UNDERGROUND HYDRAULIC CAR PARKING SYSTEM

A Project Report

Submitted in partial fulfillment for the

Award of the degree of

BACHELOR OF TECHNOLOGY

In

MECHANICAL ENGINEERING

Submitted by

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2015-2016

DECLARATION

We hereby declare that this submission is our own work to the best of our knowledge and belief, it contains no material previously or written by any other person nor material which to a substantial extent has been accepted for the award of any degree or diploma of the university or other institute of higher learning, except where due acknowledgment and references has been made in the text.

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CERTIFICATE

This is to certify that project report entitled "**UNDERGROUND HYDRAULIC CAR PARKING SYSTEM"** which is being submitted by **Nitesh Raj Srivastava, Sandeep Maurya, Sandip Sharma, Ajay Kumar Sharma, Akhilanand Yadav** in partial fulfillment for the requirement for the award of the degree of Bachelor of Technology in department of Mechanical Engineering of Ideal Institute of Management and Technology, Ghaziabad (Dr. A.P.J. Abdul Kalam Technical University). They have worked under the guidance of **Mr. K. K. Gupta** (Asst. Prof., Department of Mechanical Engineering) and have fulfilled the requirement for the submission of the project. The matter embodied in this thesis is original and has not been submitted for the award of any other degree.

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ACKNOWLEDGEMENT

First of all I would like to thank the almighty God for listening my prayers and giving me strength to complete the dissertation work.

I would like to express a deep sense of gratitude and thanks profusely to **Mr. K. K. Gupta** Assistant Professor, Department of Mechanical Engineering Ideal Institute of Management and Technology, Ghaziabad (U.P.), my guides and mentors, without the wise counsel and able guidance, it would have been impossible to complete the dissertation in this manner.

I am also grateful to Ideal Institute of Management and Technology, Ghaziabad, especially Department of Mechanical Engineering for extending all facilities and cooperation to me for carrying out this work. I shall be failing in my duty if I don't acknowledge the support received from **Mr. K. K. Gupta**, Department of Mechanical Engineering, IIMT, Ghaziabad (U.P.) in order to complete my work.

I must also express my deep regards and thanks to my parents for supporting and boosting my morale so that I can overcome my hard times. I also want to thanks my senior & my friend **Mr. Ashutosh Verma and Abhishek Maurya** Department of Mechanical Engineering, IIT, Ghaziabad (U.P.). There are two person helped me a lot in order to complete my thesis work.

I finally pray that Almighty fulfils the aspirations of all the people who have been a part of this journey and those who will be a part of future journeys.

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ABSTRACT

Underground Hydraulic Car Parking System is a mechanical device that multiplies parking capacity inside a parking lot. This parking system is generally powered by electric motors or hydraulic pumps that move vehicles into a storage position. The project is based on Pascal's law which is simple in working and due to incompressible fluid used as transmitting medium for pressure, it is noiseless.

Our Multi- storey car park systems are less expensive per parking slot, since they tend to require less building volume and less ground area than a conventional facility with the same capacity. Underground Car parking systems garage systems reduce pollution because cars are not running or turning around while drivers look for parking spaces.

The limitation of this project is that, it can only be used for domestic purpose in urban areas. The cost of project is not much more, so it can utilize by rich family as well as middle class family. Finally an Underground Hydraulic Car Parking System is a way to parking a car or multiple cars in a limited space. It also provides security and safety of cars in low cost of parking.

NOMENCLATURE

Symbol	Description
D	Dia. of master cylinder
A	Cross-section area of master cylinder
d	Bore of pillar cylinder
a	Cross-section area of pillar cylinder
a_e	Equivalent cross-section area of pillar cylinder
L	Stroke length of master cylinder
l	Stroke length of pillar cylinder
T_{ps}	Torque produced at pinion shaft
T_{in}	Torque produced at gearbox input
F_{in}	Force produced by motor
r_m	Radius of motor gear
d_g	Effective dia. of gear
P_m	Motor power
f	Force exerted on the pillar piston
F	Master cylinder force
W	Work done by master cylinder
d_p	Dia. of pinion
L_e	Effective distance between pinion and motor shaft
Nm	Newton meter
Hp	Horsepower
rpm	Revolution per minute
ΔP	Hydrostatic pressure
ρ	Density of fluid
g	Acceleration due to gravity
Δh	Fluid depth from the surface
IMA	Mechanical advantage

TABLE OF CONTENT

LIST OF FIGURE

LIST OF TABLE

CHAPTER-1

INTRODUCTION

These days what is the common question arise in all big metropolitan cities? And Question is, I need my own conveyance for daily routine work but I am not sure where to park this conveyance?

Less space for parking is common cause for neighbors fight.

Basically, we are trying to sort this problem by construct our final year project. This innovative, space-saving car lift & storage system doubles your parking space by putting your car underground. Whether you've got limited square footage or simply prefer to store your vehicle safely, our project is electro-hydraulic mechanism lowers or lifts your vehicle with the touch of a button as shown in fig. 1.1.

Fig. 1.1 Electro-Hydraulic Parking System

1.1 AIM OF OUR PROJECT

Here, we want facilitate for easy car parking in less space i.e. our main aim is to reduce the parking space for multiple cars at a single place.

By providing multiple floors at one place which can move up & down by hydraulic system as shown in fig. 1.1. In multiple floor system, one floor can be at ground level & other (two or three floors) may be underground or may be first floor or second floor rather providing double or triple space at ground level for two or three cars.

For example, for parking of two cars at one place, we make two floors in which one which one floor is the ground floor & the other is below the ground.

These floors can move up & down which helps to reduce the extra movement of the car for parking as shown in fig. 1.2.

Fig. 1.2 Two Car Parking System

1.2 INSPIRATION TO CONSTRUCT THIS PROJECT

Delhi Businessman, 57, Dies After Neighbours Beat Him in Row Over Parking

A 57-year-old businessman died on Sunday after he was allegedly thrashed inside his home by neighbors and property dealers over a parking row in Central Delhi's West Patel Nagar area. The victim Rajinder Bhatia owned a three-storey building and sold his second floor to a man named Karthik Bhatia was with his family when Karthik and two property dealers came to visit him to discuss an unresolved parking dispute.

Sleuths said Karthik had rented the second floor to another family, who had a tiff with Bhatia's son Mokshit over car parking on Saturday night. Karthik, along with his mother and local property dealers, came to meet Bhatia to resolve the squabble on Sunday. Unfortunately, the discussion turned ugly and Bhatia was manhandled by the visitors as shown in fig. 1.3 and 1.4.

Fig. 1.3 Car Parking Accident

Fig. 1.4 Victim Rajinder Bhatia Died of a Suspected Heart Attack on the Way to Hospital

Bhatia's wife and son Mokshit were unable to save him from the angry men. He was declared brought dead by doctors at the BLK Hospital in Rajendra Palace.

Investigators suspect that the victim might have suffered a cardiac arrest that led to his death, as there was no injury marks on his body.
According to the victim's family, Karthik started beating Bhatia as soon as he entered their room.
"The moment we opened the door Karthik started beating my father. He had come with local property dealers, his mother and some other people. They hit father on his chest and groin. Karthik's mother had threatened us in the past," Mokshit claimed. Initially, the row over parking was solved between the two sides at the intervention of their families.

"On Sunday morning, Bhatia was sitting in his home when around 11.25am, Karthik along with his mother came to meet him. They started abusing each other and after around 10 minutes, property dealers Ashok Oberoi and Dharmendra along with 10 others also reached there," a police officer said, adding that matters worsened thereafter.

"During the clash, the victim suddenly fell on the ground. All the alleged persons fled and the victim was taken to a nearby hospital where doctors declared him brought dead," the police officer added.

Although other neighbors' witnessed the scuffle, none tried to pacify the two sides. The investigators ruled out use of any weapon during the scuffle.

Additional Commissioner of Police (Central) Alok Kumar said a case was registered on the complaint of the victim's other son Mohit Bhatia.

"We are yet to confirm the reason behind Bhatia's death as he was only slapped and pushed by the other party. We have arrested Karthik and Ashok Oberoi. All the accused have been booked under Section 304 (culpable homicide not amounting to murder) of the IPC," he added.

1.3 FINDING PARKING SPACE IS A DAILY STRUGGLE

In the congested lanes of a West Delhi neighborhood, finding space to park a vehicle is a daily struggle which has led to small tiffs among residents many times.

But on Sunday morning one such scuffle led to the death of a businessman, allegedly by the hand of someone he had sold a floor of his three-storey building.

Locals said that the issue of parking has increased over the last few years as more house owners have started building multistory houses.

Many neighbors' noted that while the number of people living in the area has increased as house-owners started giving their floors up for rent, the space for parking remains the same.

The issue of parking space has lead to verbal spats among neighbors', but it had never before lead to a violent incident in the area.

"As West Delhi became a popular destination for students and migrants, people here started building multi storey buildings. Everyone here has at least a three floor house but nobody cares about the space for parking as shown in fig. 1.5. You can construct one floor over another but vehicles can only be parked on the road. Parking is a daily problem for us," a resident said.

Fig. 1.5 Finding Parking Space in daily Life [1]

Many people said that they overlook the problems related to parking as they know there is no solution in sight.

"What can be done? There are vehicles parked on both sides of the roads and in front of our homes but still there is lack of space. There is no solution to it so we just let it be," said Deepak, a neighbor of Rajendra Bhatia, who was allegedly killed on Sunday after he had a tiff over the parking space. Neighbours describe Bhatia as a cordial and silent man who mostly kept to himself. "He was very nice, cordial, and non controversial. We never saw him fighting with anyone in the area. This is a shocking incident as killing someone over lack of parking space is bizarre. It only shows how aggressive people have become," a neighbor said.

1.4 FRUSTRATION AND EGO LEAD TO DEATH

Mail-Today spoke to Sameer Malhotra, director, Mental Health & Behavioural Sciences at Max Healthcare.

He said: "It has become common to hear violent incidents happening over petty matters. What leads a man or woman to become violent in the heat of moment may differ from case to case, but it is primarily happening due to frustration and fragile ego. "People have low frustration level these days which leads them into committing avoidable mistakes.

"While every case of violence is different and there can be many reasons behind why a person loses temper over small issues like parking space, driving on roads et cetera, but the lack of tolerance among people is one of the main causes.

"The general level of stress has increased in our day-today life and people suffer from high stress levels, especially in metropolitan cities.

"But despite all these factors, our coping abilities have not developed. We are seeing a rise in number of people suffering from high frustration levels. At times, people don't think about the results of their action while they are committing an act.

"People have become impatient and want everything as per their own wishes. Due to their fragile egos, they feel hurt at even small incidents. So, a small tiff over parking space or any other issue can hurt their sense of self if things do not happen as they want."

1.4.1 FROM THE ABOVE INCIDENT AND LESS SPACE FOR PARKING VEHICLE INSPIRED US TO CONSTRUCT THIS PROJECT

These days what is the common question arise in all big metropolitan cities? And Question is, I need my own conveyance for daily routine work but I am not sure where to park this conveyance?

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Fig. 1.6 Underground Hydraulic Car Parking System

Innovative, space-saving car lift & storage system doubles your parking space by putting your car underground. Whether you've got limited square footage or simply prefer to store your vehicle safely, our project is electro-hydraulic mechanism lowers or lifts your vehicle with the touch of a button as shown in fig. 1.6.

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CHAPTER- 2

PRINCIPLE OF PROJECT

2.1 PASCAL'S LAW

Pascal's law or the principle of transmission of fluid-pressure (also *Pascal's Principle*) is a principle in fluid mechanics that states that pressure exerted anywhere in a confined incompressible fluid is transmitted equally in all directions throughout the fluid such that the pressure variations (initial differences) remain the same. The law was established by French mathematician Blaise Pascal as shown in fig. 2.1.

