A PROJECT REPORT

ON

"DESIGN AND DEVELOPMENT OF DENSITY VARIATION MECHANISM OF SUBMARINE"

Submitted by

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IN PARTIAL FULFILMENT FOR THE AWARD OF THE DEGREE

OF

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UNDER THE GUIDANCE

OF

PROF. ASLAM HIRANI

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"DESIGN AND DEVELOPMENT OF DENSITY VARIATION MECHANISM OF SUBMARINE"

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APPROVAL OF DISSERTATION

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PATEL SAHIL

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(Internal Examiner) **(External Examiner)**

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Date: _____

DECLARATION

We declare that this written submission represents our ideas in our own words and where others' ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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ABSTRACT

A submarine is a vehicle which travels underneath the sea surface by varying its buoyancy. They are powered by diesel engines, whose drawbacks to a large extent are now overcome by nuclear reactors. It travel into the sea by means of ballast tank, so the design of ballast tank is one of the most important aspect. It should be design in such a way that the submarine should submerged by partially filling the ballast tank. In this project, we have designed and developed a density variation mechanism of submarine using air chamber and ballast tank. We use the rolling pump which plays a vital role in this mechanism which helps to suck and discharge water into the ballast tank. This helps the submarine to sink inside the water and float it back to surface. In addition, we also implement the pressure relief valve to overcome the drawback of the excess pressure generated in the air chamber and the navigation system which will help the submarine to take a turn in left and right direction. Surely the ballast tank is an engineering master piece that has proved its purpose and might over the years Submarine is a vehicle which travel underneath sea surface by varying its buoyancy. The world is looking forward to seeing the newer changes in the submarine technology.

The paper is an effort to look into the engineering aspects of a ballast tank which includes construction details, submerging of submarine, and different mechanism for achieving the task.

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Chapter 1

Introduction

1.1 Introduction

A submarine can be defined as an underwater counterpart for the surface vessels. In other words, it's a craft which can operate completely submerged in water for long periods. A submarine or ship can float because the weight of the water displaced is equal to the weight of the ship. This displacement of water creates an upward force called the buoyant force and acts opposite to gravity. The main use of submarine is in the field of military defense. The submarine was first used for war in the First World War, by the Germans. They were called U-Boats. Ever since the First World War it has been a main weapon for the warring parties. The submarines provide stealth and quick attack on its enemies. The modern day submarines are powered by mini nuclear reactors. The submarines are also used for research activities and other peaceful works.

A submarine are mainly used as a part of the defense system. The inside of a submarine is a totally unknown to the civilian world. Ever since its invention it has undergone various changes and transformations to become what it is now. The world is looking forward to seeing the newer changes in the submarine technology.

This paper is the effort to look into engineering aspects of the submarine model which include rough construction details, how the submarine goes beneath and come out and the mechanism which govern it.

1.2 Objective

Our aim is to design and build a low cost, light weight and an efficient density variation mechanism in submarine that will perform the same task as used by actual submarine. Below is the list of our objectives that are based on given specific parameters such as weight and the size of the submarine. Our main objective is to build the mechanism for submarine using cheaper and effective material that would withstand the pressure based on the depth and type of water.

1. To learn the existing mechanism.

2. To design ballast tank for submarine by using:

   a) Pumps and air vessel

   b) Rolling Pumps and air vessel.

   c) Piston and cylinder with gear motor.

   d) Comparison and optimization of Pump and Piston.

Chapter 2

Literature review

2.1 Literature review

Early History

The first successful underwater craft was a leather-encased wooden rowboat, built in England in the 1620s by the Dutch inventor Cornelis Van Drebbel. The first submarine to be used as an instrument of war was an egg-shaped craft, which carried only one person. Called 'Bushnell's turtle', it was invented in the 1770s by the American engineer David Bushnell.

In 1800 the American inventor Robert Fulton built a 6.4-m (21-ft) submarine named the Nautilus, which was similar in shape to the modern submarine. In 1864 a Confederate submarine, the Hunley, blew up the USS Housatonic in Charleston, South Carolina, Harbour, but was itself destroyed by the explosion.

The first practical submarine with an efficient source of power was developed by the American inventor John Philip Holland, who used a dual-propulsion system. Launched in 1898, his submarine was equipped with a gasoline engine for surface cruising and with an electric motor for underwater power. The boat, which had an overall length of 16.2 m (53 ft), was purchased by the U.S. government in 1900 and named the USS Holland.

20 Century

In 1906 the Germans adapted the diesel engine to the submarine. With the development of the periscope and the self-propelled torpedo, the submarine became a formidable factor in naval warfare. The effectiveness of the underwater craft as a deadly weapon was first demonstrated during World War I, when German submarines, known as U-boats, were used extensively against Allied warships and merchant vessels. Their success led to the development of depth charges.

Between World War I and World War II various improvements were made in submarine design and operation. Underwater sound devices were developed for communications and for detection of enemy ships. During World War II the German navy developed a device, called the snorkel, which permits the submarine to recharge its batteries while cruising at periscope depth.

A new type of hull, shaped like a blimp, was introduced in the USS Albacore, launched in 1953.In 1954 the British navy launched the submarine HMS Explorer, powered by turbines using hydrogen peroxide fuel, which greatly extended the underwater range.

2.2 Table of Submarine mechanism.

Year	Country	Inventor	Mechanism
1580	England	William Bourne	Leather wrapped pad
1623	Dutch	Cornelius Drebbel	Neutral buoyancy
1634	French	Marin Mersenne	Pressure variation
1653	Belgians	De Son	Spring driven
1680	Italian	Giovanni Borelli	Ballast system
1696	England	Denis Papin	Air pump
1729	England	Nathaniel Symons	Telescopic hull
1773	England	J Day	Stone and ballast
1776	Yale	David Bushnell	Ballast tank
1797	America	Robert Fulton	Flatter
1800	Algeria	Fulton	Hull-form and sail rig
1812	New London	Silas Halsey	Force pump and air tube
1850	Germany	Wilhelm Bauer	Buoyancy by ballast tank
1852	Indiana	Lodnerd Phillips	Hand-cranked propeller
1855	Russia	Wilhelm Bauer	Neutral buoyancy
1861	America	Villeroi	Hand-cranked
1863	New Orleans	Hunleys	Electric motor
1864	America	HL.Hunley	Stemmer
1870	French	Jules Yerne	Compressibility of sea water
1874	Irish	John Phillips	Cubic foot ballast tank
1879	Anglican	George Garrett	Pressurized steam
1885	French	Claude Goubet	Battery
1885	America	Josiah Tuck	Caustic soda
1888	French	Gustave Zede	Battery
1895	Holland	John .P	Gasoline
1902	Spanish	Raimondo	Kerosene
1908	America	U.S.Navy	Buoyancy
1910	England	Royal Navy	Saddle tank
1913	Germany	German Navy	Torpedo tube
1939	Dutch	Dutch Navy	Sniffer
1940	Germany	German Navy	Peroxide
1944	Russia	Russian Navy	Hydrogen parrafine
1950	Germany	Tom Clancy	Pump jet propulser
1960	America	U.S.Navy	Liquid oxygen
1982	America	U.S.Navy	Buoyancy
1995	Russia	Russian Navy	Sesmic device
2003	America	U.S.Navy	Nuclear reactor
2008	Russia	Russian Navy	Nuclear reactor
2012	India	Indian Navy	Steerling mechanism

Chapter 3

Market survey

3.1 Market survey

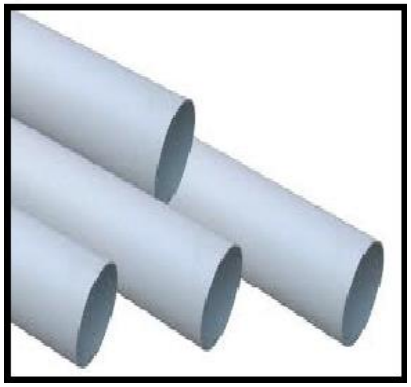
Following are the material and there cost we used in the project:

Fig 3.1. Battery.

