A Project Report On

"Hydraulic Tracking of Solar Panel"

By

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C E R T I F I C A T E

This is to certify that ***Mr. Barve Aniket Baban***, has successfully completed the Project Stage I entitled **"Hydraulic Tracking of Solar Panel**" under my supervision, in the partial fulfilment of Bachelor of Engineering - Mechanical Engineering of Savitribai Phule Pune University, in the academic year 2020-21.

Date: 21/06/2021

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This is to certify that ***Mr. Gangarde Tushar Uttam***, has successfully completed the Project Stage I entitled **"Hydraulic Tracking of Solar Panel**" under my supervision, in the partial fulfilment of Bachelor of Engineering - Mechanical Engineering of Savitribai Phule Pune University, in the academic year 2020-21.

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This is to certify that ***Mr.Satkar Sanket Paraji***, has successfully completed the Project Stage I entitled **"Hydraulic Tracking of Solar Panel**" under my supervision, in the partial fulfilment of Bachelor of Engineering - Mechanical Engineering of Savitribai Phule Pune University, in the academic year 2020-21.

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This is to certify that ***Mr. Kanojiya Gaurav Sunil.***, has successfully completed the Project Stage I entitled **"Hydraulic Tracking of Solar Panel**" under my supervision, in the partial fulfilment of Bachelor of Engineering - Mechanical Engineering of Savitribai Phule Pune University, in the academic year 2020-21.

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Mr.Barve Aniket Baban
Mr.Gangarde Tushar Uttam
Mr.Satkar Sanket Paraji
Mr.Kanojiya Gaurav Sunil

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Chapter 1 - Introduction

This chapter includes Problem Statement, background for research work and objectives of current work. It also covers need for dissertation work, problem statement, definition of methodology to achieve desired objectives.

Chapter 2 - Literature Review

In this chapter study of various researchers is summarised shortly. The papers from various journals and conferences, which are relevant to the topic of dissertation are included.

Chapter 3 – Mechanism of Solar Tracking

Lever machine mechanism, hydraulic system related to project and working of hydraulic tracking discussed here.

Chapter 4 – Design Consideration

Here we find out cylinder dimensions by design procedure.

Chapter 5-Scheme of Implementation

Month wise action plan are given here for both semester.

Chapter 6-Manufacturing Processes

In this chapter various manufacturing processes related to reservoir weight holder lever is studied in detail.

Chapter 7-Cost Estimation

Cost of brought out material and manufacturing processes both are added here.

Chapter 8-Result and Discussion

Performance of solar plate carried here.

Chapter-9 Outcomes of Project

In that advantages & disadvantages of projects are discussed.

Chapter 10- Conclusion

Based on the concept and design summary has been made, which is mentioned in this chapter.

1. INTRODUCTION

1.1 Solar Energy

Energy from the sun travels to the earth in the form of electromagnetic radiation similar to radio waves, but in a different frequency range called solar energy. Solar power is the conversion of received solar radiation into usable energy. It is a process that consists of harnessing the sun's present emissions of heat or light. This heat and light are the effects of the sun's constant nuclear fusion of hydrogen nuclei. The process of fusion produces helium nuclei as well as large amounts of energy. Available solar energy is often expressed in units of energy per time per unit area, such as watts per square meter (W/m2). The amount of energy available from the sun outside the earth's atmosphere is approximately 1367 W/m2. Some of the solar energy is absorbed as it passes through the Earth's atmosphere. As a result, on a clear day the amount of solar energy available at the Earth's surface in the direction of the sun is typically 1000 W/m2. The level of solar radiation a region receives depends on latitude and local weather conditions.

Solar Panels are a form of active solar power, a term that describes how solar panels make use of the sun's energy; solar panels harvest sunlight and actively convert it to electricity. Solar Cells, or photovoltaic cells, are arranged in a grid-like pattern on the surface of the solar panel. Solar panels are typically constructed with crystalline silicon, which is used in other industries (such as the microprocessor industry), and the more expensive gallium arsenide, which is produced exclusively for use in photovoltaic (solar) cells. Solar panels collect solar radiation from the sun and actively convert that energy to electricity. Solar panels are comprised of several individual solar cells. These solar cells function similarly to large semiconductors and utilize a large area p-n junction diode. When the solar cells are exposed to sunlight, the p-n junction diodes convert the energy from sunlight into usable electrical energy. The energy generated from photons striking the surface of the solar panel allows electrons to be knocked out of their orbits and released, and electric fields in the solar cells pull these free electrons in a directional current, from which metal contacts in the solar cell can generate electricity. The more solar cells in a solar panel and the higher the quality of the solar cells, the more total electrical output the solar panel can produce. The conversion of sunlight to usable electrical energy has been dubbed the Photovoltaic Effect.

1.2 Solar Tracking

A solar tracker is a device that orients a payload toward the sun. The use of solar trackers can increase electricity production by around a third, and some claim by as much as 40% in some regions, compared with modules at a fixed angle. In any solar application, the conversion efficiency is improved when the modules are continually adjusted to the optimum angle as the sun traverses the sky. As improved efficiency means improved yield, use of trackers can make quite a difference to the income from a large plant.

Commercial purpose of solar tracking system:

1. Increase Solar Panel Output.
2. Maximum efficiency of the panel.
3. Maximize Power per unit area.
4. Able to grab the energy throughout the day.

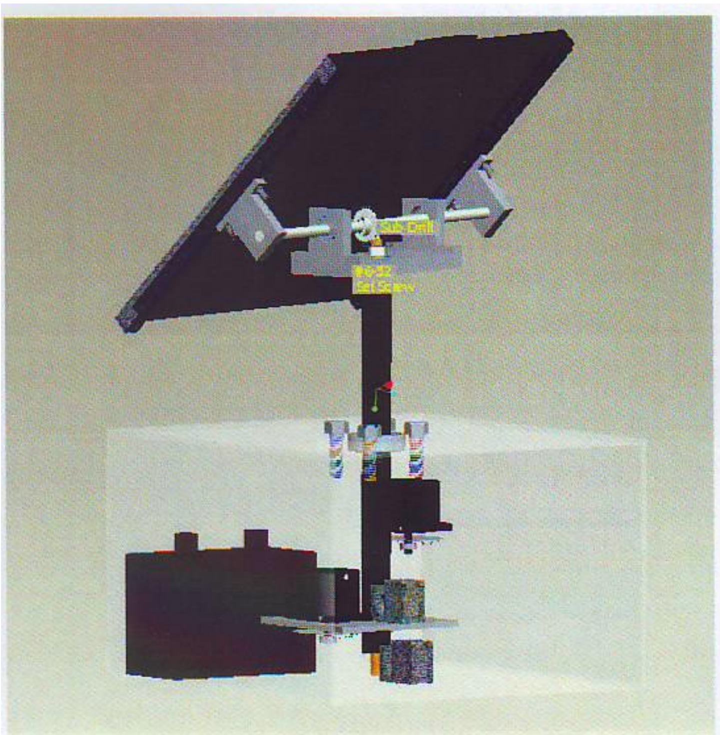

Fig. 1.2.1 Solar tracking system

The sun's position in the sky varies both with the seasons (elevation) and time of day as the sun moves across the sky. Hence there are also two types of solar tracker:

1. Single Axis Solar Tracker
2. Dual Axis Solar Tracker

Single Axis Solar Tracker: Single axis solar trackers can either have a horizontal or a vertical axle. The horizontal type is used in tropical regions where the sun gets very high at noon, but the days are short. The vertical type is used in high latitudes (such as in UK) where the sun does not get very high, but summer days can be very long.

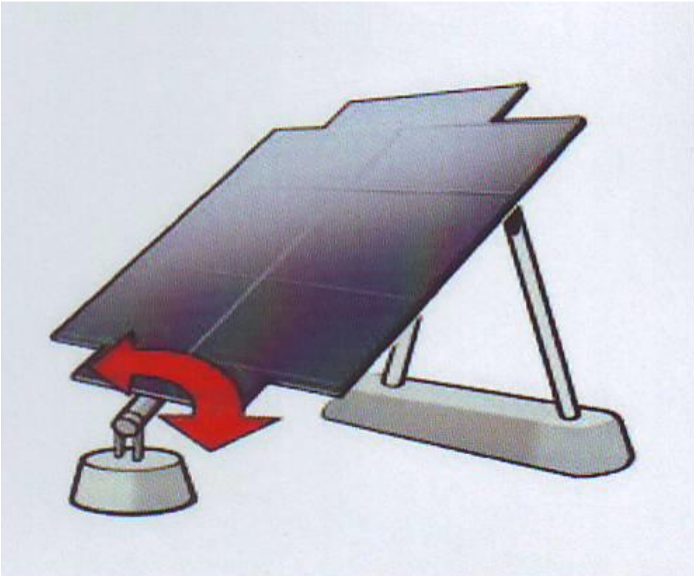

Fig. 1.2.2 Single axis solar tracker

Dual Axis Solar Tracker: Double axis solar trackers have both a horizontal and a vertical axle and so can track the sun's apparent motion exactly anywhere in the world. This type of system is used to control astronomical telescopes, and so there is plenty of software available to automatically predict and track the motion of the sun across the sky. Dual axis trackers track the sun both east to west and north to south for added power output (approx 40% gain) and convenience.

Fig. 1.2.3 Dual axis solar tracker

Solar tracker drives, can be divided into three main types depending on the type of drive and sensing or positioning system that they incorporate.

1 Passive Trackers: Use the sun's radiation to heat gases that move the tracker across the sky.
2 Active Trackers: Use electric or hydraulic drives and some type of gearing or actuator to move the tracker.
3 Open Loop Trackers: Use no sensing but instead determine the position of the sun through pre recorded data for a particular site.

Passive Trackers: Passive trackers use a compressed gas fluid in two canisters each place in west and east of the tracker.The mechanism is in such a way that if one side cylinder is heated other side piston rises causing the panel to tilt over the sunny side. This affects the balance of the tracker and caused it to tilt. This system is very reliable and needs little maintenance.