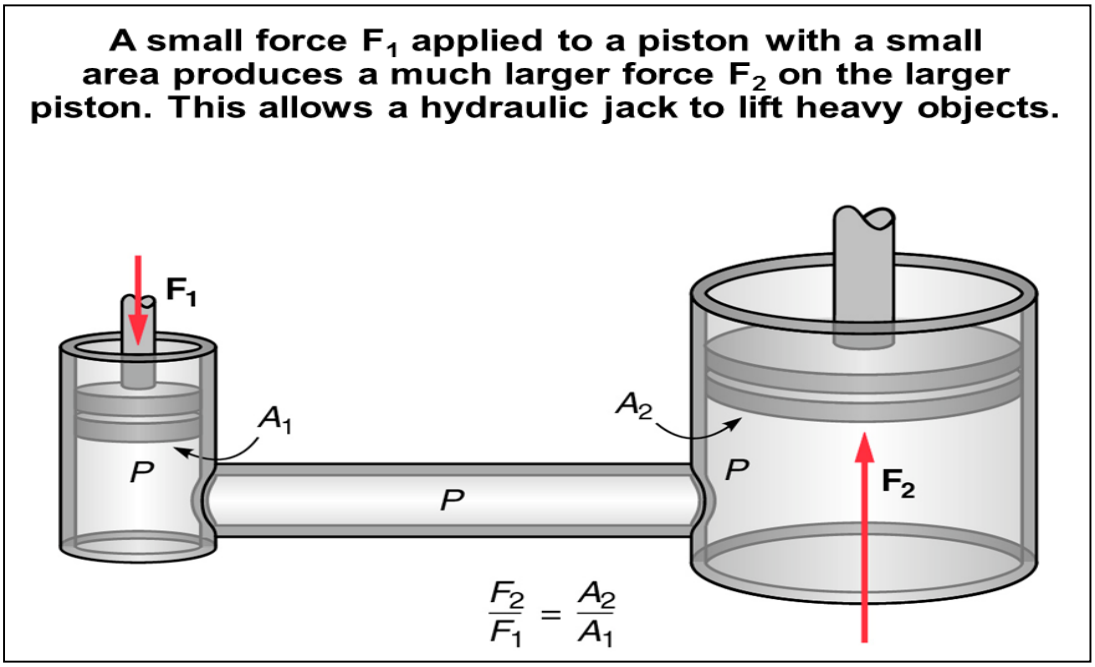

Fig. 2.1 Study of Pascal's Law [1]

This principle is stated mathematically as:

$$\Delta P = \rho g(\Delta h)$$

ΔP is the hydrostatic pressure (given in Pascal's in the SI system), or the difference in pressure at two points within a fluid column, due to the weight of the fluid; ρ is the fluid density (in kilograms per cubic meter in the SI system); g is acceleration due to

gravity (normally using the sea level acceleration due to Earth's gravity, in SI in metres per second squared);

Δh is the height of fluid above the point of measurement, or the difference in elevation between the two points within the fluid column (in metres in SI).

The intuitive explanation of this formula is that the change in pressure between two elevations is due to the weight of the fluid between the elevations. A more correct interpretation, though, is that the pressure change is caused by the change of potential energy per unit volume of the liquid due to the existence of the gravitational field. Note that the variation with height does not depend on any additional pressures. Therefore, Pascal's law can be interpreted as saying that any change in pressure applied at any given point of the fluid is transmitted undiminished throughout the fluid.

2.2 PROJECT BASED ON PASCAL'S PRINCIPLE AND HYDRAULICS

Hydraulic systems use an 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.

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.

For example, in the figure below, P3 would be the highest value of the three pressure readings, because it has the highest level of fluid above it .

If the above container had an increase in overall pressure, that same added pressure would affect each of the gauges (and the liquid throughout) the same. For example P1, P2, P3 were originally 1, 3, 5 units of pressure, and 5 units of pressure were added to the system; the new readings would be 6, 8, and 10 as shown in fig. 2.2.

Applied to a more complex system below, such as a hydraulic car lift, Pascal's law

allows forces to be multiplied. The cylinder on the left shows a cross-section area of 1 square inch, while the cylinder on the right shows a cross-section area of 10 square inches. The cylinder on the left has a weight (force) on 1 pound acting downward on the piston, which lowers the fluid 10 inches. As a result of this force, the piston on the right lifts a 10 pound weight a distance of 1 inch.

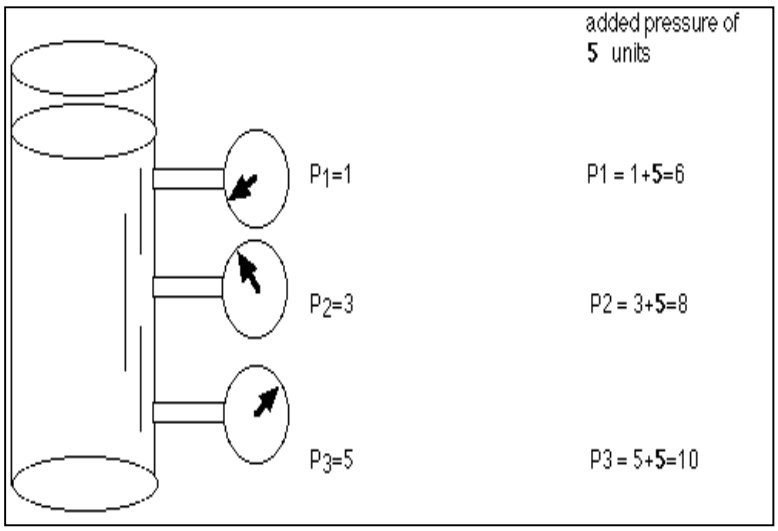

Fig. 2.2 Pascal's Principle

The 1 pound load on the 1 square inch area causes an increase in pressure on the fluid in the system. This pressure is distributed equally throughout and acts on every square inch of the 10 square inch area of the large piston. As a result, the larger piston lifts up a 10 pound weight. The larger the cross-section area of the second piston, the larger the mechanical advantage, and the more weight it lifts as shown in fig. 2.3.

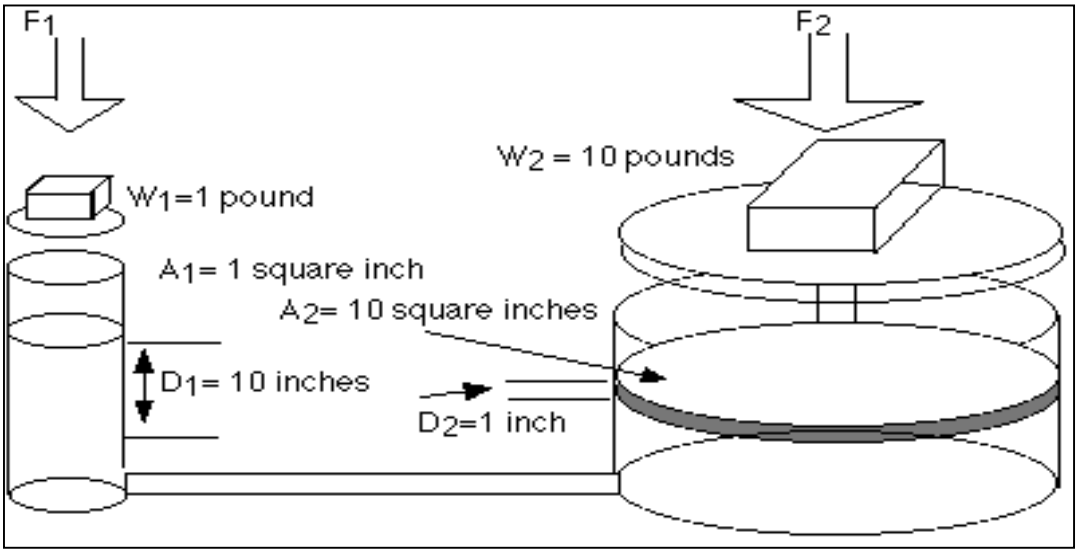

Fig. 2.3 Verification of Pascal's law

The formulas that relate to this are shown below:

P1 = P2 (since the pressures are equal throughout).

Since pressure equals force per unit area, then it follows that

F1/A1 = F2/A2

It can be shown by substitution that the values shown above are correct,

1 pound / 1 square inches = 10 pounds / 10 square inches

Because the volume of fluid pushed down on the left side equals the volume of fluid that is lifted up on the right side, the following formula is also true.

V1 = V2

by substitution,

A1 D1 = A2 D2

- **A** = cross sectional area
- **D** = the distance moved

or

A1/A2= D2/D1

This system can be thought of as a simple machine (lever), since force is multiplied. The mechanical advantage can be found by rearranging terms in the above equation to

Mechanical Advantage (IMA) = D1/D2 = A2/A1

For the sample problem above, the IMA would be 10:1 (10 inches/ 1 inch or 10 square inches / 1 square inch).

Given these simple formulas, try to answer the questions below.

2.3 EXPLANATION

If a U-tube is filled with water and pistons are placed at each end, pressure exerted against the left piston will be transmitted throughout the liquid and against the bottom

of the right piston. (The pistons are simply "plugs" that can slide freely but snugly inside the tube.) The pressure that the left piston exerts against the water will be exactly equal to the pressure the water exerts against the right piston.

Suppose the tube on the right side is made wider and a piston of a larger area is used; for example, the piston on the right has 50 times the area of the piston on the left. If a 1 N load is placed on the left piston, an additional pressure due to the weight of the load is transmitted throughout the liquid and up against the larger piston. The difference between force and pressure is important: the additional pressure is exerted against the entire area of the larger piston. Since there is 50 times the area, 50 times as much force is exerted on the larger piston. Thus, the larger piston will support a 50 N load - fifty times the load on the smaller piston.

Forces can be multiplied using such a device. One Newton input produces 50 Newton output. By further increasing the area of the larger piston (or reducing the area of the smaller piston), forces can be multiplied, in principle, by any amount. Pascal's principle underlies the operation of the hydraulic press. The hydraulic press does not violate energy conservation, because a decrease in distance moved compensates for the increase in force. When the small piston is moved downward 10 centimeters, the large piston will be raised only one-fiftieth of this, or 0.2 centimeters. The input force multiplied by the distance moved by the smaller piston is equal to the output force multiplied by the distance moved by the larger piston; this is one more example of a simple machine operating on the same principle as a mechanical lever.

2.4 APPLICATIONS OF PASCAL'S LAW

Pascal's principle applies to all fluids, whether gases or liquids. A typical application of Pascal's principle for gases and liquids is the automobile lift seen in many service stations (the hydraulic jack). Increased air pressure produced by an air compressor is transmitted through the air to the surface of oil in an underground reservoir.

The oil, in turn, transmits the pressure to a piston, which lifts the automobile. The relatively low pressure that exerts the lifting force against the piston is about the same as the air pressure in automobile tires. Hydraulics is employed by modern devices

ranging from very small to enormous. For example, there are hydraulic pistons in almost all construction machines where heavy loads are involved.

2.5 LINE DIAGRAM OF UNDERGROUND HYDRAULIC CAR PARKING SYSTEM

We have designed an Underground Hydraulic Car Parking System which is shown as shown in fig. 2.4 by simple line diagram. Our project is based on Pascal's law where a master cylinder is used which supply pressurized fluid to four pillar-cylinders with the help of 4 ways connector. Pillar-cylinders lift the platform (platform with car to be lifted) which is mounted on these Pillars-cylinders.

To apply pressure on the master cylinder's fluid Rack and Pinion arrangement is used which are coupled with a DC motor with the help of spindle. This spindle mounted on two bearing and connects the DC motor and Pinion. DC motor run by DC supply which was supply by Step down transformer after rectification. Here rectifier converts the AC supply to DC supply and help to run DC motor. Two ways switch is provide to rotate the switch in Clockwise and Anticlockwise direction.

