CLEANER

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INTRODUCTION

India is basically an agrarian society. A lot of food grains are used for dietary purposes. Therefore there is a need of energy efficient, low cost, food grain cleaner. Thus, manually operable cleaner serves the purpose.

RATIONALE

Food grains for our daily use are required to be cleaned at different levels. First at farm level, second at marketing yard level and finally at household consumer level. So the need of time is a food grain cleaner that is very easy and fast to operate and will consume no electricity.

SCIENTIFIC PRINCIPLE INVOLVE

As the grain passes through the rotating sieve, according to the size of sieve mesh, it gets cleaned. Rotating sieve will be kept inclined to get natural flow due to gravity.

MATERIALS REQUIRED

1. Rotating Sieve : Galvanised Iron Sheet
2. Hopper : Mild Steel Sheet

3. Main Body : Mild Steel Sheet
4. Handle : Mild Steel
5. Rotating Shaft : Mild Steel
6. Bearings : Bearing Steel
7. Main Frame Legs : Mild Steel Angles
8. Clean Grain Collectors : Plastic

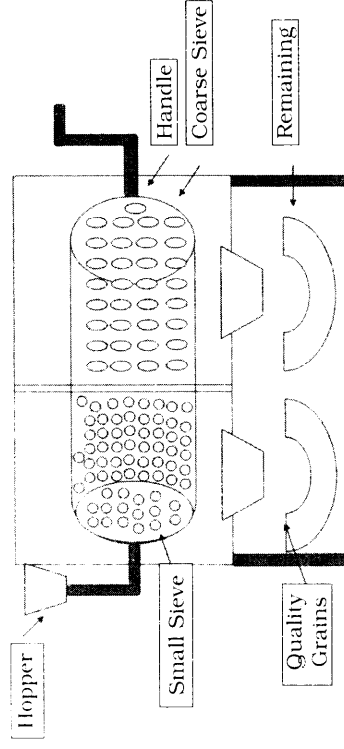


Fig. 2.1: Food Grain Cleaner

CONSTRUCTION AND WORKING

There is a rotating cylindrical sieve connected to the shaft with the help of ribs so that it allows sieve to rotate and at the same time allows the grains to pass from one end to the other. A handle is connected with one end of the shaft and the shaft is connected with the main frame with the help of bearings. There is a hopper at one end of the rotating cylindrical sieve from where food grains are added. The cylindrical sieves have two type of mesh surface, first the smaller mesh and second the larger one. As the grain passes through the first part of mesh the smaller grain, dirt, small stones, broken grains are cleaned and collected in first plastic tray and only good size of grains enters in second part of mesh where it passes through the mesh and gets collected in the second plastic tray. If there is any other impurity which are bigger than the grain size it will remain in the cylindrical sieve at the end and can be collected as the sieve is removable. The entire frame is stabilised with help of four legs.

DE-HUMIDIFIED DRYING OF HIGH VALUE FOOD COMMODITIES

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INTRODUCTION

Increasing population necessarily requires large quantities of food products and their preservation. Diversity in climatic conditions during places stops food from being stored in natural conditions. The traditional methods of food drying for preservation are either inefficient or defective. The vegetables are dried at 70°C to 80°C by blowing hot air from a compressor. Since Vitamin-C (ascorbic acid) is volatile in nature and readily destroyed by heat and light, it escapes out of the food at this temperature. Higher temperature is required only due to the presence of humidity in air. If humidity is reduced from air, then food can be dried at low temperature between 40°C to 50°C. The sole purpose of this exhibit is to create awareness about new scientific techniques used in food drying for preservation so that dried food does not lose Vitamin-C, green pigments and flavor. It also highlights the eradication of scurvy disease which is caused due to deficiency of Vitamin-C.

RATIONALE

This project is an attempt to solve the problems arising during the present system of drying food for preservation in which lot of

food nutrient values are destroyed. In the present model the humidity of air is reduced at first stage by silica gel and then exposed into the drying chamber being hot by solar ray. After reduction of humidity from air, drying of food is made at low temperature to preserve food value of the dried food.

SCIENTIFIC PRINCIPLES INVOLVED

De-Humidification: Silica gel absorbs the water particles from the air and make the air dry.

Heat Radiation: Black body radiation causes very good heating effect to heat the dry air.

Parabolic Reflector: Parabolic reflector concentrates solar rays at a point for better efficiency and heat the air moderately.

Food Drying: De-humidified drying of food at low temperature preserves food values like Vitamin-C, green pigments and flavour.

Energy Conservation: Solar cell is used to drive all the electrical equipments to conserve traditional energy

Convention of Air: Hot dried air enters into the food drying chamber and absorbs water content from the vegetables and gets saturated with moisture. Exhaust fan exhausts this air out of the chamber and natural air from the atmosphere enters in to fill the vacuum.

MATERIALS REQUIRED

Wooden house, aluminium reflector, transparent plastic sheet, 6V solar cell, metal pipe, wire net, wooden stand, wire, switch and hardware materials, 2 nos. fan blades to be fitted with the motors, silica gel, chalk pieces, 6V motor (2 nos.), gear box etc.

CONSTRUCTION AND WORKING

Make a small house of plywood. Fit two nos. of wire net inside this house at six inches distance with respect to each other. The frame of wire net should be parallel to the floor of the house. Fit one door on the front side of the house. The roof of the house should be made up of transparent plastic sheets to allow sun rays to enter into the drying chamber. Make a hole on one side of the roof and fit a 6V exhaust fan in it. The 6V solar cell should be

fitted on top end of the wall of the house. A hole should be made on the bottom of another wall and the metal pipe be inserted in it. Another fan should also be fitted on the one end of the pipe. Now connect both the fans with the solar cell through wire and switch. The other end of the pipe should be fitted with an air dryer filled with silica gel. The middle part of the metal pipe should be covered by a parabolic aluminium reflector from one side. Fit a plastic separator in between the air dryer and the metal pipe to prevent heat conduction. Paint the metal pipe which is in the reflector by black paint. The reflector should be fitted with the gear box through a 6 V motor which will be driven by solar cell. Now expose the whole system to the sunlight.

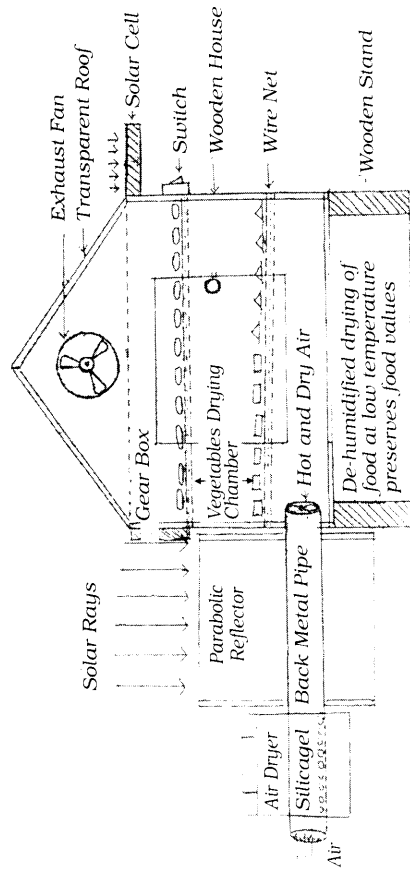


Fig. 3.1: Food Drying Machine

When the set-up is exposed to the sunlight, both the fans will start rotating as these get power from solar cell. The inner fan which is fitted with the metal pipe will suck air from the atmosphere. The air will flow through the air dryer which is filled with silica gel. The water vapours in the air will be absorbed by silica gel here. Only dry air will flow through the rest pipe. Due to black body radiation and reflection of light of sun, the inner air would be hot enough. Then only hot and dry air will enter into the drying chamber. Vegetables which are to be dried up should be kept on the wire net. When dry hot air will enter inside, the air itself will absorb water content of the vegetables at faster rate as the air is dry and hot. Hence vegetables will be dried below 50°C.

The other fan fitted at the top end of the roof, will exhaust the hot air from inside of the drying chamber. The gear box already fitted with the reflector will rotate the reflector very slowly so that the 'hot air pipe' will always face towards the sun to gain more heating effect. Through this process, we can dry vegetables at low temperature and preserve Vitamin-C, green pigments and flavour of the dried food.

APPLICATIONS

It is a dynamic model made out of new indigenous technology run on solar energy. Food drying at low temperature has great and wonderful applications. Compared with the traditional methods, above technique is energy saving, economical and can provide safe food. No food value is damaged while drying.

4

LOW-COST COLD STORAGE

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INTRODUCTION

Fresh fruits and vegetables start to deteriorate as soon as they are harvested because they are cut off from their source of water and nutrition. They lose weight, texture, flavor, nutritive value, and appeal. Cooling significantly slows down the rate of deterioration, thereby increasing the shelf-life of the produce. The cooler the temperature, the slower the deterioration and the longer the storage life. Much commercial produce is stored at low temperatures just above which it will damage, so that it can have the maximum possible shelf-life for many weeks or even months and can be transported to very long distance. Sometimes long storage times at very low temperatures may not be required for many produce because fresh produce deteriorates substantially within a day or two if not cooled at all from ambient condition, especially during the hot summer months. Low-cost cold storage options can benefit growers by preserving freshness and quality of produce for a few additional days. Produce losses of growers can be significantly reduced, especially for the growers who have higher level of production and can carry excess produce of one to the next day to the market.

REQUIREMENT ANALYSIS

The following problems are being observed in different cash crops and other major cultivations.

Ginger

Fungal Diseases: Yellowing of leaves, rhizome rot by *Fusarium oxysporum*, *Pythium* sp.

Bacterial Disease: *Pseudomonas* sp.

Cardamom

Fungal Disease: *Glomerula* sp., *Fusarium oxysporum*, *Pythium* sp.

Bacterial Diseases: *Pseudomonas* sp.

Orange

Fungal Disease: Mild Dew, *Elsinoe fawcettii* (causes citrus scab) *Alternaria citri* (causes decay).

Potato

Bacterial Diseases: Brown Rot (*Pseudomonas solanacearum*).

Fungal Disease: Brown spot and black pit (*Alternaria tenuis*).

The objective of this endeavour of making a low-cost cold storage system are to construct the ecofriendly, low cost storage system affordable by the weaker section of the society and to provide the optimum temperature for the storage of fruits and vegetables.

The construction of low-cost cold storage is based on the principle of evaporation and latent heat transfer.

MATERIALS USED

Plywood, fevicol, nails, straw, saw-dust, sand, thermometer, water, plastic pipe, water reservoir, charcoal, wood bark etc.

CONSTRUCTION AND WORKING

Low-cost cold storage consists of a double walled room (wooden or concrete), having a gap of 6 to 10 inches between the outer and inner wall. Between the walls sufficient amount of straw, saw-dust, sand, charcoal, wood bark are placed accordingly. The holes are made at roof between the two layers as water can enter through these holes in the gap. The ventilation and holes are made at the outer wall so that air can pass and evaporated gas can come out through it. The excess water comes out through the outlet which can again be used for irrigation purpose.