Fig. 1.2.4 Passive tracker

Active Trackers: Active trackers measure the light intensity from the sun by using light sensors to determine where the solar modules should be pointing. Light sensors are positioned on the tracker at various locations in specially shaped holders. If the sun is not facing the tracker directly there will be a difference in light intensity on one light sensor compared to another and this causes to determine in which direction the tracker has to tilt with the help of the stepper or dc motor in order to be facing the sun.

Fig. 1.2.5 Active tracker

1.3 Problem statement

At present, the solar tracking system use electrical energy for tracking operations and this electrical energy for operations is supplied by same solar panels or by external electrical storage or supply lines, this reduces efficiency of the solar panels. Using mechanical energy for tracking will increase the output of solar panels and remove the constraint on the location of the tracking system.

1.4 Objective of Project

The position of the sun keeps on changing every day. Solar panels as we know are entirely dependent on the sun. The more the sun rays fall on the panels the more outcomes we get and it serves our purpose of installing a solar panel. The challenge nowadays is to keep a track of the position of the sun so that we get the maximum output from the panels. We hope to achieve this with a Mechanical tracking system.

1.5 Scope

To study on hydraulic tracker and how to implement it in tracking system project. To Study related to fluid mechanics which is we are going to use in this project. To study on hydraulic system and its components mainly piston, control valves, check valves and hydraulic oil. also to study implementation of this system for domestic or commercial solar applications

1.6 Methodology

Step 1:- Identification of problem

Step 2:- Literature Review

Step 3:- Design of mechanical parts

Step 4:- Brought our material.

Step 5:- Manufacturing processes.

Step 6:- Running of project.

1.7 Organisation of Dissertation

2. LITERATURE REVIEW

Anika et.al[1] Solar tracker provides three ways of operation and control mechanism through the programmer written in microcontroller.

A. Normal day light condition: - Two photo resistors are used in the solar tracker to compare the output voltages from two junctions. As the sun rotates from east to west in the day time, AIN0 needs to provide higher voltage than AIN1 to sense the rotation of the sun. This condition is considered as normal day light condition and tracker rotates the panel 3.75° after every 15 minutes.

B. Bad weather condition: - When the sky gets cloudy, there will be less striking of light on both the photo resistors and so sufficient voltages might not be available at junction point. The difference of voltage at junction point will not be greater than the threshold value to rotate the tracker. At the meantime, sun continues rotating in the western direction. To solve this problem, a short delay is provided which will check for voltage input from junction point in every 1.5 minutes. Microcontroller will use the variable Count to check for consecutively 10 times to make the 'wait' state equal to 15 minutes (moderate delay) to rotate the stepper motor one step.

C. Bidirectional rotation: - At day time, the solar tracker will rotate in only one direction from east to west. Variable I will count the total rotation in day time and that is approximately calculated as 40 rotations considering 150° rotation. When the sun sets, no more rotation is needed in western direction. For the next day, the solar panel needs to go to the initial position in the morning to track the sun's position again. To do so, the variable I that counts the number of rotation in the day time will work out. When the variable (I) shows value greater than 40, the tracker stops rotating in the western direction and rotates reversely in the eastern direction to set the tracker to the initial position for the next day. When it goes to initial position, power supply to the tracker will be turned off and the tracker will be in stand by till sunlight in the next morning.

The attractive feature of the constructed prototype is the software solution of many challenges regarding solar tracking system. The designed prototype requires only two photo resistors to sense the light, which lessens the cost of the system. Power consumption of the system is negligible.

Fig.2.1 Designed working Prototype of solar tracker.

The solar PV modules are generally employed in dusty environments which is the case in tropical countries like India. The dust gets accumulated on the front surface of the module and blocks the incident light from the sun. It reduces the power generation capacity of the module. The power output reduces as much as by 50% if the module is not cleaned for a month. To reduce this loss, a brush along with rollers was fixed with the panel. This brush-roller system rolls down twice in 24 hours, when the panel is in vertical position and makes this prototype a self-cleaning system.

Tudorache et.al [2] To command the PV panel motion, we used two light intensity sensors, executed using two luminescent diodes of LED type, placed so that the signal they generate is correlated with the light intensity applied to the PV panel, as in Fig. 2.2 The two LEDs are placed normal to the panel surface and are separated by an opaque plate.Thus, depending on the relative position between the PV panel and the solar light direction, one of the two LEDs will generate a stronger signal and the other LED a weaker one. In principle, the stronger signal will indicate the movement direction of the PV panel, so as to be normally oriented to the incident sun light rays and thus to have a maximum conversion efficiency of light into electricity. The operation scheme of the experimental model of the solar tracking system supposed the amplification of the two signals generated by the two LEDs up to the value range of the analog inputs of IBL2403 drive unit, at which were connected the two signals.

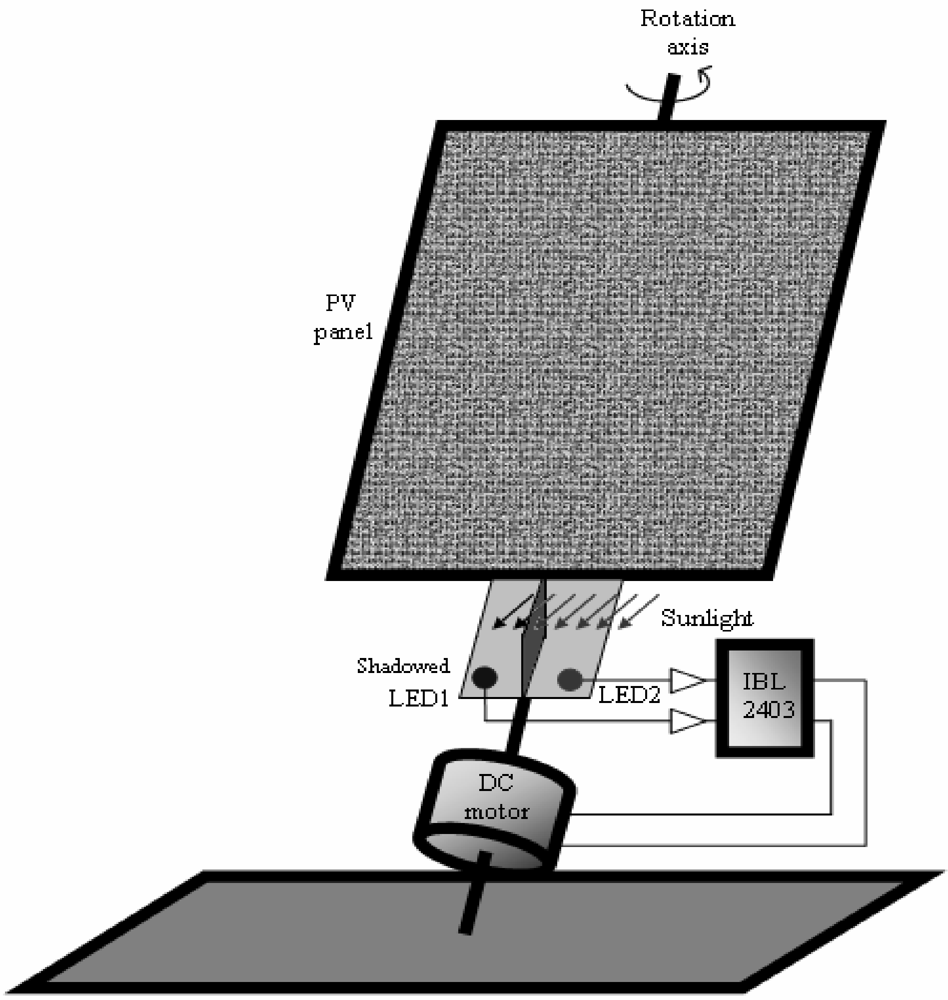

Fig.2.2 Principle of light sensors and motion control of PV panel

The proposed solution, which uses two independent light intensity sensors and the separate measurement of their output signals, has the following advantages:

1. by measuring each separate signal we can detect, for the maximum signal intensity of the signal, if the light intensity is strong enough to justify the panel movement, which means additional energy consumption.
2. In the case that the maximum signal intensity is higher than the minimum admitted values, an additional decision criterion of movement will be determined by the difference between the signals from the two LEDs. When this difference becomes greater than an imposed limit, the command for anew movement of the

PV panel will be triggered and thus the panel will be oriented again in order to achieve a better position with respect to the sun.

Thus, the proposed solution will remove the intermittent, frequent and unnecessary movements of the PV panel that would entail a higher consumption of energy, and thus decreasing in this way the conversion efficiency of the system. They should point out that when the motor is not active, the power circuit of the IBL2403 drive unit can be completely deactivated, thus minimizing in this way the energy consumption of the system.

3. MECHANISM OF SOLAR TRACKING

The mechanism selected for tracking system is based on lever principle. The type of lever used manipulate the required load is Second type lever. Basically, a lever is rod or bar capable of turning about a fixed point called fulcrum. It is used as a machine to lift / transmit a load by the application of small effort. The ratio of load lifted to the effort applied is called mechanical advantage. A lever may be Straight or curved and the forces applied on the lever (or by the lever) may be parallel or inclined to one another.

3.1 Application Of Levers In Engineering Practice

The load (W) and the effort (P) may be applied to the lever in three different ways. The Fulcrum is denoted by F and direction of reaction is indicated by an arrow mark.

1 First type/First class lever

In the first type of levers, the fulcrum is in between load and effort. These levers are commonly used in railway signalling, rocker arms, hand pumps, foot levers etc.

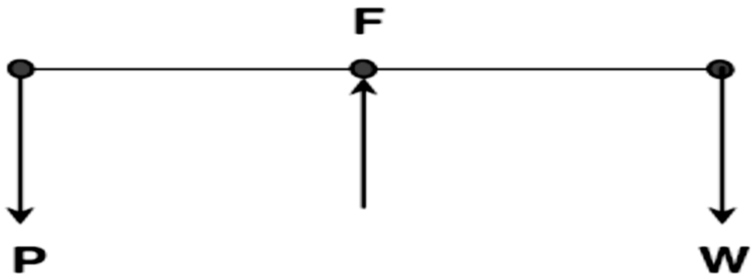

Fig.3.1.1 First Type of Lever

2 Second type/Second class lever

In this type, the load is in between the fulcrum and effort. The application of such type of lever is found in levers of loaded safety valves.