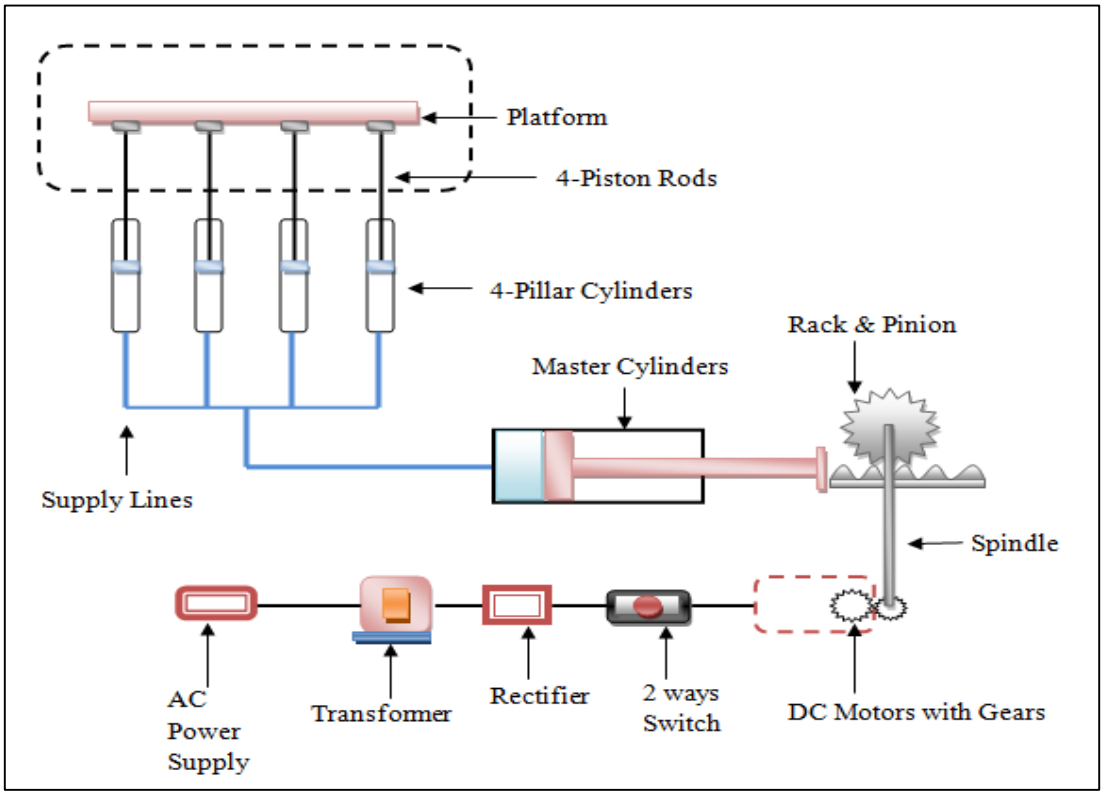

Fig. 2.4 Line Diagram of UHCPS

2.6 CALCULATIONS

To design the Underground Hydraulic Car Parking System (UHCPS) first we have to calculate the force required to drive the master cylinder's piston or to pressurize the fluid which further (pressurized fluid) supply to 4 pillar-cylinders and lift the platform on which a car is parked.

Thus to calculate the Force required to life the 4 pillar-cylinders which are hydraulic based, we will use here Pascal's law. Here we have assumed following input parameter to find the force required on master cylinder which further lift the pillar-cylinders. All the input parameters are shown in table 2.1.

Table: 2.1 Following Input parameter required to determination of Force on Master Cylinder:

S.No	Description	Parameters
1	Motor capacity	10 hp
2	Motor Rpm	1000rpm
3	Diameter of master cylinder (D)	0.15m
4	Cross-section area of master cylinder (A)	$0.01766m^2$
5	Bore of pillar cylinder (d)	0.04m
6	Diameter of pinion (d_p)	0.05m
7	Cross-section area of pillar cylinder (a)	$0.001256m^2$
8	Equivalent area of pillar cylinder (a_e)	4a ($0.005024m^2$)
9	Load lifted by pillar cylinder (f)	22.563 KN
10	Radius of motor gear	0.05m
11	Stroke length of pillar cylinder	5m
Following parameter need to be calculated :		
1	Stroke length of master cylinder	L
2	Torque produced at pinion shaft	T_{ps}

3	Torque produced at gearbox input or torque produced by motor	T_{in}
4	Force produced by motor	F_{in}
5	Force by master cylinder	F
6	Radius of bigger gear in the gearbox	r_g

Calculation:-

Volume of master cylinder = Volume of all pillar cylinder

$$A \times L = a_e \times l$$

$$0.01766 \times L = 0.005024 \times 4.572$$

L = 1.3m = 1300mm

Force required by the master cylinder piston (F):

$$F / A = f / a_e$$

$$F / 0.01766 = 22563 / 0.005024$$

F = 79311.81 N

Work done by master cylinder (W) = F x L

$$W = 79311.81 \times 1.3 = 103105.3 \text{ J}$$

W = 103.105 kJ

Torque produced at pinion shaft (T_{ps}) = F x d_p / 2

$$T_{ps} = 79311.81 \times 0.025$$

T_{ps} = 1982.79 Nm

Torque produced by motor (T_{in}):-

$$P_m = (2 \pi N T_{in}) / 60000$$

$$7.46 = (2 \pi \times 1000 \times T_{in}) / 60000$$

$$\mathbf{T_{in} = 71.237\ Nm}$$

Force produced by motor (F_{in}):-

$$T_{in} = F_{in} \times r_m$$

$$71.237 = F_{in} \times 0.025$$

$$\mathbf{F_{in} = 2849.48\ N}$$

Effective radius of gear (r_g):-

$$T_{ps} = F_{in} \times r_g$$

$$1982.79 = 2849.48 \times r_g$$

$$\mathbf{r_g = 0.6958m = 695.8mm}$$

Effective distance between pinion & motor shaft (L_e):-

$$L_e = r_g + r_m = 0.6958 + 0.025$$

$$\mathbf{L_e = 0.7208m = 720.8mm}$$

Table 2.2:- Calculated design parameters

We have calculated following design parameters for UHCPS:		
1	Stroke length of master cylinder (L)	1300mm
2	Torque produced at pinion shaft (T_{ps})	1982.79 Nm
3	Torque produced at gearbox input or torque produced by motor (T_{in})	71.237 Nm
4	Force produced by motor (F_{in})	2849.48 N
5	Force by master cylinder (F)	79311.81 N
6	Radius of bigger gear in the gearbox (r_g)	695.8mm

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CHAPTER-3

COMPONENTS & MATERIAL SELECTION

In this chapter the Components or Hardware required to fabricate the Underground Hydraulic Car Parking System (UHCPS) are given. This chapter also tabulated with detailed information of components with their specification, quantity and cost.

3.1 COMPONENTS REQUIREMENT

1. Slow speed Crouzet motor gear box
2. Rack and pinion gear
3. Sliding channel
4. Bearing 608
5. Bearing stand
6. Syringe
7. Syringe pipe
8. Sliding switch
9. Transformer
10. Metal and wooden body frame
11. Cut off switch
12. T-junction
13. Diodes
14. Glue Gun
15. Nuts and Bolts

Table 3.1 Component Requirement with Specification & Quantity

S. No.	Component	Specification (mm)	Quantity
1	Rack	100x20x20	1
2	Pinion	Φ45, 22 teeth	1
3	DC motor	12V/90mA	1
4	Gear Box	1000rpm-4rpm	1
5	Sliding channel	210x40x13	1
6	Bearing 608	Φ8, Φ22,7	1
7	Bearing Stand	Φ22, Φ30	1
8	Syringe	10ml	4
9	Master Cylinder Syringe	50ml	1
10	Syringe Pipe	Φ6	1
11	Sliding Switch	24V/100mA	1
12	Cut off Switch	24V/100mA	2
13	Transformer	220V/110V – 12V/90mA	1
14	T – Junction	5 pin junction	1
15	Wooden Block	480x325x225	1
(a)	Wooden Ply 1	5mm thickness	1
(b)	Wooden Ply 2	11mm thickness	1
16	Parking Box	190x120x70	1
17	Diode	24V/100mA	4
18	Glue Gun	500ml	1
19	Nut and Bolt (Fasteners)	70mm	4

3.2 COMPONENT DETAILS

3.2.1 SLOW SPEED CROUZET MOTOR GEAR BOX

The Crouzet DC mind Brushless motors represent a new generation of direct current brushless motors. They offer outstanding performance, more power, more precision and more functionality. With a mechanical power rating of up to 150 W, the DC mind

Brushless motor is the most powerful in its range, yet is the same size as the old 80 W version. So DC mind Brushless motors are suitable for the most demanding markets, in industry, valves and pumps, access control and the energy sector.

12VDC 4RPM CROUZET MOTOR W/GEARBOX

Powerful gear motor.10 RPM @ 12 Vdc / 90 mA (no-load). Operates on 4-15 Vdc. 3.6" x 2.36" x 2.24" overall dimensions. Crouzet motor and final drive shaft both extend from same side of plastic gearbox. 5/16" diameter flatted shaft is 0.9" long. 8" pigtail leads as shown in fig. 3.1.

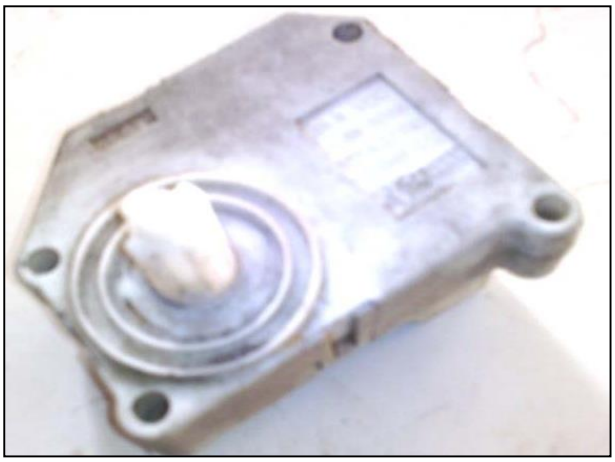

Fig. 3.1a DC Motor

The modern DC motor was invented by accident in 1873, when Zénobe Gramm connected a spinning dynamo to a second similar unit, driving it as a motor. The classic DC motor has a rotating armature in the form of an electromagnet. A rotary switch called a commutator reverses the direction of the electric current twice every cycle, to flow through the armature so that the poles of the electromagnet push and pull against the permanent magnets on the outside of the motor. As the poles of the armature electromagnet pass the poles of the permanent magnets, the commutator reverses the polarity of the armature electromagnet. During that instant of switching polarity, inertia keeps the classical motor going in the proper direction. (See the diagrams 3.1a , 3.1b).

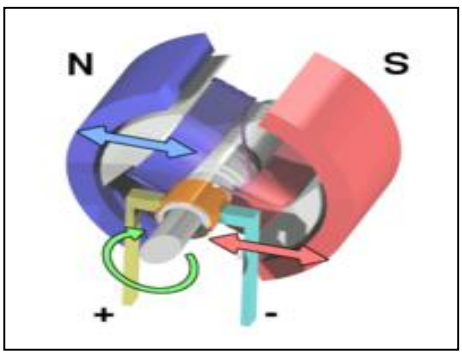

Fig. 3.1b Rotation of Armature w.r.t. Stator [1]

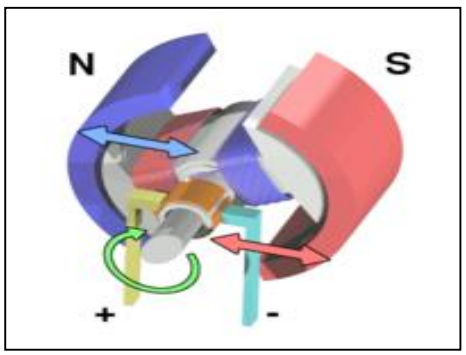

Fig. 3.1c Rotation of Armature w.r.t. Stator [1]

In a simple DC electric motor, When the coil is powered, a magnetic field is generated around the armature. The left side of the armature is pushed away from the left magnet and drawn toward the right, causing rotation.

The armature continues to rotate. When the armature becomes horizontally aligned, the commutator reverses the direction of current through the coil, reversing the magnetic field. The process then repeats.

