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Design of Special purpose Machine for Bolt Loosening

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Abstract

Automation is the technology by which process or procedure is performed with minimum human assistance automation. Automatic control is the use of various control system for operating equipment such as machinery processes in factories boilers and heat treating ovens, switching on telephone networks, steering and stabilization of ships, aircraft and other applications and vehicles with minimal or reduce human intervention. Some processes have been completely automated.

Automation has been achieved by various means including mechanical, hydraulic, pneumatic, electrical, electronic devices and computers, usually in combination. Complicated systems, such as modern factories, airplanes and ships typically used all these combined techniques. The benefit of automation includes labour savings, savings in electricity cost, saving in material, cost and improvement to quality, accuracy and precision.

1 AIM OF PROJECT

To design a mechanism for special purpose of loosening bolts of intermediate plate of clutch housing.

The operation of loosening bolt is performed to remove intermediate plate, thereby enabling worker to clean and perform other operation on the surface below the intermediate plate.

Conventionally, the industry had to undergo a very lengthy process to meet production requirements. Worker had to loosen the tightly fit bolts using Spanners by hand and job was tedious. As the size of the bolts where different handling different spanners would consume a bit of time, the operation would consume a lot of energy of worker as losing required large initial force increasing inconvenience and resulting into exhausting of worker at the end of the day, eventually reducing production rates.

Thus number of parts cleaned and bolts loosened fell short of requirement, this became another demerit of conventional method.

To overcome above-mentioned demerits company decided to switch over to special purpose machine which would transform manual operation into automatic operation. Automation ensures Mass production and less rejection of jobs but requires high initial investment, therefore need for an SPM with low cost became necessary. Design proposal with low cost was no less than challenge for „Phoenix engineering“.

Features expected in machine are as follows,

- Automation
- Safety
- Display
- Loosening

To attain automation design of machine becomes crucial part, mechanism should be designed that the process takes place stepwise and works error-free path of component moment should be attained in many ways but we had to choose the method which becomes most convenient to design and assures low cost automation with above considerations components where decided.

- Pneumatic cylinders
- PLC
- Sensors
- Locating assembly
- Gear-box
- Power-pack
- Servo Motor

Due to human tendency of being lazy at times, it should be kept in mind to include components ensuring safety and Full focus of worker,

- Two hand start/stop
- Poka-yoke
- Emergency stop
- Safety curtain

2 METHODOLOGY

- Adaptive project Framework.
- CAD based development.
- Feature driven development.
- DMAIC.
- Poka-yoke.

2.1 Adaptive Project Framework

It accommodates the unknown factors that can crop up during a project. It prepares terms to anticipate the unexpected and respond. Think of it core principal as "learning by doing" by approaching projects with the understanding that key components are constantly in flux, teams can adopt a flexible mind set to continually learn by re- evaluating results and decisions throughout a project. This requires regular communication with stakeholders at every level for the team to effectively adapt.

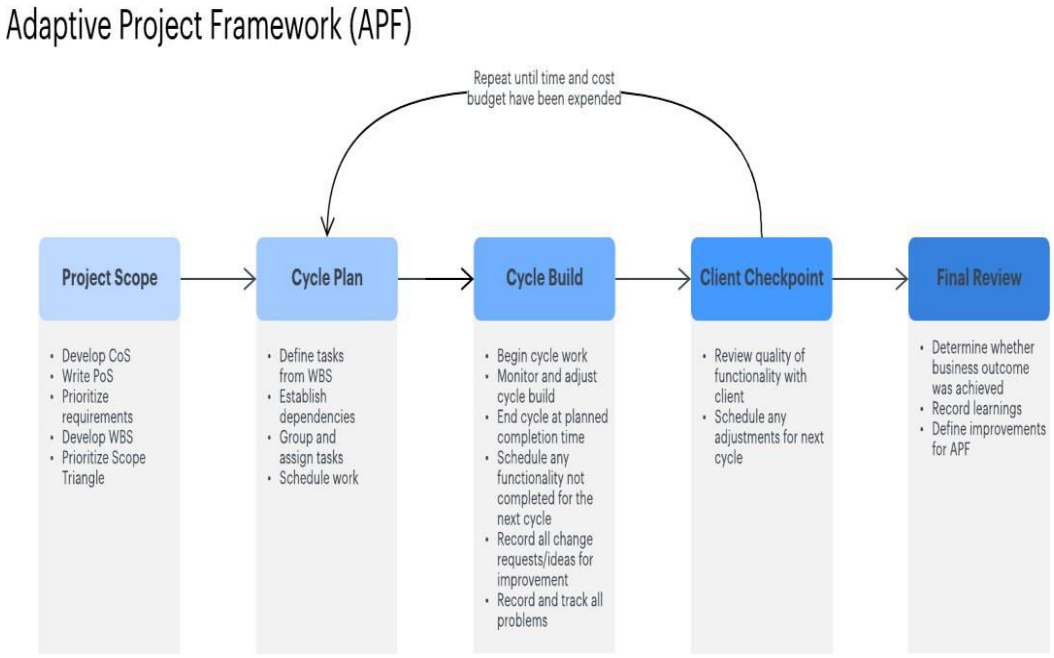


FIG 3.1 ADAPTIVE PROJECT FRAMEWORK

2.2 CAD Based Development

Computer-aided design CAD involves creating computer models Defined by geometrical parameters. These models typically appear on a computer monitor as a three dimensional representation of a part or a system of parts, which can be readily altered by changing relevant parameters. CAD systems enable designers to view objects under a wide variety of representations and to test these objects by simulating Real world conditions.

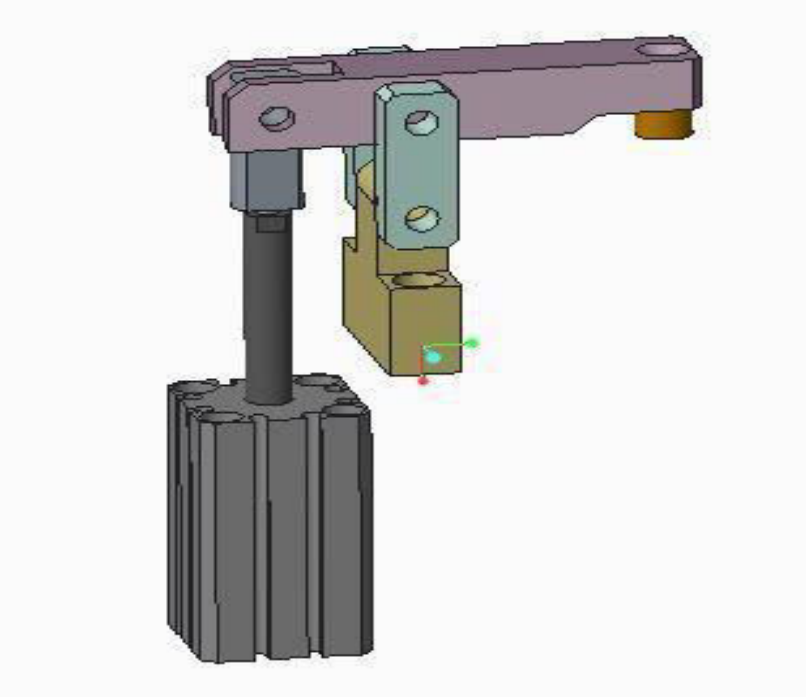


FIG 3.2 CAD BASED DEVELOPMENT

2.3 Feature Driven Development

The feature driven development methodology is aligned to Agile development methodology. It is a design oriented Agile process developed and refined by geoff De Luca, Peter code and others. The project is divided into features. These features are small pieces of a complete project. With the help of FDD you can create design, code and code inspection schedules without going into elaborate paperwork. Here the focus is more on relying on people and their roles for development.

FDD has 5 process steps

FIG 3.3 FDD

Develop an overall model: client and development team make an overall model. Detailed domain models are created and then these models are progressively merged into overall model. Guided by a chief architect, team members get a good understanding of the complete model.

Build a features list: information gathered in the first step is now deduced to make a list of required features. A feature is a small, client valued output the whole project is divided into features. A feature needs to be delivered every 2 weeks. Therefore the feature the team decides to work on must take less than 2 weeks to be implemented.

Plan by feature: now the development of the feature is planned. It is all about in which order the features will be implemented. Teams are selected and assigned feature sets.

Design by feature: chief programmer chooses the feature and the domain classes that will be involved in designing the feature. Sequence diagrams are drawn. General designs of the features are also finalized. Class and method prologues are written. It is all followed by design inspection.

Build by feature: After the design inspection, the domain expert explains the specifics, class owner‟s start building and implementing all the items necessary to support the design. Code is developed, unit tested and inspected and approved by chief programmer who then gives an ok and the completed feature is added to main build.

b) FDD is a spectacle short iteration process.

Feature driven development is model driven, short iteration process. Before the process begins the overall model shape is established. The development of features is then on track with a series of 2 Week “design by feature, built by feature” iterations. Most importantly the features are small “useful in eyes of the client” results. Developers focus on the features that are important to client.

c) FDD is Agile,

FDD is an Agile methodology. Businesses these days don‟t want to wait a long time for results. The crux of this methodology depends iteration cycle of two weeks. The features are build within 1 to 12 days. Any feature that requires longer time than this his futher broken down until it meets the two weeks rule.

d) FDD uses the best methodologies

FDD incorporates the best of different Agile methodologies like extreme programming and scrum. It uses models-centric techniques including domain driven design by Eric Evans and modelling in colour by Peter code. Domain driven design focuses on co- domain and domain logics. Complex designs are based on the model of domain. One needs to constantly collaborate with domain expert to improve application model and resolve domain related issues. There is UML colour standard a set of 4 colours associated with unified modelling language(UML) diagrams. The colours indicate the the archetypes applied to UML objects.UML reporting components captures feature progress during FDD. The use of colour enables quick understanding of the problems domains dynamics.

2.4 DMAIC

Define, Measure, Analyze, Improve, Control. Incremental process improvement using Six Sigma methodology. See DMAIC Methodology

Pronounced (Duh-May-Ick).

DMAIC refers to a data-driven quality strategy for improving processes, and is an integral part of the company"s Six Sigma Quality Initiative. DMAIC is an acronym for five interconnected phases: Define, Measure, Analyse, Improve, and Control.