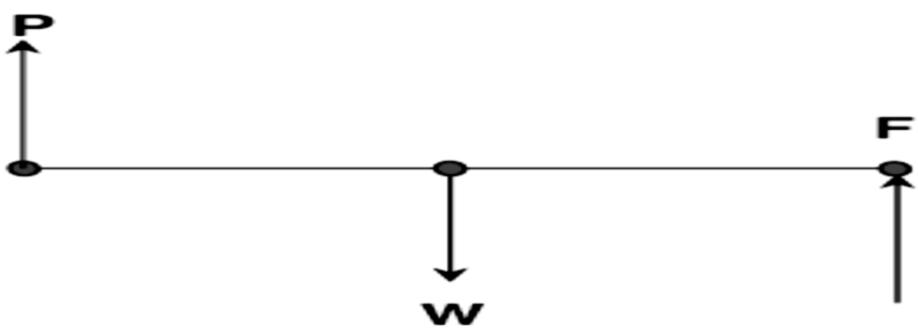

Fig.3.1.2Second Type of Lever

3 Third type/Third class levers

In this type of levers, the effort is in between the fulcrum and load. The use of such type of levers is not recommended in engineering practice. However a pair of tongs, the treadle of sewing machine is the examples of this type of lever.

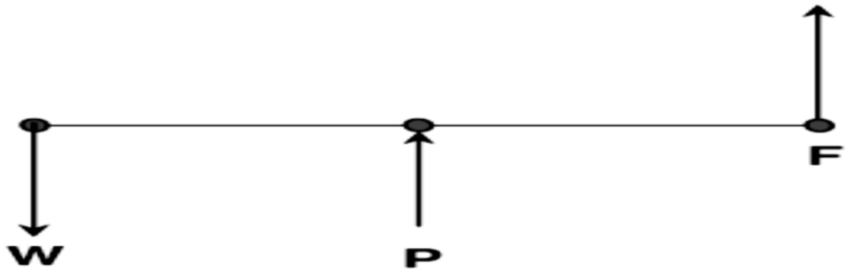

Fig.3.1.3 Third Type of Lever

3.2 Construction

The arrangement of the hydraulic components and other mechanical elements are illustrated by the following schematic diagram.

The components of the system are,

1. Panel seat
2. Column
3. Base
4. Weight
5. Weight holder
6. Double acting cylinder
7. Check valve
8. Flow control valve
9. Reservoir
10. Filter
11. Rod end mounting
12. Piston end hinge
13. Handle
14. Counter weight platform
15. Connecting hose
16. T-Connector
17. Stopper

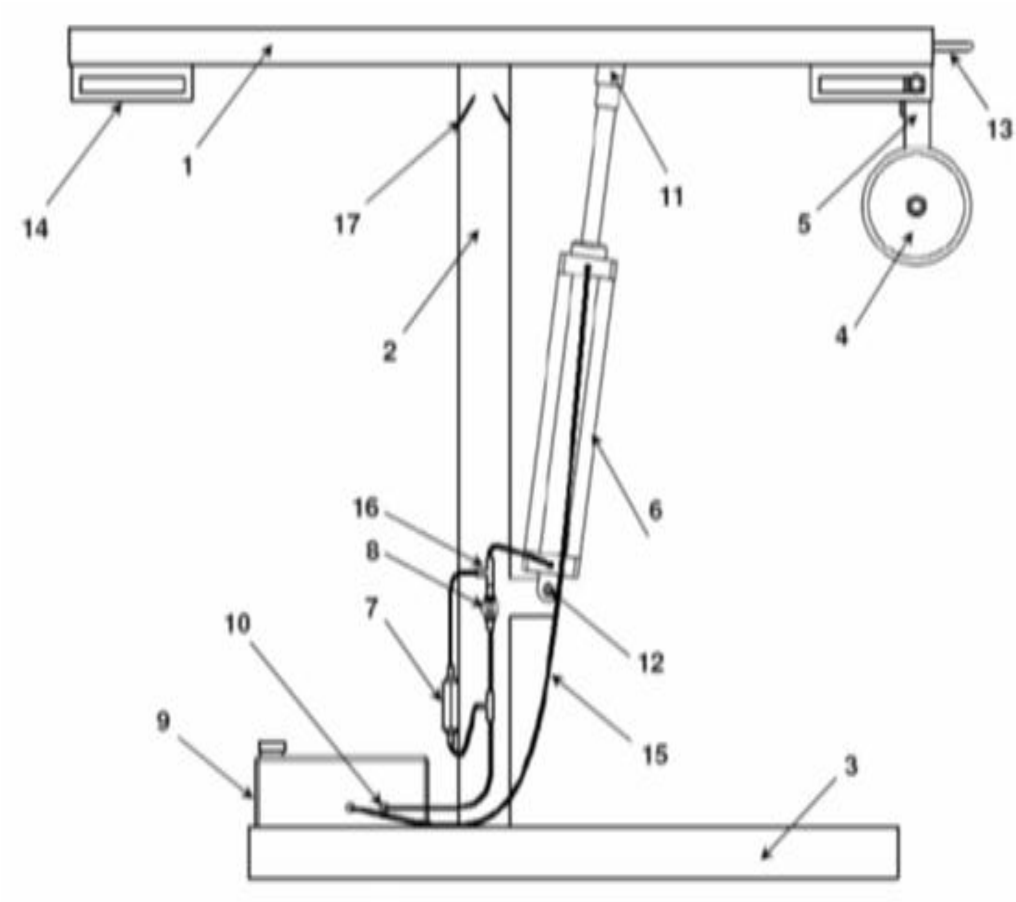

Fig.3.2 Construction of tracking system

3.3 Working procedure

Working procedure of the designed tracking system is explained by the hydraulic circuit diagram and by the schematic diagrams. Each duty cycle of the system contains two steps, those are,

1. Tracking

As the tracking weight acts on the piston through piston rod, it pushes the oil out of the cylinder and the oil flows towards reservoir. While, due to the restricted cross sectional area at flow control valve the piston moves with the velocity equal to calculated tracking velocity. During this action the check valve remains closed, hence oil is allowed to flow only through flow control valve. At the rod end of the cylinder, the oil is sucked into cylinder due to the vacuum pressure created by the applied weight.

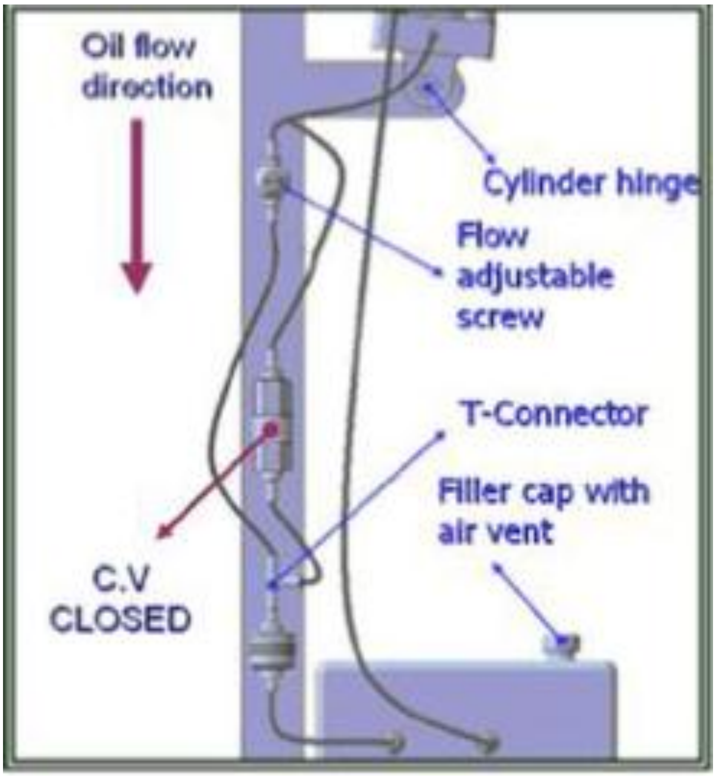

Fig.3.3.1Tracking

2. Return

As the tracking time finishes, the panel seat has to be rotated by applying the torque, manually, to bring back into initial position. The vacuum pressure is created at piston end chamber and oil from reservoir rushes towards cylinder. As soon as the system pressure exceeds the cracking pressure of check valve, check valve opens and allowing full flow of oil from it, reducing the time required for repositioning operation. The flow control valve also allows the oil to flow from it, increasing rate of flow and reduced panel repositioning time. At rod end of cylinder the piston forces the oil. The oil pressure increases and oil flows out of the cylinder. Oil returns to reservoir through a filter placed in the return line.