Model	- Accuplus (EC10)
Voltage	- 12V/1.3AH
Standby use	-13.5-13.8V
Weight	- 0.350KG
Battery dimension	- 95x40x50(mm)
Price	- ₹ 350

Fig 3.2. Rolling pump

Brand	- Oken seisko
Voltage	- 6v
Type	- 2 Way
Price	- ₹ 650



	Hull	Ballast tank	Air chamber
Diameter	105 mm	38.5 mm	32 mm
Length	380 mm	300 mm	300 mm
Material	PVC	PVC	PVC

Fig 3.3. PVC pipe.

Model - KM-25A370

Voltage - 12V

Speed - 45 rpm

Characteristics - low speed high torque

Price - ₹ 120

Fig 3.4. Gear motor.

Model - FF-N20VA-08260

Voltage - 6V

Speed - 1460rpm

Price - □ 50

Fig 3.5. Motor.

Model - SZF-280 PVC

Voltage - 6V

Type - One Way

Price - ₹ 270

Fig 3.6. Mini water pump.

Model - 1811-200
Weight - 10gm
Thrust - 130gm/5000rpm
Diameter - 18 mm
Price - ₹ 150

Fig 3.7 Propeller

Material -Transparent plastic
Type -Flexible
Diameter - 6.5mm
Price - ₹ 15/ meter

Fig 3.8 Flexible pipe.

Type - M-Seals
Withstand temperature - 120C
Price - ₹ 60

Fig 3.9 M-seal.

Type - Araldite
Handling time - 4Hrs
Mix ratio - 1:1
Price - ₹ 95

Fig 3.10 Araldite.

Chapter 4

Methodology

4.1 Methodology

The methodology used for the mechanism in our project is to fill the ballast tank with water in an air tight condition so that as the water flows inside the ballast tank, air present inside the ballast tank will flow into the air chamber. Due to which more volume will be available thus more quantity of water will be filled in the ballast tank which will help to sink the submarine more conveniently. When the submarine is required to bring back to the surface, pump is started, the water is expelled from the ballast tank and the compressed air present in the air chamber will occupy the ballast tank which will help to bring the submarine back on the surface.

Our methodology comprises of various experiment which are performed on trial and error basis. We have successfully performed experiments on 12 models which are listed below with detailed information.

01. Ballast tank using single 1-way pump.
02. Ballast tank with an air vent using single 1-way pump.
03. Ballast tank with an air chamber using single 1-way pump.
04. Ballast tank with an air chamber using two 1-way pump.
05. Ballast tank with single propeller using single 1-way pump.
06. Ballast tank with two propeller using single 1-way pump.
07. Ballast tank with balloon inside it using single 1-way pump.

08. Ballast tank with balloon outside it using single 1-way pump.
09. Ballast tank with piston and gear arrangement.
10. Ballast tank with T-type air chamber using 2-way pump.
11. Ballast tank with air chamber using 2-way pump.
12. Ballast tank with hull and air chamber using 2-way pump.

In our experiments which were performed on several models, during flooding of the ballast tank the major hurdle was due to the presence of air inside the ballast tank due to which the submarine was unable to sink, thus we upgraded the old models with new concept and tested again and again until a successful model was built.

Below are the detailed information of the models built, starting from 1st model till 12th model.

01. Ballast tank using single 1-way pump :

The very first model which we tested was using ballast tank with 1-way pump, using this arrangement the ballast tank was only partially filled with water, due to the presence of air trapped inside, the ballast tank was not able to sink. To overcome this problem we built another model providing an air vent inside the tank.

02. Ballast tank with an air vent using single 1-way pump:

In this model an air vent was provided so that the air which is trapped inside the tank would be released so that the tank would completely filled with water. By providing this arrangement the tank was able to submerge but at the time of removal of water from the tank, the pump was unable to expel the water out of the tank as the suction pressure was created due to absence of air in the tank. So to overcome this problem another model was built.

03. Ballast tank with an air chamber using single 1-way pump:

In this model an air chamber was provided so that at the time of filling the water inside the tank the air would not be release into the atmosphere else it would be trapped inside the air chamber, so that at the time of removal of water from the tank the air which is compressed inside the chamber would occupy the space inside the tank but this model failed as we were using one way pump.

04. Ballast tank with an air chamber using two 1-way pump:

In this model we used two 1-way pump so that one pump would fill the tank and the other would remove the water from the tank so as to bring the tank back to the surface, but the problem over here was at the time of filling the water inside the tank the water was coming out from the other pump so it was unable to fill the tank, thus this model failed.

4.1 Methodology

05. Ballast tank with single propeller using single 1-way pump:

In this model we used a single propeller on the rear side of the tank so that it would help the tank to propel, but it was unable to propel due to the weight of the tank. So we built a new model using two propellers.

06. Ballast tank with two propeller using single 1-way pump:

In this model we used two propellers which were fitted at the center of the tank. With this arrangement it was able to propel the tank.

07. Ballast tank with balloon inside it using single 1-way pump:

In this model we made use of balloon as a ballast tank so that more quantity of water will be filled inside it, but due to pressure difference which was created inside the balloon burst out. So it was not possible to use inside the ballast tank.

08. Ballast tank with balloon outside it using single 1-way pump:

In this model we used balloon outside the ballast tank as an air chamber but the air was not being compressed rather it was expanding due to which the balloon was floating on the water surface. So the balloon cannot be used neither as ballast tank nor as an air chamber.

09. Ballast tank with piston and gear arrangement:

In this model water was filled inside the tank using piston and gear arrangement. In this arrangement we used a gear motor, the power was supplied to the motor through battery which in turn would drive the gear arrangement. Gear was mounted on the rod, one end of the rod was fixed to the piston while the other end was free. Due to the rotary motion of the motor the piston was reciprocating inside the cylinder due to which suction was created on one end, the water was filled inside the tank. At the time of removal of water due to the reciprocating motion the water was expelled out of the tank. In this arrangement the power consumption was very high so this model was not feasible. So we built another model using

10. Ballast tank with air chamber using 2-way pump

This model is same as that of the ballast tank using air chamber but in this we are using two way pump so that the same pump will fill as well and remove the water as required. This was a successful model. With this arrangement we were able to sink the tank as well as bring it back on the surface.

11. Ballast tank with T-type air chamber using 2-way pump:

In this model we built the ballast tank with T-type air chamber so that the upper portion of T will perform the action of neutral buoyancy. But the problem in this model was that during the filling of water inside the tank, back pressure was created due to which the water was not able to go inside the tank. So we stick to our previous model and currently we are in the final phase with the last model.