Each step in the cyclical DMAIC Process is required to ensure the best possible results. The process steps:

- Define the Customer, their Critical to Quality (CTQ) issues, and the Core Business Process involved.
- Define who customers are, what their requirements are for products and services, and what their expectations are,
- Define project boundaries the stop and start of the process.
- Define the processes to be improved by mapping the process flow.
- Measure the performance of the core business process involved.
- Developer data collection plan for the process.
- Collect data from any sources to determine type of defects and metrics.
- Compare to customer service to determine short fall.
- Analyze the data collected and processed map to determine route causes of defect and opportunities for improvement.
- Identify gaps between current performance and goal performance priorities opportunities to improve.
- Identify sources of variation.
- Improve the target process by designing creative solutions to fix and prevent problems.
- Prevent solutions using technology and discipline.
- Create innovate solutions using technology and discipline.
- Develop and deploy implementation plan.
- Control the improvement store keeps the process on the new course.

- Prevent reverting back “the old way”
- Require the development, Documentation and implementation of an ongoing monitoring plan.
- Institutionalize the improvement through the modification of system and structures (staffing, training, incentives).

2.5 Poka-Yoke

Poka-yoke is Japanese term that means “mistake proofing” or “inadvertent error prevention”. Poka yoke is any mechanism in any process that helps an equipment operator avoid mistakes. Its purpose is to eliminate product defects by preventing, correcting or drawing attention to human errors as they occur. The concept was formulised and the term adopted by Shingeo Shingo as part of the Toyota Production System. It was originally described as Baka-yoke, but as this means “fool-proofing” the name was changed to my milder poka-yoke.

More broadly, the term can refer to any behaviour-shaping constraint designed into a process to prevent incorrect operation by the user.

Simple poka-yoke example is demonstrated when a driver of the car equipped with a manual gearbox just press on clutch pedal prior to starting an automobile. The interlock service to prevent unintended moment of the car.

Poka yoke can be implemented at any step of the manufacturing process where something can go wrong or an error can be made. For example a fixture that holds pieces for processing might be modified to only allow pieces to be held in the correct orientation, or Digital counter my track the number of spot welds on each piece to ensure that the worker executes the correct number of Welds.

Shingeo Shingo recognised Three Types of poka yoke for detecting and preventing errors in a mass production system:

1. The contact method identifies product defects by testing the product shape, size, colour or other physical attributes.
2. The fixed value method alerts the operator if a certain number of moments are not made.
3. The motion step method determines whether the prescribed steps of the process have been followed.

Either the operator is alerted when a mistake is about to be made, or the device actually prevents the mistake from being made.

Benefits of poka-yoke implementation,

A Typical feature of poka yoke solution is that they don‟t let an error in a process happened. But that is just one of their advantages others include,

Less time spent on training workers.

Elimination of many operations related to quality control. Unburning of operators from repetitive operations.

Promotion of work improvement oriented approaches and action. Reduce number of rejects.

Immediate action when problem occurs. 100% built-in quality.

3 LITERATURE REVIEW

Existing paper by Prof.Prasad Bapat,**"Case Study Of Designing a special purpose machine"** in Nov2014: States that special purpose machine tools are designed and manufactured for specific jobs. Special purpose machine replaces the job of 2 to 3 workers in a single unit with time reduction so that more time is saved per unit. An application mechanism which could make justice to our problem statement is chosen. Mechanism is operated by fluid power. Mechanism is application of pneumatics, Gear drives and induction motor giving combined effect.

From the paper **"High speed Induction motor with an Integrated Gearbox For Propulsion"** written by Kevin S.Campbell states about the working principles of high speed induction motor and planetary gears. Induction motor consisting of stator and rotor. The rotor in her produces the final torque while the stator has electrical windings that will have an alternating current (AC).Electromagnetic field is created. Along with this losses are also considered. The windings in an induction motor are key to the operation and efficiency of the system. Different windings of layout are there.
Single winding and double winding.

Planetary Gears: Mainly consists of sun gear, planet gears, planet carrier an ring gear. One amongst this gear is constrained, which is normally the ring gear. Cases are given which considers sun gear can as input gear and planet gear are output of system through planet carrier. The planet gears are connected with planet carrier. This configuration as discussed in paper gave us the idea of output speed is reduced from the input.

Above table thus gives a broad idea how exactly the design should be done so as to increase torque or to decrease the speed. Combining both the induction motor and planetary gear make up promising alternative for electric drive system. Using high speed induction motor with the planetary gear can improve overall torque density. Thus giving a combined idea of achieving a proper usage of reduction gear box for having a good torque performance.

SUN GEAR	CARRIER	RING GEAR	SPEED	TORQUE
INPUT	OUTPUT	HELD	MAXIMUM REDUCTION	INCREASE
HELD	OUTPUT	INPUT	MINIMUM REDUCTION	INCREASE
OUTPUT	INPUT	HELD	MAXIMUM INCREASE	DECREASES
HELD	INPUT	OUTPUT	MINIMUM INCREASE	DECREASES
INPUT	HELD	OUTPUT	REDUCTION	INCREASE
OUTPUT	HELD	INPUT	INCREASE	DECREASES

A research article written by Yan Chen,Qiang Gao and Zehenquan Guan named as **"Self-loosening failure analysis of bolt joints under vibration considering the process of loosening. "**This paper nearly states the types of failures which are likely to happen in the case of bolt. It is worth considering the bolt failures as the machine is designed for the purpose of bolt loosening and bolt is a main component. So to ensure that bolt remains safe when a external force i.e. driven gears act on nit inserted in bolt does not twist it while rotating the nut. This paper gives us proper considerations by which the analysis are carried out giving us information of the actions to be taken for proper processs to work without any distortion in the bolt.

Paper Presented by Dr.R.Vinaygasundaram, Dr.C.Velmurugan **"Implementation of zero defect through poka yoke approaches in the assembly line of compressor manufacturing Industry."** Poka yoke is mechanism used in project to reduce rejection and rework percentage. Poka Yoke ensures that proper condition exists before actually executing a process step, preventing defect from occurring in first place. The main objective of paper was to produce zero defect machine i.e. improving product and process quality by implementing preventive tool. Main research methodology used were defect data collection and primary data source collected through assembling brainstorming sessions, PDCA. This paper describes the steps which would certainly help in error reduction. A process flow must be followed for achieving the Poka Yoke. Fixture implemented part added on the guidance, for the machine part fixing and fixtures while the complete design is been formed and implemented.

From the paper **"Design and development of Pneumatic punching machine"** written by Anand kumar singh,Mites L Patil: Hand Presses done have many disadvantages and while carrying or lifting process through. So the equipment like pneumatic helps in lot of sector for purpose of serving a better task and selection of the pneumatic cylinder configuration is based on the work to be done in more accurate way. The pneumatic system has gained a lot of importance. This is due to accuracy and cost. This Can be easily operated by the operators and complied with PLC's. It has an advantage to work even on low pressure of 6 bar. The Pressurized air passes through tubes of cylinder, forces the piston out whose power through the linkage is transmitted to the punch. Thus according to the work material the operating pressure can be varied.

Considering all the above papers which we have referred gave us a guideline to develop and make justice to problem statement with zero error by following it through Poka Yoke. What all components are needed and how to implement them together for providing a profitable outcome with minimum labour use was made up. Selection of Induction motor with gear box was clearly oriented from the paper referred so as to provide torque to do the task as and when required without giving any fluctuations in work process. This overall System built will ensure that the latest technology quality and the required task will be fulfilled for holding up company in good standards.

4 COMPONENTS

4.1 THE WORK PIECE

5.1.1 CLUTCH HOUSING

Clutch Housing is a critical part of housing system which holds clutch plates, pressure plates and conducts complete clutch function in combination with clutch centre and hub. A cast iron or aluminium housing that sounds the clutch mechanism. This cover is made by cold forming process of 2.5 to 4 mm thick sheet steel. It is aligned relatively to the flywheel axis with the aid of locating pins, collars or bolts.

The clutch housing should ensure good airing:

For cooling the frictional surfers.

To remove the wear products from them.

Openings are made in the house subject to the condition of housing desired rigidity.

5.1.2 Intermediate plate

The gearbox has a cast intermediate plate which support all the main bearings in this gearbox. This intermediate plate are casted from aluminium and are not as solid as they should be. The bearings can move vertically into opposite direction by giving talk on the main shaft. This intermediate plate encloses the bearings in various table way and give them a much better support.

Additionally this intermediate plates gives you the possibility to a adopt the gearbox oil cooling system. We have place two trades on the undesired of the plates where the oil line and and thermo switch can be bolted on. On Top of plate we have another thread for the return line of the cooled oil. This intermediate plate made very precisely. There is no alignment necessary on the gearbox itself. Mounting of the plate can be done during a revision of the gearbox.

4.2 Pneumatic Cylinder

1. General description.

Pneumatic cylinders are mechanical devices which use the power of compressed gas to produce of force in a reciprocating linear motion. Hydraulic cylinder something forces piston to move in the desired directions. The pistol is a disc or cylinder and the piston rod transfer the 48 developed to the object to be most but instead if this we use pneumatic cylinder because they are quite, cleaner and do not require large amount of space for fluid storage.

Because operating fluid is gas, leakage from pneumatic cylinder will not drip out and contaminate the surrounding, making pneumatics more desirable where cleanliness is requirement.
Once actuated, compressed air enters into the tube at one end of the piston and impact force on the piston.

2. CYLINDER USED:

Double-acting cylinders

Double-acting cylinders (DAC) use the force of air to move in both extends and retract strokes. They have two ports to allow air in, one for outstroke and one for in stroke.

Stroke length for this design is not limited, however, the piston rod is more vulnerable to buckling and

bending. Additional calculations should be performed as well.

As the International Fluid Power Society explains, other cylinder systems are double- acting, or systems that use valves to inject two different streams of compressed air, alternating on either side of the piston. One burst of compressed air pushes the piston out, and another burst pushes it back it to the starting position. More compressed air is needed in this system, and like the others the pressure of the air used needs to be carefully controlled.