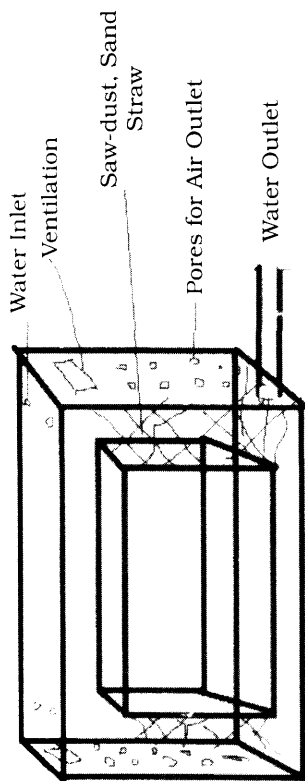


Fig. 4.1: Storage of Fruits and Vegetables

Table 4.1: Fruits and Vegetables that Require Cold, Moist Conditions

Vegetable	Temperature (°F)	Relative Humidity	Length of Storage
Asparagus	32-36	96	2-3 weeks
Apples	32	90	2-6 months
Beets	32	95	3-5 months
Broccoli	32	95	10-14 days
Brussels Sprouts	32	95	3-5 weeks
Cabbage, Early	32	95	3-6 weeks
Cabbage, Late	32	95	3-4 months
Cabbage, Chinese	32	95	1-2 months
Carrots, Mature	32	95	4-5 months
Carrots, Immature	32	95	4-6 weeks
Cauliflower	32	95	2-4 weeks
Celeriac	32	95	3-4 months
Celery	32	95	2-3 months
Collards	32	95	10-14 days
Corn, Sweet	32	95	4-8 days
Endive, Escarole	32	95	2-3 weeks
Grapes	32	90	4-6 weeks
Kale	32	95	10-14 days
Leeks, Green	32	95	1-3 months
Lettuce	32	95	2-3 weeks
Parsley	32	95	1-2 months
Parsnips	32	95	2-6 months
Pears	32	95	2-7 months

Pears, Green	32	95	1-3 weeks
Potatoes, Early	30	90	1-3 weeks
Potatoes, Late	39	90	4-9 months
Radishes, Spring	32	95	3-4 months
Radishes, Winter	32	95	2-4 months
Rhubarb	32	95	2-4 months
Rutabagas	32	95	2-4 months
Spinach	32	95	10-14 days

Table 4.2: Vegetables that Require Cool, Moist Conditions

Vegetable	Temperature (°F)	Relative Humidity	Length of Storage
Beans, Snap	40-50	95	7-10 days
Cucumbers	45-50	95	10-14 days
Eggplant	45-50	90	1 week
Cantaloupe	40	90	15 days
Watermelon	40-50	80-85	2-3 weeks
Peppers, Sweet	45-50	95	2-3 weeks
Potatoes, Early	50	90	1-3 weeks
Potatoes, Late	40	90	4-9 months
Tomatoes, Green	50-70	90	1-3 weeks
Tomatoes, Ripe	45-50	90	4-7 days

Table 4.3: Vegetables that Require Cool Dry Conditions

Vegetable	Temperature (°F)	Relative Humidity	Length of Storage
Garlic	32	65-70	6-7 months
Onions	32	65-70	6-7 months

Table 4.4: Vegetables that Require Warm Dry Conditions

Vegetable	Temperature (°F)	Relative Humidity	Length of Storage
Peppers, Hot	50	60-65	6 months
Pumpkins	50-55	70-75	2-3 months
Squash, Winter	50-55	50-60	2-6 months
Sweet Potato	55-60	80-85	4-5 months

Source: ISO Standard for Food Storage

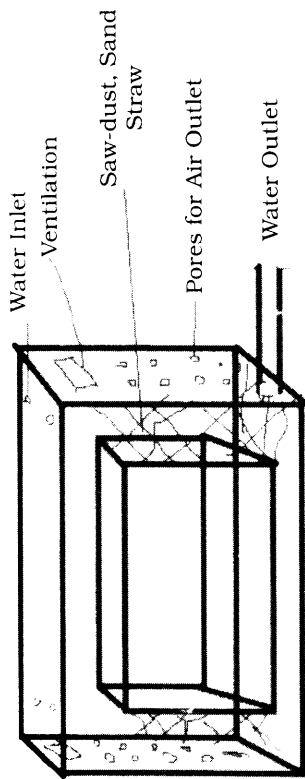


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Watermelon	40-50	80-85	2-3 weeks
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Pumpkins	50-55	70-75	2-3 months
Squash, Winter	50-55	50-60	2-6 months
Sweet Potato	55-60	80-85	4-5 months

Source: ISO Standard for Food Storage

WORKING OF THE EXHIBIT

The low-cost cold storage works on the principle of evaporation and latent heat transfer. Water enters in the gap between the outer and inner layer which is filled with sand, straw, saw-dust, and gets trapped into it. The excess water comes out through the outlet which is used for irrigation and other purposes. The water source can be rain or stored water from river or stream water. The trapped water particles of sand, straw and saw-dust, when gets in contact with outside air, the temperature inside starts increasing thereby causing the water molecules inside to be evaporated and comes out through the pores on the wall. Thus, inside heat is transferred according to latent transfer of heat thereby causing the inside temperature to fall, which makes the inner room conducive for storing the vegetables and fruits.

EFFECTIVENESS OF THE EXHIBIT

This model is specially designed for the storage of food articles mainly produced in the mountainous region like Sikkim. We have measured the inside and outside temperatures of cold storage room and temperature difference of 10-18°C is observed. Thus, the optimum temperature for the storage of ginger (*Zingiber officinale*), potato (*Solanum tuberosum*), sweet potato (*Ipomea batatas*), orange (*Citrus reticulata*) and dry cardamom (*Amomum subulatum*) can be achieved by using this storage.

ADVANTAGES OF THE EXHIBIT

Such low-cost cold storages are cost effective, environment friendly and use natural resources. These are easy to install and can be used by farmers to store ginger, potato, orange, etc.

The cold storage provide the efficient utilisation of rain water. The excess water may further be utilised for irrigation and for some other domestic purpose after filtration. The straw after certain months can be replaced by the fresh one and the old straw can further be utilised as manure.

5

MECHANICAL BIRD

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INTRODUCTION

When we observe the sky, we see many animals in flight, be them birds, bats or bees. Man has been fascinated with flight and has tried to achieve it since time immemorial. Leonardo da Vinci was one of the first persons to observe and make a detailed scientific account of their flight in the 1500s. In the early 1900s, the Wright brothers created history by being the first persons to build a plane that could fly. After the invention of the first aeroplane, there has been no turning back. Today we have supersonic jets that can fly faster than sound and rockets that can escape the earth's gravity.

Commercial flying has become a major way to transport people. However, commercial flight is not popular in India due to the relatively high costs. But commercial flight has come under immense scrutiny these days due to the global scenario of increase in fuel prices and environmental problems.

This project is an aim to create mechanism of low – drag flight, so as to ensure a greener, cheaper future.

What it Takes to Fly

For an object to fly with constant velocity, a lifting force or **lift** equal to its **weight** and a forward force or **thrust** equal to the viscous friction or **drag** is needed.

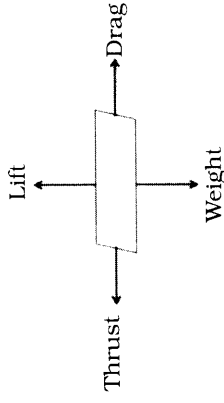


Fig. 5.1: Four Forces for Flight

Aeroplane

An aeroplane employs two separate mechanisms, viz. one for lift and other for thrust.

For lift, the aeroplane has wings tilted to the horizontal at an angle (α). The aeroplane move forward against the direction of airflow. It is opposed by a force which can be resolved into a horizontal component (drag) and vertical component (Lift).

For thrust, the plane has to make use of a propeller that increases the airflow opposing it so as to get pushed forward.

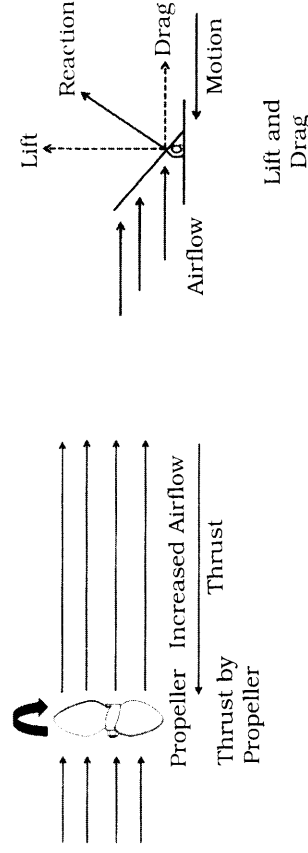


Fig. 5.2: Mechanisms of an Aeroplane

An aeroplane must achieve lift and thrust separately. This reduces efficiency and in the present day scenario of increasing costs and environmental pollution, this leads to a problem.

Flapping Wings

Flapping wings ensures that one can gain both lift and thrust in the same stroke resulting in higher efficiency.

The upstroke however, presents problems. The lift and thrust gained in the downstroke is lost on the upstroke.

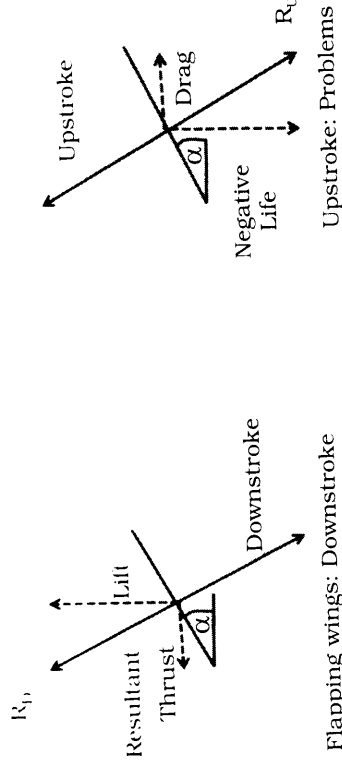


Fig. 5.3: Ray Diagramme of Flapping Wings

Equations Governing Flapped Wing Flight

Resultant force on downstroke (R_d) for a circular wing is given by:

$R_d = dp/dt$ (p is the momentum of the displaced air)

$R_d = mdv/dt$ (m is the mass of air and v is the velocity of air)

$m = V\rho$ (V is the volume of the air displaced and ρ is the density of air)

$R_d = V\rho dv/dt$

If the resultant force on the upstroke $R_u < R_d$, then the object will fly.

Bird: A Case Study

R_u (bird), assuming circular wings is given by, $R_u = (4/3)\pi r^3 \rho dv/dt$

R_d (bird) = $V\rho dv/dt$ (accelerations on both strokes are same)

Birds reduce volume of air displaced on the upstroke by splitting and bending their wings.

In our discussion, let us assume that due to the split wing the radius of the wing is reduced by a factor of 2

Therefore, R_u (bird) = $(1/6)\pi r^3 \rho dv/dt$

Mechanical Bird for Flight

The project involves a novel adaptation of a rack and pinion gear mechanism for efficient flapping wing flight. The flapping mechanism is analogous to the breaststroke in swimming.

In swimming also, $R_0 = V \rho \, dv/dt$

Since ρ (water) $> \rho$ (air), V and dv/dt need not be very high and practical experience validates this.

Whereas in the case of the mechanical bird, since ρ (air) is small, V and dv/dt need to be proportionally higher.

Test for R_0

The Mechanical Bird was mounted on a 6-axis Force and Torque sensor. The sensor comprises 6 strain gauges, which capture forces and moments along 3 axes.



Fig. 5.4 (a)

Mechanical Bird

Fig. 5.4 (b)

We are interested in forces along the Z-axis. When the Mechanical Bird flaps its wings, two types of forces are generated, viz. inertial forces due to movement of set up, and aerodynamic forces due to movement of wing. In order to measure only aerodynamic forces, the test was carried out in two steps.

Step 1: The Mechanical Bird was mounted on the set up without its wings so as to measure only the inertial forces (assuming the wing frame produces negligible aerodynamic forces).

Step 2: The Mechanical Bird was mounted with the wings on the set up to measure both aerodynamic and inertial forces.

Result

The forces measured in the above two steps were plotted in a Force-time graph. The difference between the graph of Step 1 and that of Step 2 gives the aerodynamic forces produced (assuming that the wing produces negligible inertial force).

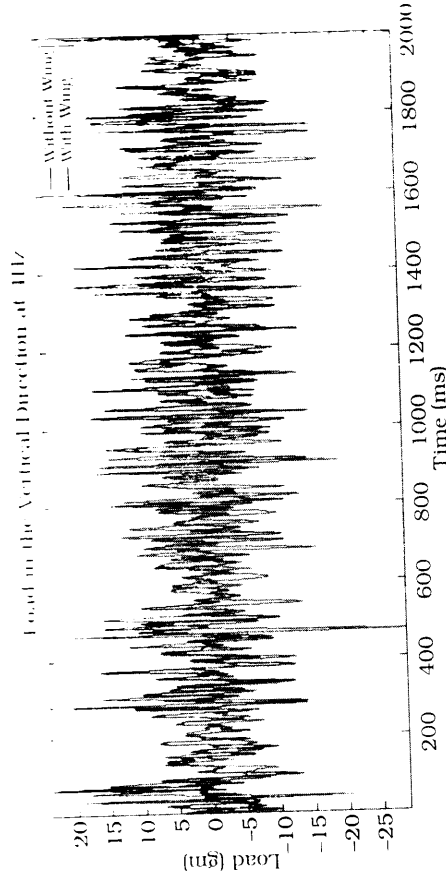


Fig. 5.5: Force-time Graph

In the above graph, we see eight cycles in a time period of two seconds. Each cycle can be broken into two parts, downstroke and upstroke.