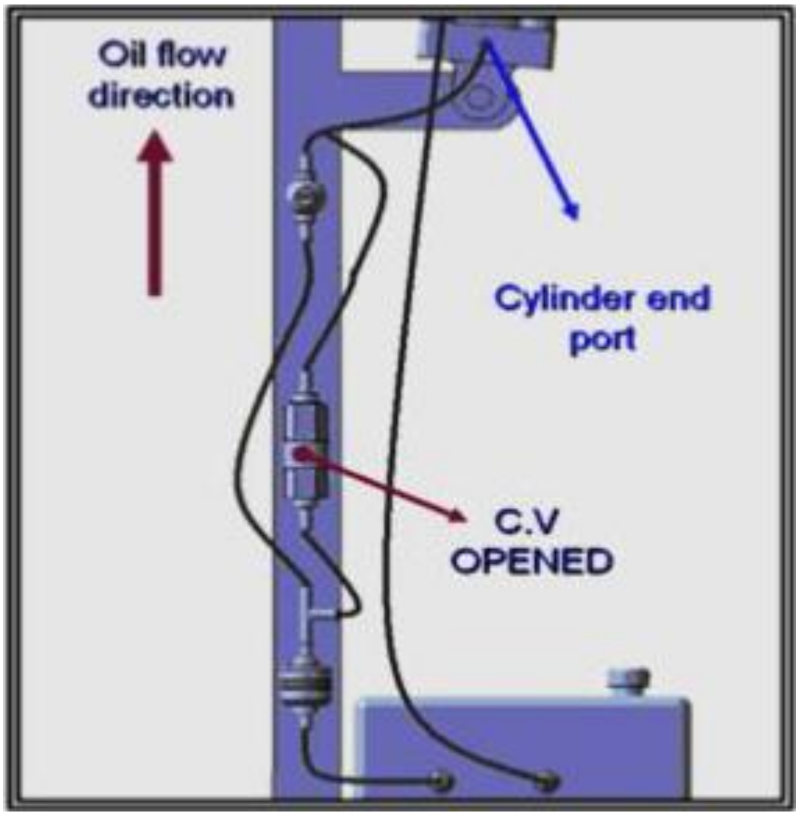

Fig.3.3.2 Return

The lever mechanism used for the current tracking system is illustrated by the figure

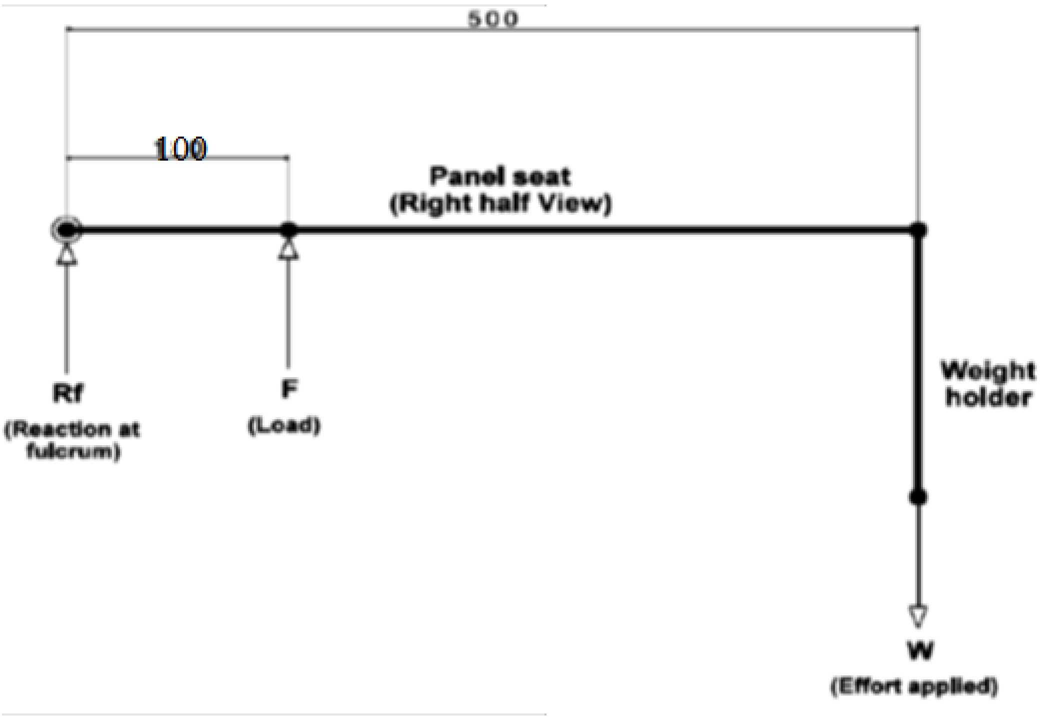

Fig.3.3.3Lever Mechanism

Here, the load is the resistance offered by the cylinder for displacement, which while depends on the rate of flow from the cylinder. The weight of the disc is the applied driving force, hence it is the effort applied on the system to perform the desired operation. The weight is applied through a weight holder. Comparing with the types of lever systems, as the load is between fulcrum and effort point, this is a system with second type lever system. The arrow on the points shows the direction of force.

3. 4 HYDRAULICS

Hydraulic systems use a incompressible fluid, such as oil or water, to transmit forces from one location to another within the fluid. Most aircraft use hydraulics in the braking systems and landing gear. Pneumatic systems use compressible fluid, such as air, in their operation. Some aircraft utilize pneumatic systems for their brakes, landing gear and movement of flaps.

Pascal's law states that when there is an increase in pressure at any point in a confined fluid, there is an equal increase at every other point in the container.

A container, as shown below, contains a fluid. There is an increase in pressure as the length of the column of liquid increases, due to the increased mass of the fluid above.

Pascal's Law is a theory which states that the pressure (P) in a confined fluid, caused by a force (F1), over an area (A1), is transmitted undiminished, causing a force (F2), over the area (A2). This law can be applied to magnify a small force by the ratio of the areas to give a larger force – $F2 = F1 (A2/A1)$.

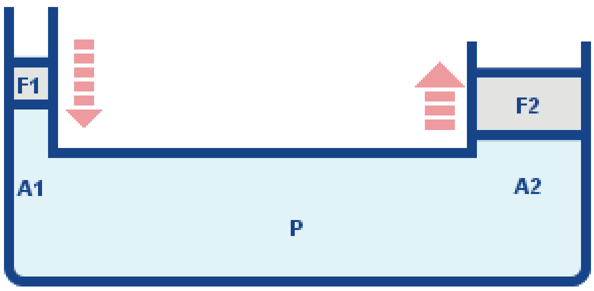

Fig.3.1 Principle of Pascals law

3.4.1 Applications of hydraulic systems

The hydraulic systems are mainly used for precise control of larger forces. The main applications of hydraulic system can be classified in five categories:

1 Industrial: Plastic processing machineries, steel making and primary metal extraction applications, automated production lines, machine tool industries, paper industries, loaders, crushes, textile machineries, R & D equipment and robotic systems etc.

2Mobile hydraulics: Tractors, irrigation system, earthmoving equipment, material handling equipment, commercial vehicles, tunnel boring equipment, rail equipment, building and construction machineries and drilling rigs etc.

3 Automobiles: It is used in the systems like breaks, shock absorbers, steering system, wind shield, lift and cleaning etc.

4 Marine applications: It mostly covers ocean going vessels, fishing boats and navel equipment.

5 Aerospace equipment: There are equipment and systems used for rudder control, landing gear, breaks, flight control and transmission etc. which are used in airplanes, rockets and spaceships.

3.4.2 Advantages

1. The hydraulic system uses incompressible fluid which results in higher efficiency.
2. It delivers consistent power output which is difficult in pneumatic or mechanical drive systems.
3. Hydraulic systems employ high density incompressible fluid. Possibility of leakage is less in hydraulic system as compared to that in pneumatic system. The maintenance cost is less.
4. These systems perform well in hot environment conditions.

3.4.3 Disadvantages

1. The material of storage tank, piping, cylinder and piston can be corroded with the hydraulic fluid. Therefore one must be careful while selecting materials and hydraulic fluid.
2. The structural weight and size of the system is more which makes it unsuitable for the smaller instruments.
3. The small impurities in the hydraulic fluid can permanently damage the complete system, therefore one should be careful and suitable filter must be installed.

4. The leakage of hydraulic fluid is also a critical issue and suitable prevention method and seals must be adopted.
5. The hydraulic fluids, if not disposed properly, can be harmful to the environment.

3.5 Hydraulic Circuit

Hydraulic circuit is representation of various components of the hydraulic system by using graphic symbols. The design of hydraulic circuit which precedes the design of actual components, does not really involve any calculations as it is the mere representation of the system using different graphic symbols.

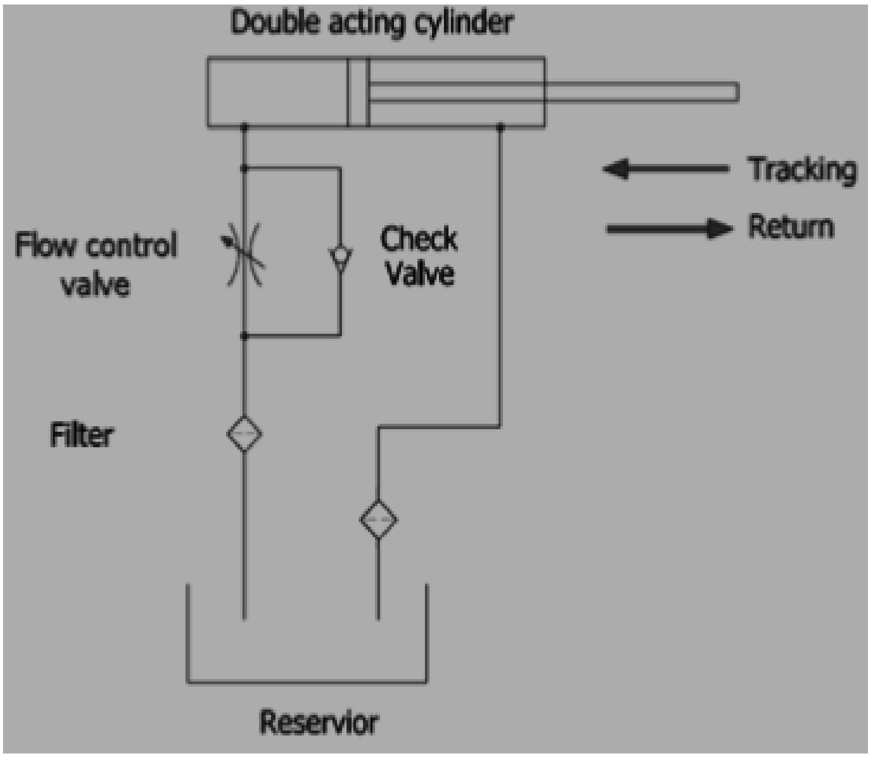

Fig.3.5 Hydraulic circuit diagram

Hydraulic circuit diagram for the mechanical solar tracking system is illustrated by the figure 3.4

The components of the hydraulic circuit and their functions are,

1. Hydraulic actuator (Hydraulic Cylinder)

The actuators are used in hydraulic systems to convert the fluid energy (i.e. fluid with high pressure) back into mechanical energy by reducing the pressure of fluid. The power developed by the actuator depends on,

a. Flow rate

b. Pressure drop across the actuator

c. Efficiency of actuator

There are three types of hydraulic actuators,

1. Linear actuators
2. Rotary actuators (Continuous)
3. Rotary actuators (Limited angle)

Linear actuators are nothing but hydraulic cylinders, which produce straight line motion. The linear motion achieved in a hydraulic cylinder depends on the stroke length. These actuators are generally termed hydraulic cylinders. Other specific terms like rams and jacks are also used for hydraulic actuators, depending on their end use. The term ram is used for single acting cylinder that causes linear motion in horizontal plane and the term jack refers to a hydraulic cylinder that is used to lift the loads.