12. Ballast tank with hull and air chamber using 2-way pump:

This is the same model as explained in the 10^{th} model, the working concept is same, but in this concept the tank is placed inside the hull which will carry all the accessories and the air chamber is fitted on above the hull as well as a counter weight will be attached so that with slight filling of water it would submerge inside the water as well come at the surface.

4.2 Flow chart

Fig 4.1 shows the overall flow of project. This includes all the process required from the start, literature review to final report submission. These are steps for the project to finish successfully.

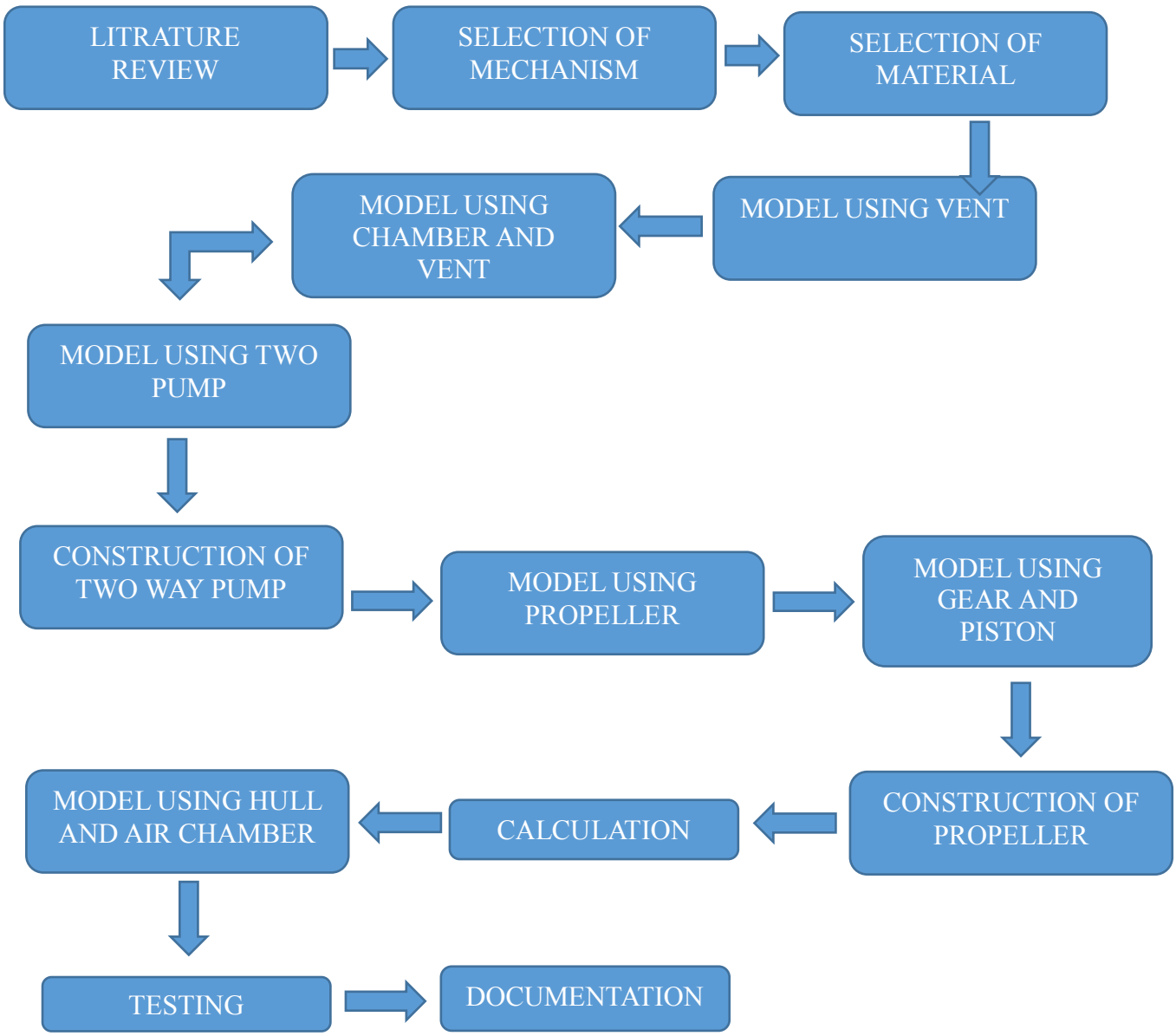


Fig .4.1. Flow chart

Chapter 5

Proposed Methodology

5.1 Construction of model

We have used Ballast tank with hull and air chamber using 2-way pump concept to implement in our final model. We have made our model as follows:

Initially we took 3 pvc pipes, one of diameter 11 cm and length 38.2 cm (hull pipe), other of diameter 4.7 cm and length 31 cm (air chamber) and another pipe of diameter 5.5 cm and length 30.5 cm (ballast tank) respectively. . We have packed the ballast tank and air chamber from both side and drilled 5 holes of 1 cm on top of the hull pipe, air chamber and ballast tank equidistant to one another. We fix the ballast tank inside the hull. We took flexible pipe of diameter 1 cm and attached to the air chamber. Then we pass the flexible pipe from the hull and attached to the ballast tank.

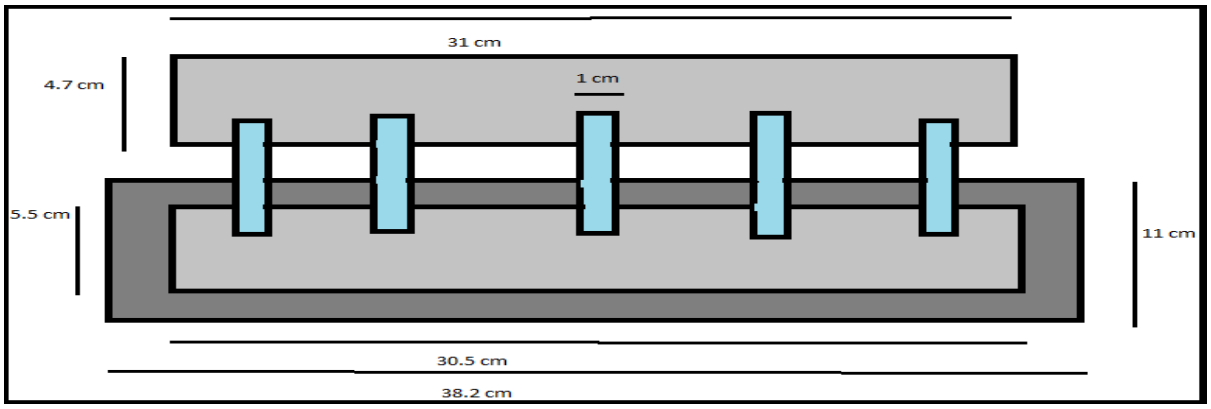


Fig .5.1 Ballast tank

5.1 Construction of model

After completion of the body part we took the rolling pump. The function of rolling pump is to suck and discharge the water by reversing its polarity. We drill the small 0.5 cm of hole at the bottom side of the ballast tank and at the bottom of the hull to fix pump inlet and outlet pipe to it. We seal the pump and fixed it in the hull. We attached the dome of 11 cm on the front side of the hull.