Inference

From the above graph, assuming the mechanical bird is oriented perpendicular to the ground, we infer that for a flapping frequency of **4 Hz** and wing area of **90 cm²**, the average lift produced is **7 gf**. Hence we conclude that a Mechanical Bird of such specification and weight less than **7 gf** can achieve flight.

Theoretical analysis of R_0

We compare the R_0 values of a bird and the mechanical bird
 R_0 (mechanical bird) $= V \rho \, dv/dt$ (acceleration of bird and mechanical bird are same)

V = Volume of the wing $= \pi r^2 h$ (h is the thickness of the wing)

R_0 (mechanical bird) $= \pi r^2 h \rho \, dv/dt$

R_0 (mechanical bird) / R_0 (bird) $= \pi r^2 h / (1/6) \pi r^3 = 6h/r$

By construction, $h \ll r$

Hence, R_0 (mechanical bird) $< R_0$ (bird)

Flight is thus **possible** and more **efficient**.

MATERIALS USED

Acrylic, Balsa wood, Carbon Fibre Rod, DC Motor, Wires and Screws

CONSTRUCTION AND WORKING

Racks and pinions of specified dimensions were laser cut on acrylic sheet. They were then mounted onto a sheet of balsa wood. A motor was mounted on top to drive the mechanism. Paper wings were attached to the rack-gears.

The basic structure consists of a gear system with two pairs of gears – one rack and one pinion each. The rack is anchored at a point. When the pinion rotates, the rack traces an arc of radius equal to the length of the rack. This motion replicates the downstroke of a bird. For the upstroke, the rack traces a straight-line path back to its initial position.

APPLICATIONS

Such a mechanical bird would find immense practical applications at both micro and macro level.

At the macro level, if we could make aeroplanes for public transport, lots of fuel would be saved leading the way to a greener cheaper world.

At the micro level, the following applications may be cited:

- (i) *Search and Rescue*: This application would prove to be life-saving in rough terrains and water-logged areas.
- (ii) *Security and Surveillance*: These applications could be used to prevent frauds and thefts.
- (iii) *Spying*: These are useful for national security.
- (iv) *Animal Surveys*: They can be used to maintain ecological balance.
- (v) *Traffic Control*: Mechanical birds can be used to ensure every one follows the rules and aid in de-clogging of streets.
- (vi) *Agriculture*: In order to check pest infestation and ensure all plants are growing well, mechanical birds can be used. They may also be used for drip irrigation in fields in order to conserve water, one of the most important and depleting resources.

6

ROVER WITHOUT DRIVER

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INTRODUCTION

The knowledge of science helps humans to handle unpredictable critical conditions endangering life. Technological advancements like robotics help to make life safe and easy. Disaster is an unexpected event that brings heavy loss to property, life and it may leave its effects for a long time. A disaster may be natural like tsunami, earthquakes, volcanic eruption, landslides, avalanches, forest fire or may be due to human activities like leakage of poisonous gases, nuclear spill out from atomic reactors.

This exhibit presents the design of a rover which is unmanned automatic vehicle which can be easily employed in numerous real time applications like material handling, in hazardous, in slummy and inaccessible environments. Often it is difficult to operate rescue procedures at the time of disaster to mitigate their effects. It is mainly due to inaccessibility to the site. Such issues require automobiles that can be operated without driver to reach at site for performing mitigation procedure.

Here in this project, a prototype module of line follower trolley type machine is designed, which can be used for many applications. To prove practically for one application, this trolley can be used to carry goods from one reference point to the other, which in turn may provide service to the soldiers at borders.

Depending upon the programme prepared for micro controller, the work cycle is simple.

This exhibit is based on the principle of transformation of electrical energy into mechanical energy using I.R. sensors.

Materials Used

IR sensors (LEDs, detectors); MCU (Micro Controller Unit); two relays; H – Bridge IC (amplifier); three DC Motors; two for movement of the vehicle and one for avoiding the obstacle; capacitors; transistors; resistors; voltage regulators; alarm; knot gates; tone decoder; obstacle avoider; battery (12 Volts); On/Off switch; crystal oscillator; diode and limit switches.

CONSTRUCTION AND WORKING

This is to develop a robot that will follow a specific line. The path can be visible like a black line on white surface or it can be invisible like a magnetic field. This robot is designed with a sensor array, controlling circuitry and motors working together to follow a black line.

Sensor Arrays

Sensor array is designed with two sets of optical sensors. These sensors are arranged below the vehicle at front side. The function of these sensors is to detect the black line if any deviation is there in the vehicle movement that information is fed to the MCU.

Path Sensing Controlling Circuitry

Depending upon the information produced by sensors the microcontroller controls motors through the H-Bridge IC and obstacle avoiding mechanism motor is controlled through relays.

The basic operation is to identify and recognise the black line. This is achieved by the help of IR Sensors mounted below the vehicle. Preferable black tape may be stuck over the white floor for better results. The idea of choosing black colour is that the IR energy delivered from the IR LED (Light Emitting Diode) will be absorbed by the black colour. If there is any deviation, IR energy hits the white floor and the signal will be reflected. The output of the IR detector is amplified and it is fed to microcontroller through

knot gates. These are used to generate a perfect logic output, essential for microcontroller. If the vehicle is running over the track, both sensors output will be zero. Otherwise depending upon the deviation side corresponding sensor output would become high.

Motors that Drives the Vehicle

The common configuration used in mobile robots consists of two differentially driven wheels and one castor wheel (steerable front wheel or free running wheel). DC motors or step motors can be used for driving the two controlled wheels. In our design, we choose DC motors since these are easy to control and consume less energy. These are 12 volts DC motors used to drive the mechanism. Wooden plank is used as platform. The two motors are mounted below the platform at rear side. It is provided with a reduction gear mechanism to regulate the speed.

Micro Controller Unit

A microcontroller count contains C.P.U., Clock Circuitry, ROM and RAM and I/O, Circuitry on a single integrated circuit package. The intension behind choosing MCU instead of conventional microprocessor is as there are several advantages like cost and space effectiveness, cheaper maintenance, portability etc.

Working Theory of H-Bridge

The name H-Bridge is derived from the actual shape of the switching circuit which controls the motion of the motor. It is also known as Full Bridge. Basically there are four switching elements in the H-Bridge. When these switches are turned on in pairs motor changes its direction accordingly like if we switch on high side left and low side right then motor rotate in forward direction, as current flows from power supply through the motor coil goes to ground via switch low side right. Similarly, when we switch on low side left and high side right, the current flows in opposite direction and motor rotates in backward direction.

Obstacle Sensing Circuit

It is designed with IR sensors with tone decoder IC and it also generates tone frequency. Presently, the demo module is

constructed with 3 sets of IR sensors and they are arranged at the front portion of the trolley. The function of these sensors is to detect the presence of any object that is existed over the path. If the circuit detects any object, the controller stops the vehicle and avoids the object through obstacle avoiding mechanism, and after clearance, the vehicle will be moved further automatically. Sensing block is designed with two IR LES namely IR signal transmitting LED and IR signal sensor.

The tone generator part of the IC is configured as a stable mode of operation. The amplified signal is radiated through the transmitting IR LED. The signal delivered by the IR LED transmits in a line like LASER beam, whenever this signal strikes the object the signal will be interrupted and it will be spread into the air in all directions. Some of the signal will be reflected back. This signal is tracked by the IR signal detector that is arranged side by the IR LED.

On the receipt of optical signal, the tone decoder part of the IC detects the signal through the optical sensor and generates a high signal for the micro controller. According to the received information from the sensors, the controller controls the motor through relays and avoids the obstacle with its mechanism.

Limit Switches

A limit switch is one of the most basic and reliable of all available sensors. This exhibit produces the lowest noise and most easily interpreted signal. Here this switch is used to restrict the movements of obstacle avoiding mechanism. To stop the mechanism at a particular position for both sides, two limit switches are used. When the switch detects the obstacle mechanism immediately controller stops the motor. There are different types and design of limit switches available in the market however all limit switches have the same operating concept.

The basic design and working of such a vehicle is given in Fig. 6.1. The detailed electrical circuitry is also available. Some designed and developed rovers may be useful in: (i) carrying radioactive materials from nuclear power stations; (ii) transporting things to the contaminated areas; (iii) help the people in disaster

places like radiation leakage areas in nuclear power stations, in poisonous gas leakage places; (iv) supplying the daily needs to the army at borders; transporting material through hazardous places like forests and deserts; helping humans in places where human access is limited etc.

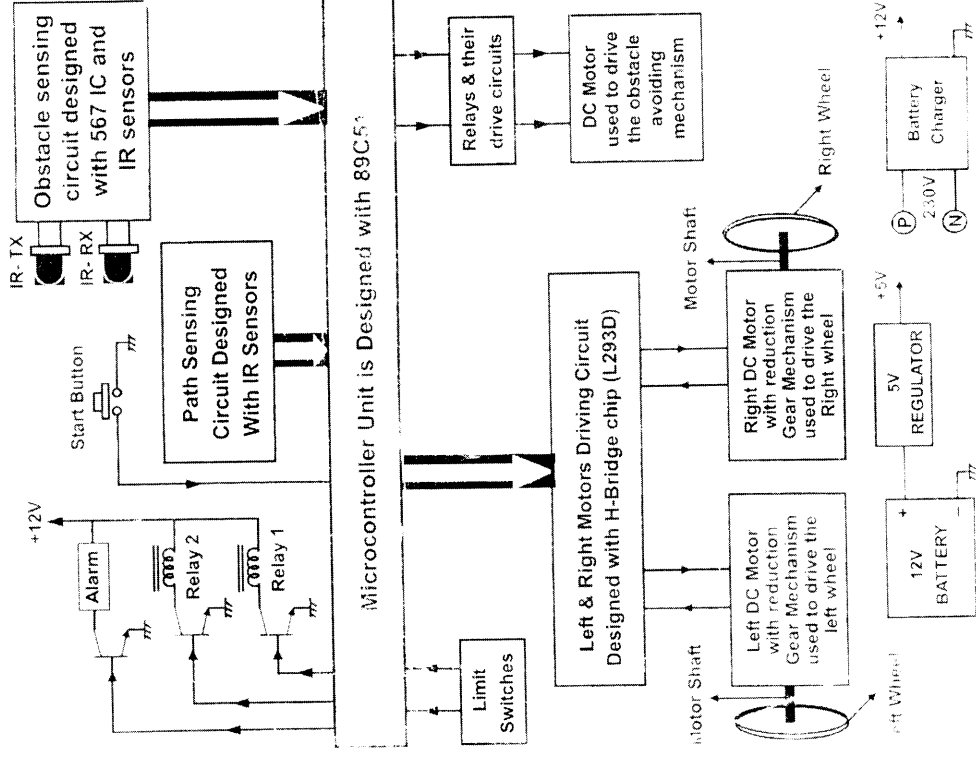


Fig. 6.1: Trolley with Obstacle Avoiding System

WATER PUMP SYSTEM

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INTRODUCTION

Water is a precious gift of nature. One cannot survive without water. Now a days, we are facing a prime concern, i.e., scarcity of water, not only in metros but also in smaller cities. Most of the cities are supplied with water by the Municipal Corporations or other water supply system is made possible through pipe lines and channels.