The common types of linear actuators are,

a. Single acting cylinder

b. Double acting cylinder

c. Displacement cylinder

Double acting cylinder: Double acting cylinder produces linear motion in two directions. Hydraulic power is applied on either side of the piston. The construction of double acting cylinder is similar to single acting cylinder except that rod end of the cylinder also has oil port. The constructional details of the double acting cylinder is as shown in fig. Constructional details of double acting cylinder

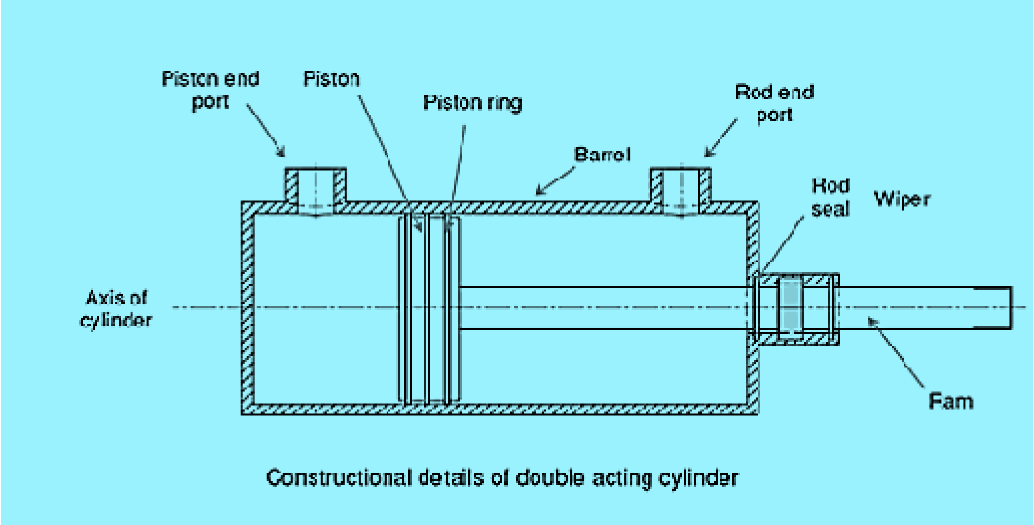

Fig.3.5.1 Hydraulic Cylinder

Double acting cylinder has a hollow cylinder (barrel), piston and piston rod. Both the ends are sealed with the end caps, which are either threaded or welded to the main cylinder. In some designs, the end caps are held with the cylinder by tie rods. The piston is provided with a piston seal, commonly used are piston rings to protect the leakage of oil. The rod is provided with seal to protect the leakage, a bearing to carry the radial loads, a wiper to protect the foreign particles like dust entering into cylinder. Oil ports are provided on either side of the piston, so that the fluid pressure can be applied alternatively on both the sides.

2. Flow control valve (FCV)

The function of flow control valve is to regulate the flow rate of fluid in a hydraulic system. This in turn used to control the speed of actuator/s. These valves are basically variable area orifices, in which increasing the area of orifice increases the flow rate and decreasing the area of orifice reduces the flow rate.

The purpose of flow control in a hydraulic system is to regulate speed. All the devices discussed here control the speed of an actuator by regulating the flow rate. Flow rate also determines rate of energy transfer at any given pressure. The two are related in that the actuator force multiplied by the distance through which it moves (stroke) equals the work done on the load. The energy transferred must also equal the work done. Actuator speed determines the rate of energy transfer (i.e., horsepower), and speed is thus a function of flow rate.

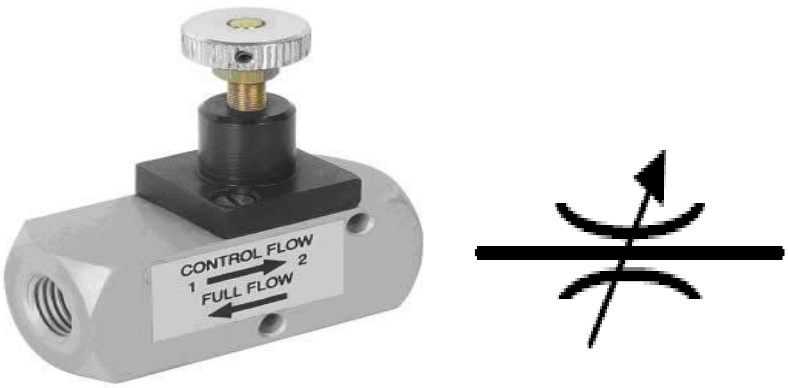

Fig.3.5.2 FCV with symbol

The common types of FCVs are,

1. Simple needle valve

2. Needle valve with integral check

3. Pressure compensated FCV

Classification of Flow-Control Valves Flow-control valves can be classified as follows:

1. Non-pressure compensated.

2. Pressure compensated.

Non-pressure-compensated flow-control valves are used when the system pressure is relatively constant and motoring speeds are not too critical. The operating principle behind these valves is that the flow through an orifice remains constant if the pressure drop across it remains the same. In other words, the rate of flow through an orifice depends on the pressure drop across it. The disadvantage of these valves is discussed below. The inlet pressure is the pressure from the pump that remains constant. Therefore, the variation in pressure occurs at the outlet that is defined by the work load. This implies that the flow rate depends on the work load. Hence, the speed of the piston cannot be defined accurately using non-pressure-compensated flow-control valves when the working load varies. This is an extremely important problem to be addressed in hydraulic circuits where the load and pressure vary constantly.

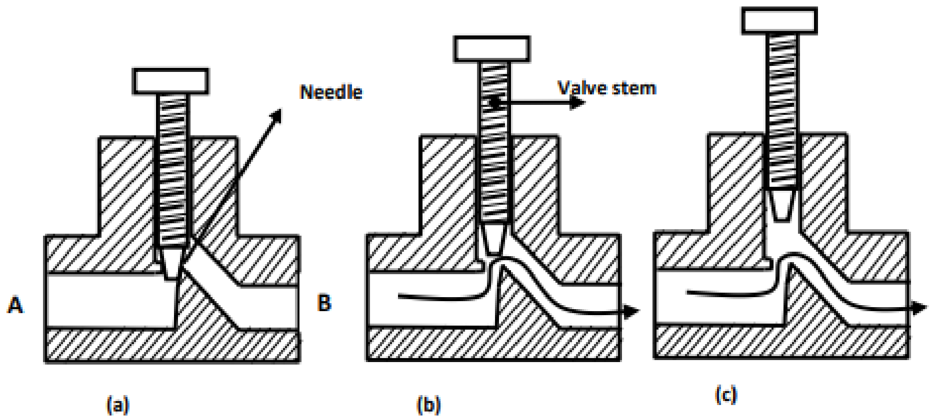

Fig. Non-pressure-compensated needle-type flow-control valve. (a) Fully closed; (b) partially opened; (c) fully opened.

Schematic diagram of non-pressure-compensated needle-type flow-control valve is shown in Fig.. It is the simplest type of flow-control valve. It consists of a screw (and needle) inside a tubelike structure. It has an adjustable orifice that can be used to reduce the flow in a circuit. The size of the orifice is adjusted by turning the adjustment screw that raises or lowers the needle. For a given opening position, a needle valve behaves as an orifice. Usually, charts are available that allow quick determination of the controlled flow rate for given valve settings and pressure drops. Sometimes needle valves come with an integrated check valve for controlling the flow in one direction only. The check valve permits easy flow in the opposite direction without any restrictions. As shown in Fig., only the flow from A to B is controlled using the needle. In the other direction (B to A), the check valve permits unrestricted fluid flow.

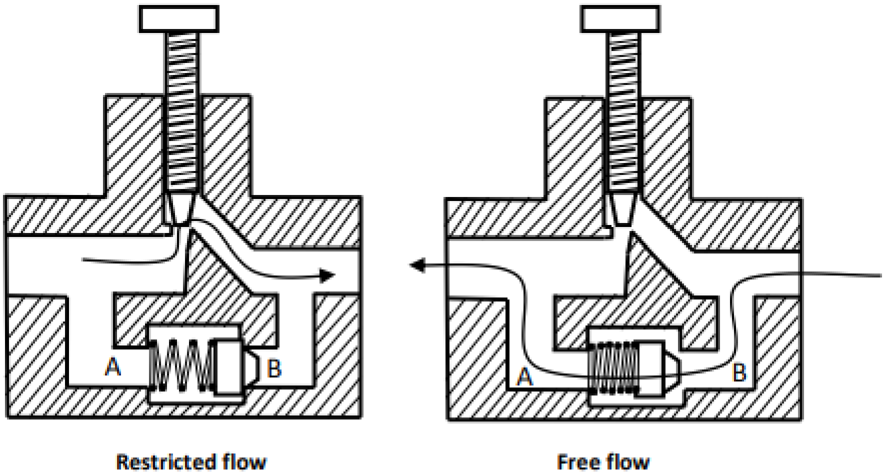

Fig. Flow-control valve with an integrated check valve.

3. Check Valve

Check valves are also known as directional control valves. The function of check valve is to direct the free flow in only one direction, and block any flow in reverse direction. These are similar in operational analogy of electronic diodes. A check valve, clack valve, non-return valve, reflux valve, retention valve or one-way valve is a valve that normally allows fluid (liquid or gas) to flow through it in only one direction.