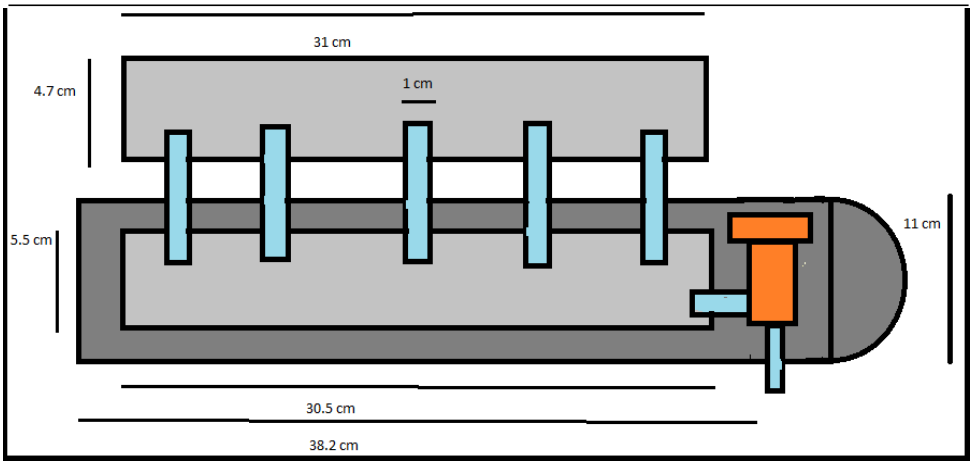


Fig.5.2 Model with rolling pump

We mounted a pressure relief valve on top-midst portion of an air chamber to relief the excess pressure getting generated inside the air chamber and ballast tank. Then the propeller is made from sheet metal of diameter 9 cm to propel the submarine model inside the water. After making a propeller we took pvc pipe of diameter 11 cm and cut it into length of 8 cm to make a rim, inside this rim we made an arrangement of sheet metal plate to mount a motor on it which will drive the propeller.

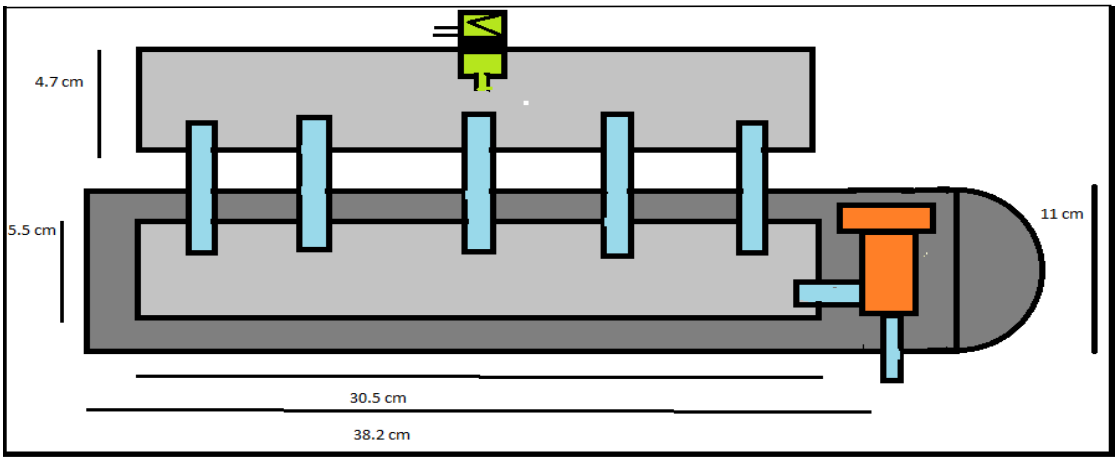


Fig .5.3 Model with pressure relief valve

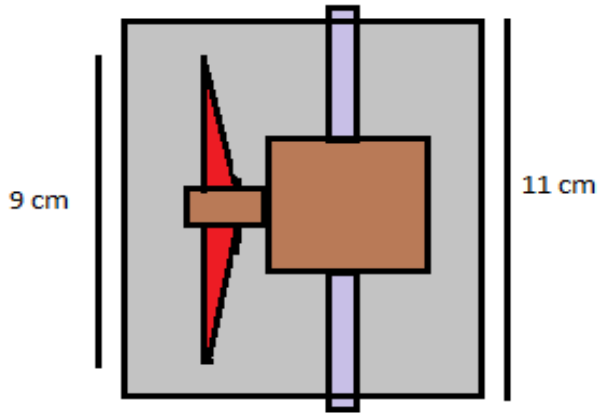


Fig .5.4 Propeller with rim

To navigate the submarine left and right we build a navigation system.it consist of a gear motor and 3 links A, B and C. A gear motor of 45 rpm is mounted inside the bottom of the hull. The shaft of the gear motor is fixed to the center of link A. The links B and C are fixed on the end of link A. The other end of link B and C is fixed on the both ends of sheet metal plate attached on rim.

We made the 2 clamps of hard sheet metal plate and fixed it to hull and pivoted it on the rim at top and bottom. At last we painted the model with black paint for good appearance and for the balancing of the model we added the counter weight.

5.2 Working of model

When we placed the model in the water surface, ¾ portion of the model will be immersed in the water due to its weight. Then start the rolling pump which will suck the water and get collected into the ballast tank due to which its density will increase and model will start to sink. When we increase the quantity of water inside the ballast tank, the excess air pressure generated in the ballast tank will relieved by the pressure relief valve and the model will sink completely.

To navigate the model in left and right direction, we will start the gear motor. When the gear motor is rotating in clock wise direction, submarine tends to turn right and when rotated in anti- clockwise direction, the submarine will tends to turn left.

Now to bring the model back to the water surface, we will start the rolling pump by changing its polarity. This action of rolling pump will remove water from ballast tank and discharge it into the water. Due to this, density of ballast tank will reduce and it will start floating on the water surface.

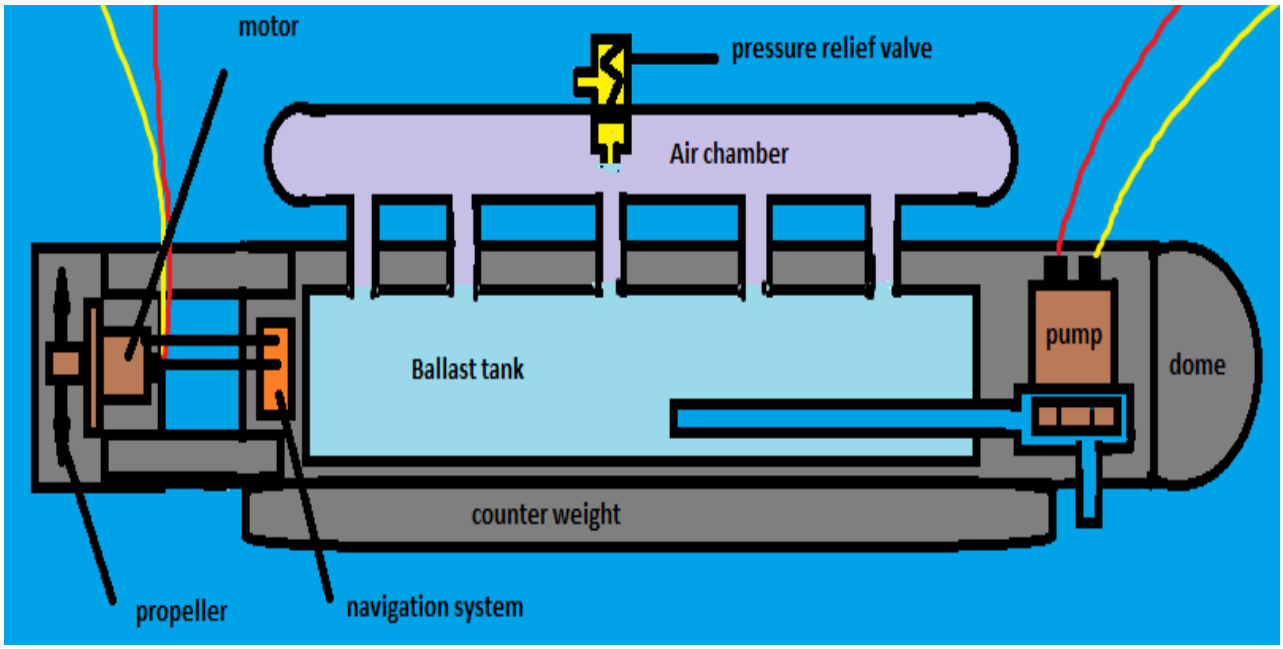


Fig .5.6 Final model.