Life gets frozen when the water supply is blocked for a single day. Thousands of gallons of water is lost or wasted due to wreckage of the pipes. This becomes a huge loss to the people who are suffering due to acute water scarcity. The breakages found in water supply chains are attributed mainly to the high pressure formed in the pipes, and the pipes which got wrecked due to usage for a very long period of time. Sometimes the breakage of pipes and channels create artificial water stagnation and inturn disruption of vehicular and manual traffic.

In villages, the situation is not different. Wastage of water leads to pooling of water in agricultural fields causing heavy damage of crops. The solution to this problem lies in implementing a working model.

MATERIALS REQUIRED

pVC pipes; relay switches; valves; floating ball (plastic ball); metal string; copper wire; water; pump; batteries (Volt); motor and 6V mini motor and mechanism of time piece

CONSTRUCTION AND WORKING

The main pipe is attached with two vertical pipes, one big and the other small. As the water flows in the main pipe, the water level in these side pipes is as par with the main one.

The vertical pipes are provided with 2 balls on the surface of the water level with one attached with a metal string that keeps them floating. In order to showcase the high pressure in the pipeline, a valve at the other end of the pipe is closed.

When high pressure is formed due to obstruction caused by some or the other reason the floating ball in the big vertical pipe gets raised in turn raising the metallic strip attached with the floating ball leading to the completion of one circuit. This makes the relay switch on and resulting in closure of the valve from the pumping station and it will stop further water supply to the pipeline. Thus, we can avoid the situation of breakage of pipes.

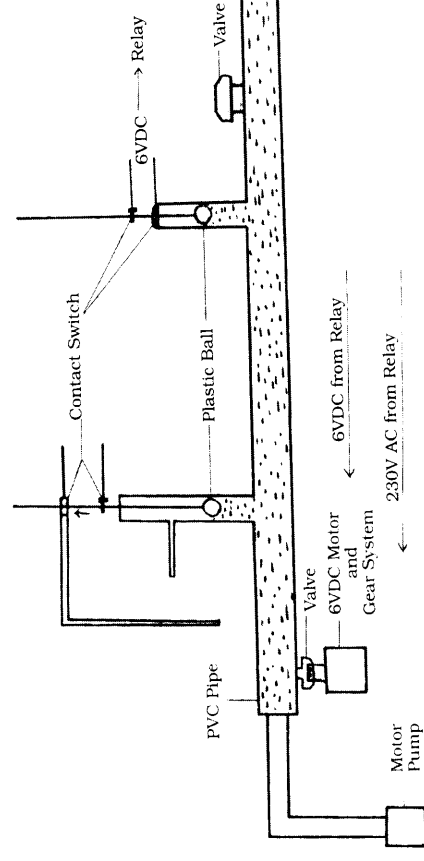


Fig. 7.1: Water Pump System

In order to showcase the breakage of the pipe in the model, another pipe is kept open at the starting of the pipe. When the pipe breaks due to some reason or the other, a low pressure is

created in the pipe line. As a result of this, the water level in the smaller pipe gets down and in turn the floating ball (plastic ball) with metallic strip gets down making the 2nd circuit complete. In turn it will switch on the relay circuit resulting in closure of the valve in the pumping station. There will be no further loss of water.

APPLICATIONS

To detect the breakage of water and to avoid the cause that results in breakage. This is done by not allowing excess pressure created inside the water pumps.



MAGLEV RAIL

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INTRODUCTION

In city, road traffic blocks are common. To overcome this, metro rails are introduced in cities to meet the everyday travel needs of employees and workers within time. Conventional trains require more energy due to the friction between rail and the wheels than Maglev trains. But the levitation is attained only at very high speed. This technology is not suitable for metros because before attaining the levitation speed, next station is reached. Also this requires huge capital investment, maintenance cost, sophisticated equipments, highly qualified and skilled employees. It also consumes a large amount of electricity. To cut down all these, especially the energy consumption of electricity, we are introducing a concept for city travel, "Energy Saving Maglev Rail Plane Metro".

SCIENTIFIC PRINCIPLES INVOLVED

Like poles of magnets repel each other. This principle is used in levitation of train. Electric motor driven propellers can propel the floating train easily. Rack and pinion mechanism with electric geared motor can open/close the train doors smoothly and efficiently. A small electronic circuit with microcontroller can display the "coming station" in an LCD display in the train.

MATERIALS REQUIRED

Plywood, wooden reaper, aluminium angle, acrylic sheet, bar magnets, parts of toy train, toy plane and toy car, electronic circuits, DVD loader, microcontroller, LCD display, On/Off switches, micro leaf limit switches, wires, screws, paint, DC power supply 12 Volts and 5 Volts, etc.

CONSTRUCTION AND WORKING

Our new model is constructed as two separate units. One consists of Maglev train with rail and propulsion system. Other unit consists of train door opening/closing facility and automatic coming station (next stop) display system. These are explained below.

OVERHEAD RAIL WITH LEVITATING MAGNETS

A wooden platform having 4 feet long 10 inches wide and 2 inches thick is made out of plywood and reaper which is used as under side road. Wooden reapers of 13 inches height are erected at both sides (5 nos. on each side) of the road as supporting pillars for the rail. Aluminium angles 25 mm × 40 mm, 4 feet long are screwed

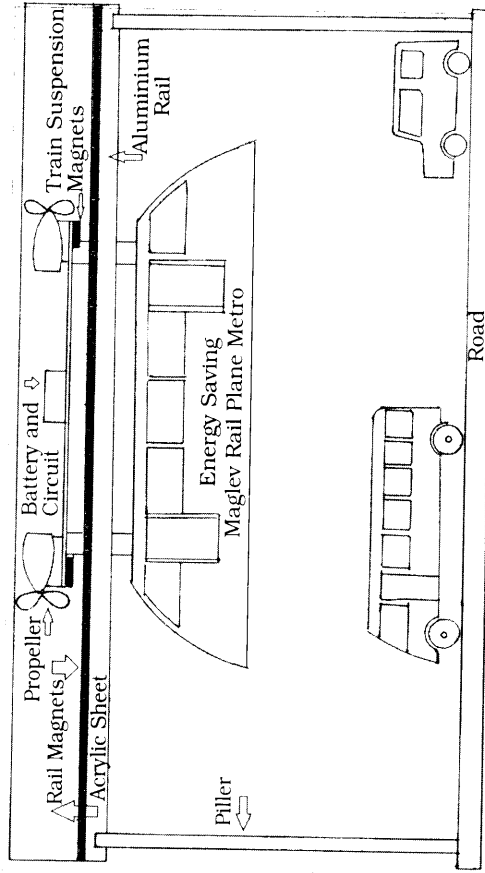


Fig.8.1: Layout of Maglev Rail Plane System

on these pillars to act as rails. Bar magnets 26 mm × 10 mm × 6mm size are glued on these rails (48 nos. on each side) with south poles on the top side. Acrylic sheet having 4 feet long, 5 inches height and 3 mm thick are screwed on the outer side of each rail which is used as guards.

Train with Suspension Magnets and Propulsion System

An acrylic sheet (28 mm × 11 cm × 2mm) is suspended horizontally above the magnetic rail by fixing bar magnets (South Pole bottom side) below this sheet. Above this fix two propellers of toy plane with driving motors of 6 volt DC, one on each end. At the centre of this floating platform there is an electronic circuit (receiver of remote controlled toy car) with chargeable cell for remote controlling. A plastic toy train body is attached at the bottom of platform by 4 small acrylic pieces. A rubber roller (pinch roller of tape recorder) is glued to each corner of this platform to reduce any friction when running. To change the direction of the train a two way switch is provided on train body.

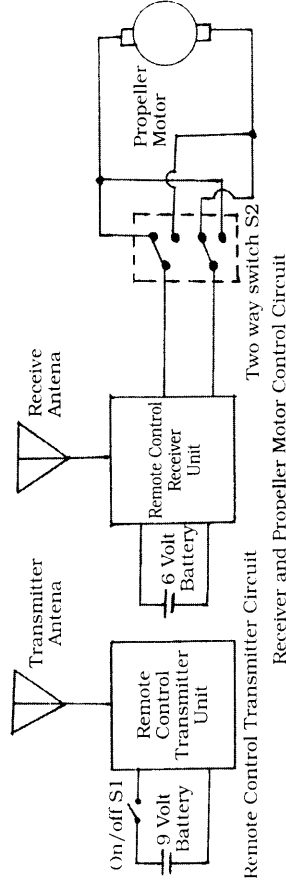


Fig. 8.2: Train Propulsion Control Circuit

When the switch S1 of the remote control is pressed, the transmitter emits a signal in a particular frequency. This signal is picked up by the receiver circuit on the train. This causes switching on of 6 Volt DC to the propeller motors. The propellers rotate and push air backwards with some force. According to Newton's third law of motion, "Every action has an equal and opposite reaction", a thrust is induced in the propellers. This thrust propels the train forward. To reverse the train, put the two-way switch S2 in reverse position. Now the polarity of DC voltage to the propeller motors is reversed. They rotate in reverse direction and train moves in backward direction. The acrylic guards prevent sideways movement of the train and also protect the outer environment from propulsion air.

Door Opening and Closing System

A hylam sheet of 2 feet long and 10 inches height is fitted on a wooden base. An opening of 16 cm × 12 cm is made on this as

door opening of the train compartment. On each side of the opening, one DVD loader mechanisms is screwed as doors. Each mechanism has a 5 volt DC motor and rack and pinion arrangement for opening and closing of the doors. One two-way switch S3 is provided for changing the polarity of DC supply to the motor for clock wise and anti-clock-wise rotation. Two limit switches (micro leaf switches) L1 and L2 are also provided to stop the motor when the doors are fully opened or fully closed on each mechanism. The circuit of this is shown in Fig. 8.3.

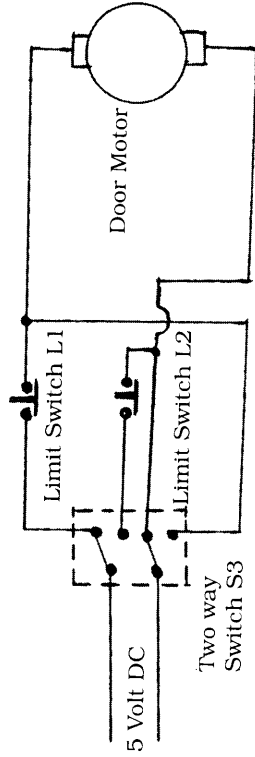


Fig. 8.3: Door Opening/Closing Circuit

To open the door, engine driver put the two-way switch S3 in open position. Now the DC voltage from the battery turns the motors of the DVD mechanisms in clock-wise direction which causes opening of the doors. When the doors are fully opened its end touches a limit switch L1 and the supply to the motor become Off. To close the door, put the switch in close position. Now the polarities of DC supply to the motors are changed and the motors turn in anti clock-wise direction and the gates are closed. After the gates are fully closed the end of the gate touches the limit switch L2 which stops the motors.

Coming Station Display System

This is based on a micro controller PIC 16F 877A. The block diagram of this circuit is shown in the Fig. 8.4. The circuit board is fitted on above the doors of the compartment. The display can be seen through an opening above the door. This can be fitted anywhere in the train.

After every stop, the door is closed for resuming the journey. When door is fully closed, limit switch L2 is activated. This sends

a signal to the micro controller. Micro controller process this signal and gives an output to the LCD to display the name of the coming station. A push button switch is also provided to change the display manually.

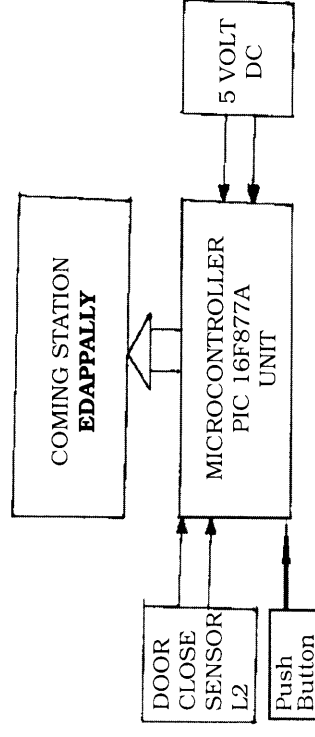


Fig. 8.4: Block Diagramme of Coming Station Display

APPLICATION AND ADVANTAGES

This system can be used in city or suburban to meet the daily travel needs of employees and workers due to the following reasons:

- (i) As the train floats on magnetism, there is no physical contact between track and train, so energy required for running the train is very less compared to conventional railway.
- (ii) By using permanent magnet for levitation, energy required for electromagnetic levitation can be saved as compared to maglev trains.
- (iii) In maglev trains levitation is attained only at very high speed. But in metro rails, stops are generally within every km and to attain this levitation speed is not possible within this short distance. But the new model can run at any speed.
- (iv) Sophisticated levitation and traction coils embedded track construction can be avoided.
- (v) Huge capital investment can be saved.
- (vi) It can be constructed over the existing road. So land acquisition and related issues are avoided.