Fig.3.5.3 Check valve

Check valves are two-port valves, meaning they have two openings in the body, one for fluid to enter and the other for fluid to leave. There are various types of check valves used in a wide variety of applications. Check valves are often part of common household items. Although they are available in a wide range of sizes and costs, check valves generally are very small, simple, or inexpensive. Check valves work automatically and most are not controlled by a person or any external control; accordingly, most do not have any valve handle or stem. The bodies (external shells) of most check valves are made of plastic or metal.

An important concept in check valves is the cracking pressure which is the minimum differential upstream pressure between inlet and outlet at which the valve will operate. Typically the check valve is designed for and can therefore be specified for a specific cracking pressure.

Heart valves are essentially inlet and outlet check valves for the heart ventricles, since the ventricles act as pumps.

The three types of check valves are generally used.

a. Ball type valve

b. Poppet type valve

c. Pilot operated check valve

A spring operated direction valve requires a small pressure to open, which is called as cracking pressure. Due to this it can work like low pressure relief valve to some extent. A ball check valve is a check valve in which the closing member, the movable part to block the flow, is a ball. In some ball check valves, the ball is spring-loaded to help keep it shut. For those designs without a spring, reverse flow is required to move the ball toward the seat and create a seal. The interior surface of the main seats of ball check valves are more or less conically-tapered to guide the ball into the seat and form a positive seal when stopping reverse flow.

Ball check valves are often very small, simple, and cheap. They are commonly used in liquid or gel minipump dispenser spigots, spray devices, some rubber bulbs for pumping air, etc., manual air pumps and some other pumps, and refillable dispensing syringes. Although the balls are most often made of metal, they can be made of other materials; in some specialized cases out of highly durable or inert materials, such as sapphire. High pressure HPLC pumps and similar applications commonly use small inlet and outlet ball check valves with balls of (artificial) ruby and seats made of sapphire or both ball and seat of ruby, for both hardness and chemical resistance. After prolonged use, such check valves can eventually wear out or the seat can develop a crack, requiring replacement. Therefore, such valves are made to be replaceable, sometimes placed in a small plastic body tightly-fitted inside a metal fitting which can withstand high pressure and which is screwed into the pump head.

There are similar check valves where the disc is not a ball, but some other shape, such as a poppet energized by a spring. Ball check valves should not be confused with ball valves, which is a different type of valve in which a ball acts as a controllable rotor to stop or direct flow.

Applications

Pump

Check valves are often used with some types of pumps. Piston-driven and diaphragm pumps such as metering pumps and pumps for chromatography commonly use inlet and outlet ball check valves. These valves often look like small cylinders attached to the pump head on the inlet and outlet lines. Many similar pump-like mechanisms for moving volumes of fluids around use check valves such as ball check valves. The feed pumps or injectors which supply water to steam boilers are fitted with check valves to prevent back-flow.

Check valves are also used in the pumps that supply water to water slides. The water to the slide flows through a pipe which doubles as the tower holding the steps to the slide. When the facility with the slide closes for the night, the check valve stops the flow of water through the pipe; when the facility reopens for the next day, the valve is opened and the flow restarts, making the slide ready for use again.

Industrial processes

Check valves are used in many fluid systems such as those in chemical and power plants, and in many other industrial processes. Typical applications in the nuclear industry are feed water control systems, dump lines, make-up water, miscellaneous process systems, N2 systems, and monitoring and sampling systems. In aircraft and aerospace, check valves are used where high vibration, large temperature extremes and corrosive fluids are present. For example, spacecraft and launch vehicle propulsion propellant control for reaction control systems (RCS) and Attitude Control Systems (ACS) and aircraft hydraulic systems.

Check valves are also often used when multiple gases are mixed into one gas stream. A check valve is installed on each of the individual gas streams to prevent mixing of the gases in the original source. For example, if a fuel and an oxidizer are to be mixed, then check valves will normally be used on both the fuel and oxidizer sources to ensure that the original gas cylinders remain pure and therefore nonflammable.

In 2010, NASA's Jet Propulsion Laboratory slightly modified a simple check valve design with the intention to store liquid samples indicative to life on Mars in separate reservoirs of the device without fear of cross contamination.

Domestic use

Some types of irrigation sprinklers and drip irrigation emitters have small check valves built into them to keep the lines from draining when the system is shut off. Check valves used in domestic heating systems to prevent vertical convection, especially in combination with solar thermal installations, also are called gravity brakes. Rainwater harvesting systems that are plumbed into the main water supply of a utility provider may be required to have one or more check valves fitted to prevent contamination of the primary supply by rainwater.

Hydraulic jacks use ball check valves to build pressure on the lifting side of the jack. Check valves are commonly used in inflatables, such as toys, mattresses and boats. This allows the object to be inflated without continuous or uninterrupted air pressure.

4. Hydraulic oil

The working fluid in all hydraulic systems is a fluid. Various oil based fluids which had the desirable properties were developed for the use in hydraulic systems.

The functions of the hydraulic fluid are,

a. To transmit power, this is the primary function.

b. To lubricate various moving parts, so as to avoid metal-to-metal contact, and reduce wear and noise.

c. To carry the heat generated in the system due to friction between moving parts and moving fluid, and to dissipate to the environment either through a suitable heat exchanger or through the reservoir.

Classification of lubricants

Wide variety of lubricants may be arranged according to the following classification methods:

General classification of lubricants

Classification of lubricants by application

Classification of lubricants by additives

General classification of lubricants

Mineral lubricants

Fluid lubricants (Oils)

Mineral fluid lubricants are based on mineral oils. Mineral oils (petroleum oils) are products of refining crude oil. There are three types of mineral oil: paraffinic, naphtenic and aromatic.

Paraffinic oils are produced either by hydrocracking or solvent extraction process. Most hydrocarbon molecules of paraffinic oils have non-ring long-chained structure. Paraffinic oils are relatively viscous and resistant to oxidation. They possess high flash point and high pour point.

Paraffinic oils are used for manufacturing engine oils, industrial lubricants and as processing oils in rubber, textile, and paper industries.

Naphtenic oils are produced from crude oil distillates.

Most hydrocarbon molecules of naphtenicnic oils have saturated ring structure. Naphtenic oils possess low viscousity, low flash point, low pour point and low resistance to oxidation.

Naphtenic oils are used in moderate temperature applications, mainly for manufacturing transformer oils and metal working fluids.

Aromatic oils are products of refining process in manufacture of paraffinic oils.

Most hydrocarbon molecules of aromatic oils have non-saturated ring structure.

Aromatic oils are dark and have high flash point.

Aromatic oils are used for manufacturing seal compounds, adhesives and as plasiticezers in rubber and asphalt production.

Semi-fluid lubricants (greases)

Semi-fluid lubricants (greases) are produced by emulsifying oils or fats with metallic soap and water at 400-600°F (204-316°C).

Typical mineral oil base grease is vaseline.

Grease properties are determined by a type of oil (mineral, synthetic, vegetable, animal fat), type of soap (lithium, sodium, calcium, etc. salts of long-chained fatty acids) and additives (extra pressure, corrosion protection, anti-oxidation, etc.).

Semi-fluid lubricants (greases) are used in variety applications where fluid oil is not applicable and where thick lubrication film is required: lubrication of roller bearings in railway car wheels, rolling mill bearings, steam turbines, spindles, jet engine bearings and other various machinery bearings.

Solid lubricants

Solid lubricants possess lamellar structure preventing direct contact between the sliding surfaces even at high loads.

Graphite and molybdenum disulfide particles are common Solid lubricants. Boron nitride, tungsten disulfide and polytetrafluorethylene (PTFE) are other solid lubricants.

Solid lubricants are mainly used as additives to oils and greases. Solid lubricants are also used in form of dry powder or as constituents of coatings.

Synthetic lubricants

Polyalphaolefins (PAO)

Polyalphaoleins are the most popular synthetic lubticant. PAO's chemical structure and properties are identical to those of mineral oils.

Polyalphaoleins (synthetic hydrocarbons) are manufactured by polymerization of hydrocarbon molecules (alphaoleins). The process occurs in reaction of ethylene gas in presence of a metallic catalyst.

Polyglycols (PAG)

Polyglycols are produced by oxidation of ethylene and propylene. The oxides are then polymerized resulting in formation of polyglycol.

Polyglycols are water soluble.

Polyglycols are characterized by very low coefficient of friction. They are also able to withstand high pressures without EP (extreme pressure) additives.

Ester oils

Ester oils are produced by reaction of acids and alcohols with water.

Ester oils are characterized by very good high temperature and low temperature resistance.

Silicones

Silicones are a group of inorganic polymers, molecules of which represent a backbone structure built from repeated chemical units (monomers) containing Si=O moieties. Two organic groups are attached to each Si=O moiety: eg. methyl+methyl ($(CH_3)_2$), methyl+phenyl ($CH_3 + C_6H_5$), phenyl+phenyl ($(C_6H_5)_2$).

The most popular silicone is polydimethylsiloxane (PDMS). Its monomer is $(CH_3)_2SiO$. PDMS is produced from silicon and methylchloride.

Other examples of silicones are polymethylphenylsiloxane and polydiphenylsiloxane.

Viscosity of silicones depends on the length of the polymer molecules and on the degere of their cross-linking. Short non-cross-linked molecules make fluid silicone. Long cross-linked molecules result in elastomer silicone.

Silicone lubricants (oils and greases) are characterized by broad temperature range: -100ºF to +570ºF (-73ºC to 300ºC).

Vegetable lubricants

Vegetable lubricants are based on soybean, corn, castor, canola, cotton seed and rape seed oils.Vegetable oils are environmentally friendly alternative to mineral oils since they are biodegradable. Lubrication properties of vegetable base oils are identical to those of mineral oils.The main disadvantages of vegetable lubricants are their low oxidation and temperature stabilities.