3.2.2 RACK AND PINION

Rack and pinion is a type of linear actuator that comprises a pair of gears which convert rotational motion into linear motion. A circular gear called "the pinion" engages teeth on a linear "gear" bar called "the rack"; rotational motion applied to the pinion causes the rack to move, thereby translating the rotational motion of the pinion into the linear motion of the rack as shown in fig. 3.2. For example, in a rack railway, the rotation of a pinion mounted on a locomotive or a railcar engages a rack between the rails and pulls a train along a steep slope.

Fig. 3.2 Rotation of a Pinion in a Rack Railway [2]

3.2.3 SLIDING CHANNEL

Sliding channel gives the both forward and backward moment to the rack as shown in fig. 3.3.

Fig. 3.3 Sliding Channel

3.2.4 BEARING (608)

Have you ever wondered how things like inline skate wheels and electric motors spin so smoothly and quietly? The answer can be found in a neat little machine called a bearing. The bearing makes many of the machines we use every day possible. Without bearings, we would be constantly replacing parts that wore out from friction. In this article, we'll learn how bearings work, look at some different kinds of bearings and explain their common uses, and explore some other interesting uses of bearings show as shown in fig. 3.4 and 3.5.

Fig. 3.4 Bearing 608 [5]

Fig. 3.5 Tapered Roller Bearing from a Manual Transmission [5]

The concept behind a bearing is very simple: things roll better than they slide. The wheels on your car are like big bearings. If you had something like skis instead of wheels, your car would be a lot more difficult to push down the road.

That is because when things slide, the friction between them causes a force that tends to slow them down. But if the two surfaces can roll over each other, the friction is greatly reduced.

Bearings reduce friction by providing smooth metal balls or rollers, and a smooth inner and outer metal surface for the balls to roll against. These balls or rollers "bear" the load, allowing the device to spin smoothly.

The bearing above is like the one in a barstool. It is loaded purely in thrust, and the entire load comes from the weight of the person sitting on the stool.

The bearing below is like the one in the hub of your car wheel. This bearing has to support both a radial load and a thrust load. The radial load comes from the weight of the car, the thrust load comes from the cornering forces when you go around a turn.

3.2.4.1 Ball Bearing

Ball bearings, as shown as shown in fig. 3.6, are probably the most common type of bearing. They are found in everything from inline skates to hard drives. These bearings can handle both radial and thrust loads, and are usually found in applications where the load is relatively small.

In a ball bearing, the load is transmitted from the outer race to the ball, and from the ball to the inner race. Since the ball is a sphere, it only contacts the inner and outer race at a very small point, which helps it spin very smoothly. But it also means that there is not very much contact area holding that load, so if the bearing is overloaded, the balls can deform or squish, ruining the bearing.

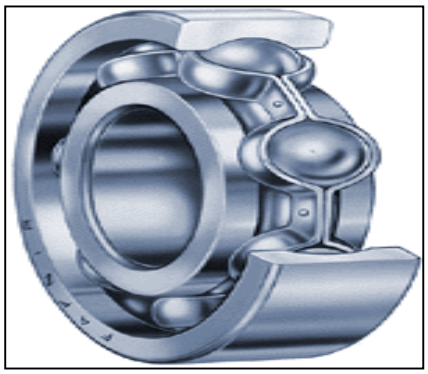

Fig. 3.6 Sectional View of Ball Bearing [5]

Fig. 3.7 hexagonal Nut

3.2.5. BEARING STAND

The function of bearing stand is to support the bearing. We will fit the ball bearing inside the hexagonal bolt as shown in fig. 3.7.

3.2.6. SYRINGE

A **syringe** is a simple pump consisting of a plunger that fits tightly in a tube as shown in fig. 3.8 and 3.9. The plunger can be pulled and pushed along inside a cylindrical

tube (called a barrel), allowing the syringe to take in and expel a liquid or gas through an orifice at the open end of the tube. The open end of the syringe may be fitted with a hypodermic needle, a nozzle, or tubing to help direct the flow into and out of the barrel. Syringes are often used to administer injections, insert intravenous drugs into the bloodstream, apply compounds such as glue or lubricant, and measure liquids.

Fig. 3.8 Syringe of 10mL [5]

Fig.3.9 Syringe of 60mL [5]

3.2.7. PIPE

A 6 mm diameter pipe is used for flow fluid. Pipe is used for the conveyance of drinking water, waste water, chemicals, heating fluid and cooling fluids, foodstuffs, ultra-pure liquids, slurries, gases, compressed air and vacuum system applications as shown in fig. 3.10.

Fig.3.10 Pipe [1]

3.2.8. SLIDING SWITCH

Slide switches as shown in fig. 3.11 are mechanical switches using a slider that moves (slides) from the open (off) position to the closed (on) position. They allow control over current flow in a circuit without having to manually cut or splice wire. This type of switch is best used for controlling current flow in small projects.

There are two common internal designs of slide switches. The most common design uses metal

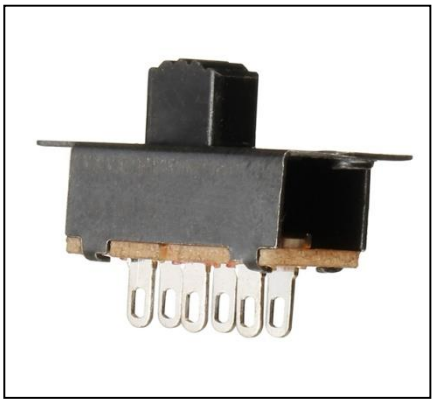

Fig. 3.11 Sliding Switch [1]

slides that make contact with the flat metal parts on the switch. As the slider is moved it causes the metal slide contacts to slide from one set of metal contacts to the other, actuating the switch. The second design uses a metal seesaw. The slider has a spring that pushes down on one side of the metal seesaw or the other. Slide switches are maintained-contact switches. Maintained-contact switches stay in one state until actuated into a new state and then remain in that state until acted upon once again.

3.2.9. TRANSFORMER

As a step-down unit, the transformer converts high-voltage, low-current power into low-voltage, high-current power as shown in fig. 3.12. The larger-gauge wire used in the secondary winding is necessary due to the increase in current. The primary winding, which doesn't have to conduct as much current, may be made of smaller-gauge wire.

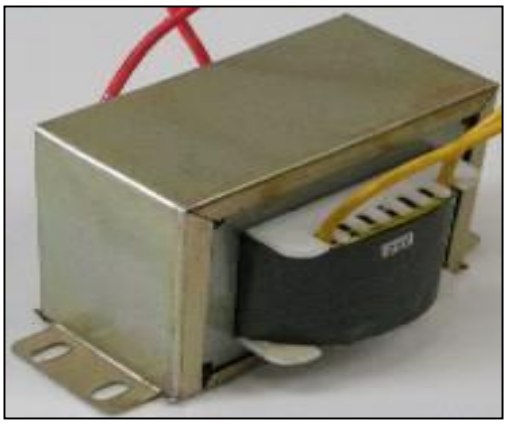

Fig. 3.12 Step down transformer

3.2.10. METAL AND WOODEN BODY FRAME

Body-on-frame is an automobile construction method mounting a separate body to a rigid frame that supports the drive train was the original method of building automobiles, and continues to this day. Originally frames were made of wood show as shown in fig. 3.13.

Fig.3.13 Wooden block

3.2.11. CUT OFF SWITCH

When used as an AC signal amplifier, the transistors Base biasing voltage is applied in such a way that it always operates within its "active" region, that is the linear part of the output characteristics curves are used as shown in fig. 3.14. However, both the

NPN & PNP type bipolar transistors can be made to operate as “ON/OFF” type solid state switch by biasing the transistors base differently to that of a signal amplifier.

Fig. 3.14 Cut off switch [5]

3.2.12. T-JUNCTION

Pipe networks are mainly used for transportation and supply of fluids and gases. These networks vary from fewer pipes to thousands of pipes (e.g. water supply network of a large city, see in figure 3.15). In addition to pipes, the network also consists of elbows, T-junctions, bends, contractions, expansions, valves, meters, pumps, turbines and many other components.

3.2.13. DIODE

Fig.3.15 T-Junction [1]

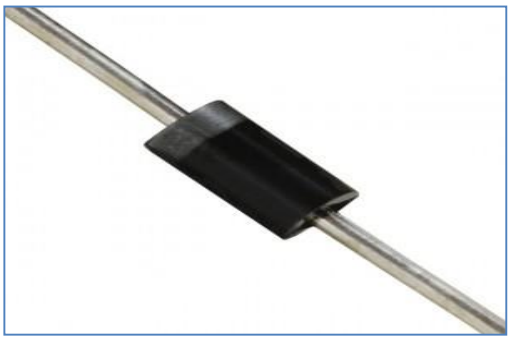

Fig. 3.16 Diode [1]

In electronics, a diode is a two-terminal electronic component that conducts primarily in one direction (asymmetric conductance); it has low (ideally zero) resistance to the flow of current in one direction, and high (ideally infinite) resistance in the other. A semiconductor diode, the most common type today, is a crystalline piece of semiconductor material with a p–n junction connected to two electrical terminals as shown in fig. 3.16.

3.2.14. GLUE GUN

Hot melt adhesive (HMA), also known as hot glue, is a form of thermoplastic adhesive that is commonly supplied in solid cylindrical sticks of

various diameters, designed to be melted in an electric hot glue gun. The gun uses a continuous-duty heating element to melt the plastic glue, which the user pushes through the gun either with a mechanical trigger mechanism on the gun, or with direct finger pressure. The glue squeezed out of the heated nozzle is initially hot enough to burn and even blister skin. The glue is tacky when hot, and solidifies in a few seconds to one minute. Hot melt adhesives can also be applied by dipping or spraying.

3.2.15. NUT AND BOLT

A **nut** is a type of fastener with a threaded hole. Nuts are almost always used opposite a mating **bolt** to fasten a stack of parts together. The two partners are kept together by a combination of their threads' friction, a slight stretch of the **bolt**, and compression of the parts as shown in fig. 3.18.

Fig. 3.17 Nut and Bolt [2]

3.3 COST OF COMPONENTS

We have purchase/procure the following component from market which cost is given in the table 3.2.

Table 3.2 Cost of Components

S. No.	Component	Specification (mm)	Quantity	Cost (Rs)
1	Rack	100x20x20	1	1200/-
2	Pinion	Φ45, 22 teeth	1	200/-
3	DC motor with gear box	12V/90mA	1	800/-
4	Sliding channel	210x40x13	1	150/-
5	Bearing 608	Φ8, Φ22.7	1	80/-
6	Bearing Stand	Φ22, Φ30	1	100/-
7	Syringe	10ml	4	100/-
8	Master Cylinder Syringe	60ml	1	30/-
9	Syringe Pipe	Φ6	1	150/-
10	Sliding Switch	24V/100mA	1	50/-
11	Cut off Switch	24V/100mA	2	100/-
12	Transformer	220V/110V – 12V/90mA	1	500/-
13	T – Junction	5 pin junction	1	200/-
14	Wooden Block	480x325x225	1	2500/-
15	Diode	24V/100mA	4	30/-
16	Glue Gun	500 ml	1	500/-
17	Nuts and Bolts	70 mm,	4	40/-
18	Miscellaneous	-	-	600/-
		Total Cost		**Rs. 7330/-**

****

CHAPTER-4

PROJECT CONSTRUCTION

In this chapter we have explained the fabrication or assembly process step by step with their proper figures. These chapters also include the distribution of power supply to efficiently run the project. This chapter has been included prior to fabrication process of Underground Hydraulic Car Parking System (UHCPS) to make the fabrication and assembly process easy.

4.1 METHODOLOGIES & CONSTRUCTION

Step-1

Now we take four 10 ml plastic syringe as hydraulic cylinder as shown in fig. 4.1.