(vii) Quite simple mechanism and easy to operate as compared to bullet trains.

CONCLUSION

Our new model saves and conserve energy and money in construction, running and maintenance of metro rails in the cities and suburban areas.



SAFE SKY SCRAPER

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INTRODUCTION

No more fear for earthquake. No storm, no lightning, no flood can affect your building. Not a dream, not an illusion, but it is simply a reality. Scientifically proven theories back this innovative multicomplex structure. It can provide safe buildings. No lightning can destroy them. These can resist earthquakes, lightning, storm and flood.

This exhibit proposes to use base isolation technique for the purpose. To rectify the problem of small angular displacements that may be caused to the building during the earthquake, a shear core is constructed through the exact centre of the building. To address the problem of lightning arrest, a lightning conductor through inside the shear core is placed. Building's resistance to wind and storm is improved by providing a special unique shape and also by making the building to be porous externally as shown in Fig. 9.1 and Fig. 9. 2. Now if the building is being built on sea shore areas there may be the threat of tidal waves and tsunamis. To overcome this problem a hydraulic lift may be used.

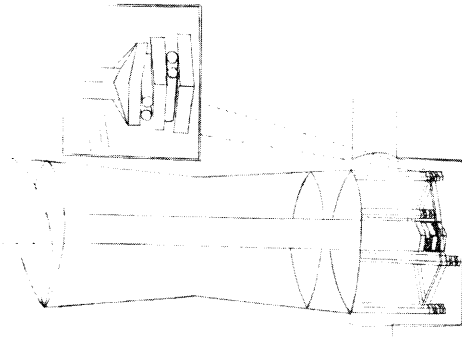
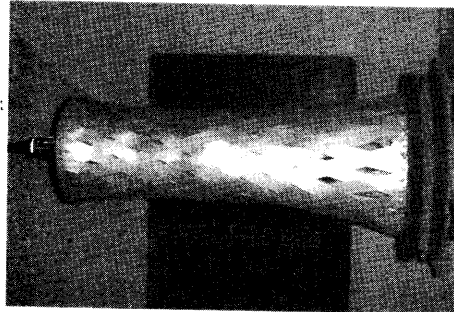


Fig. 9.1: The Building **Fig. 9.2: Sectional View of the Building**

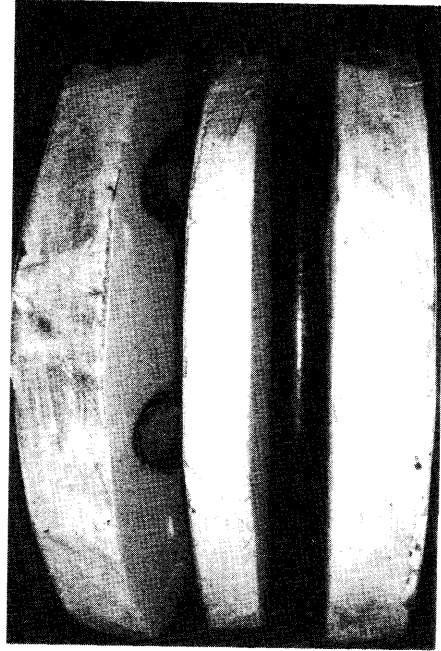


Fig. 9.3: Base Isolators

SCIENTIFIC PRINCIPLES INVOLVED

First of all we shall mention about the principle behind the base isolation for resistance against earthquakes. The concept of base isolation is that the building is resting on frictionless rollers as shown in Fig. 9.3. In this, two pairs of rollers are arranged perpendicularly between three concrete slabs. Even though the building exerts a greater pressure on the ground, the seismic

waves are much powerful and has the potential to collapse the building. So when the ground shakes, the rollers freely roll, but the building above does not move. Thus, no force is transferred to the building due to the shaking of the ground. But there is a chance for the building to get a small angular displacement. So, to correct this, a shear core is used.

The next thing to be mentioned is that of the porous external structure (Fig. 9.1). In whichever direction the wind (Hurricane/Storm) come, it enters through the pores in a particular direction and comes out through the corresponding pores on the other side of the building. And also due to the special unique shape of this building (as shown in Fig. 9.1), the wind diverges into two directions such that their strength is reduced. Thus the building is protected from stormy winds.

Now to protect the building from lightning, a lightning arrester (or a conductor) is used. Here lightning conductor is a thick rod which runs through inside the shear core. When a charged thundercloud, say a positively charged cloud, flows over the lightning arrester, by induction negative charges are induced on the sharp spikes fitted to the upper end of the lightning arrester. Since the lightning arrester is earthed the positive induced charges at the farther end flow to the earth. Due to the action of points, the negative charges carried by the air near the points flow upwards. When the negatively charged air comes in contact with the cloud, the cloud is neutralised. Thus lightning is prevented from affecting the building.

Now if the building is in a sea-shore area, there is a threat of tidal waves and tsunamis. So to prevent this problem a hydraulic lift may be used. In this hydraulic lift, the principle used is that, whenever external pressure is applied on any part of a fluid contained in a vessel, it is transmitted undiminished and equally in all directions. Here we could make a huge slab around the building so as to take up the maximum amount of force from the tidal waves or tsunamis. Thus the force is imparted to the hydraulic fluid and it lifts the building by about five to seven metres above the original level. Thus the building is protected from tidal waves.

Various materials are used for the construction of this building. As a frame the building is supported with vertical,

horizontal and diagonal supports throughout (as seen in Fig. 2). The main frame is an exterior diagonal tube which is suitable for building upto 100 storeys. The main structure of the building is made of steel bars as used in most skyscrapers. The building is supported at the base by four equatorial legs and a larger leg at the centre. Beneath each leg there is an isolator. Each isolator consists of three very thick (approximately four feet) concrete slabs and in between each of the two concrete slabs there is a pair of rollers. Thus in an isolator there are two pairs of rollers and they are placed perpendicular to each other between the three concrete slabs.

The rollers that are placed between the concrete slabs are lead-rubber bearings. The lead rubber bearing is made from layers of rubber sandwiched together with layers of steel. In the middle of the solid lead "Plug", on top and bottom, the bearings are fitted with steel plates which are used to attach the bearing to the building and foundation. The bearing is very stiff and strong in the vertical direction, but flexible in the horizontal direction so that it can withstand the whole weight of the building. The shear core that is used to rectify the small angular displacements of the building is actually made out of concrete mixed with some suitable substance that provide the building with maximum shear strain. There is a wider but small hole through the middle of the shear core which accommodates the long rod for the lightning arrester.

To meet the energy needs, there are solar panels attached to the external walls of the building.

10

MAKE YOUR OWN STAR FINDER

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Diu

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INTRODUCTION

This 'Star Finder' demonstrates the working of a device to locate a star or planet simply by turning two dials and then looking through a specially designed sight.

SCIENTIFIC PRINCIPLE INVOLVED

The working principle of the Star Finder is simple. It is based on the fact that the positions of stars and constellations in the night sky at any particular hour on any specific date is always the same regardless of the year. For example, if you find any bright star overhead at 9 P.M. on 15th November this year, it will be more-or-less so every year at 9 P.M. on 15th November.

Next to recall is the slow but steady westward 'movement' of the constellations, night after night. Every night the stars and constellations rise in the east four minutes earlier than on the previous night. This means that they gain two hours in a month. Over a year, the gain is a full 24 hours so that the constellation pattern on any night becomes the same at the end of the year.

The third point to remember here is that in an hour the constellation pattern moves westward by 15°.

Construction

Essentially, the Star Finder consists of two dials – one of which we may call the Right Ascension Dial (Fig. 10.1) and the other is called Declination Dial. Along the outer rim of the RA Dial dates are marked along with month of the year. Next to the month scale is another circle which shows right ascension values from 0h 0m to 23h 50m. Each hour division is further subdivided into 10-minutes segments. The important point to note here is that the 0h 0m mark of the RA scale falls just below the date September 23 marked on the outermost scale.

The RA dial is fixed on a board which has a semi-circular scale marking the 'local time' from 6 P.M. to 6 A.M. Mounted at the centre of the RA dial is an upright bracket which holds the Declination Dial at the Star Sight. The Declination Dial is a simple semi-circular scale marked in degrees as shown in Fig. 1 when the Declination Dial is at 0 degree the star sight point exactly to the celestial equator.

The assembly of the Star Finder is shown in detail in Fig. 10.1. The RA dial is fixed to a base board held at an angle with the horizontal equal to 90 minus, the latitude of the place of use (Table 10.1). On the base board is marked a line which is aligned with the north-south direction before using the instrument. The star sight is fitted at the end of long tube or wooden dowel to clear the base of the instrument. This is necessary for viewing stars near the zenith.

Table 10.1: Correction Factor for Selected Towns

Form	Latitude (Degrees North)	Longitude (Degrees East)	Correction Factor (Minutes)
Munadabad	23.0	72.5	- 40
Bangalore	12.5	77.5	- 20
Kolkata	22.5	88.0	+ 22
Delhi	28.5	77.0	- 22

Table 10.2: Coordinates of Prominent Stars

Star	Constellation	Magnitude	RA	Declination
Alhena	Eridanus	0.60	1h 40m	57.0° S
Bellatrix	Orion	1.70	5h 20m	6.0° N
Castor	Gemini	1.99	7h 30m	31.5° N
Deub	Cygnus	1.33	20h 40m	45.0° N

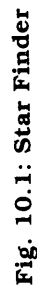


Table 10.3: Coordinates of Some Star Clusters and Nebulas

Star	Magnitude	RA	Declination
Andromeda Galaxy (M31)	4.8	0h 40m	40° N
Hyades cluster	0.6	4h 20m	15.5° N
Orion Nebula (M42)	3.8	5h 30m	6.0° S
Pleiades cluster (M45)	1.3	3h 40m	24.0° N

Table 10.4. Mean coordinates of constellations

Constellation	RA	Declination
Aries	3h	20° N
Cancer	9h	20° N
Gemini	7h	20° N
Leo	11h	15° N

Working

The first step in using the Star Finder is to align the instrument with the North-South direction. For this a magnetic compass will be required. The next thing is to set the latitude angle correctly (Latitude of Diu is nearly 21.42 degree N).

Once the Star Finder is set in North-South direction and set the latitude angle correctly, one can go ahead with finding any star. The working of the Star Finder is based on location.

Next the date can be set on the outer scale of RA dial against the local time (as calculated from the IST) marked on the semi-circular scale. Now the inner scale of RA dial will show the right ascension of stars and constellations in the sky in their correct orientations for that particular time and date. To locate any particular star or constellation one can find out its RA and Declination value from Table-10.2, now the two pointers are to be set accordingly against the RA and Declination dials. You will see the required star or constellation if you now look through the star sight. On locating through the Star Sight, the required star or constellation can now be seen. RA and Declination values for the prominent constellation are given in Table 10.3 and 10.4.

APPLICATIONS

- This simple and low cost project can be utilised in the classroom to give the practical knowledge to students in getting a clear concept about the sight of star and constellation.
- To know the position of the star and constellation in the sky.
- This instrument is very useful in space science study.

WEALTH FROM WASTE

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INTRODUCTION

Plastics are polymers mostly containing carbon and hydrogen. Polymers are made up of small molecules called monomers. They are light in weight, easily moulded, have very good strength and toughness, chemically inert, and have thermal and electric insulating properties, very good water resistor, strong and cheap to produce. Because of these advantages, plastic is everywhere in today's lifestyle. It is used in packing, for protection, serving, communication, infotech, building construction, etc. We are not in a position to avoid its usage.