Animal lubricants

Animal lubricants are produced from the animals fat. There are two main animal fats: hard fats (stearin) and soft fats (lard). Animal fats are mainly used for manufacturing greases.

Classification of lubricants by application

Engine oils

Gear oils

Hydraulic oils

Cutting fluids (coolants)

Way lubricants

Compressor oils

Quenching and heat transfer oils

Rust protection oils

Transformer oils (insulating oils)

Turbine oils

Chain lubricants

Wire rope lubricants

Classification of lubricants by additives

Extreme pressure (EP)

Anti-wear (AW)

Friction modifiers

Corrosion inhibitors

Anti-oxidants

Dispersants

Detergents

Compounded

Anti-foaming agents

Pour point depressant

Hydraulic oil 68

Fig.3.5.4 hydraulic Oil

SAE 10W is equivalent to ISO 32, SAE 20 is equivalent to ISO 46 and 68, and SAE 30 is equivalent to ISO 100. As you can see, there is a bit of a difference between ISO 68 and SAE 30. The viscosity of the fluid largely determines the oil temperatures within which the hydraulic system can safely operate.

Table 3.5.4 Property of Hydraulic Oil

Hydraulic oil ISO 68				
Mineral based hydraulic oil				
Property	Value in metric unit		Value in US unit	
Density at 60°F (15.6°C)	0.880 *10^3	kg/m^3	54.9	lb/ft^3
Kinematic viscosity at 104°F (40°C)	68.0	cSt	68.0	cSt
Kinematic viscosity at 212°F (100°C)	10.2	cSt	10.2	cSt
Viscosity index	135		135	
Flash point	204	°C	400	°F
Pour Point	-40	°C	-40	°F
Aniline Point	88	°C	190	°F
Color	max.7.0		max.7.0	

5. Reservoir

Reservoirs are basically storage tanks for the hydraulic oil. The functions of a hydraulic reservoir are,

a. To act as a storage tank.

b. To provide heat exchange, thus cooling the oil.

c. To allow entrained air to escape from fluid.

d. To allow fluid contaminations to settle down.

e. To make-up any leakages in the system.

f. To provide filling point for the system.

The reservoir design should be optimum. A smaller size reservoir then required causes problems like overheating, increased contamination, higher wear and tear. An over sized reservoir will increase the cost of tank and longer warming period.

4. DESIGN CONSIDERATION

4.1 Material Selection

To prepare any machine part, the type of material should be properly selected, considering design, safety. The selection of material for engineering application is given

by the following factors:-

1) Availability of materials

2) Suitability of the material for the required components.

3) Suitability of the material for the required components.

4) Cost of the materials.

The machine is basically made up of mild steel. The reasons for the selection are Mild steel is readily available in market. It is economical to use and is available in standard sizes. It has good mechanical properties i.e. it is easily machinable. It has moderate factor of safety, because factor of safety results in unnecessary wastage of material and heavy selection.

4.2 Design Constraints

1. Should consume less space, less energy and have less weight *(Functionalconstraints)*
2. Operation of the machinery should be safe for the people involved with *(Safety constraints)*
3. Production of components ,purchase of components, assembly, transport, processes etc to be taken care of *(Manufacturing constraints)*
4. Should be cost effective – construction cost/operation cost *(Economic constraints)*
5. Should save time for the persons involved with *(Time constraints)*
6. Should have high quality and should be reliable*(Quality constraints)*
7. Should have a very good appeal*(Aesthetic constraint)*
8. Should be environment friendly*(Environment constraint)*
9. Should be user friendly*(Ergonomic constraint)*
10. Should be as per regulations and should avoid usage of cheaper materials *(Legal & Ethical constraints)*

4.3 DESIGN OF LEVER

Material : Mild steel **C45** …………PSG Design Data book Pg. No. 1.10

Property of C45

Syt=380N/mm^{2}.. ……………………...PSG Design Data book Pg. No. 1.12

i. e. $\underline{\sigma b}$ =380N/mm^2

Following fig. Shows the cross section of lever for that purpose we have selected the square pipe having dimension 20mm x 20 mm

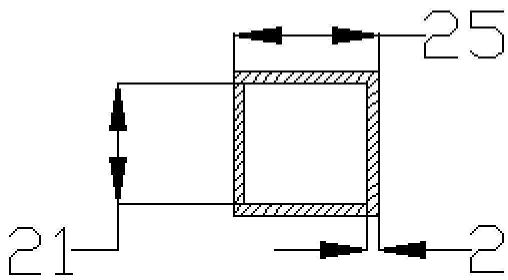

Fig.4.3.1 cross section of lever

A_1= 20 X 20=400 mm^2

A_2= 16 X 16=256 mm^2

$I=[I_{G1}+A_1h_1^2]-[I_{G2}+A_2h_2^2]$

$I_{G1}=bd^3/12$

$=20x\ 20^3/12$

$=13333.33$

$I_{G2}=bd^3/12$

$=16 \times 16^3/12$

$=5461.33$

$Y_1=20/2$

$=10mm$

$Y_2=16/2$

$=8$ mm

Y=A1Y1-A2Y2/(A1-A2)

=(625X12.5)-(441X10.5)/(625-441)

= 17.29

h1=(17.29-12.5)=4.79mm

h2=(17.29 -10.5)=6.79mm

Moment of inertia $I= [I_{G1}+A1 \times h1^2]- [I_{G2}+A_2h_2^2]$

$=[32552.08+625 \times 4.79^2]- [16206.75+441 \times 6.79^2]$

$=46892.14-36538.6$

$=10353.54\ mm^4$

This lever subjected to following type of loading

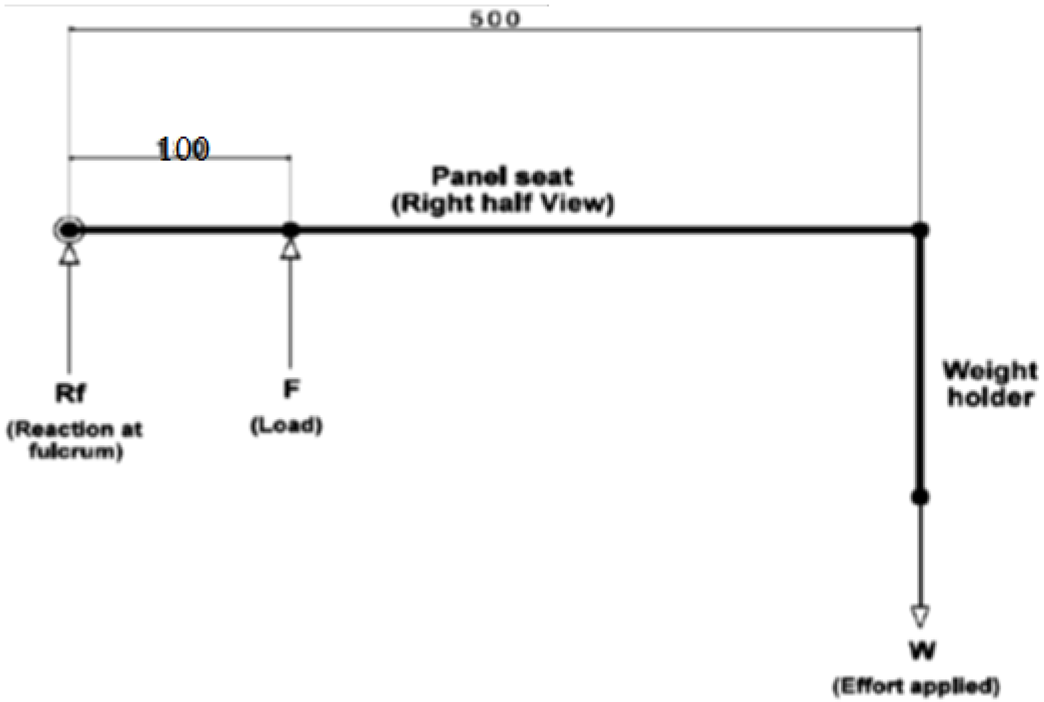

Fig.4.3.2 load on lever

Assuming max. effort applied by dead weight is of 2 kg at extreme position

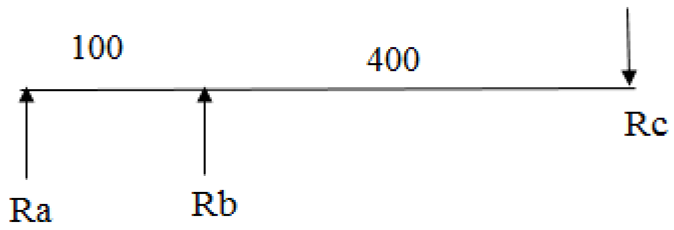

Fig.4.3.3 loading diagram of lever

ΣFy=0

Ra+Rb-(2 x9.81)=0

Ra+Rb=19.62 N

ΣM@A=0

-100 x Rb+Rc(500)=0

-100 x Rb+19.62(500)=0

Rb=98.1 N

Ra=-78.48 N

Bending moment

M@A=0

M@B= -(-78.48 x 100)=7848Nmm

M@C=0

Max. bending moment at B=7848Nmm

Flexure formula for bending is given as,

$$\frac{M}{I} = \frac{\sigma b}{y}$$

Ymax=25/2

Y=12.5

$$\frac{7848}{10353.54} = \frac{\sigma b}{12.5}$$

$\sigma b = 9.47\ Nmm^2 < 380 N/mm^2$

Hence our design is safe against bending failure.

1.4 DESIGN OF CYLINDER ROD

Material : Mild steel **C45** …………PSG Design Data book Pg. No. 1.10

Property of C45

Syt=380N/mm^{2}.. ……………………...PSG Design Data book Pg. No. 1.12

i. e. σb =380N/mm^2

Following fig. Shows the cross section of cylinder rod.