3. Design

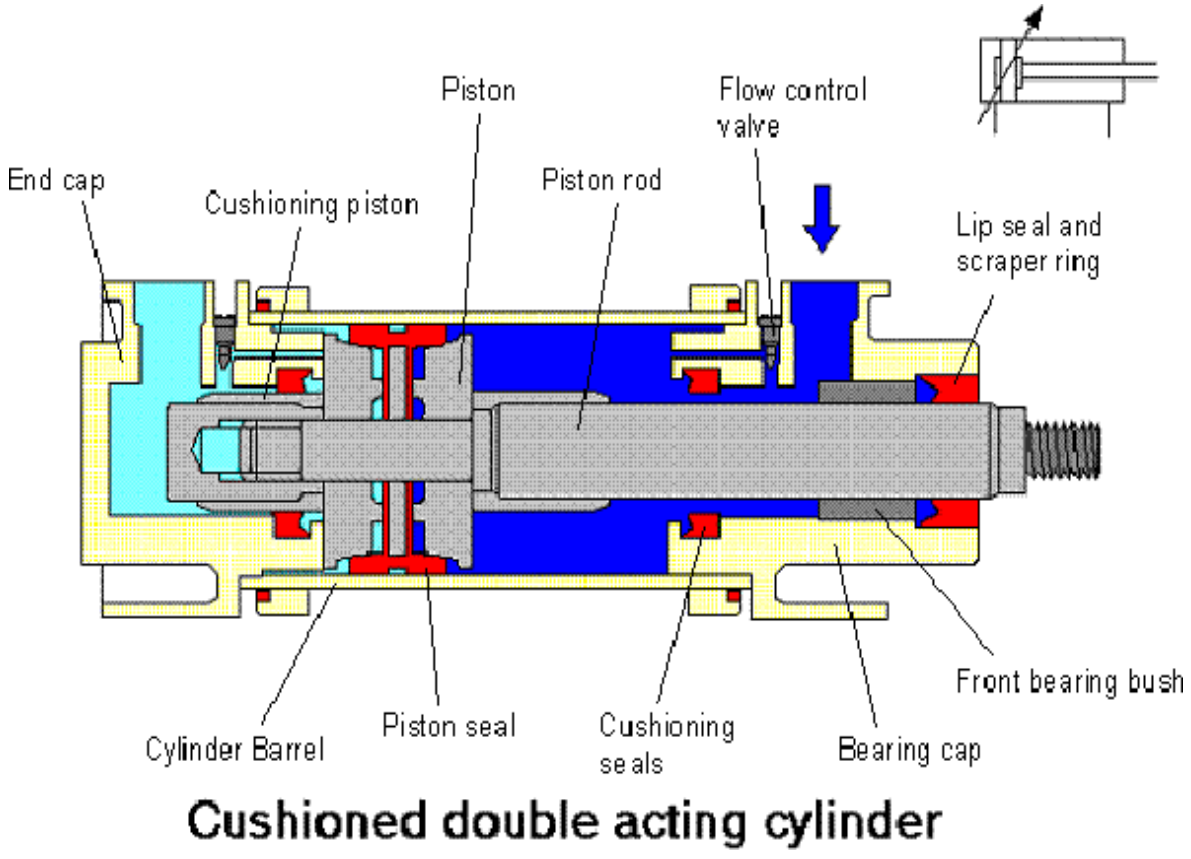


FIG 5.2.3 PNEUMATIC CYLINDER

4 Construction

Double acting cylinder with piston rod on one side. Figure shows the operation of a double acting cylinder with piston rod on one side. To extend the cylinder, pump flow is sent to the blank end port as in Figure. Fluid from the rod end port returns to the reservoir. To retract the cylinder, the pump flow is sent to the rod end port and fluid from the blank end port returns to the tank as in Figure.

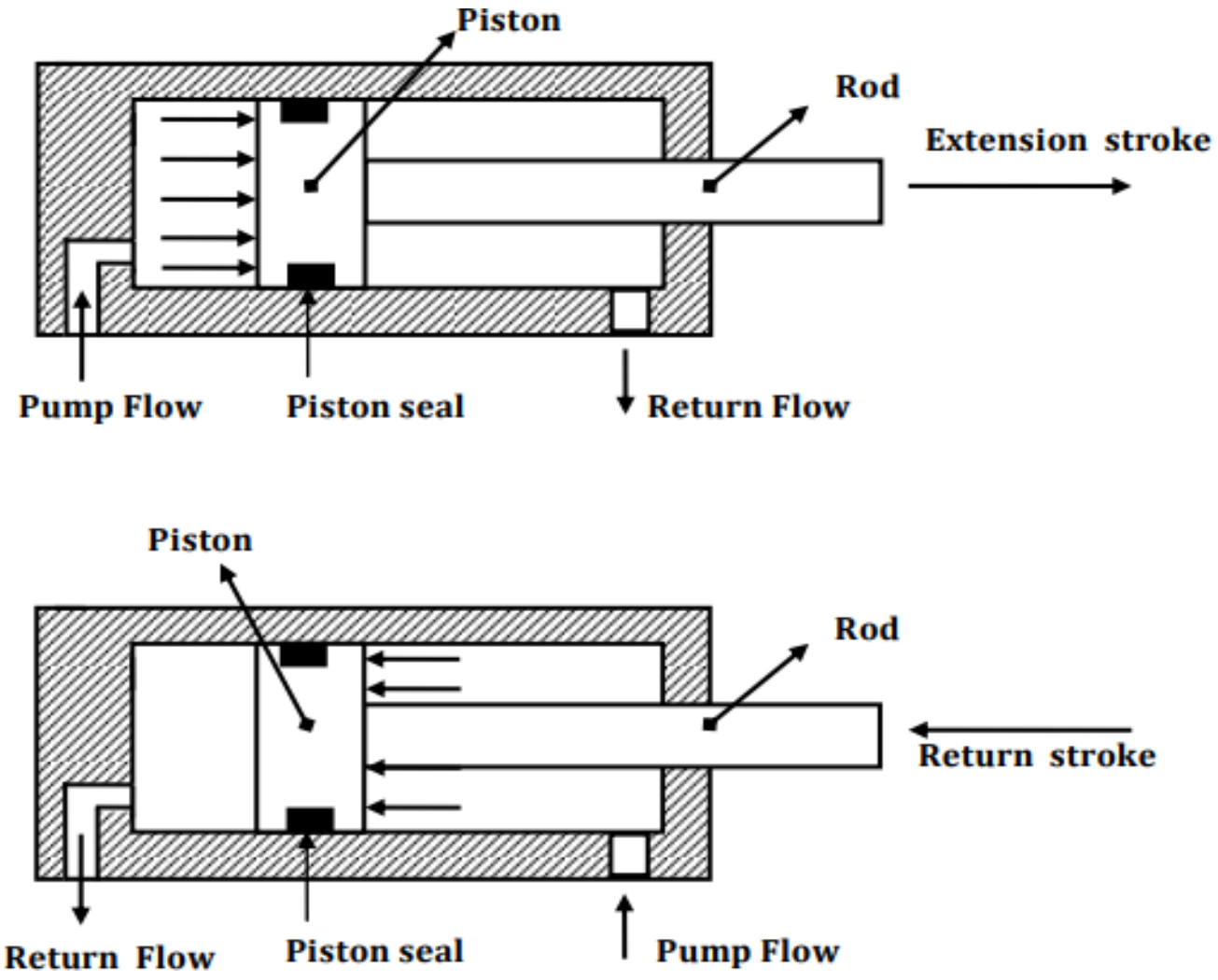


FIG 5.2.4 WORKING OF DOUBLE ACTING CYLINDER

4.3 FRL

FRL unit is a device consisting of air filter, air regulator and air lubricator. It is also called as air servicing unit, because it does the functions of cleaning, pressure adjustment and lubricating the compressed air.

Functions of FRL unit:

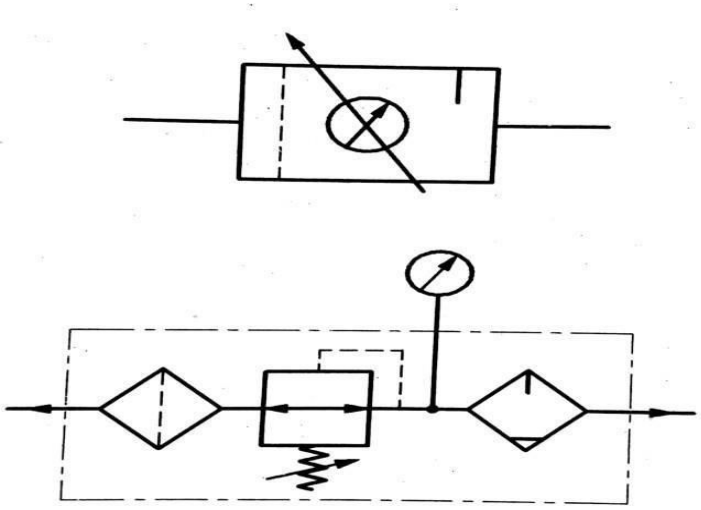


FIG. 5.3.1 SYMBOL

-Air filter: It separates solid contaminants from compressed air and provides clean air to pneumatic system.

-Air regulator: It is a pressure reducing valve. It maintains constant reduced pressure in pneumatic system.

-Air Lubricator: It adds lubricating oil to the following compressed air in the form of mist and fog.