Chapter 6

Calculation

6.1 Calculation

Hull diameter = 11cm, Length = 38.2cm

Air chamber diameter = 4.7cm, Length = 31cm

Ballast tank diameter = 5.5cm, Length = 30.5cm

Total length = 52 cm

Propeller diameter = 9 cm, Propeller speed = 300 rpm

Gear motor speed = 45 rpm

Area of ballast tank = $\pi/4 * (5.5^2) = 23.75$ cm^2

Area of air chamber = $\pi/4 * (4.7^2) = 17.34$ cm^2

Area of hull = $\pi/4 * (11^2) = 95.03$ cm^2

PVC model weight = 0.520 kg.

Weight of turning mechanism = 0.110 kg.

Weight of rolling pump = 0.100 kg.

Discharge of rolling pump = 1000 ml in 22 sec

Therefore, volume flow rate = $1.35 * 10^{-5}$ m^3/s

Chapter 7

Result and Conclusion

7.1 Result and Conclusion

We have developed a low cost, density variation mechanism which will make submarine able to sink in the water at required depth and help it to float it again. This mechanism is implemented in the submarine in such a way that it has equal weight distribution which will help submarine to balance in the water.

We have used the concept of "density variation" for balancing of the submarine. When the ballast tank volume decreases, the density increases, so that the submarine can move downward and vice versa. The advantage of this ballast water density adjustment technique is its ease.

We have implemented the navigation system inside the submarine to take required direction .It is built in such a way that it can be balanced underwater.

Chapter 8

Future scope

8.1 Future scope

The scope of this project is very large and can be integrated into a variety of applications. Wireless surveillance Camera can be used for the surveillance purposes. The submarine can be controlled wirelessly for better motion and results.

The main purpose of the submarine is for surveillance as we can add surveillance radar and Automatic Identification System (AIS). Underwater Speaker and underwater Sound Deterrent Unit can be added. It can be used as “Mine sniper” which is a mine disposal, efficient mine identification and destruction vehicle.

Underwater sensor networks has significantly advanced in recent years, it is clear that a number of challenges still remain to be solved. With the flurry of new approaches to new mechanism, networking and applications, effective analysis, integration and testing of these ideas is paramount, the field must develop fundamental insights, as well as understand what stands up in practice. The awareness sonars can be added on the underwater surveillance robot such as long Range Awareness Sonar for long range and Passive Awareness Sonar for short range. We can also add diver detection sonar to get the information about the divers into the seas.

Chapter 9

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DESIGN AND DEVELOPMENT OF DENSITY VARIATION MECHANISM OF SUBMARINE

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ABSTRACT

A submarine is a vehicle which travels underneath the sea surface by varying its buoyancy. The submarines are powered by diesel engines, whose drawbacks to a large extent are now overcome by nuclear reactors. It can travel underneath the sea by means of ballast tank, so the design of ballast tank is one of the most important aspect. It should be design in such a way that the submarine should submerged by partially filling the ballast tank. Surely the ballast tank is an engineering master piece that has proved its purpose and might over the years. The inside of a submarine is a totally unknown to the civilian world. Ever since its invention it has undergone various changes and transformations in its different mechanisms to become what it is now. The world is looking forward to seeing the newer changes in the submarine technology. The paper is an effort to look into the engineering aspects of a ballast tank which includes construction details, submerging of submarine, and different mechanism for achieving the task.

Keywords: Submarine, Density variation, Ballast tank, Hull.

I. INTRODUCTION

A submarine can be defined as an underwater counterpart for the surface vessels. In other words, it's a craft which can operate completely submerged in water for long periods. A submarine or ship can float because the weight of the water displaced is equal to the weight of the ship. This displacement of water creates an upward force called the buoyant force and acts opposite to gravity. A submarine can control its buoyancy thus allowing it to sink and surface at will, but a ship can't. A submarine is a vehicle which travels underneath the sea surface by varying its buoyancy. The submarines are powered by diesel engines, whose drawbacks to a large extent are now overcome by nuclear reactors. They are mainly used as a part of the defense system.

II. OBJECTIVE

Our aim is to design and build a density variation mechanism that will perform the same task as used by actual submarine. Below is the list of our objectives that are based on given specific parameters such as weight and the size of the submarine. Our main objective is to build the mechanism for submarine using cheaper and effective material that would withstand the pressure based on the depth of the water.

1. To learn the existing mechanism.
2. To design ballast tank for submarine.

III. PROPOSED METHODOLOGY

The methodology used for the mechanism in our project is to fill the ballast tank with water in an air tight condition so that as the water flows inside the ballast tank, air present inside the ballast tank will flow into the air chamber. Due to which more volume will be available thus more quantity of water will be filled in the ballast tank which will help to sink the submarine more conveniently. When the submarine is required to bring back to the surface, pump is started, the water is expelled from the ballast tank and the compressed air present in the air chamber will occupy the ballast tank which will help to bring the submarine back on the surface.

Our methodology comprises of various experiment which are performed on trial and error basis. We have successfully performed experiments on 12 models which are listed below with detailed information.

01. Ballast tank using single 1-way pump.

02. Ballast tank with an air vent using single 1-way pump.
03. Ballast tank with an air chamber using single 1-way pump.
04. Ballast tank with an air chamber using two 1-way pump.
05. Ballast tank with single propeller using single 1-way pump.
06. Ballast tank with two propeller using single 1-way pump.
07. Ballast tank with balloon inside it using single 1-way pump.
08. Ballast tank with balloon outside it using single 1-way pump.
09. Ballast tank with piston and gear arrangement.
10. Ballast tank with T-type air chamber using 2-way pump.
11. Ballast tank with air chamber using 2-way pump.
12. Ballast tank with hull and air chamber using 2-way pump.