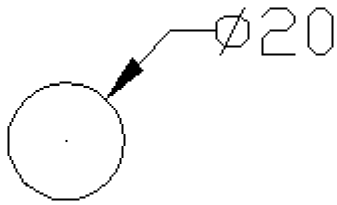

Fig.1.4 Cross section of cylinder rod

Flexure formula for bending is given as,

$$\frac{M}{I} = \frac{\sigma b}{y}$$

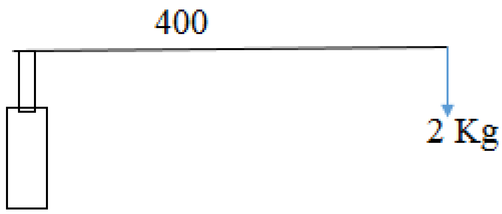

Fig.1.5 load on cylinder rod

Moment=M=400 x 2 x 9.81

M=7848Nmm

Ymax=20/2

Y=10

I=$\pi d^4/64$

I=7850mm^4

$$\frac{7848}{7850} = \frac{\sigma b}{10}$$

σb =9.99 Nmm^2 < 380

N/mm^2 Hence our design of cylinder rod is safe against bending failure.

5. SCHEME OF IMPLEMENTATION / ACTION PLAN

The proposed work concentrates on Design of mechanism for suitable operation of climbing obstacle. The work regarding this will be divided in the following phases.

Phase I: Information Gathering -Literature Survey.

Phase II: Gap Analysis, Project Formulation.

Phase III: Objective, Problem statement definition.

Phase IV: Design of component of tracking system

Phase V: Brought out Material

Phase VI: Manufacturing of project.

Phase VII: Test & result discussion

The phase wise scheme of implementation is as follows,

Table 5.1 Phase Wise Scheme of Implementation

Period	Phase I	Phase II	Phase III	Phase IV	Phase V	Phase VI	Phase VII
July -20							
Sept-20							
Oct-20							
Nov-20							
Dec-20							
Jan-21							
Feb-21							
March-21							

6. MANUFACTURING PROCESSES

6.1 FRAME

Raw material: c channel

Rectangular Hollow Pipe

Table 6.1 Process sheet of frame

Sr. No.	Process	Machine tool	Time	Cost
01	C channel cutting	Grinding cutter	10min.	100
02	Rectangular Hollow Pipe	Grinding cutter	10 min.	100
03	Holes on pipe	Drilling machine	10 min.	50
04	Fabrication of channel and hollow pipe	Arc welding	20 min.	200
Total			50 min.	450

6.2 Solar Plate Loaded Lever

Raw material: square hollow pipe

1’’ angle

Table 6.2 Process sheet of solar plate loaded lever

Sr. No.	Process	Machine tool	Time	Cost

01	Square pipe cutting	Grinding cutter	10 min.	50
02	Holes on pipe	Drilling machine	10 min.	50
03	Slot on pipe	Grinding cutter	10 min.	50
04	1'' angle cutting	Grinding cutter	20 min.	100
05	Fabrication of 1" angle to form frame for solar plate	Arc welding	15 min.	75
06	holes on frame of solar panel	Drilling machine	10 min.	50
07	Attachment of solar plate frame to lever	Arc welding	10 min.	50
08	Attachment of square washer to lever	Arc welding	10 min.	50
Total			95 min.	475

6.3 Cylinder Assembly

Raw material: Spring holder

Table 6.3 Process sheet of cylinder assembly

Sr. No.	Process	M/c tool	Time	Cost
01	Fabrication of washer to cylinder	Arc welding	10 min.	50
02	plate cutting for bottom of cylinder	Grinding cutter	20min.	100
03	Holes on bottom plate	Drilling Machine	10 min.	50
04	Fabrication of hinge, bottom plate and rec. pipe of frame	Arc welding	20 min.	100
Total			60 min.	300

6.4 Reservoir

Raw material: Circular pipe, plate and disc

Table 6.4 Process sheet of Reservoir

Sr. No.	Process	Machine tool	Time	Cost
01	Pipe cutting	Grinding cutter	10 min.	50
02	plate cutting for bottom of reservoir	Grinding cutter	20min.	100
03	Holes on disc	Drilling Machine	20 min.	100
04	Fabrication of nipple, bottom plate, cap nut and disc to pipe	Arc welding	20 min.	100
05	fabrication of reservoir to frame	Arc welding	10 min.	50
Total			80min.	400

6.5 Dead weight

Raw material: plate and shaft

Table 6.5 Process sheet of cylinder assembly

Sr. No.	Process	Machine tool	Time	Cost
01	Shaft cutting	Grinding cutter	10 min.	50
02	1’’ width plate cutting	Grinding cutter	5min.	20
03	Holes on above plate	Drilling machine	5 min	20
03	Fabrication of plate to shaft	Arc welding	10 min.	50
Total			30min.	140

7 COST ESTIMATION

7.1 BROUGHT OUT MATERIAL COST

Table 7.1 Brought Out Material Cost

Sr. No.	Name of component	Specification	QTY.	Cost
01	cylinder	30 x 150	01	2500
02	C channel	100 mm width	12 feet	400
03	Rectangular hollow pipe	50 x 20	5 feet	200
04	Square hollow pipe	1’’	5 feet	100
05	Washer	15 mm bore	02	40
06	plate	3 mm thick	01	150
07	1” width plate	1’’ width	2 feet	50
08	1” angle	1” width	8 feet	150
09	Flow control valve	10mm pipe size	01	250
10	Non return valve	10mm pipe size	01	250
11	Nipple	10mm pipe size	03	150
12	Circular pipe	70 mm dia.	1 feet	100
13	Disc	4” dia.	01	30
14	Reservoir cap nut	0.75”	01	80
15	Solar plate	10 W	01	1000
16	Battery	6 V	01	500
17	Hydraulic oil	SAE 68	2 litr	200
18	Other (nut Bolt, clip)			200
TOTAL				6350

7.2 MANUFACTURING COST

Table 7.2 Manufacturing Cost

Sr. No.	Manufacturing Component	Time	Cost
01	Frame	50 min.	450
02	Lever	95 min.	475
03	Cylinder assembly	60 min.	300
04	Reservoir	80min.	400
05	Dead weight	30min.	140
TOTAL		6 hr. 15 min.	1765

BROUGHT OUT MATERIAL COST =6350

MANUFACTURING COST =1765

TRANSPORTATION COST =485

TOTAL COST =8600/-

8.RESULT AND DISCUSSION

For the tracking of duration 10 hr. following things we have observed,

From the period 3 PM to 6 PM

Table.8.1 Performance of solar plate

Sr. No.	Name of arrangement	Time require to charge 6 V battery from 5.5 volt
01	Solar plate without tracking	60 min. approx..
02	Solar plate with tracking	48 min. approx..

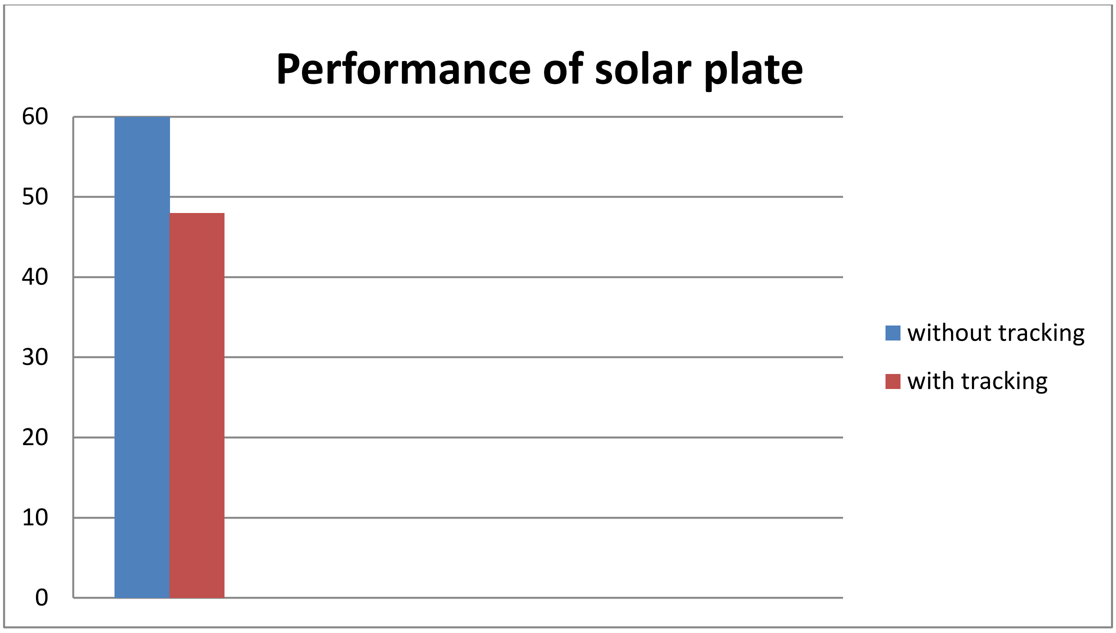

Fig..8.1 Performance of solar plate

From the above chart it is clear that there is definitely time reduction take place for charging the battery by using tracking of solar plate. Further study is required to get the information related to which time interval it get maximum performance. Approximately we taken duration 3 pm to 6pm at which solar plate tilted perpendicular to solar rays direction mostly.

9. OUTCOMES OF PROJECT

9.1 Advantages

1. Hydraulic solar tracker is easy to design and manufacture compare to other tracker system.
2. Increased reliability of hydraulic control system compared with other solar tracker.
3. Hydraulic solar trackers generate more energy than other tracking system like electric solar tracker.
4. Lubrication of system is not necessary due to less moving parts.
5. Compare to other tracking system hydraulic tracking system cost is less. Important reduction of whole life maintenance cost of solar tracker

9.2 Disadvantages

1.Required manual power to pump the oil in cylinder.

10.CONCLUSION

It is observed that the designed mechanical tracking system is a system, which consumes no energy for operation and contributing towards increasing the productivity of the solar panels. In view of increasing demand for the electrical power, this tracking system can contribute a little in the fulfilment this demand.

FUTURE SCOPE

In future we want to remove the drawback of system is that it required manual power to pump the oil in cylinder. We want to do return application automatically by some less energy consumable device. So that there is no necessity to set solar panel at initial position during morning period.

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