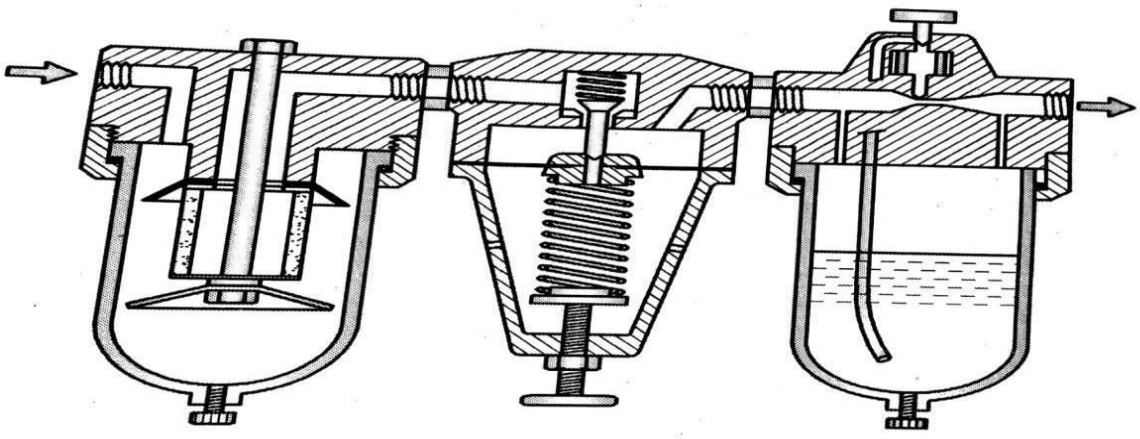


FIG 5.3.2 FRL UNIT

4.4 PLC

A programmable logic controller PLC for programmable controller is an industrial digital computer which has been ruggedized an adopted for the control of manufacturing processes, such as assembly lines, for robotics devices, or any activity that requires highly reliability control and is of programming and process fault diagnosis.

They were first developed in the automobile manufacturing industry to provide flexible, ruggedized and easily program programmable controller to replace hard- wired relay, timers and sequencers. Since then they have been widely adopted as high- reliability automation controller suitable for harsh environments. A PLC is an example of a “hard” real-time system since output results must be produced in response to input conditions within a limited time otherwise Unintended operation will result

Need:

PLC is used in the fully automated industries for plants or processes, the the actual process handled and controlled by the controllers which are nothing but the programming logic controllers that means PLC plays a very important role in automation section. PLC constantly monitor the state of the system through input devices and generate the control actions according to the logic given in the user program. It is a heart of control system, PLC monitors the state of the system through field input devices, feedback signals and based on the feedback signal PLC determine the type of action to be carried out at field output devices. PLC provides easy and economical solutions for many automation task like operates control and monitoring.

- Coordination and communication.
- PID computing and control.
- logic/sequence control.

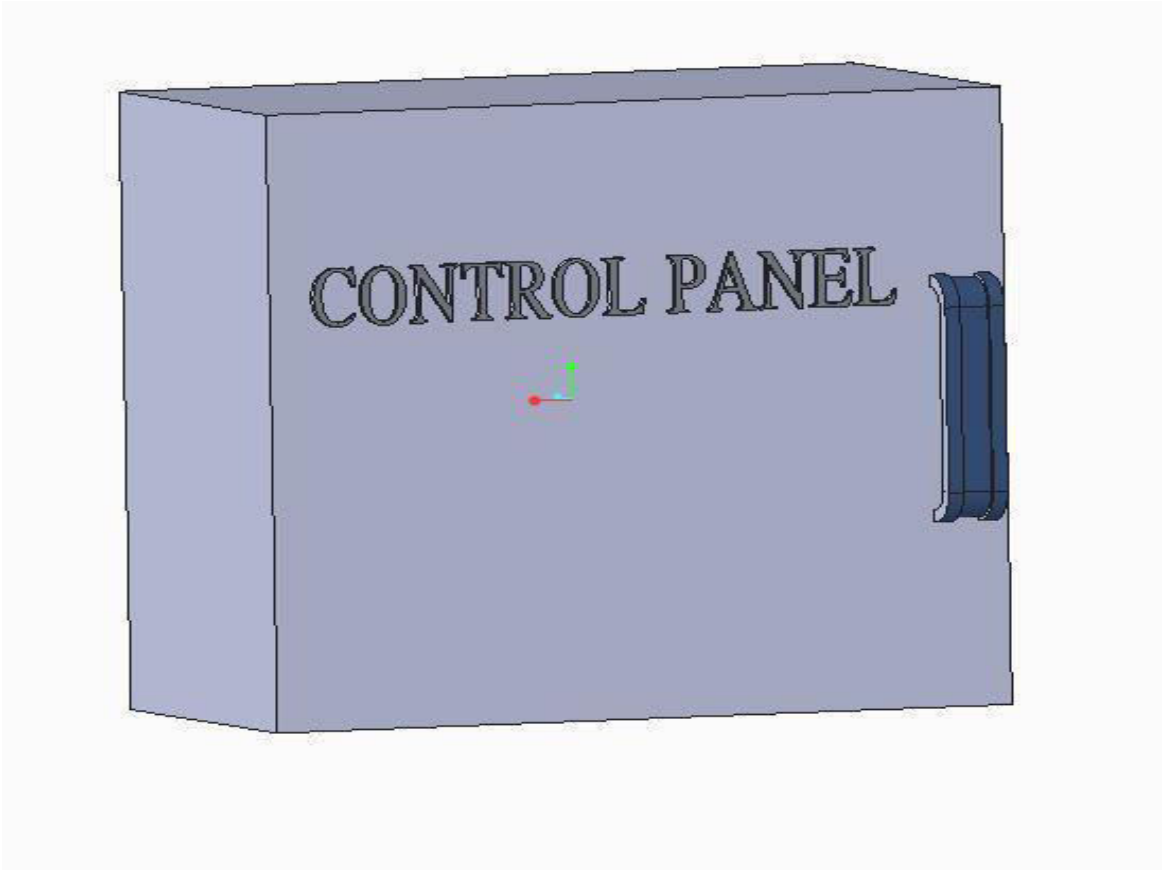


FIG 5.4 CONTROL PANEL

4.5 HMI

A Human-machine interface HMI is a user interface or dashboard that connects a person to a machine, system or device. While the team can technically be applied to any screen that allows a user to interact with the device HMI is most commonly used in the context of an industrial process.

All through HMI is the most common term for this technology, it is sometimes referred to as man machine interface (MMI), operator interface terminal (OIT), local operator interface (LOI) or operator terminal (OT). HMI and graphical user interface (GUI) are similar but not synonymous GUI‟s are often leveraged within HMI‟s for visualization capabilities.

In industrial setting HMI can be used to:
Visual display data
Trac production time, trends and tax Oversee KPI‟s
Monitor machine inputs and outputs And more.
HMI‟s comes in a variety of forms, from built-in screen on machines, to computer monitors, to tablets but redguard less of their format or which term used to refer to them, their purpose is to provide insight into mechanical performance and progress.
Common uses of HMI

HMI‟s communicate with programmable logic controller (PLC) and input/output sensors to get and display information for users to review. HMI‟s screen is can be used for a single function, like monitoring and tracking, or for performing more sophisticated operations, like switching machines of or increasing production speed, depending on how they are implemented.

HMIs are used to optimize and industrial process by digitalizing and centralizing data for viewer. By leveraging HMI, operators can see important information, displayed in graph ,chart for digital dashboard, view and manage alarm and curl connect with SCADA and MES system all through one console.

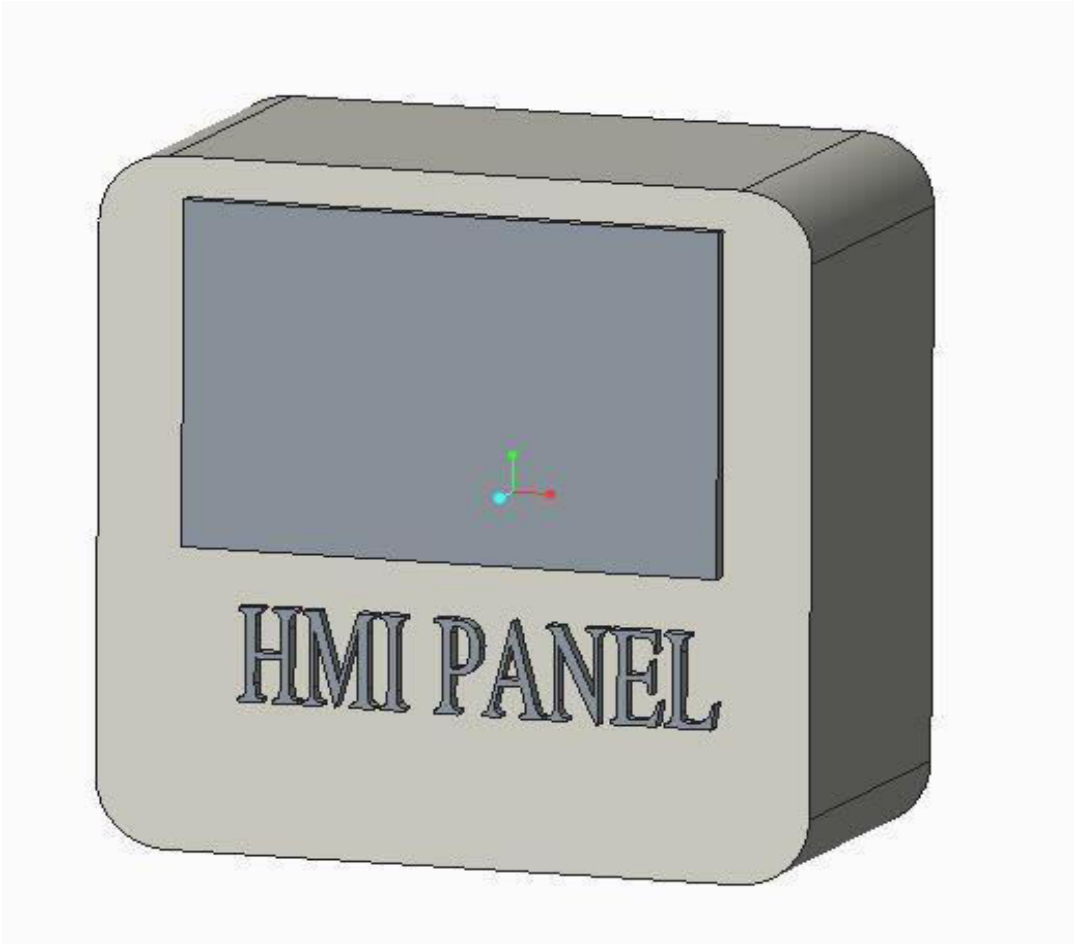


FIG 5.5 HMI PANEL

4.6 BASE PLATE

A flat supporting plate on frame at the base of a column designed to to distribute the columns wait over a great area and provide increased stability.

function:-

When you provide a base plate Beneath a column the load gets dispersed to larger area and after that if is transferred to concrete Foundation hence the system is safe.