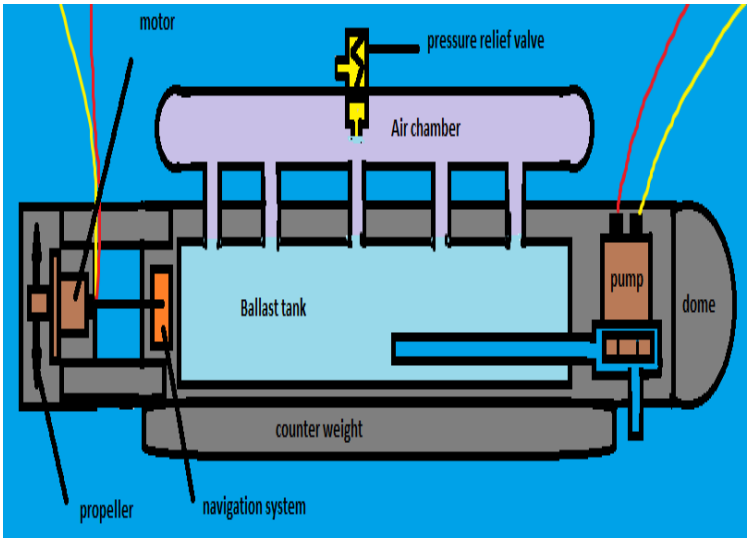
IV. IMPLEMENTATION METHODOLOGY

We have used the ballast tank with hull and air chamber with 2 way pump technique to implement in our final model. Firstly we took the big diameter pvc pipe for our submarine body (hull) in which the two same diameter pipe are fixed one at the top of the bigger pipe i.e. air chamber and another one inside it i.e. ballast tank. We drill the 5 holes at top portion of hull and pass the flexible transparent pipe through it. One end of the flexible pipe is connected to air chamber which is at the top of the hull and other end is connected to the ballast tank which is inside the hull. On the top middle portion of the air chamber we have implement the air pressure relief valve to relief the excess pressure of air.

Then we have drill in the bottom of ballast tank and connect the two way pump to suck and discharge the water as shown in figure. In front of the two way pump there is the dome attached to get the curved shape body and on the other corner navigation system is attach which will navigate the propeller.

Then we took one more hull diameter pipe and cut it into small length. Then we have attached the propeller and motor on it. Propeller is made up of sheet metal of diameter 4.5. Both the hull and propeller pipe is connected with each other using sheet metal plate. (Pivoted on propeller pipe).The counter weight is added to balance and submerged the submarine half inside the water. All the components are sealed properly and took the connected wire out from the model. Both the pipe i.e. air chamber and ballast tank are interconnected with each other with flexible pipe

When we start the pump the water starts flowing inside the ballast tank and air inside the ballast tank get compressed which will get released through pressure relief valve. As it density gets increased than water it gets sink. To float it again we reverse the polarity of 2 way pump which will remove the water from the ballast tank. The navigation mechanism is to to give the left/right direction to submarine model inside water.



V. CALCULATION

Hull diameter = 11cm, Length = 38.2cm
Air chamber diameter = 4.7cm, Length = 31cm
Ballast tank diameter = 5.5cm, Length = 30.5cm
Total length = 52 cm
Propeller diameter = 9 cm, Propeller speed = 300 rpm
Gear motor speed = 45 rpm
Area of ballast tank = $\pi/4 * (5.5^2) = 23.75$ cm^2
Area of air chamber = $\pi/4 * (4.7^2) = 17.34$ cm^2
Area of hull = $\pi/4 * (11^2) = 95.03$ cm^2
PVC model weight = 0.520 kg.
Weight of turning mechanism = 0.110 kg.
Weight of rolling pump = 0.100 kg.
Discharge of rolling pump = 1000 ml in 22 sec

Therefore, volume flow rate = $1.35 * 10^{-5}$ m^3/s

VI. RESULTS AND DISCUSSION

We have developed a low cost, density variation mechanism which will make submarine able to sink in the water at required depth and help it to float it again. The mechanism is implemented in the submarine in such a way that it has equal weight distribution which will help submarine to balance in the water. we have used the concept of "density variation" for balancing of the submarine. When the ballast tank volume decreases, the density increases, so that the submarine can move downward and vice versa. The advantage of this ballast water density adjustment technique is its ease. We have implemented the navigation system inside the submarine to take required direction .It is built in such a way that it can be balanced underwater.

VII. FUTURE SCOPE

The scope of this project is very large and can be integrated into a variety of applications. Wireless surveillance Camera can be used for the surveillance purposes. The submarine can be controlled wirelessly for better motion and results. The main purpose of the RC submarine is surveillance as we can add surveillance radar and Automatic Identification System (AIS). Underwater Speaker and underwater Sound Deterrent Unit can be added. It can be used as "Mine sniper" which is a mine disposal, efficient mine identification and destruction vehicle.

Underwater sensor networks has significantly advanced in recent years, it is clear that a number of challenges still remain to be solved. With the flurry of new approaches to new mechanism, networking and applications, effective analysis, integration and testing of these ideas is paramount, the field must develop fundamental insights, as well as understand what stands up in practice. The awareness sonars can be added on the underwater surveillance robot such as long Range Awareness Sonar for long range and Passive Awareness Sonar for short range. We can also add diver detection sonar to get the information about the divers into the seas.

VIII. ACKNOWLEDGMENT

The prof. Aslam Hirani, Department of mechanical engineering, New panvel, for his valuable support and guidance throughout our project work. Without his kind guidness and support this was not possible.

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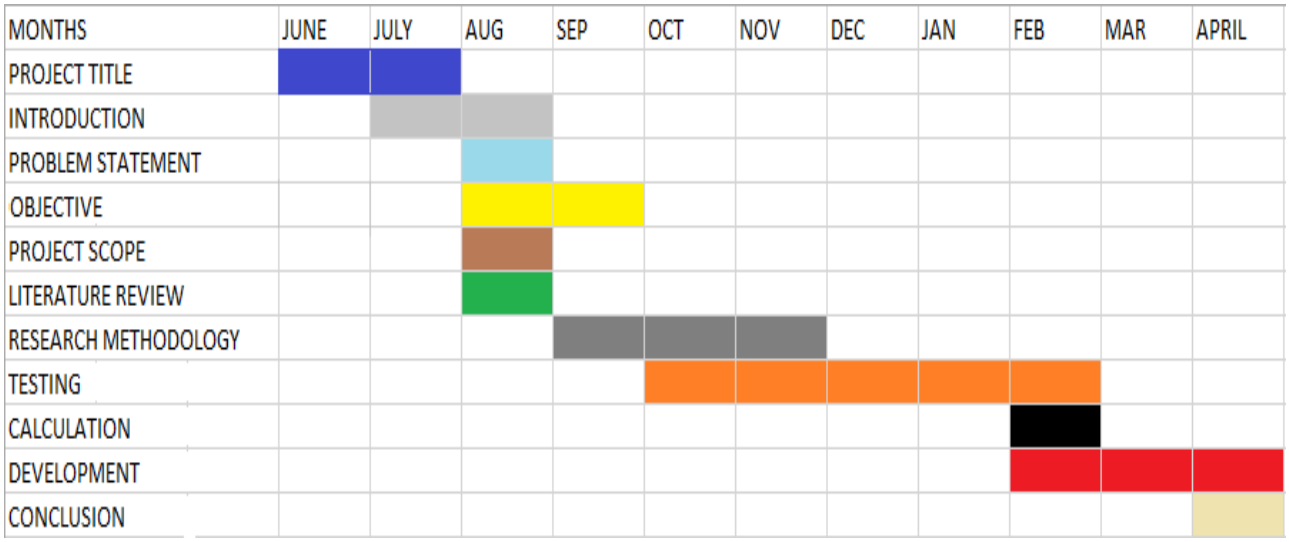
Appendix I

Table shows words with abbreviations used is paper.