However, plastics are hazardous to our health and the environment. Over 10,000 metric tonnes of plastic wastes are generated daily in our country, of which only 40% is recycled and the rests cause various kinds of environmental and health hazards. We are aware that improper usage of plastic leads to health problems such as breast cancer, reproductive problems in humans and animals, genital abnormalities and even a decline in human sperm count and quality. But if a ban is put on the use of

plastic the cost would be much higher and inconveniences rise. So, environmental burden is concerned with the judicious use and reuse of plastics.

Energy in the form of fuel is also a problem to the world. The issues of plastic waste disposal and energy crisis can be solved by using plastic waste for the following: (i) construction of walls of houses with PET (Polyethylene terephthalate) bottles, (ii) producing crude oil and energy from garbage, and (iii) laying roads, by keeping our environment clean "Let us live a long and healthy life".

RATIONALE BEHIND THE CONSTRUCTION OF THE EXHIBIT

This project is an attempt to solve the problems arising due to waste plastic and shortage of energy. In the present model the waste plastic is used for laying roads, constructing walls and extracting fuel by depolymerising plastic waste without polluting environment. The bi-product in the process of extracting fuel is LPG.

SCIENTIFIC PRINCIPLE INVOLVED

Depolymerisation is a process of conversion of the polymers into monomers.

MATERIALS REQUIRED

Used plastic bottles, PVC Pipes, Coloured paper, Petrol, Thermocol, PET bottles and Charts.

CONSTRUCTION AND WORKING

Roads from Plastic Waste

Waste plastic is ground and made into powder. Then 3 to 4% of plastic is mixed with bitumen. The mixture is blended at 45-50°C. The mixture is then laid on the land surface like the normal road.

Plastic Walls

Waste PET bottles are filled with mud and sand. One or two layers of these PET bottles and one layer bricks are used in constructing walls.

Plastic Fuel

Depolymerised product of waste plastic is plastic fuel. Plastic is made from crude oil. If we break down waste plastic using the right catalyst we get liquid hydrocarbons. Fractional distillation of these liquid hydrocarbons gives the plastic fuel. Every kind of plastic is raw material for the production of plastic waste. 600 mL to 700 mL of petrol and 850 mL of diesel or 450 mL of perfumes are produced from 1 kg waste plastic. LPG is the bi-product.

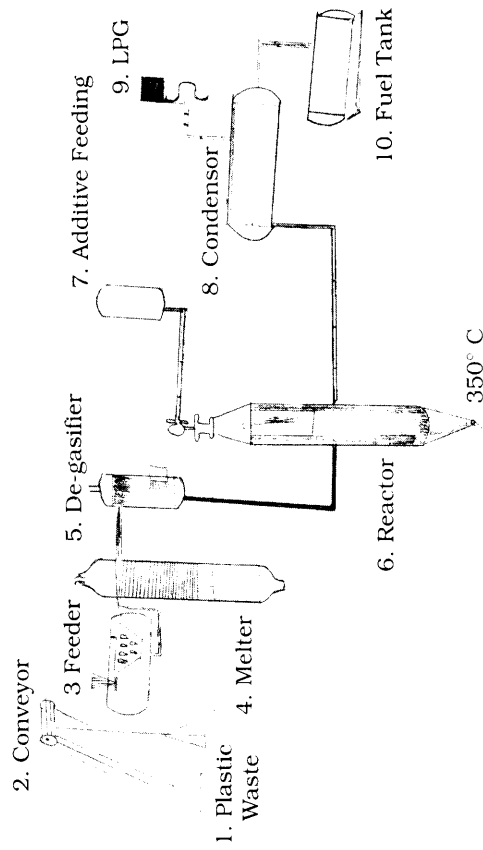


Fig. 11.1: Process Flow

Garbage into Oil

Garbage from factories, houses, hospitals, etc., is collected. Water and garbage are dumped into a grinder and pulverized into a slurry. The slurry is then heated to 260°C and subjected to 275 kg of pressure. In the first reactor the heated and pressurised mixture is depolymerised and the mixture is sent to flash tank. The pressure is released in the flash tank. The resulting steam is recaptured to power the system. Minerals sink to the bottom and flow into a separate tank. Organic materials move to the second reactor. In the second reactor, 500°C temperature breakdown the organic materials and then moves into a drum. The hot fluid moves into a distillation tank where it cools and condenses. Organic materials and water gets separated. The water sinks to the bottom. The crude oil moves into the storage tank.

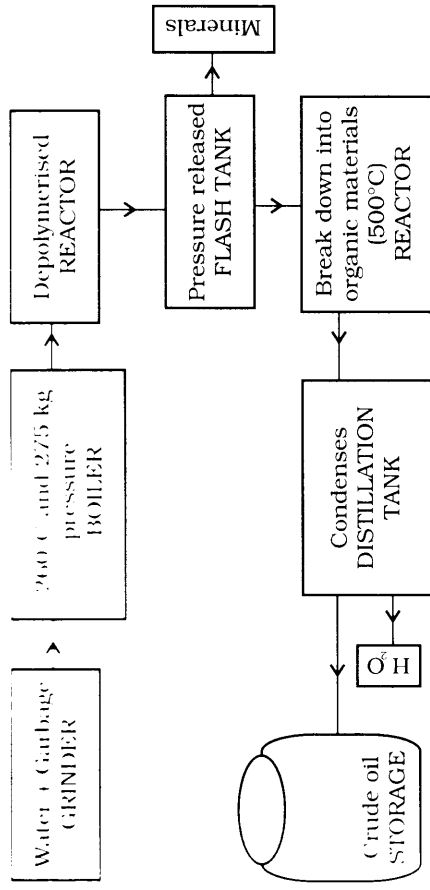
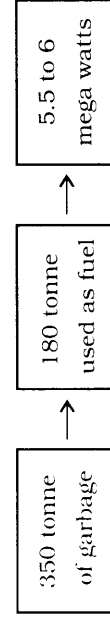


Fig. 11.2: Energy Plant

Power from Garbage

Garbage collected by municipalities is sent to the plant. Cloth, glass pieces and stones are separated by hand from the garbage collected. It is sent to the first roller (35 mm to 40 mm holes) to filter the sand. The garbage from the roller is cut into pieces in the crusher. For further filtration the garbage is sent through the second roller (5 mm to 10 mm). The filtered garbage is again sent through another crusher. Fluff from the crusher is mixed with husk (70% fluff + 30% husk). This is then sent to the boiler where the water pipes are attached. Steam produced from pipes turns the turbines and electricity is produced (11 KV). Through step up transformer 33 KV is produced which is sent to the electricity board.



Bi-products

- Discarded portions from the two rollers are used for land filling and used by the farmers also.
- Bricks are made from the ash generated from the boiler.

APPLICATIONS

It is used in construction of roads, construction of buildings, production of energy, oil and LPG.

ADVANTAGES

- (i) Plastic-bitumen roads are strong, durable (can last upto 10 years) and eco-friendly. Relieves the earth from all types of plastic wastes. Though construction cost increases up to 6%, the longevity of roads also increases.
- (ii) Construction of plastic walls reduces the cost of construction of buildings and relieves the earth from plastic bottles.
- (iii) Garbage oil plant is self-sustaining and produces crude oil. The by-product, water, is used for running the plant. There is no emission that causes pollution.
- (iv) Production of plastic fuel is one of the solutions for energy crisis. Its by-product is LPG, which is very useful. It shrinks the disposal problem and dangerous effects of waste plastics and reduces plastic waste on earth. The fuel is used for running generators, replacement for naphtha in power generation, to power automobiles but without pollution.
- (v) It increases job opportunities.

12

A UNIQUE AIR FILTRATION SYSTEM

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INTRODUCTION

Our environment is gradually becoming polluted by CO_2 , SO_2 etc., gases from different sources. Being aware of that, serious effective step should be taken to prevent these gases from being released or to reduce their amount for a healthy environment. Automobile industries or other industries will continue to flourish but we have to take an innovative measure to reduce pollution of our environment.

SCIENTIFIC PRINCIPLE INVOLVED

Pollutant gases are converted into salt.

MATERIALS REQUIRED

Pollutant gases such as CO_2 , SO_2 , etc., from industry, factory or automobiles.

CONSTRUCTION AND WORKING

Pass the pollutant gases through calcium hydroxide solution. These gases will react and some of the CO_2 and SO_2 will be precipitated as CaCO_3 or $\text{Ca(SO}_4)_2$ [calcium carbonate or calcium

sulphate]. That is, amount of gases reduce. If this process is repeated again and again percentage of CO_2 and SO_2 will reduce further more. If this CO_2 passes through Na_2CO_3 solution it will convert into sodium hydrogen carbonate (NaHCO_3) salt.

Later we can pass this gas through NaOH solution. Then CO_2 will react with NaOH and become precipitate as Na_2CO_3 which will convert into (NaHCO_3). In the same way SO_2 will precipitate as sodium sulphate or bisulphate.

In this way two pollutant gases will be converted into salt and give rise to comparatively better air (i.e., reduced amount of CO_2 and SO_2).

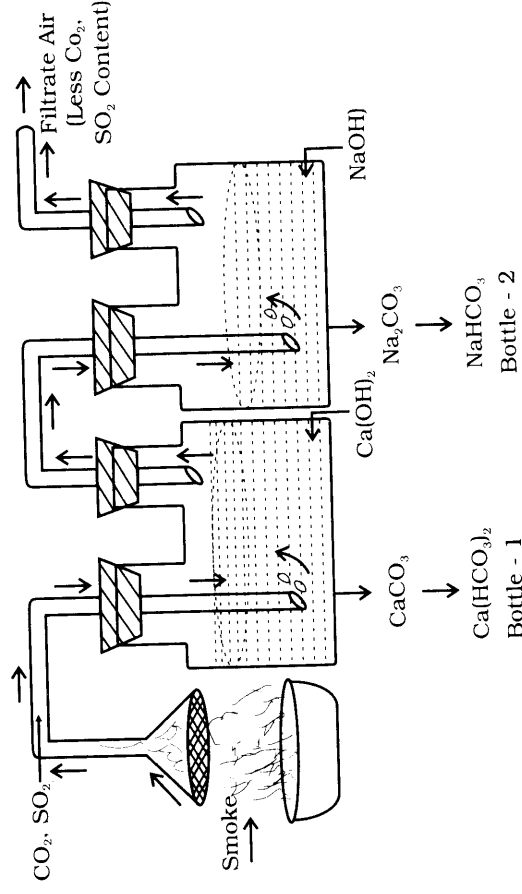
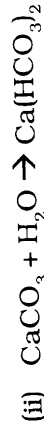
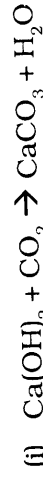


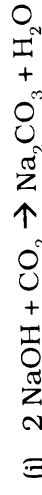
Fig. 12.1: Air Filtration System

REACTIONS

Bottle 1

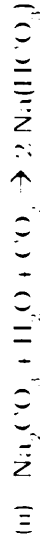


Bottle 2



↓

Used for washing clothes and utensil, vessels, etc.



↓

Used as baking powder

ADVANTAGES

- (i) The model not only reflects the air purification but also it exhibits that the by-product like Na_2CO_3 (sodium carbonate) is a useful compound which can be used for washing clothes or washing kitchen utensils.
- (ii) When CO_2 gas is passed through Na_2CO_3 solution CO_2 will precipitate as sodium hydrogen carbonate (NaHCO_3). This compound is also used as baking powder.
- (iii) When a net is used in the mouth of the chimney i.e., collecting tube, a huge amount of smoke dust carbon is collected which can be used in the production of ink, shoe polish, etc.