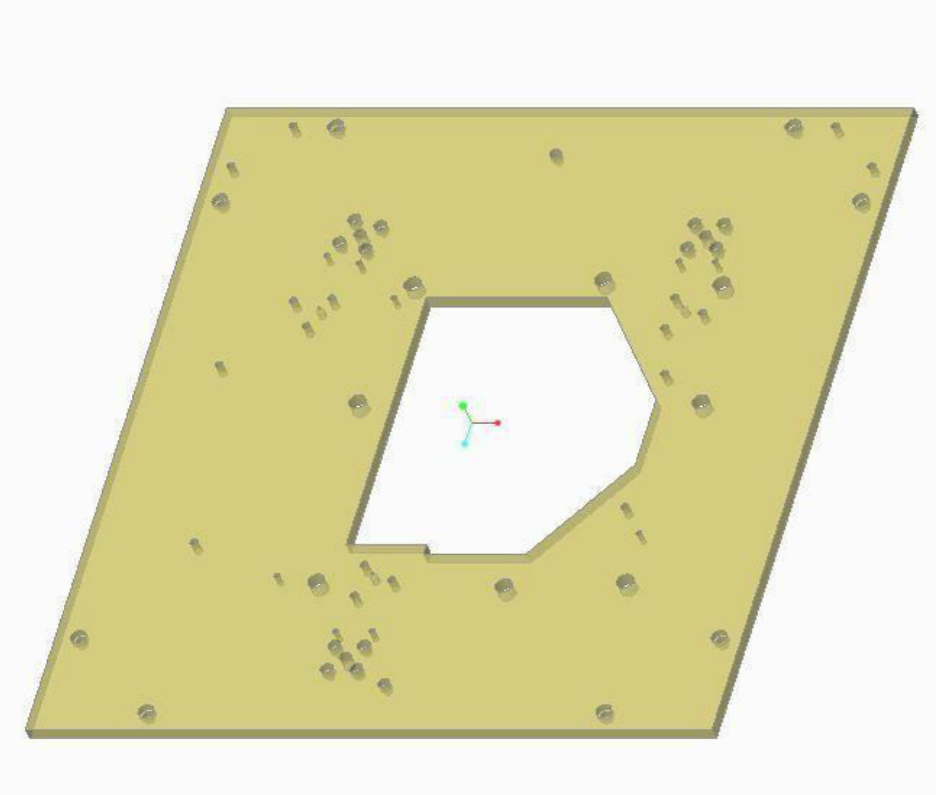


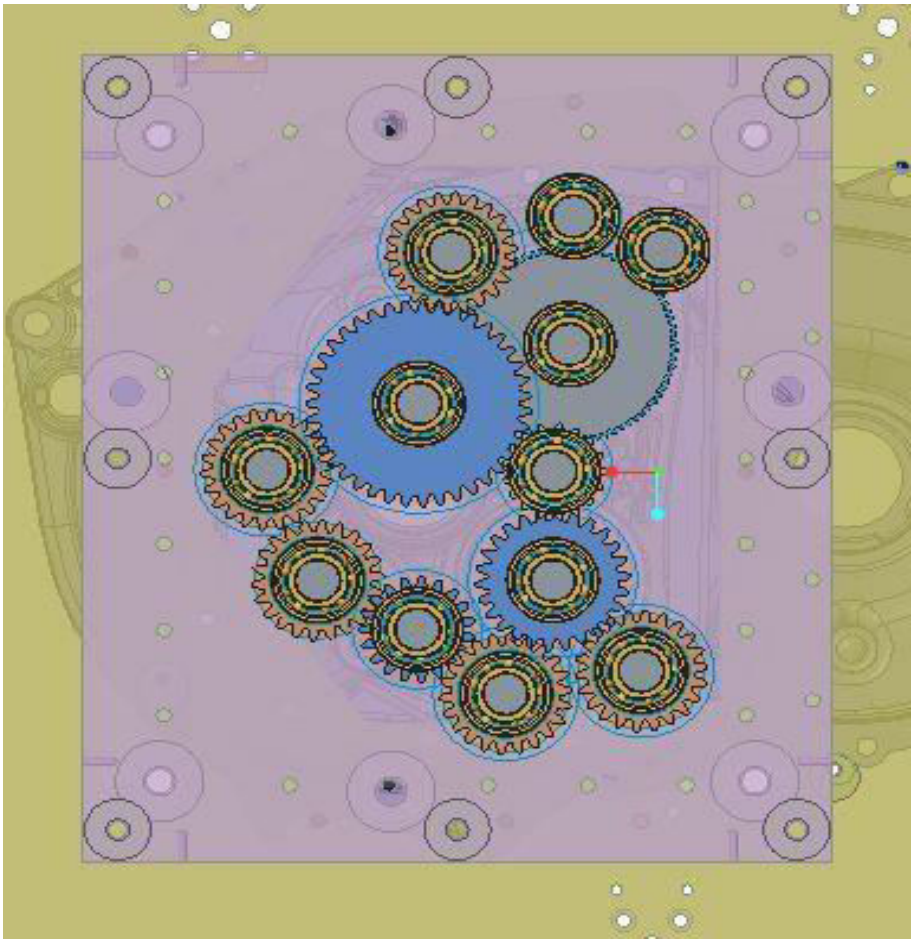
FIG 5.6 BASE PLATE

4.7 GEARBOX

Gearbox is a transmission device which is used between engines output shaft and the final drive in order to transfer required torque and power to the wheels of vehicle.

Functions:-

1. Reduction in speed produces a mechanical advantage.
2. Increasing torque.



5.7 GEAR BOX

5.8 SPACER ROD

The spacer rod is designed for stabilizing rods when using two rods on a single picture.

Functions:-

1. To provide uniform spacing of horizontally bundled conductors.
2. To ensure consistent electrical characteristics.

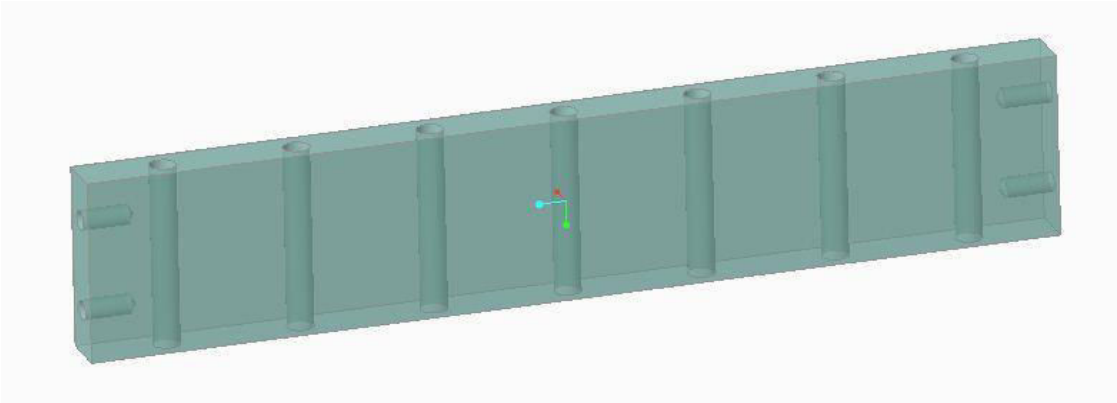
5.8 SPACER ROD

5.9 SPACER PLATE

Spacer plates are used to provide space between two or more components.

Function:-

1. To provide space between two or more components.



5.9 SPACER PLATE

5.10 BEARING LOCK CAP

The main bearings are typically held in place by caps which are bolted on. Functions:-

1. To hold the bearings gearbox

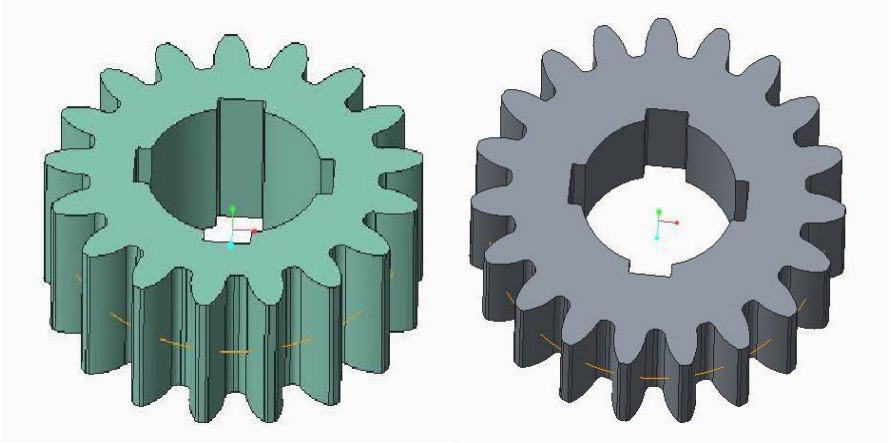
5.11 GEARS

There is a tooth cylindrical or roller shape component of machine which measures with another tooth cylindrical to transmit power from one sheet to another shaft .