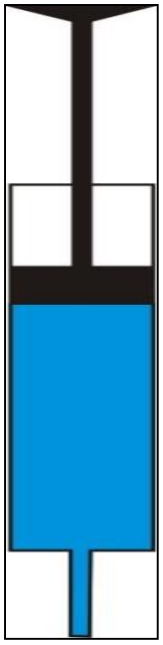

Fig. 4.1 Plastic Syringe 60mL

Step-2

We take one more syringe and filled it with water/oil and now we connected both syringe with plastic tube as shown in fig. 4.2.

If we pressurized one syringe second syringe lift up according to Pascal law, same phenomena work with other syringe too.

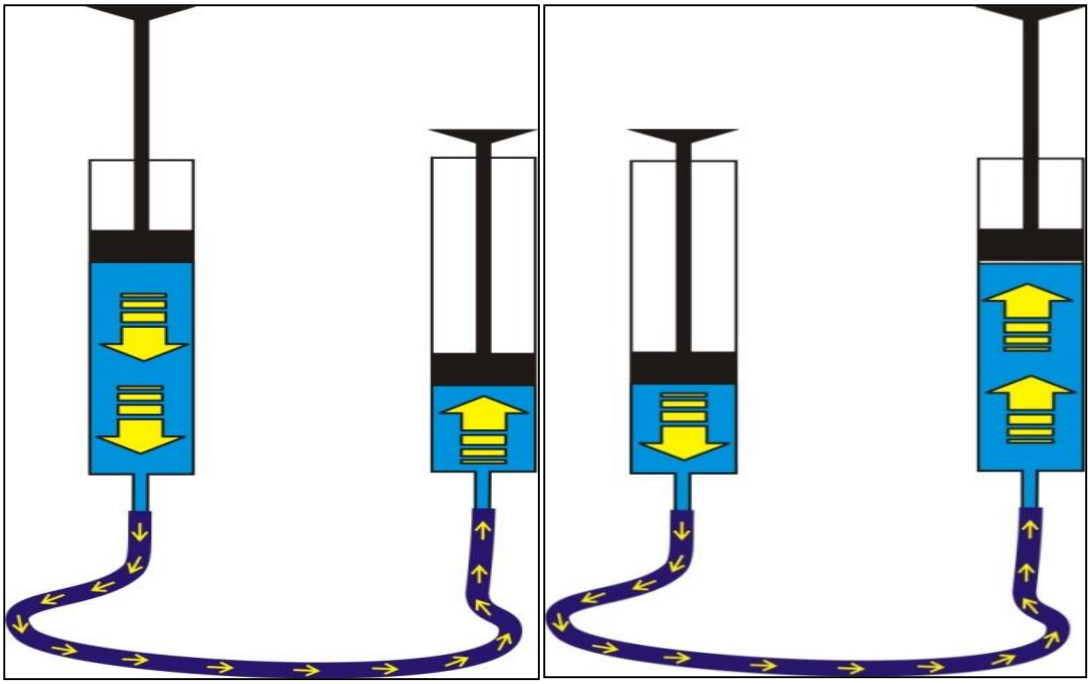

Fig. 4.2 Transfer of Pressure through Fluid

4.2 ABOUT OUR PROJECT

Now we plan to construct this Pascal law concept as a final project. We use two syringes and coupled with one sliding mechanism and this mechanism is power by slow dc gear motor for Lifting good and vehicles.

4.3 PROJECT CONSTRUCTION STEPS

Step-1

First we arrange one sliding channel and fix it on wooden frame as shown in fig. 4.3.

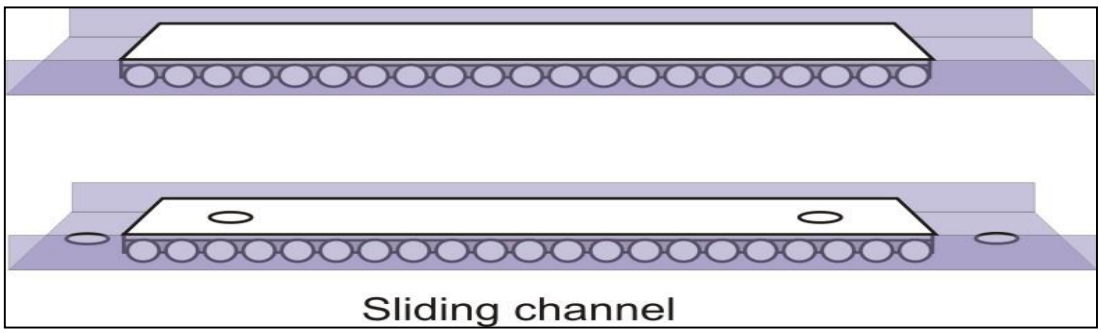

Fig. 4.3 Sliding Channel Arrangement

Step-2:-

Sliding channel fixed on the wooden block by nails as shown in fig. 4.4.

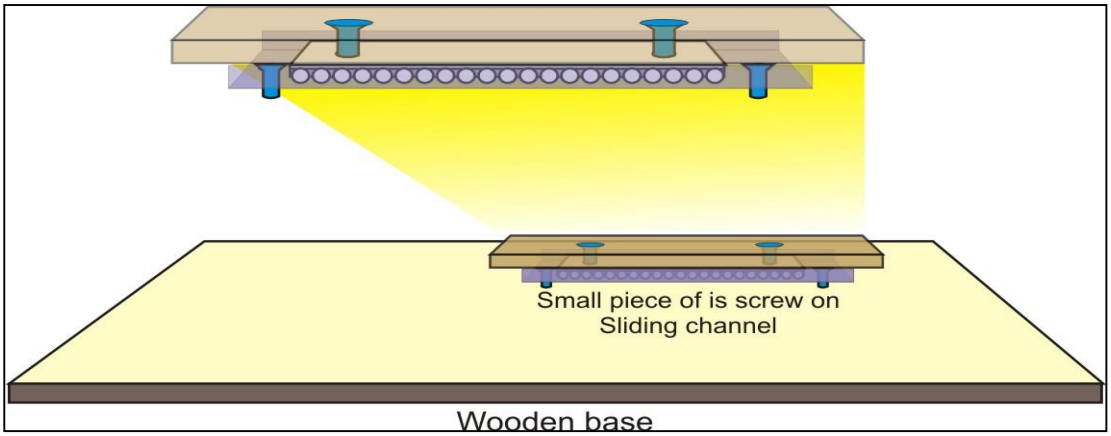

Fig. 4.4 Fixing Sliding Channel on Wooden Base

Step-3

We use 8mm iron rod and cross on between 2 bearing stand. Then we fix one Pinion gear in between 2 bearing stand. This pinion gear roll over rack mechanism which is fixed on sliding channel as shown in fig. 4.5.

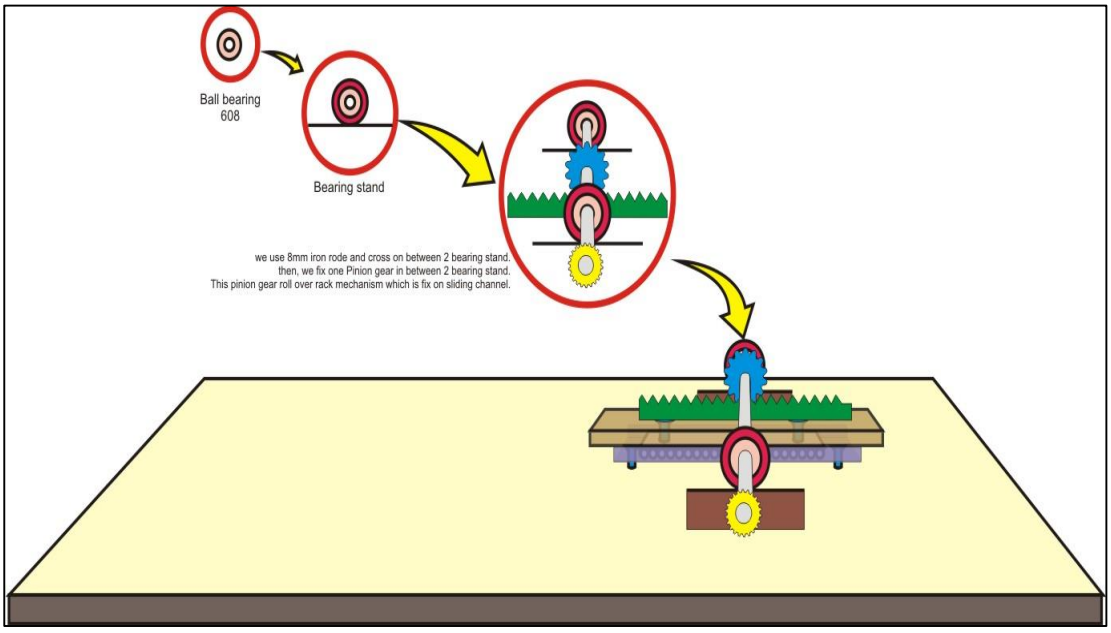

Fig. 4.5 Fixing Pinion Gear

Step-4:-

We attach one dc gear motor with rod shaft gear for sliding movement for entire set as shown in fig. 4.6. Two way switch for dc motor clockwise / anticlockwise rotation.

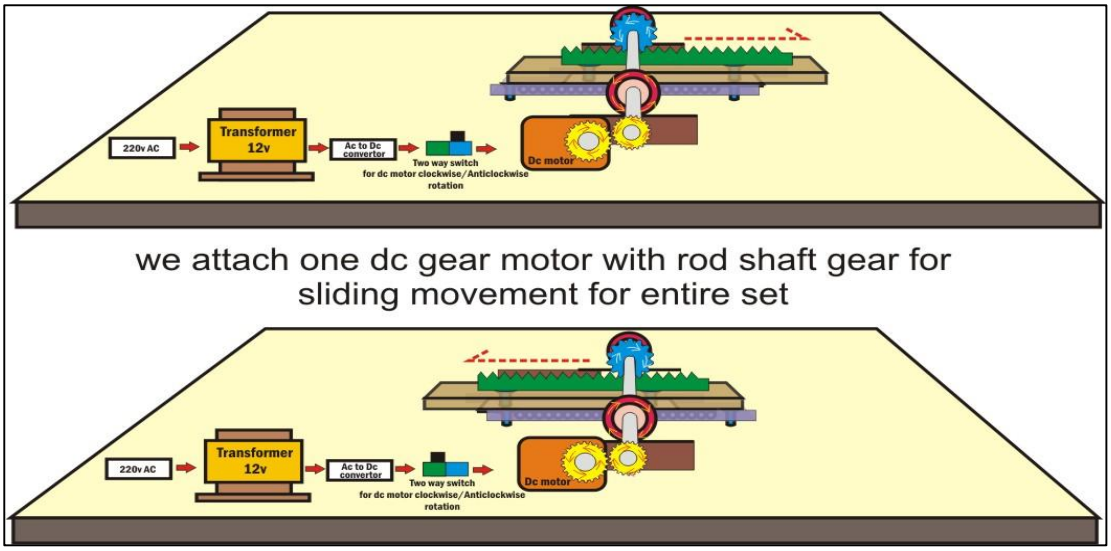

Fig. 4.6 Attachment of DC Gear Motor with Rod Shaft Gear

Step-5:-

Attachment of master cylinder to the sliding channel for providing smooth and constant fluid pressure to the master cylinder fluid as shown in fig. 4.7.