Abbreviations	Words
A	Air
B	Buoyancy, Ballast
C	Chamber
D	Density
E	Equidistant
F	Force
G	Gravity
H	Hull
M	Motor
N	Neutral
O	Operation
P	Propeller, Pipe
Q	Quantity
R	Rim
S	Submarine
T	Tank
W	Water

Appendix II

Graph shows flow of project from month June to April.



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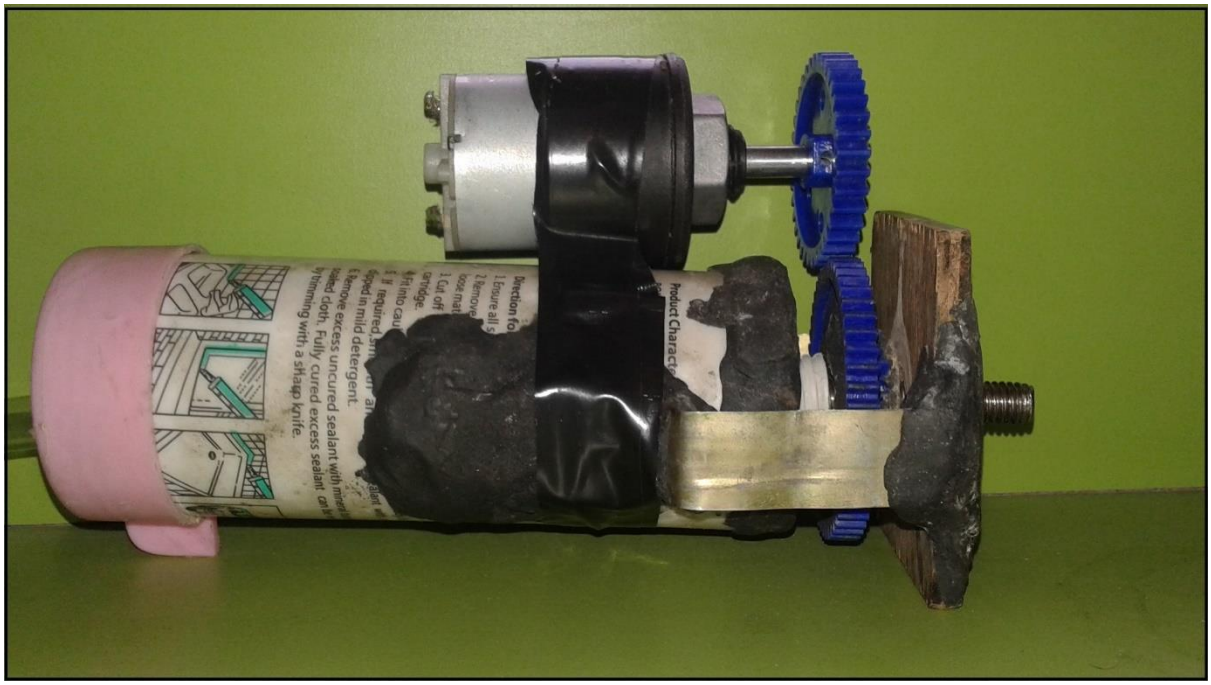
KHAN ABDUL QADIR (12ME26)

BHAIJI OWAIS (13ME127)

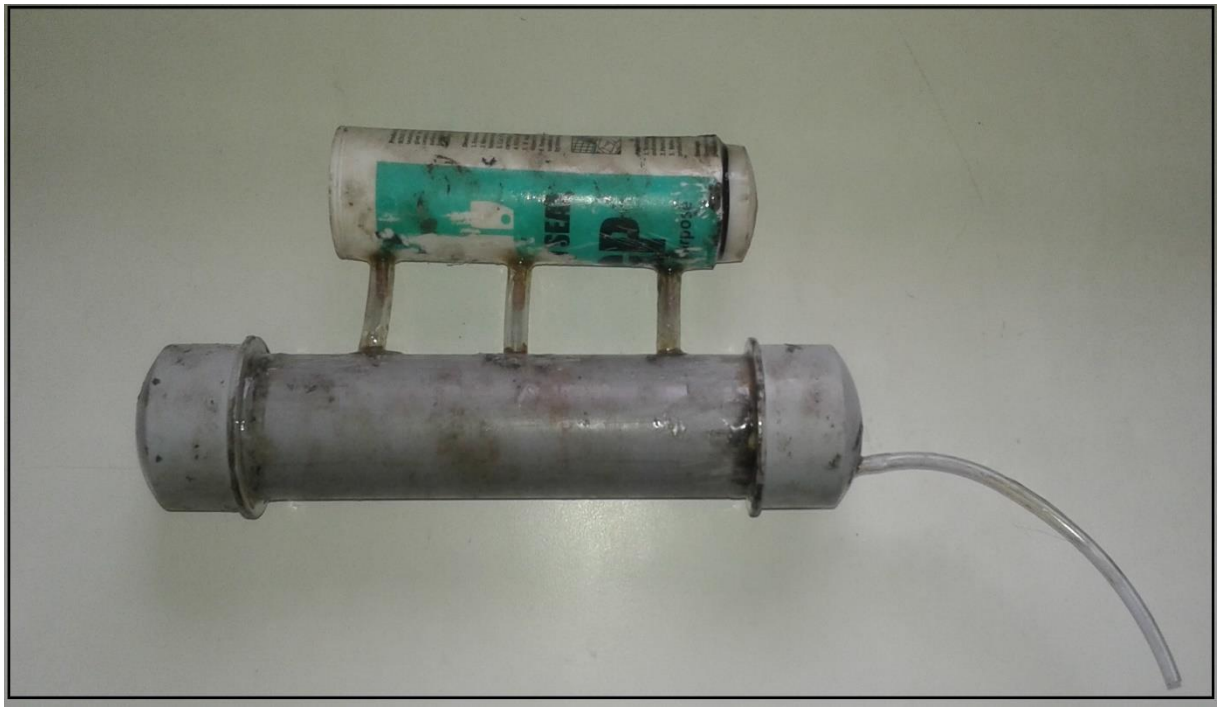
YAHU TUFAIL (13ME131)

PATEL SAHIL (13ME142)