Functions:-

Gears are mainly used to change n torque and speed of driving and driven shaft. Types of gears

1. Spur gears.
2. Helical gears.
3. Parallel axis gear.
4. Spiral gear.



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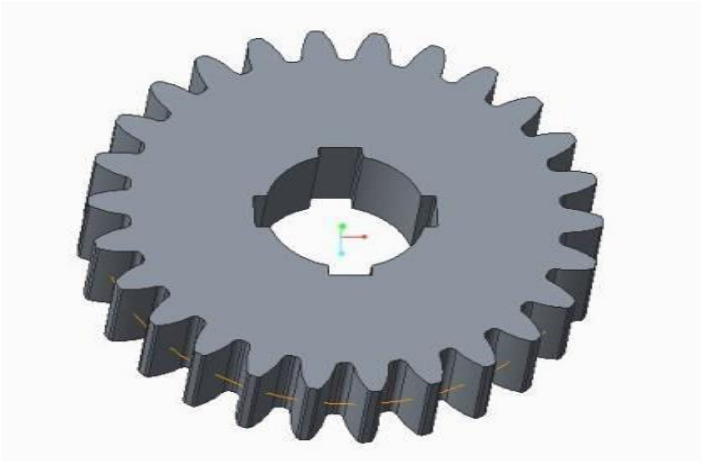

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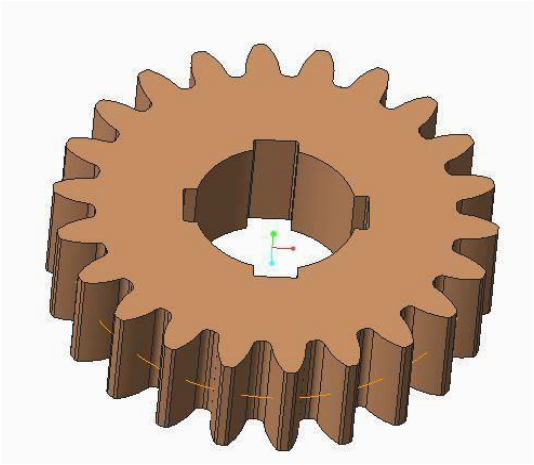

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FIG. 5.12 TYPES OF GEARS

5.12 CLAMPING ASSEMBLY

An assembly which is used to tightly hold the work piece in a place to sustain vibrations.

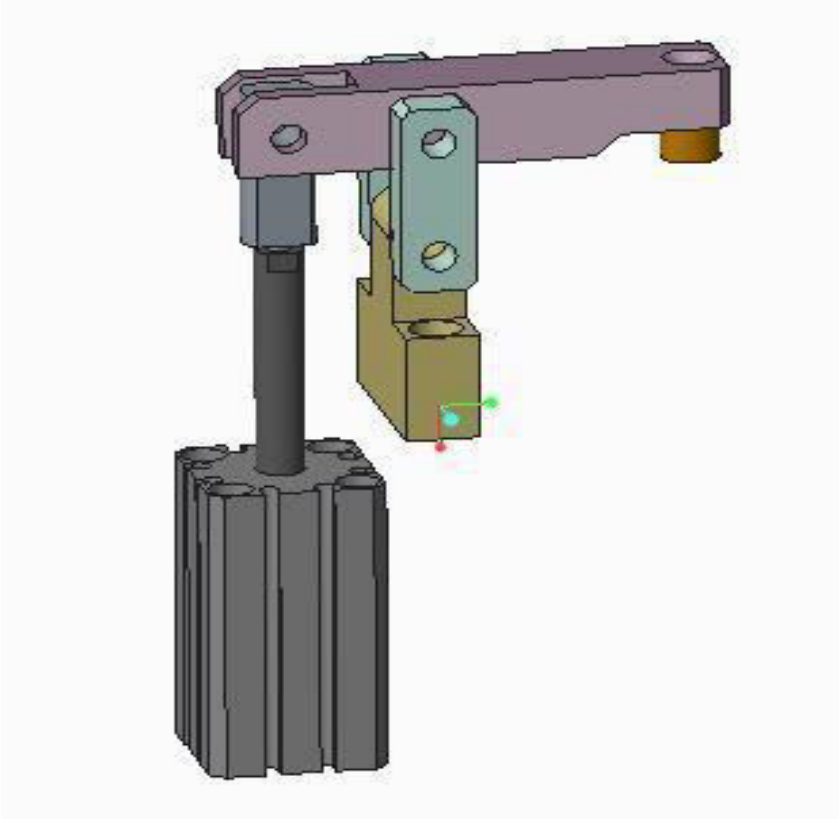


FIG 5.13 CLAMPING ASSEMBLY

5.13 SPRING

Spring is an elastic object that stores mechanical energy.Springs are made up of variety of elastic materials most common being spring steel.An extension or compression spring"s rate is expressed in units of force divided by distance.

Function:-

They store energy and release it to absorb shock or maintain a force between two contacting surfaces.

Types of spring:-

1. Helical spring leaf spring.
2. Special plates.

Spacer plates are used to provide space between two or more components. Function:-

1. To provide space between two or more components.

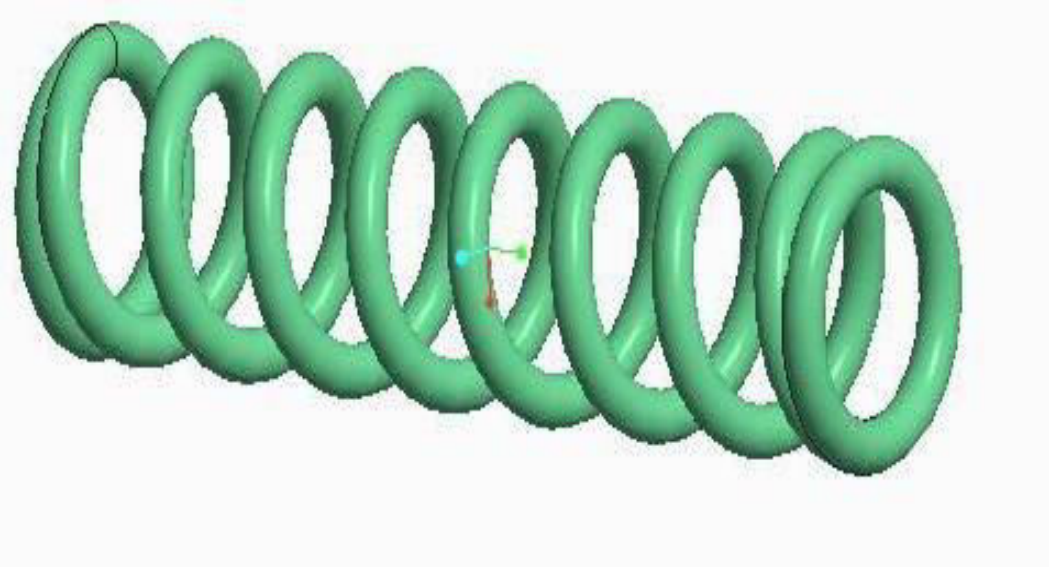


FIG 5.15 SPRING

5.14 ROUGH LOCATOR

FIG 5.16 ROUGH LOCATOR

5.15 PV-REST PAD

These pads are used to rest the work piece so as to avoid metal to metal contact.

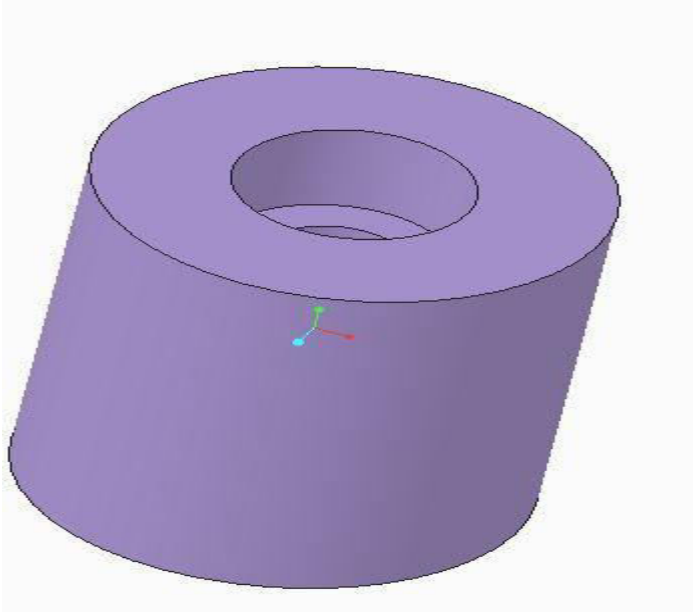


FIG 5.17 PV-REST PAD

6 MATERIAL USED

6.1 MILD STEEL:

Physical Properties: Mild steel is very strong due to the low amount of carbon it contains. In materials science, strength is a complicated term. Mild steel has a high resistance to breakage. Mild steel, as opposed to higher carbon steels, is quite malleable, even when cold. This means it has high tensile and impact strength. Higher carbon steels usually shatter or crack under stress, while mild steel bends or deforms.

Usability: Mild steel is especially desirable for construction due to its weld ability and machinability. Because of its high strength and malleability, it is quite soft. This means that it can be easily machined compared to harder steels. It is also easy to weld, both to itself and to other types of steel. It takes on a nice finish and is polish able. However, it cannot be hardened through heat treatment processes, as higher carbon steels can. This is not entirely a bad thing, because harder steels are not as strong, making them a poor choice for construction projects.

Mild Steel Components:

1. Base Plate
2. Gearbox Plates
3. Spacer Rod
4. Spacer Plate
5. Bearing Lock Cap
6. Gearbox Mounting Rod

6.2 20MNCR5:

Physical Properties: 20MnCr5 steel are low alloyed engineering case hardening steel for parts which require core tensile strength of 1000 – 1300 N/mm² and good wearing resistance. It is used in boxes, piston bolts, spind`les, camshafts, gears, shafts and other mechanical controlling parts.

Soft Annealing of 20MnCr5 steel**:** Heat to 650-700 ^{o}C.

Carburizing: Temperature 900-950 ^{o}C . Cooing from carburizing temperature: water, oil, core hardening 850 – 880 ^{o}C. Case hardening: 810 -8400C.

Hardening: Core hardening 850 – 880 ^{o}C. Case hardening: 810 -8400C. 20MNCR5 Components:

- Shaft
- Rachet wheel
- Rachet inner wheel
- Rachet top plate
- Shaft rachet joint
- Socket holder shaft
- Bolt: M8, M12
- Idler gear
- Locating pin housing
- Locating pin housing plate

6.3 EN8

Physical Properties: Good heat treatment results on sections larger than 65mm may still be achievable, but it should be noted that a fall-off in mechanical properties would be apparent approaching the centre of the bar. It is therefore recommended that larger sizes of EN8 steel materials are supplied in the untreated condition, and that any heat treatment is carried out after initial stock removal. This should achieve better mechanical properties towards the core.

Tempering – Carbon steel EN8 or 080m40 can be tempered at a heat of between 550°C to 660°C (1022°F-1220°F), heating for about 1 hour for every inch of thickness, then cool in oil or water.
Normalising of EN8 bright mild steel takes place at 830-860°C (1526°F-1580°F) then it is cooled in air.

Quenching: in oil or water after heating to this temperature will harden the steel.