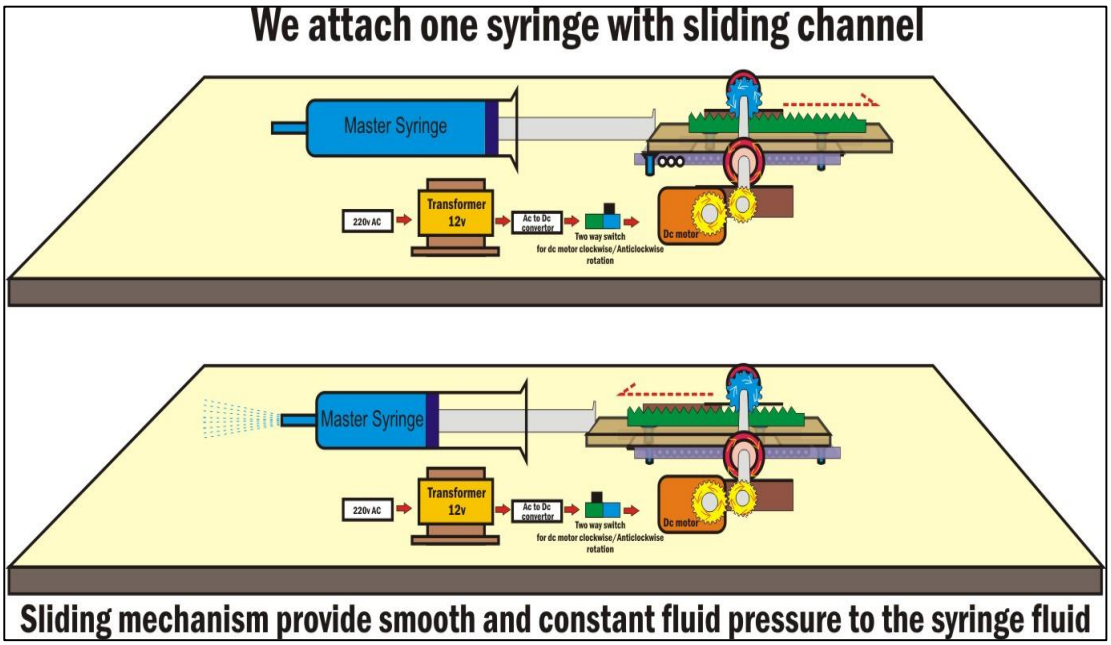

Fig. 4.7 Sliding Mechanism

Step-6

Now we construct a simple car lifting platform with help of 4 syringes and connect with master syringe as shown in fig. 4.8.

When master syringe cylinder injects fluid to 4 syringes, platform lift up.

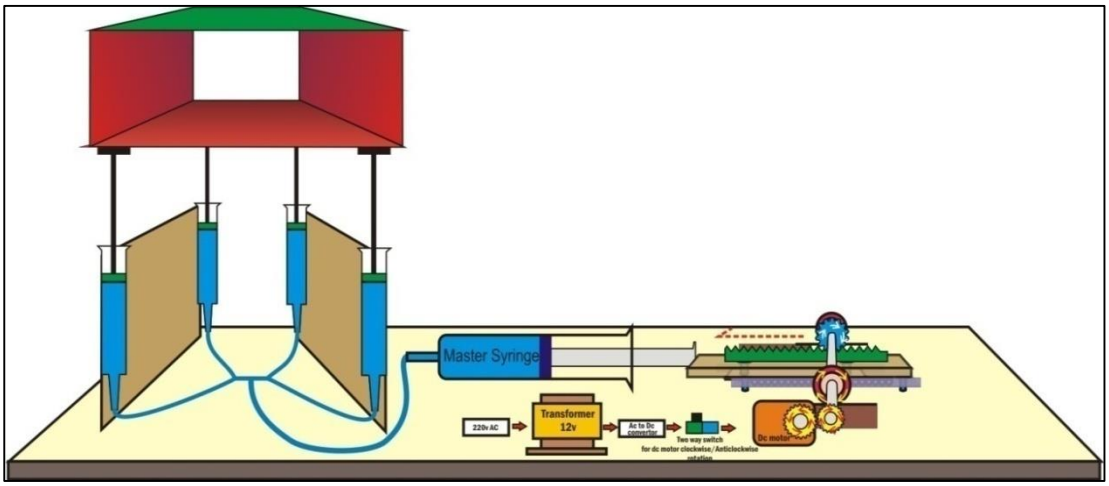

Fig. 4.8 Car Lifting Platform Construction

Step-7

All above setup fixed in the front of our house parking area, all we have to construct a small car size basement in front gate and fix entre setup there as shown in diagram 4.9a.

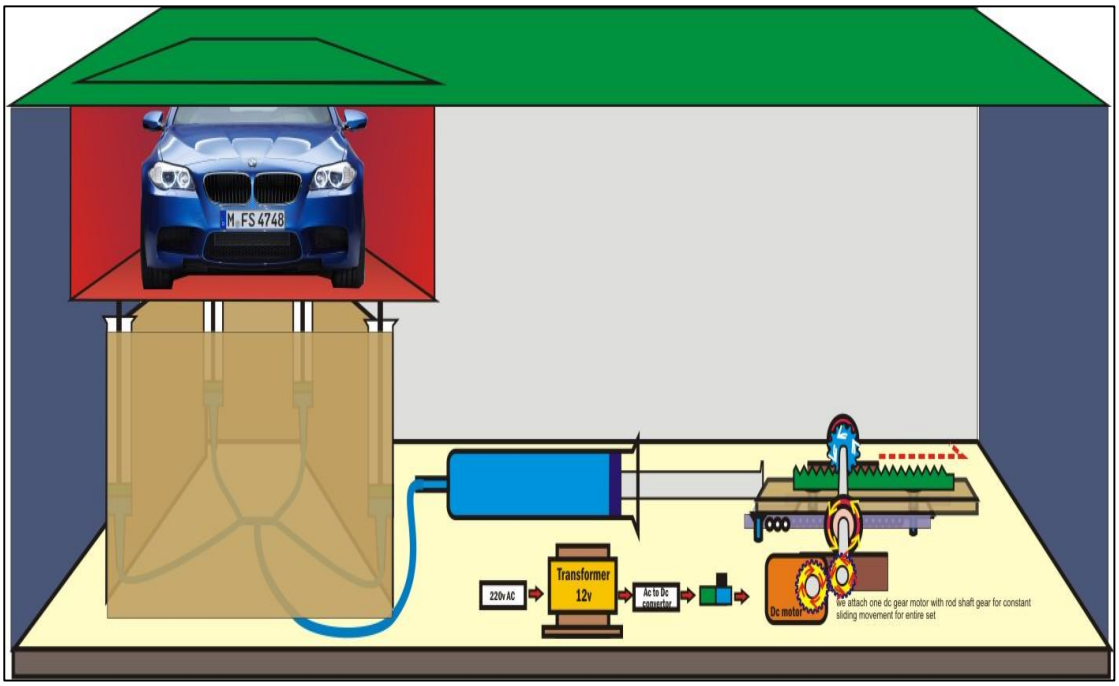

Fig. 4.9a Arrangement in Basement

We can park two cars at the time in one parking area with full safety as shown in fig. 4.9b.

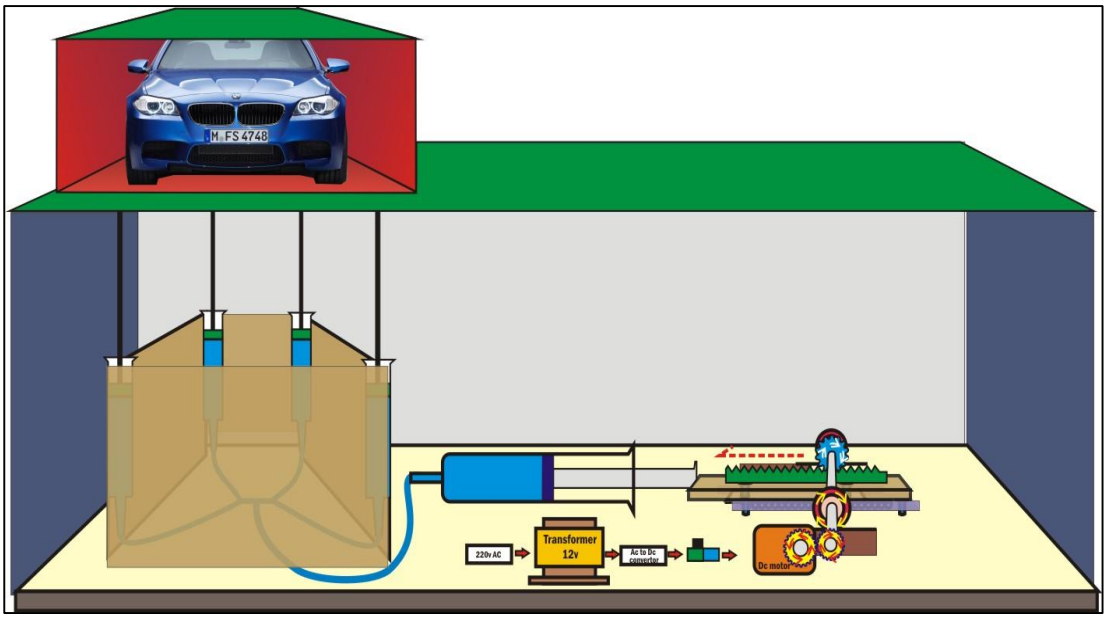

Fig. 4.9b Arrangement in Basement

4.4 FUTURE LAYOUT

Commercial application of project in future which is shown in fig. 4.10a & 4.10b & the figure 4.10c.

Fig. 4.10a Commercial Application of Project

Fig. 4.10b Commercial Application of Project

Fig. 4.10c Commercial Application of Project

4.5 POWER SUPPLY

A **power supply** is an electronic device that supplies electric energy to an electrical load. The primary function of a power supply is to convert one form of electrical

energy to another and, as a result, power supplies are sometimes referred to as electric power converters. Some power supplies are discrete, stand-alone devices, whereas others are built into larger devices along with their loads. Examples of the latter include power supplies found in desktop computers and consumer electronics devices.

4.5.1 AC-To-DC Supply

Some DC power supplies use AC mains electricity as an energy source. Such power supplies will sometimes employ a transformer to convert the input voltage to a higher or lower AC voltage. A rectifier is used to convert the transformer output voltage to a varying DC voltage, which in turn is passed through an electronic filter to convert it to an unregulated DC voltage. The filter removes most, but not all of the AC voltage variations; the remaining voltage variations are known as ripple show as shown in fig. 4.11.

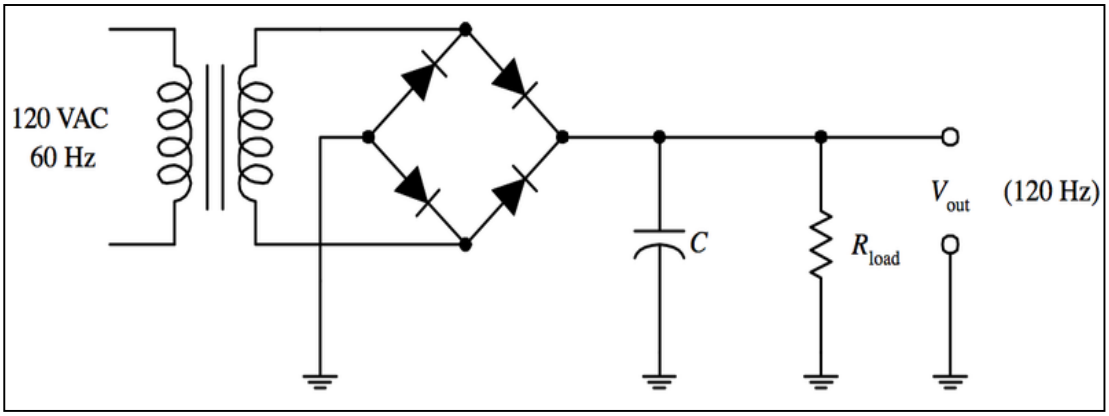

Fig. 4.11 Schematic of basic AC-to-DC power supply [1]

4.6 THEORY

4.6.1 Rectification

Rectification is a process of rendering an alternating current or voltage into a unidirectional one. The component used for rectification is called 'Rectifier'. A rectifier permits current to flow only during the positive half cycles of the applied AC voltage by eliminating the negative half cycles or alternations of the applied AC voltage. Thus pulsating DC is obtained. To obtain smooth DC power, additional filter circuits are required.

4.6.2 Full Wave Rectifier

A Full Wave Rectifier is a circuit, which converts an ac voltage into a pulsating dc voltage using both half cycles of the applied ac voltage. It uses two diodes of which one conducts during one half cycle while the other conducts during the other half cycle of the applied. ac voltage.It is possible to rectify both alternations of the input voltage by using two diodes in the circuit arrangement show as shown in fig. 4.12.