VEHICULAR EXHAUST FILTER

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INTRODUCTION

We know that many vehicles are increasing air pollution which increases global warming or the temperature of the earth. Many steps have been taken to reduce the emission level of gases coming out from the vehicle exhaust. We can see in heavy traffic areas the level of air pollution is very high. We feel uncomfortable and even feel itching in our eyes in such areas. Increasing air pollution is a danger sign for all living organisms on earth. Exhaust gases coming out from all types of automobiles contains mainly carbon mono oxide, carbon dioxide, nitrogen dioxide, hydrocarbons, sulphur dioxide and other harmful gases. These gases are very harmful for our environment and ecological system. This project is an attempt to solve the problem of high pollution level in cities due to automobiles in heavy traffic areas. This project helps us to reduce the air pollution caused by the vehicles.

SCIENTIFIC PRINCIPLES INVOLVED

In the cooling chamber two aluminium plates which have charge on them attract dust particles. The exhaust gases pushed by the exhaust fan on the nets made of synthetic fibers and solution of

sodium hydroxide (NaOH) is sprayed by the sprayer. NaOH reacts with the harmful exhaust gases and neutralizes them. This way, the level of polluted air is very low.

MATERIALS REQUIRED

Bottles of two litre capacity, T-shape water pipe joint, two exhaust fans, aluminium foil, NaOH solution, sprayer, battery, etc.

CONSTRUCTION AND WORKING

In this project the exhaust gases are collected in the cooling chamber (the shape of the cooling chamber is like a frustum) where due to the expansion of gases their temperature becomes low. In the cooling chamber there are two aluminium plates which create charge on them and attract the acidic/basic dust or harmful particles and then an exhaust fan sucks the gases and pushes the gases in NaOH treatment chamber. We can identify it in Fig. 13.1(a) where the NaOH reacts with harmful gases and make them neutral. There is a machine called sprayer placed near the exhaust fan which sprays NaOH on the nets of synthetic fibers after every 2 km distance period when the vehicle is running.

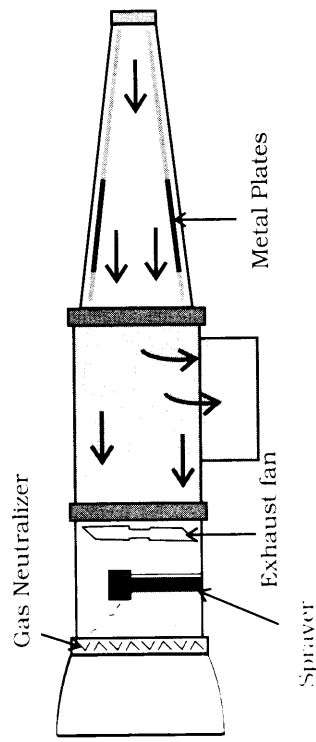


Fig. 13.1(a): Vehicular Exhaust Filter

In the vertical chamber the remaining dust particles are separated by exhaust fan which pushes the gases on a filter so the heavy solid harmful particles settle down. Then the remaining gases are again treated with NaOH. We can identify it in Fig. 13.1(b). Finally, cool and fresh air with very low air pollution comes out and spread out in the environment.

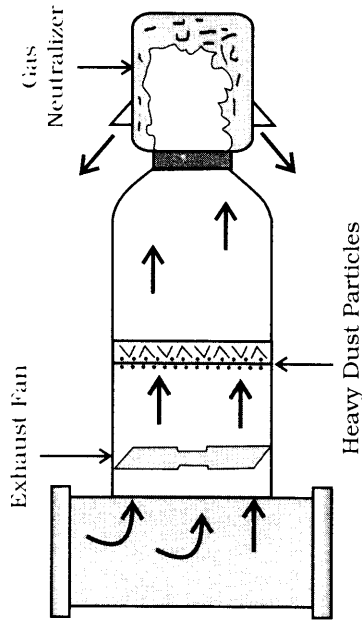


Fig. 13.2(b): Vehicular Exhaust Filter

Removal of harmful particles/chemicals: Take out the nets of synthetic fibers and wash them in NaOH solution to remove solid sediments and harmful chemicals periodically.

RESULT

It ensures lowering of the pollution level in air due to automobiles. So we can save our earth from pollution.

14

FUEL-LESS MULTIFUNCTIONAL HOME MACHINE

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INTRODUCTION

This machine is designed for the purpose of saving fuels. Petroleum products like diesel, petrol, kerosene, coal and other gases will be exhausted soon and people will face a major energy crisis. To solve such a crisis, the fuel-less multifunctional home machine will help a part. It performs more work with less energy within a short period of time. One additional benefit of this machine is the water purifier box using sunlight. When the impure water from river, sea, pond, etc., contained in the box is exposed to sunlight, it evaporates and the vapour so obtained is collected drop wise to the outside container of the box. It is the purest water which we need every day. This machine also has a knife sharpener and hence it may be named as 6-in-1 machine.

SCIENTIFIC PRINCIPLES INVOLVED

When a muscular energy is used to rotate a fuel less multifunctional machine, it leads to generation of electricity, rotation of a table fan, rotation of spinning wheel with jenny, up down movement of pounders at the same time.

Evaporation of impure water by solar energy produces pure water.

MATERIALS REQUIRED

Wood, chain, DC generator, table fan, bulb, spinning wheel, mortar with pounders, etc.

CONSTRUCTION AND WORKING

It consists of a pedal connecting to a main axis with a chain, a D.C. armature to generate D.C. electricity, a table fan to produce cold wind, a pair of mortar with pounders, a spinning wheel with a jenny and a solar water purifier machine.

When the main axis of the fuel-less multifunctional machine is rotated (moved) using muscular energy, it performs different works viz., generation of electricity, rotation of a table fan, rotation of spinning wheel with jenny, up-down movement of pounders at the same time. A separate part to obtain pure water by evaporation method using solar energy is also attached to this machine. Even when this machine is not in use, pure water is produced automatically from the water purifier by evaporating the impure water such as river, sea, pond, etc., at room temperature or during sunshine. The vapour so produced is condensed at the inner roof of evaporation box and collected to another container outside the box.

APPLICATIONS

This fuel-less multifunctional home machine can be used in many purposes such as generation of electricity, production of purest drinking water, rotation of a table fan for the production of cold wind during summer, crushing of grains in the mortar, spinning and as sharpener, etc.

ADVANTAGES

- (i) It saves non-renewable fuels as it uses not a single drop of oil when it works.
- (ii) It gives high efficiency with less effort.
- (iii) It does not pollute and is eco-friendly.

- (iv) It gives purest drinking water for health.
- (v) It performs more work with less time.
- (vi) A person can perform six works at the same time.

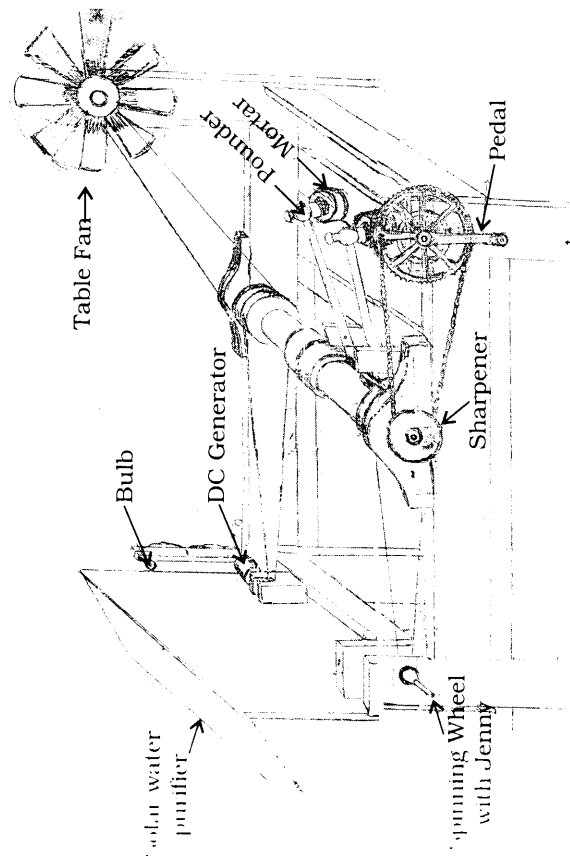


Fig. 14.1: Fuel-less Multi-Functional Home Machine

FUTURE PROSPECT

It may replace most of the machine which use petroleum products in future.

MODERN SOLAR SPRAYER

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INTRODUCTION

As of today, fossil fuel is the main source of energy. Massive population and industrialisation consume huge amount of fossil fuel everyday which reduces the total quantity of fossil fuel and within few years, all coal will be exhausted from the earth if the trend continues. So now we give emphasis on the use of solar energy as an alternate source of energy. Sun is the source of solar energy. The earth receives nearly 4000 KW of energy from the Sun on a daily basis which is approximately 100 times the total energy consumption of the world per year. As most parts of India get good amount of sunshine throughout the year, solar energy will be a good source of energy. As the solar energy will be the main source of energy in future so it is essential to know the process by which we can convert solar energy to other forms of energy as per our requirement. Here we discuss about the process "Solar Photovoltaic Technology (SPV)". An eco-friendly and economic alternative source of energy is the need of the hour.

'Agriculture' is the backbone of our nation. Our economical status will be increased by increasing agricultural products. So we need to encourage the farmers. Emphasis must be given to meet the needs of the farmer by manufacturing new hi-tech

agricultural equipment run by solar energy. Hi-tech modern solar sprayer is now the only friend of farmers.

SCIENTIFIC PRINCIPLES INVOLVED

Solar Photo Voltaic Technology (SPV): The principle of SPV is that when sunlight falls on solar cell electric voltage and current is generated. The solar energy is converted to electrical energy and to convert the energy from the energy collected in charging cell, electric energy is converted into mechanical energy, sound energy and light energy. A single solar cell generate 1 watt of power and even more depending on its conversion efficiency. Power thus generated is fed to the battery and can be drawn when actually needed. The solar cell works best at ambient temperature of around 25°C. Higher temperature reduces its power producing capacity.

MATERIALS REQUIRED

Solar plate (12.0 Volt D.C., 10 watt 2.25 Ampere), cell (12 Volt D.C.), electric pump, 15 litre plastic tank, stainless steel light weight tube frame, belt, fiber, glass, fan, FM Radio kit, small speakers, wire, inverter, circuit, transformer, rubber pipe, switch board, plastic box, control switch, paddle pump, compressor, etc.

CONSTRUCTION AND WORKING

First of all, make light weight stainless steel frame with "I" shape. The solar plate is fitted at the top. Then a plastic tank with a capacity of 15 litre is fitted at the bottom of the frame. A motor working with 12 Volt is tightly fitted at the bottom of the tank. The rubber pipe is fitted at the pump through which the liquid comes out of the pump. A nozzle with small hole pipe is fitted with the liquid coming out by that pump. A nozzle with small hole pipe is fitted at the outside of the frame. Electric current coming from the solar energy (solar plate) is fitted with battery with positive pole and negative pole. FM kit, radio, switch, plug, board, transformer and inverter are joined at the side. Two small speakers are joined at both sides. The connection of the battery is joined with the motor pump by the control switch. Now the electric

current meets the motor pump by switching on the control switch and this motor pump forces the liquid from the tank going through the nozzle from the rubber pipe.

For the taller trees which are more than 3 metre upto 10 metre insecticides or hormones can be sprayed manually or by electricity. Besides this can be it used to spray colours in vehicles. It can also be used to spray two or three-storeys building.