En8 Components:

- Cylinder rod connector
- Pivot
- Brass pad
- Pivot link
- Pivot link resting
- Rough locator

6.4 NYLON

Physical Properties: Nylon is a synthetic polymer family that is more commonly referred to as polyamides. Nylon has great abrasion resistance, good wear, and a low coefficient of friction. It is USDA approved, FDA compliant and is most often selected for its ease of fabrication. Nylon is an excellent material in regards to wear and abrasion resistance. Nylon is a material that is easily machinable, low cost and lightweight, and given its wear resistance is often used to replace metal and rubber among other materials. Nyloncolors include; Natural, black, blue, grey, red, brown, green, yellow.

KEY PROPERTIES:

1. Machinability
2. Low coefficient of friction
3. Enhanced bearing and wear grades available
4. FDA compliant grades available
5. Glass-filled grades available Nylon Components Used:

- PV-Rest pad

7 SENSORS

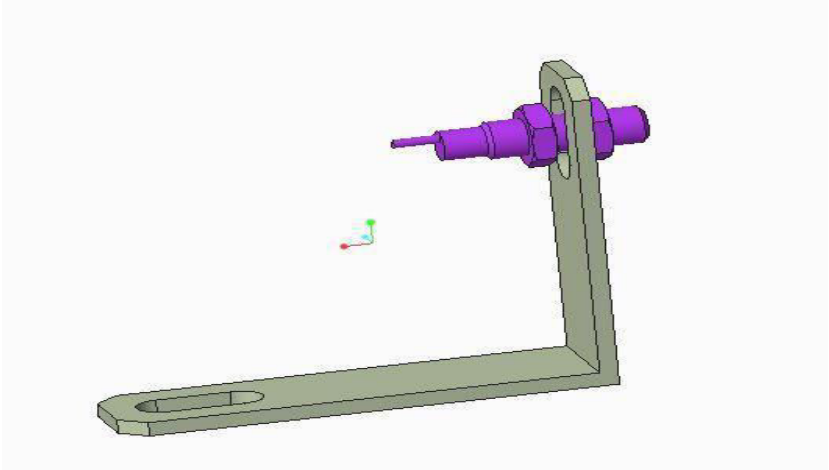
1. POTENTIOMETER
2. SAFETY CURTAIN

7.1 PROXIMITY SENSOR

A proximity sensor is a sensor able to detect the presence of nearby objects without any physical contact.

A proximity sensor often emits an electromagnetic field or a beam of electromagnetic radiation and looks for changes in field or return signal. The object being sensed is often referred to as the proximity sensors target different proximity sensors targets demand different sensors.

For example, a capacitive proximity sensor might be suitable for plastic target; an inductive proximity sensor always requires a metal target.



8 CALCULATIONS:

8.1 GEARBOX FOR M8 BOLTS :

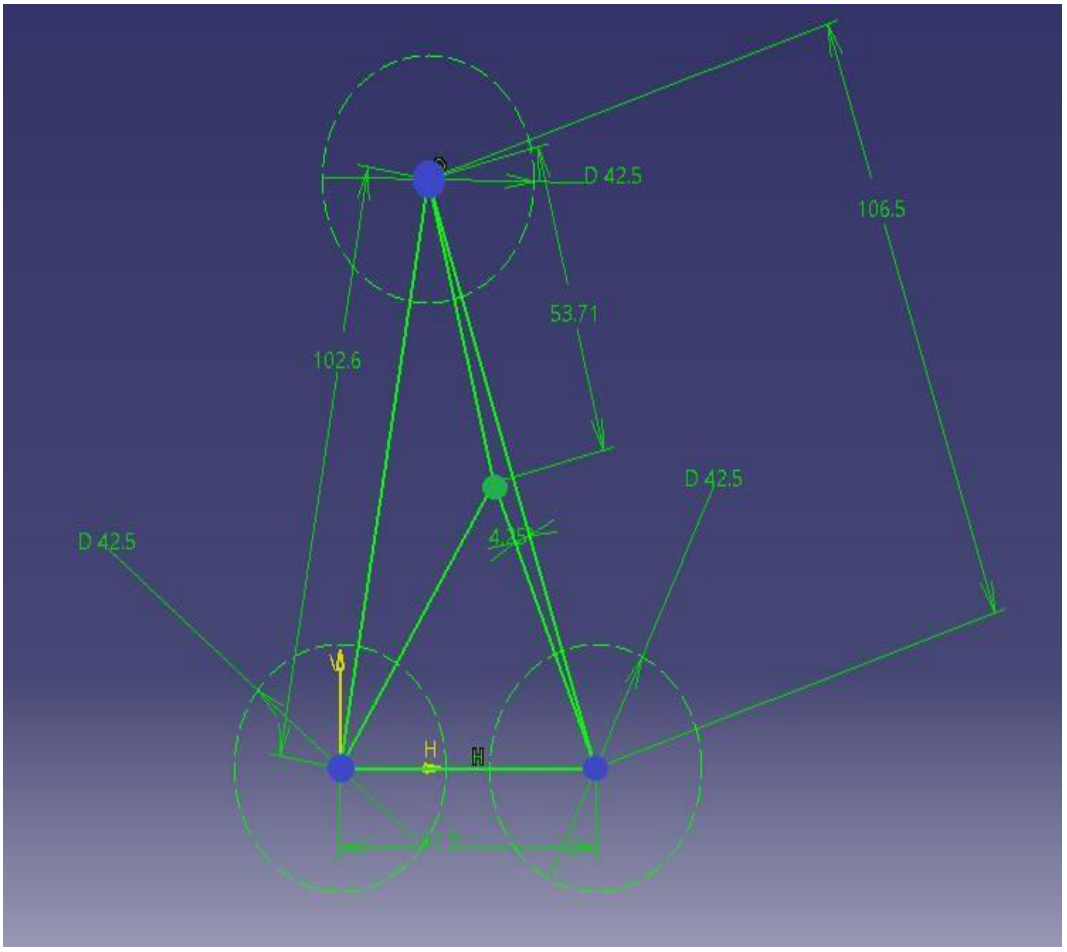


FIG 9.1 GEARBOX FOR M8 BOLT

Sum of gears = (2*cd)/m

= (2*54)/2.5

= 43.2 = 43

Considering Z_1 =17 $Z_1 - Z_{I1}$ = 48-17 = 26 Z_{I1}= 26

Now,

Reference diameter or PCD = Z*m

$(PCD)_{I1}$ =Z_{I1}*m $(PCD)_{I1}$= 26*2.5 $(PCD)_{I1}$= 65

Standardizing $(PCD)_{I1}$= 65.36

Since,

Centre distance between gears and idlers is 54,

Therefore, 54 = (65.36/2) + $(Radius)_{G1}$ $(Radius)_{G1}$ = 54- (65.36/2)

$(Radius)_{G1}$ =21.3

$(PCD)_{G1}$ =42.6

Standardizing $(PCD)_{G1}$= 42.5

8.2 GEARBOX FOR M12 BOLTS :

Set1

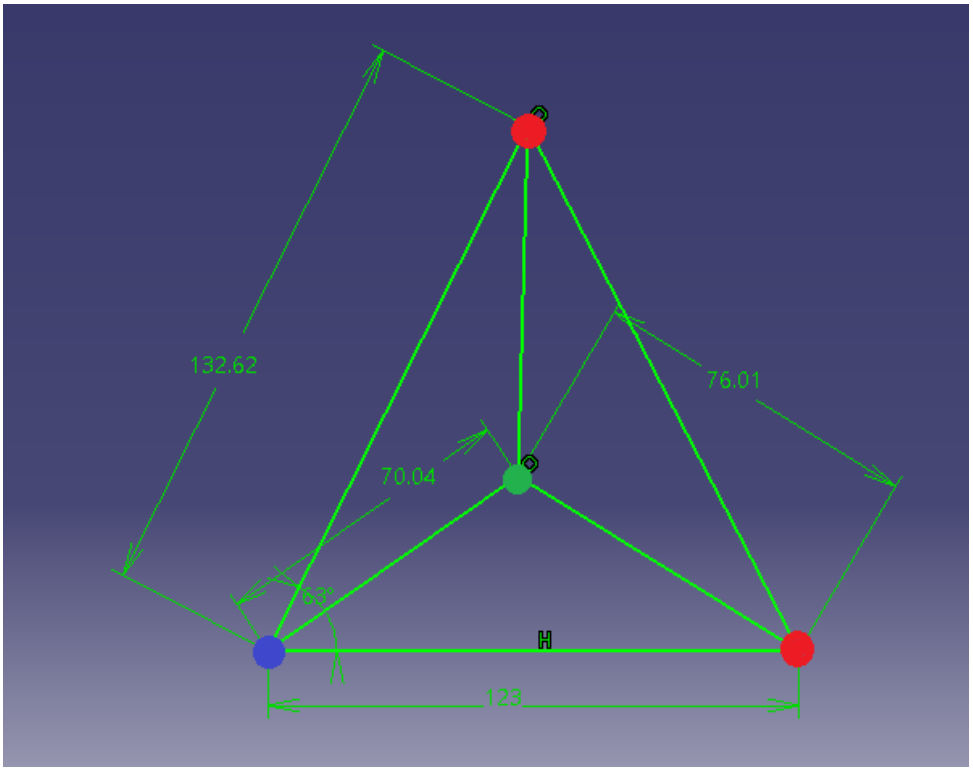


FIG 9.2 SET 1

Sum of gear teeth = $(Z)_{G1} + (Z)_{I2}$ But,

Sum of gear teeth= (2*cd/m) = (2*70/2.5)

= 56

Therefore,

$(Z)_{G1} + (Z)_{I2} = 56$

$(Z)_{I2}$ =56-17 | since, $(Z)_{G1}$ =17

$(Z)_{I2}$ = 39

Since, $(Z)_{I2}$ = 39

$(PCD)_{I2} = (Z)_{I4}$*m $(PCD)_{I2}$= 39*2.5 $(PCD)_{I2}$ = 97.5

Standardizing $(PCD)_{I2}$ =97.98

Again,

Sum of gear teeth = $(Z)_{G2} + (Z)_{I2}$

Sum of gear teeth= (2*cd/m) = (2*76.3/2.5)