PHOTOS



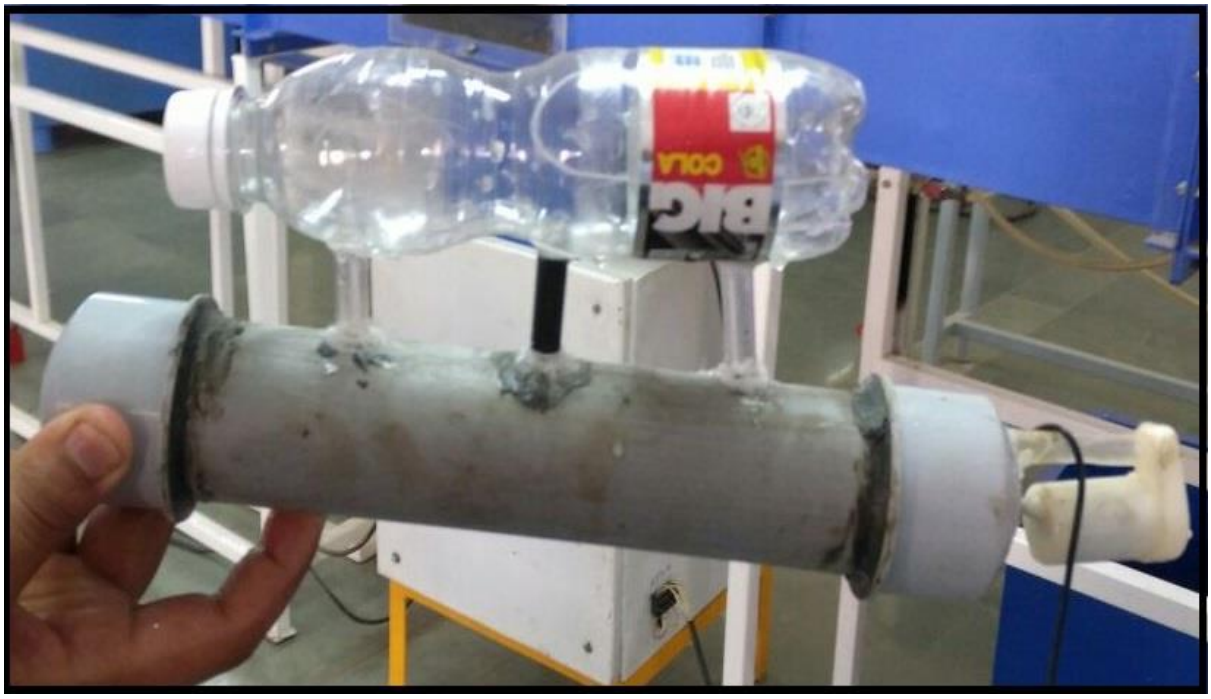
1. Gear and piston mechanism.



2. Ballast tank with air chamber.

PHOTOS

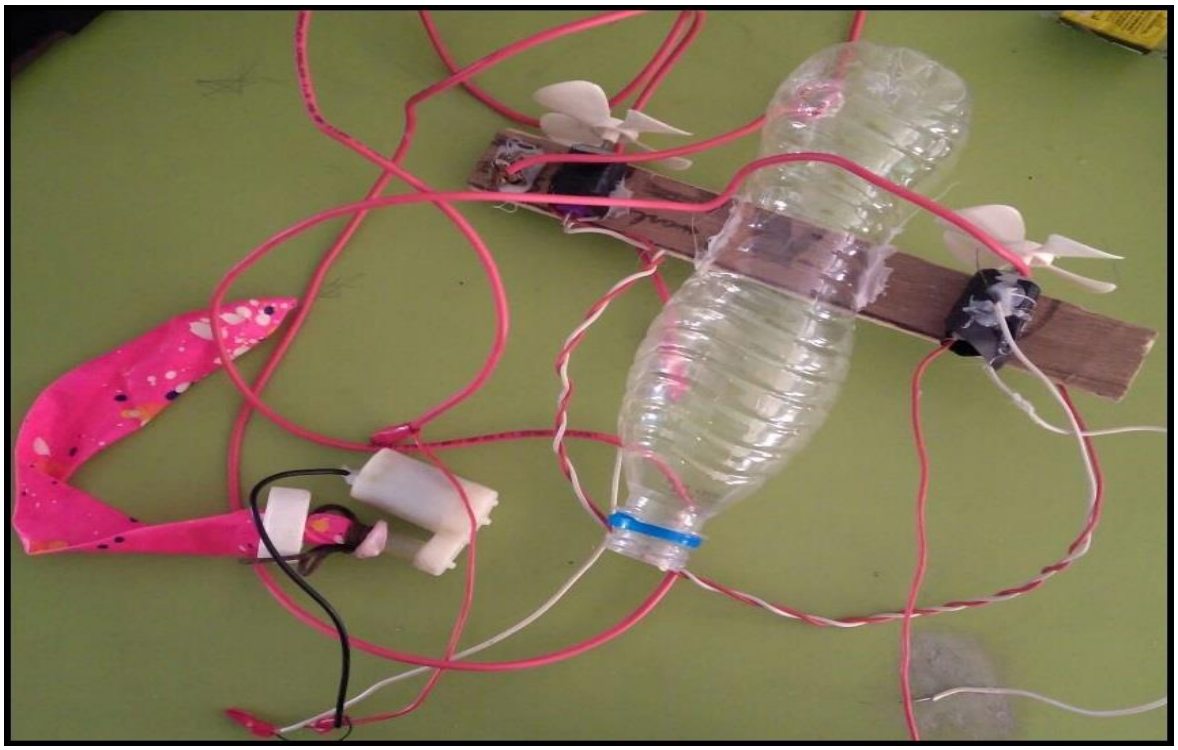
3. Drilling operation.



4. Ballast tank with one way pump and air chamber.

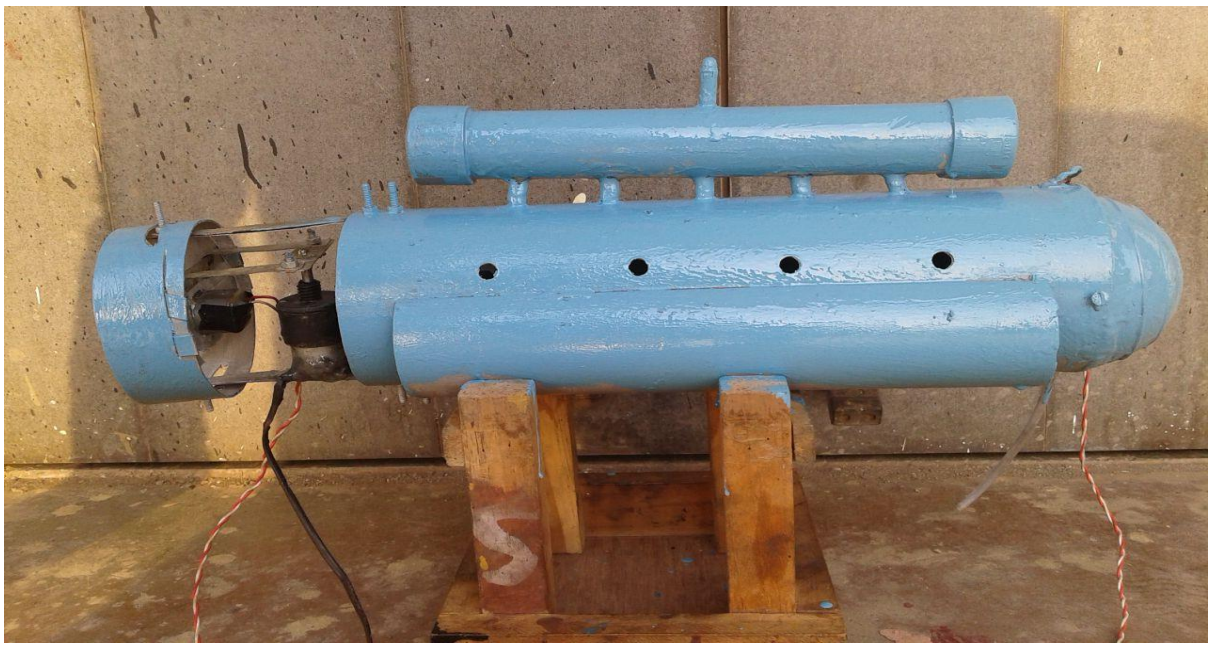
PHOTOS

5. Ballast tank with two pump



6. Model with propeller.

PHOTOS



7. Submarine Model

8. Submarine Model (back view)