- A :Stand
- B :Compressor
- C :Tank 1
- D :Filtering Funnel
- E :Stop
- G :Sprayer 1
- H :Solar Plate
- I :Belt
- J :Sprayer 2
- L :Battery.
- M :FM Radio
- N :Tank 2
- O :Paddle pump

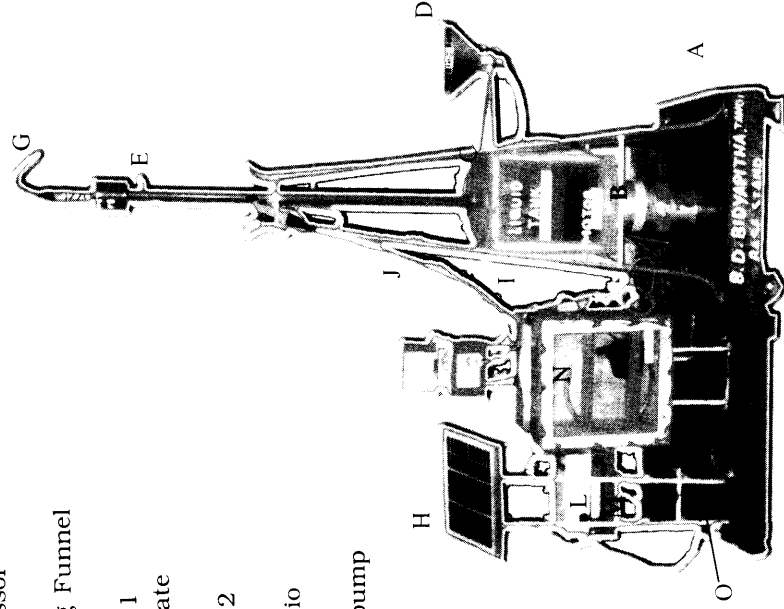


Fig. 15.1: Modern Solar Sprayer

APPLICATIONS

- (i) Spraying of pesticides, insecticides, hormones, manures in the agricultural crops and in the tallest tree up to 10 metre.
- (ii) Spraying of limited water in the vegetable.

- (iii) Charging battery while going to the farm at night.
- (iv) Emergency light at home during night.
- (v) By using special types of horns or alarms, it is easy to stop the damage of the crops by the animals and birds.
- (vi) Spraying colours to vehicles and building safely.
- (vii) Pressure check up vehicles can be done.

ADVANTAGES

Main and petrol energy is saved because it is conducted with the solar energy.

CONCLUSION

It is concluded that emphasis must be given on the use of solar energy in future. It is high time to think seriously about eco-friendly, economically valuable and sustainable energy sources such as "Solar Energy".

CONSTRUCTION AND WORKING

- (i) **Cooling Chamber:** It is made up of metallic box in which metallic pipes are connected and some wet sand has been put to make the air cool.
- (ii) **Heating Chamber:** It is made up of a metallic box in which the upper part is covered with a glass. So when the Sun rays fall on the glass the air becomes hot.
- (iii) **Air Tight House:** Two air tight houses are made up of thermocol – the lower house is used during summer season. There is and the upper house is used during winter season (upper house). a small ventilator in the summer house enters through the outside air from the surrounding and through the wet sand metallic pipe into the cooling chamber and through the air becomes cooled. and coiled metallic pipe in the chamber the air becomes cooled. Then the air goes to the lower house through pipe. This house can be used during summer season. Then the air goes to the heating chamber and with the help of sunrays (as we cannot use the Sun directly, so, 200 Watt bulb will replace the use of the sun) the air becomes hot and then the air goes to the upper house which can be used in the winter season.

Since, it is a multipurpose project, a small pipe is connected from the heating chamber to the water tank and then the hot water is directly used for various purposes. For example, the hot water is used for bathing purpose and also used for watering the plants in the garden.

17

EXTRACTION OF FLUORINE FREE WATER BY USING LOW-COST R.O. SYSTEM

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INTRODUCTION

Air, water, food, shelter, etc., are the basic needs for the existence of living world. Out of these, water is the most essential for all living beings, in terms of drinking, cooking, bathing, washing, irrigation, sustenance of aquatic life, photosynthesis, etc. Water covers $3/4$ th of total area of the earth surface. It can be again classified into two types like fresh water and saline water. Human beings consume fresh water in the form of potable water. The water consumed by human being is used for different bio-chemical reaction as well as smooth conduct of metabolic process. But water, on the other hand, is treated to be the universal solvent. Most of the ionic compound, polar covalent compounds, different gases, etc., remain in it in dissolved form. One of the most pollutant element, fluorine, present in ground water causes large scale damage to the skeletal system of our body. The fluorine water causes disease like fluorosis which directly affects our teeth and bones. The loss of calcium from teeth and bone in the form of CaF_2 (calcium fluoride) might lead to falling and decaying of teeth, bone cancer, bending and collapsing of vertebrae, abnormal mental growth, osteoporosis, etc.

The ground water of states like Rajasthan, Himachal Pradesh, Jammu & Kashmir, Haryana, Bihar, Chhattisgarh, Odisha, West Bengal, etc., are badly affected due to contamination of water by fluorine. The ground water concentration of fluorine lies between 1.5 ppm and 20 ppm, which is much higher than the normal level, i.e., 0.005 ppm. In Odisha, 854 villages in 16 districts are suffering acutely due to the presence of fluorine in ground water. The fluorine pollution is due to the contamination of ground water by industrial waste, depletion of fluoride bearing rocks, etc. The worst affected districts of Odisha are Angul, Khorda, Nayagarh, Nuapada and Puri.

SCIENTIFIC PRINCIPLES INVOLVED

The scientific principles involved in this project are that of sedimentation and Reverse Osmosis (RO). Reverse Osmosis means the movement of water from high concentration to low concentration.

MATERIALS REQUIRED

Sedimentation tank, threads, calcium oxide, RO tank, plastic pipes, plastic plate, filtration tank, bandage cloth, plaster of paris, improvised candles, etc.

CONSTRUCTION AND WORKING

First Tank

- (i) It is called the storage-cum-concentration (sedimentation) tank. The size of the tank is $1.5' \times 1' \times 1'$ which is made up of corrugated sheet (here it is made of wooden ply).
- (ii) The upper part of the tank is open and the tank is completely painted black from all sides to absorb more heat from sun rays.
- (iii) The bottom surface of it is little inclined and laid with copper plate. The upper part of the tank is covered with glass plate.
- (iv) The tank has three outlets. Through one outlet the fluorine added water enters the tank. Through the second outlet partly separated (about 70%) fluorine water enters into the reverse osmosis container and through the third outlet calcium fluoride (CaF_2) is removed from time to time.

- (v) Inside the tank some packets of calcium oxide (CaO) are suspended with the help of threads. The packets are made up of semi permeable non woven zipper cloth.

Second Tank

- (i) This is called reverse osmosis tank and precisely known as RO tank.
- (ii) This container is made of nylon. Inside it two co-axial PVC pipes have been taken with different cross-section and their height is about 8".
- (iii) Both the pipes are pricked with several pores, i.e., the pipes are well perforated. Around the inner pipe the non-woven zipper cloths are wrapped several times, such that the space between both the pipes can be filled with the semi-permeable non woven zipper cloths.
- (iv) The inner space of the inner pipe is fitted with the pipe, which have been connected already with first tank.

Third Tank

- (i) This is called improvised filtration tank with low cost improvised filtering candle which is four in number.
- (ii) Each candle is made up of plastic pipe with cross section of $1\frac{1}{2}"$ and a bandage cloth which is soaked in plaster of paris and activated charcoal.
- (iii) Length of each pipe is about 6" and perforated about the height 4". Then the water-soaked plaster of paris treated bandage is wrapped around each pipe several times. In between a definite turn of wrapping few activated charcoal is put into it.
- (iv) The prepared improvised candle is made dry and placed in their appropriate holes. At the bottom all the candles are connected together with a single outlet to obtain fluorine free zero bacteria water.

Working

- (i) Firstly the fluorine contaminated water is pumped into the storage cum concentration (sedimentation) tank, where it should be exposed to sunlight for about 1 to 2 hours. Here the black surface of the tank absorbs maximum heat from infrared zone. As a result the temperature of the whole water

in the tank reaches upto 70°C to 80°C. At this temperature the fluorine in the water react with calcium oxide (CaO) which is suspended by thread in semi-permeable membrane packets. As a result of this reaction insoluble calcium fluoride (CaF₂) is formed. Also the high temperature accelerates and concentrates the formation of CaF₂ and deposit it at the bottom in sediment form.

- (ii) 70 per cent of whole sediments can be separated from time to time from its third outlet at the base region of the first tank. But the remaining amount of CaF₂ still present in water is harmful to our body. This should be then transferred in the second RO tank.
- (iii) Due to reverse osmosis the remaining CaF₂ in water is filtered properly by non-woven zipper cloths. As a result the filtered water is completely free from fluorine. In some cases very negligible amount is left which is not harmful to the body.
- (iv) From the RO container the fluorine-free water is then taken into improvised filtration tank. Here the water further undergoes filtration by improvised candles and then taken collectively at the bottom by a connecting pipe. The water which is finally obtained is pure, fluorine-free and with zero bacteria. The pH value of this water will lie between 6.5 and 7.

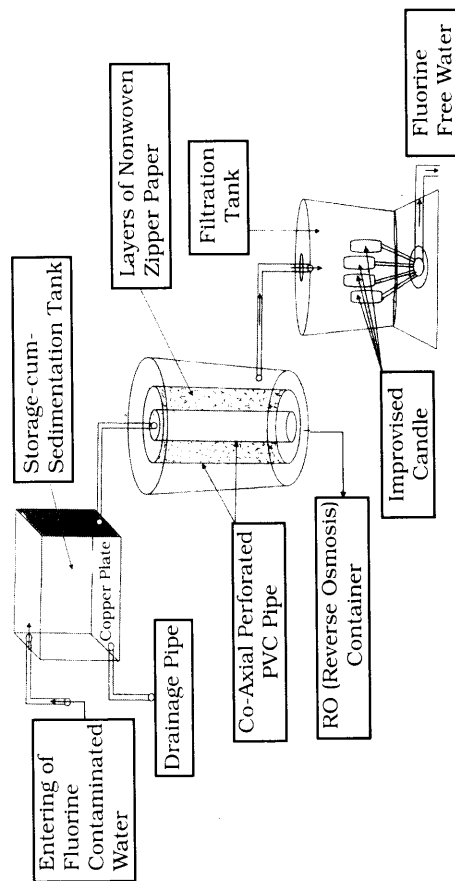
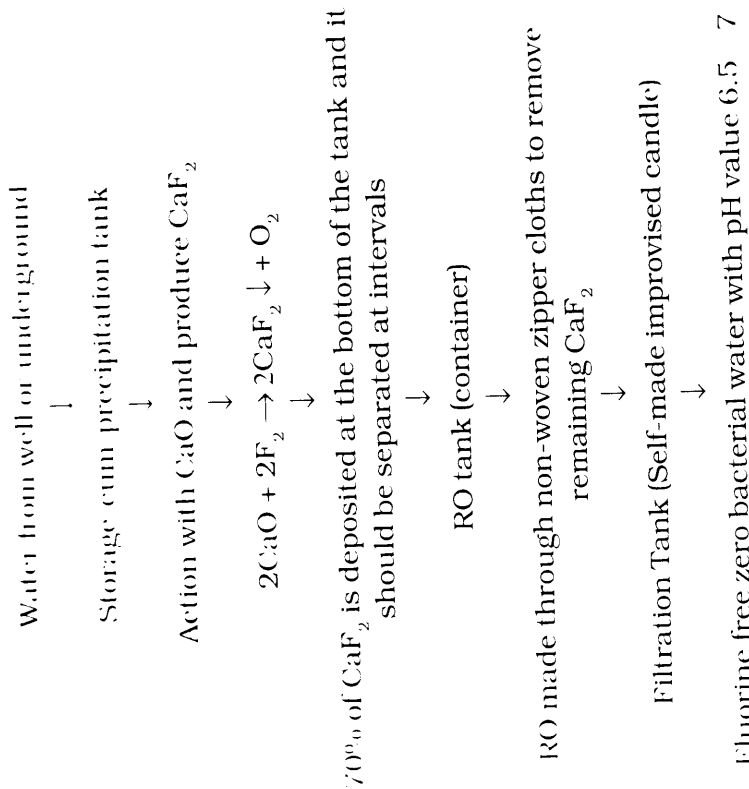


Fig. 17.1: Low-Cost R.O. System

Flow Chart for Fluorine Free Water



ADVANTAGES

In comparison to commercially available RO system, this improvised manual RO system is very cheap. The total cost of construction of this RO system for a family comprising five members is about Rs 2,000. Therefore it can be established by anyone with any income.

APPLICATIONS

- (i) It can be used at home, offices, educational institutions, community halls, hotels, hospitals, etc.
- (ii) On large scale we can also get fluorine free water by using multiple numbers of RO systems connected to a big tank.