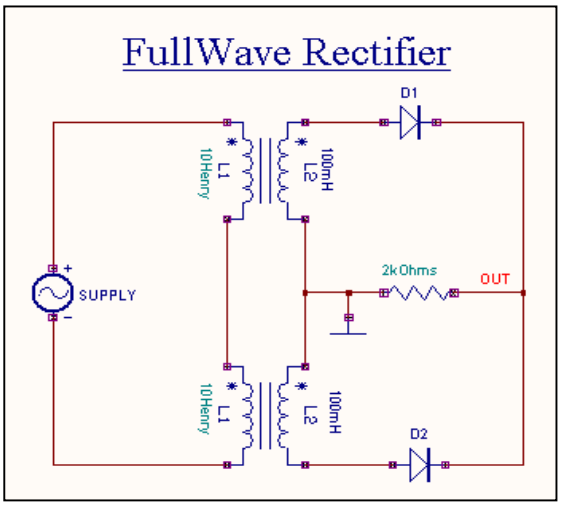

Fig. 4.12 Full Wave Rectifier [1]

When A is positive relative to C, the anode of D_1 is positive with respect to its cathode. Hence D_1 will conduct but D_2 will not. During the second alternation, B is positive relative to C. The anode of D_2 is therefore positive with respect to its cathode, and D_2 conducts while D_1 is cut off.

There is conduction then by either D_1 or D_2 during the entire input-voltage cycle.

Since the two diodes have a common-cathode load resistor R_L, the output voltage across R_L will result from the alternate conduction of D_1 and D_2. The output waveform v_{out} across R_L, therefore has no gaps as in the case of the half-wave rectifier.

The output of a full-wave rectifier is also pulsating direct current. In the diagram, the two equal resistors R across the input voltage are necessary to provide a voltage midpoint C for circuit connection and zero reference. Note that the load resistor R_L is connected from the cathodes to this centre reference point C.

An interesting fact about the output waveform v_{out} is that its peak amplitude is not 9 V as in the case of the half-wave rectifier using the same power source, but is less than 4½ V. The reason, of course, is that the peak positive voltage of A relative to C is 4½ V, not 9 V, and part of the 4½ V is lost across R.

Though the full wave rectifier fills in the conduction gaps, it delivers less than half the peak output voltage that results from half-wave rectification.

4.6.3 Bridge Rectifier

A **bridge rectifier** is an arrangement of four or more diodes in a **bridge** circuit configuration which provides the same output polarity for either input polarity. It is used for converting an alternating current (AC) input into a direct current (DC) output as shown in fig. 4.13.

A more widely used full-wave rectifier circuit is the bridge rectifier. It requires four diodes instead of two, but avoids the need for a centre-tapped transformer. During the positive half-cycle of the secondary voltage, diodes D2 and D4 are conducting and diodes D1 and D3 are non-conducting. Therefore, current flows through the secondary winding, diode D2, load resistor RL and diode D4. During negative half-cycles of the secondary voltage, diodes D1 and D3 conduct, and the diodes D2 and D4 do not conduct. The current therefore flows through the secondary winding, diode D1, load resistor RL and diode D3.

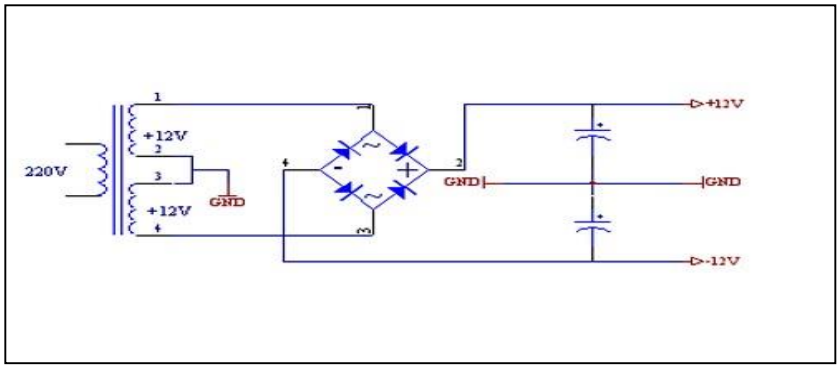

Fig. 4.13 Bridge Rectifier [1]

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CHAPTER-5

FABRICATION OF THE PROJECT

In this chapter we have executed the process of fabrication in proper way then all these components assemble together as per planning and actual model of UHCPS finally prepared. All these fabrication & assembly process given step by step in this chapter.

There are following steps are followed for modelling the project:-

Step 1:-

We have prepared the wooden box whose dimension of upper panel 480x320x5 mm^3 & lower panel 480x320x10 mm^3, two side panel dimensions is 225x320x10 & the dimension of back panel 480x225x10 in mm^3 with open at one side as shown in fig. 5.1.

Fig. 5.1 Making Wooden Block

Step 2:-

Make a platform for car parking of dimension of upper and lower panel 190x120x5 and the dimension of two side panel 190x60x10 mm^3 as shown in fig. 5.2.

Step 3:-

Making arrangements for up & down movement of car platform by using 4-syringes of 10ml with the help of Glue Gun, which act as a hydraulic-lifting device & lift the platform as shown in fig.5.3.

Fig. 5.2 Car Parking Platform

Fig. 5.3 Arrangements for Lifting System

Step 4:-

With the help of water-tube of 6mm diameter we have connected the T-joint connecter & 4- pillar cylinders (syringes). In this connecter there is one inlet passage & 4 outlet passage. Inlet passage connected to master cylinder & outlet passage connected to 4- pillar cylinders as shown in fig. 5.4.

Fig. 5.4 Fixing T-junction

Step 5:-

Fixing sliding channel 210x40x13 mm^3 on wooden block by glue gun and after that fix at the floor of the wooden box as shown in fig.5.5.

Step 6:-

Weld the rack 100x20x20 on an Iron strip 140x20x5 in mm^3 at welding shop and fixed with sliding channel by fastener as shown in fig. 5.6.

Fig. 5.5 Sliding Channel Arrangement

Fig. 5.6 Welding of Rack on Iron Strip

Step 7:-

Bolting rack and strip on sliding channel by fastener as shown in fig. 5.7.

Fig. 5.7 Rack with Sliding Channel

Fig. 5.8 Stopper

Step 8:-

Bolting iron stopper 5x10x50 mm^3at the one end of rack strip by the fastener as shown in fig. 5.8.

Step 9:-

Setting of backward & forward cut off switch 24V/100mA for maintaining the sliding movement of the rack as shown in fig. 5.9.

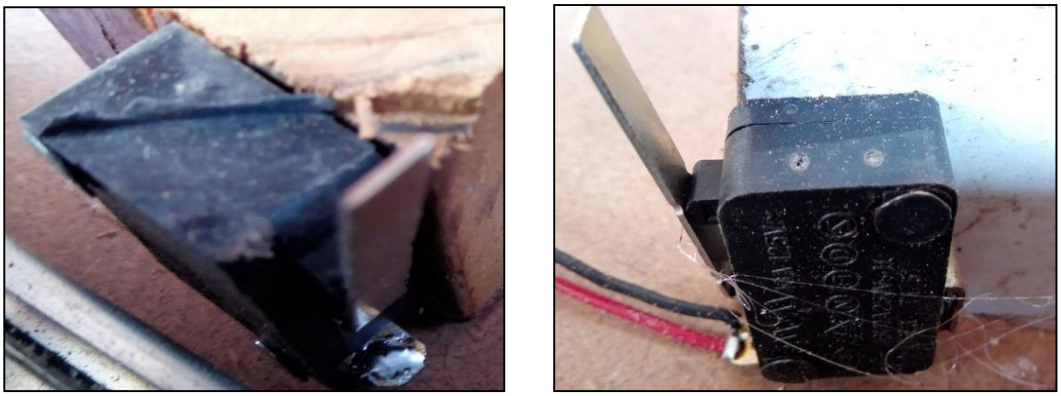


Fig. 5.9 Backward & Forward Cut off Switch

Step 10:-

Set up the Pinion (dia. 45, 22 teeth) on a shaft of dia. 8mm and connected to motor and supported by bearing stand as shown in fig. 5.10

Step 11:-

Arranging of DC motor (12V/90mA) and Gearbox (1000rpm-4rpm) connected to pinion arrangement for providing motion to rack and pinion as shown in fig. 5.11.

Fig. 5.10 Pinion Arrangement

Fig. 5.11 Gearbox with DC Motor

Step 12:-

Setting of bearing 608 in bearing stand which welded on the iron strip fixed by fastener on the lower panel of wooden block as shown in fig.5.12.

Step 13:-

Setting of transformer (220V/110V – 12V/90mA) with the help of nut & bolt as shown in fig. 5.13.

Fig. 5.12 Bearing in Bearing Stand

Fig. 5.13 Transformer Setting

Step 14:-

Welding of bearing stand on metal strip 60x15x5 in mm and bolting on wooden block. Making connection of pinion shaft with gearbox shaft and meshing the pinion with rack as shown in fig. 5.14a and 5.14b.

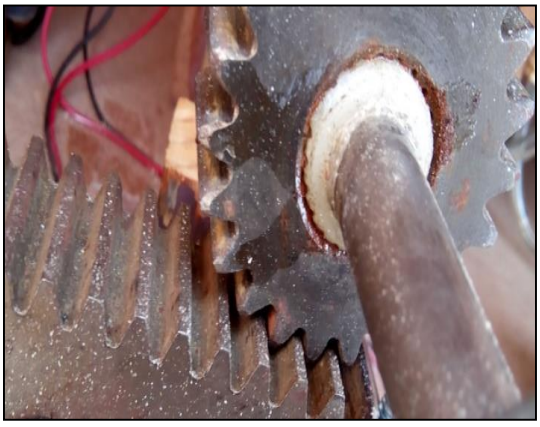


Fig. 5.14a Meshing Pinion & Rack

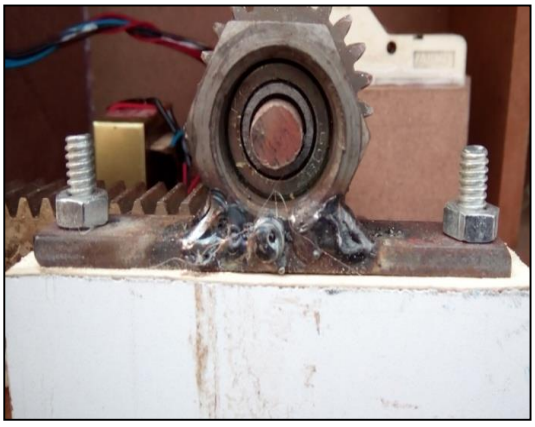


Fig.5.14b Arrangement of Bearing

Step 15:-

Connecting master cylinder (syringe) piston rod with sliding channel and fixing master syringe (60ml) at the box floor with glue gun as shown in fig. 5.15a and 5.15b.

Fig. 5.15a Connection of Sliding Channel

Fig. 5.15b Master Syringe Arrangement

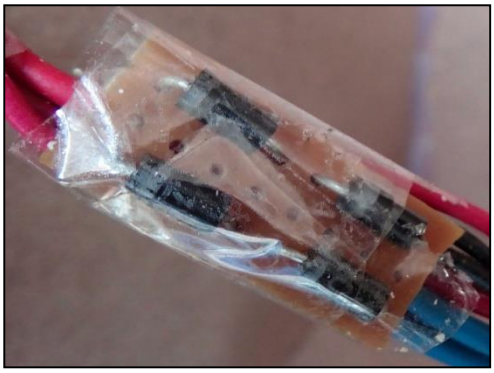
Step 16:-

Arranging two way sliding switch (24V/100mA) at the side of the wooden box by two nails and connected to power supply for cut-off as shown in fig. 5.16.

Fig. 5.16 Two Way Sliding Switch

Step 17:-

Making bridge rectifier with the help of 4-diodes (24V/100mA) and making wire connections with different electrical components and also providing input connection for the system as shown in fig. 5.17a and 5.17b.



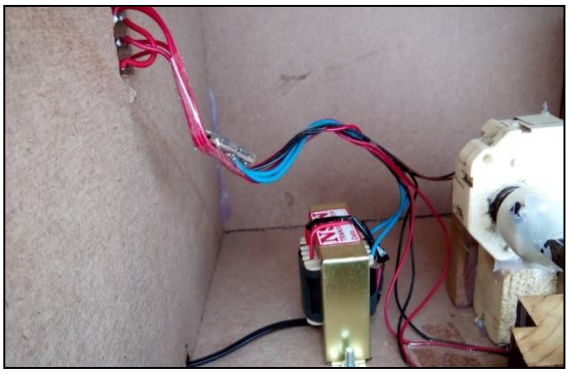


Fig. 5.17a Rectifier & Wire Connections

Fig. 5.17b Input Wire Connection

Step 18:-

Complete layout of the UHCPS throughout assembling of all component as a whole which is as shown in fig. 5.18a, 5.18b and 5.18c.

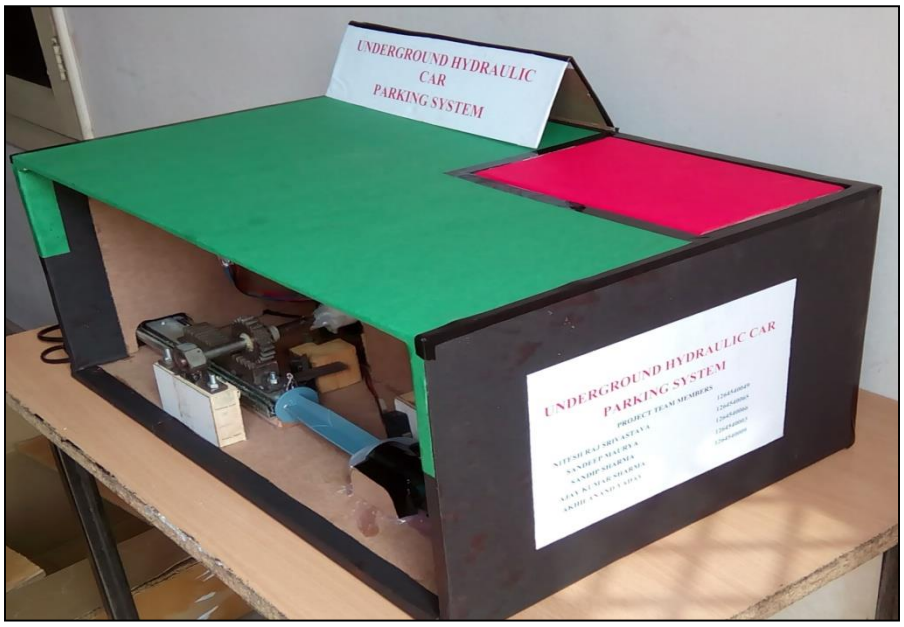


Fig. 5.18a Final View of the Project

Fig. 5.18b Final View of the Project

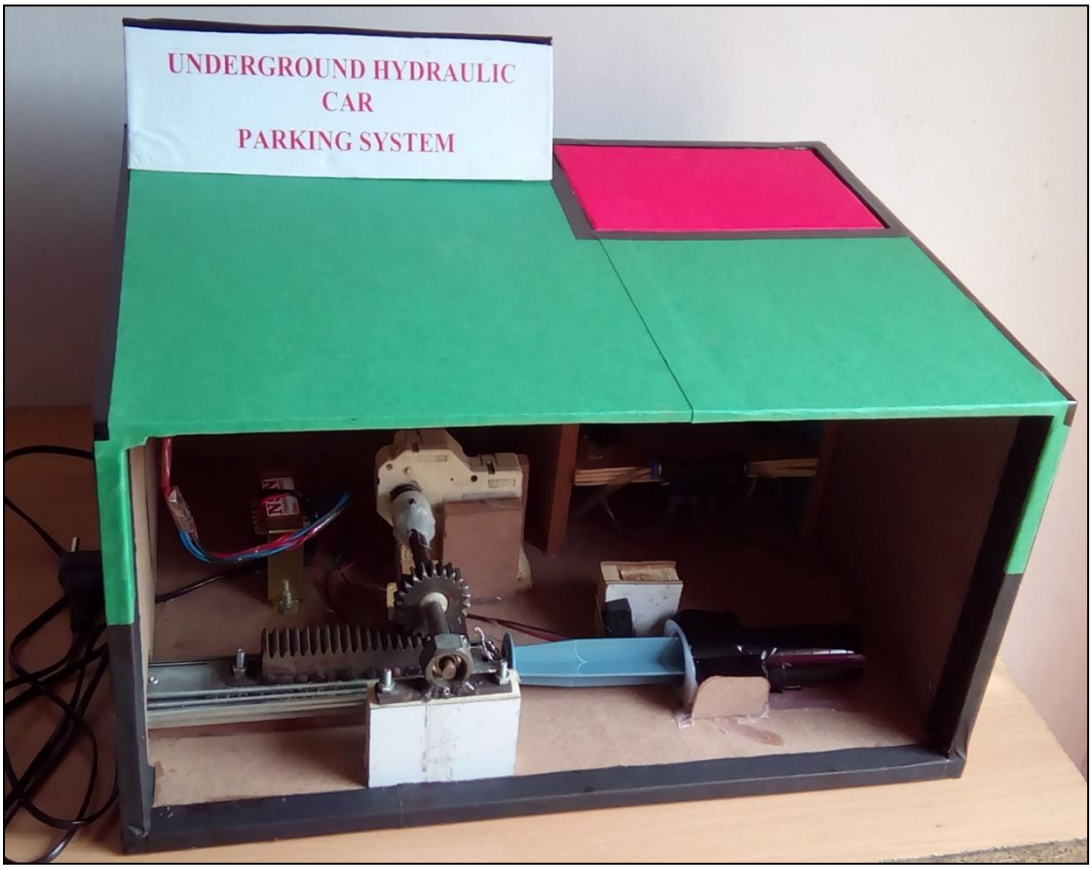


Fig. 5.18c Final View of the Project

5.1 COST OF COMPONENTS

Prior to fabrication of Underground Hydraulic Car Parking System (UHCPS) we have required the following components with their quantity and

Table 5.1 Total Cost of UHCPS

S. No.	Component	Cost (Rs)
1	Component Cost	6730/-
2	Project Manufacturing cost	1500/-
3	Miscellaneous	600/-
	Total cost	**8830/-**

Table 5.2 Tentative Cost of Actual UHCPS

S. No.	Component	Material/Specification	Quantity	Cost(Rs)
1	Motor	10Hp / 1000rpm	1	13000/-
2	Rack	C45, Carbon steel	1	2000/-
3	Pinion	Steel/Spur gear	1	250/-
4	Gearbox	Cycloidical	1	7000/-
5	Master cylinder	Carbon steel, Stainless steel	1	1800/-
6	Pillar cylinder	Carbon steel, Stainless steel	4	1200/-
7	Sliding channel	Cold rolled steel	1	7000/-
8	Pressure pipe	Synthetic rubber	1	1300/-
9	Frame	Mild steel	3	33000/-
10	Building Material	Bricks, Concrete, Sand, Cement, bar	-------	30500/-
11	Labour Cost	-------	-------	10000/-
12	Miscellaneous cost	-------	-------	10000/-
		Total Estimated Cost		**117050/-**

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6. CONCLUSION

1. An underground **car parking system** is a mechanical device that multiplies parking capacity inside a parking lot.
2. This innovative, space-saving car lift & storage system doubles our parking space by putting your car underground.
3. We have got limited square footage or simply prefer to store our vehicle safely; our project is electro-hydraulic mechanism lowers or lifts our vehicle with the touch of a button.
4. Multi- storey car park systems are less expensive per parking slot, since they tend to require less building volume and less ground area than a conventional facility with the same capacity.
5. By the use of this project, we provide multiple cars parking facility in less space which will be very helpful in resolving the problems of urban areas over car parking.
6. There are several advantages of employing a car park system for urban planners, business owners and vehicle drivers. They offer convenience for vehicle users and efficient usage of space for urban-based companies.
7. Finally an underground car parking system is a way to parking a car or multiple cars in a limited space. It also provides security and safety of cars in low cost of parking.

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7. SUGGESTION FOR FUTURE WORK

1. In future, increase the level of parking slot for parking more than two cars (three or four) at a place.

2. Use facilitates multiple stoppers for multi-level parking by providing Relays in the electronic circuit.

3. In future, sliding channel and rack can be replaced by mechanical pump such as gear pump which also reduces the floor space.

4. In future, in place of rack & pinion and sliding channel, rope & rollers can be used for pushing and pulling the piston of master cylinder for reducing the space.

5. Pillar cylinders can be set at the side corners of the parking lot instead of down corners of parking lot for reducing the depth of parking lot or basement.

6. Sensors can be used for lift up & down process, in future.

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8. REFERENCES

1. https://en.wikipedia.org/wiki/Car_parking_system
2. http://www.alibaba.com/
3. https://www.youtube.com/watch?v=8xNxwZnMPaQ
4. A textbook of Bansal R.K., Fluid Mechanics And Hydraulic Machines, Laxmi Publications (P) Ltd , Ninth edition, 2010
5. http://scienceplx.com/
6. https://www.techtransfer.com/

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9. APPENDIX

1. **Hydraulic Drive System:** A hydraulic drive system is a drive or transmission system that uses pressurized hydraulic fluid to power hydraulic machinery. The term hydrostatic refers to the transfer of energy from flow and pressure, not from the kinetic energy of the flow.
2. **Pascal's Law:** Pascal's law or the principle of transmission of fluid-pressure (also *Pascal's Principle*) is a principle in fluid mechanics that states that pressure exerted anywhere in a confined incompressible fluid is transmitted equally in all directions throughout the fluid such that the pressure variations (initial differences) remain the same.
3. **Slow Speed Crouzet Motor Gear Box:** The Crouzet DC mind Brushless motors represent a new generation of direct current brushless motors.
4. **Rack And Pinion:** Rack and pinion is a type of linear actuator that comprises a pair of gears which convert rotational motion into linear motion.
5. **Bearing 608:** Bearings reduce friction by providing smooth metal balls or rollers, and a smooth inner and outer metal surface for the balls to roll against. These balls or rollers "bear" the load, allowing the device to spin smoothly. (608 means = ball bearing with 8mm internal dia. & 22mm external dia.)
6. **Syringe:** A syringe is a simple pump consisting of a plunger that fits tightly in a tube. The plunger can be pulled and pushed along inside a cylindrical tube (called a barrel), allowing the syringe to take in and expel a liquid or gas through an orifice at the open end of the tube.
7. **Sliding Switch:** Slide switches are mechanical switches using a slider that moves (slides) from the open (off) position to the closed (on) position. They allow control over current flow in a circuit without having to manually cut or splice wire.
8. **Transformer:** As a step-down unit, the transformer converts high-voltage, low-current power into low-voltage, high-current power.
9. **Diode:** In electronics, a diode is a two-terminal electronic component that conducts primarily in one direction (asymmetric conductance); it has low (ideally zero) resistance to the flow of current in one direction, and high (ideally infinite) resistance in the other.

10. **Glue Gun:** Hot melt adhesive (HMA), also known as hot glue, is a form of thermoplastic adhesive that is commonly supplied in solid cylindrical sticks of various diameters, designed to be melted in an electric hot glue gun.
11. **Rectification:** Rectification is a process of rendering an alternating current or voltage into a unidirectional one. The component used for rectification is called 'Rectifier'.
12. **Bridge Rectifier:** A bridge rectifier is an arrangement of four or more diodes in a bridge circuit configuration which provides the same output polarity for either input polarity. It is used for converting an alternating current (AC) input into a direct current (DC) output.

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