= 61.04

$(Z)_{G2} + (Z)_{I2}$ = 61 $(Z)_{G2}$ = 61-39 =22

Now, $(Z)_{G2}$ =22

$(PCD)_{G2} = (Z)_{G2}$*m

= 22*2.5

=55

Set 2:

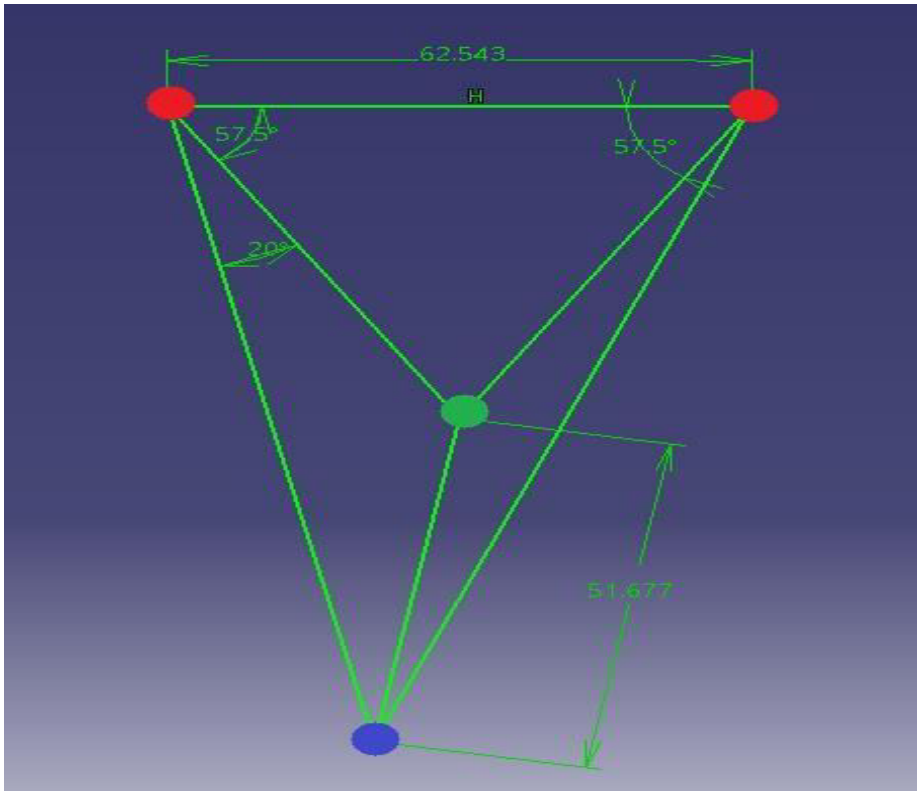


FIG 9.3 SET2

Cd=51.75

Sum of teeth = (2*51.75/2.5)

= 41.4 = 41 $(Z)_{I3}$ = 41-$(Z)_{G1}$ $(Z)_{I3}$ = 24

$(PCD)_{I3}$ = m*Z

= 60

Set 3:

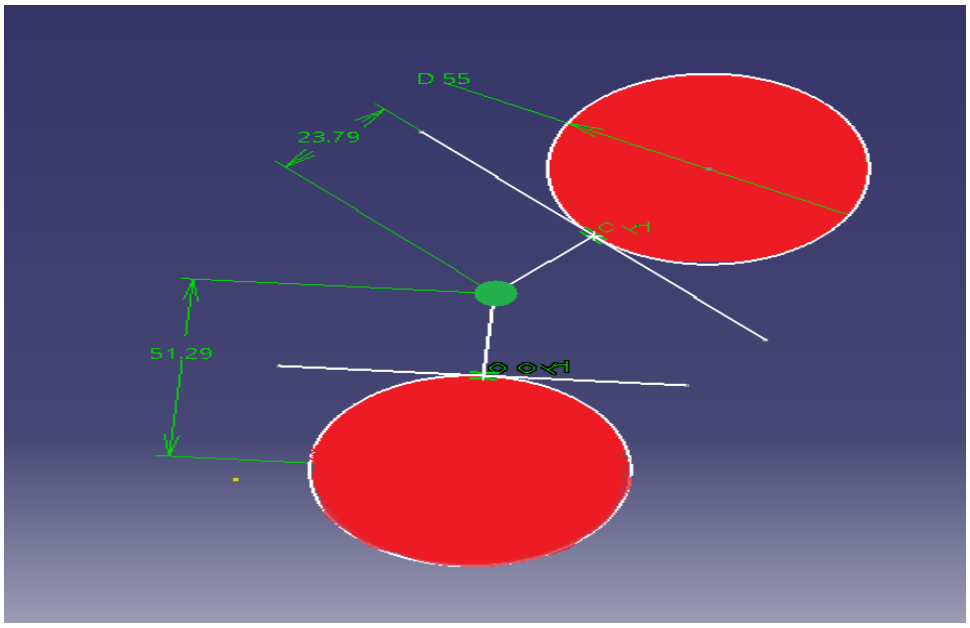


FIG 9.4 SET 3

Cd = 51.29

Sum of no of teeth = (2*cd/m)

= (2*51.29/2.5)

= 41.032

$(Z)_{G2}$ + $(Z)_{I4}$ =41

$(Z)_{I4}$ = 41-22

$(Z)_{I4}$ = 19 $(PCD)_{I4}$ = Z*m $(PCD)_{I4}$ = 19*2.5

= 47.5

Standardizing $(PCD)_{I4}$= 47.58

8.3 BOLT LOOSENING GEARS DRIVER – M8-GEAR

Module – 2.5 where, module=PCD/No of teeth

Also, module= OD/N+2. where, N=No of teeth

PCD=42.5

No of teeth (t_1)= 17

1. Addendum (h_a)= module(m)

   h_a = 2.5mm

2. Dedendum (h_f) = 1.25*m

   h_f = 3.125mm

3. Tooth thickness (circular thickness) = 1.5708*m

   = 1.5708*2.5

   = 3.927mm

4. Fillet radius = 0.4*m

   = 0.4*2.5

   = 1mm

5. Addendum circle dia = pitch + 2(h_a)

   = 42.5+2(2.5)

   = 47.5mm

6. Dedendum circle dia = pitch circle-2(h_f)

   = 42.5+2(3.125)

   = 36.25mm

7. Circular thickness angle= (360^0/no of teeth)*0.5

   = (360^0/17)*0.5

   =10.58^0

8. Circular thickness angle For teeth = 10.58/2

   = 5.29^0

9. Circle (A) diameter = PCD/8

   = 42.5/8

   = 5.3125 (radius)

   = 10.625 (diameter)

M-12 GEAR:

Module – 2.5

PCD – 55

No of teeth (T_2) = 22

1. Addendum (h_a)= module(m)

   h_a = 2.5mm

2. Dedendum (h_f) = 1.25*m

   = 1.25*2.5

   h_f = 3.125mm

3. Tooth thickness (circular thickness) = 1.5708*m

   = 1.5708*2.5

   = 3.927mm

4. Fillet radius = 0.4*m

   = 0.4*2.5

   = 1mm

5. Addendum circle dia = PCD + 2(h_a)

   = 55+2(2.5)

   = 60mm

6. Dedendum circle dia = pitch circle-2(h_f)

   = 55-2(3.125)

   = 48.75mm

7. Circular thickness angle= (360^0/no of teeth)*0.5

   = (360^0/22)*0.5

   =8.18^0

8. Circular thickness angle For teeth = 8.18/2

   = 4.09^0

9. Circle (A)diameter = PCD/8

   = 55/8

   = 6.875 (radius)

   = 13.75 (diameter)

IDLER 1;

Module = 2.5

PCD = 65.36

No. of teeth = 26

1. Addendum (h_a)= module(m)

   h_a = 2.5mm

2. Dedendum (h_f) = 1.25*m

   =1.25*2.5

   h_f = 3.125mm

3. Tooth thickness (circular thickness) = 1.5708*m

   = 1.5708*2.5

   = 3.927mm

4. Fillet radius = 0.4*m

   = 0.4*2.5

   = 1mm

5. Addendum circle dia = PCD + 2(h_a)

   = 65.36+2(2.5)

   = 70.36mm

6. Dedendum circle dia = PCD - 2(h_f)

   = 65.36-2(3.125)

   = 59.11mm

7. Circular thickness angle= (360^0/no of teeth)*0.5

   = (360^0/26)*0.5

   =6.92^0

8. Circular thickness angle For teeth = 6.92/2

   = 3.46^0

9. Circle (A) diameter = PCD/8

   = 65.36/8

   = 8.17 (radius)

   = 16.34 (diameter)

IDLER 4 :

Module = 2.5

PCD = 47.58

No of teeth = 19

1. Addendum (h_a)= module(m)

   h_a = 2.5mm

2. Dedendum (h_f) = 1.25*m

   =1.25*2.5

   h_f = 3.125mm

3. Tooth thickness (circular thickness) = 1.5708*m

   = 1.5708*2.5

   = 3.927mm

4. Fillet radius = 0.4*m

   = 0.4*2.5

   = 1mm

5. Addendum circle dia = PCD + 2(h_a)

   = 47.58+2(2.5)

   = 52.58mm

6. Dedendum circle dia = PCD - 2(h_f)

   = 47.58-2(3.125)

   = 41.33mm

7. Circular thickness angle= (360^0/no of teeth)*0.5

   = (360^0/19)*0.5

   = 9.47^0

8. Circular thickness angle For teeth = 9.47/2

   = 4.735^0

9. Circle (A) diameter = PCD/8

   = 47.58/8

   = 6.947 (radius)

   = 16.34 (diameter)

IDLER 2:

Module = 2.5

PCD = 97.58

No of teeth = 39

1. Addendum (h_a)= module(m)

   h_a = 2.5mm

2. Dedendum (h_f) = 1.25*m

   =1.25*2.5

   h_f = 3.125mm

3. Tooth thickness (circular thickness) = 1.5708*m

   = 1.5708*2.5

   = 3.927mm

4. Fillet radius = 0.4*m

   = 0.4*2.5

   = 1mm

5. Addendum circle dia = PCD + 2(h_a)

   = 97.58+2(2.5)

   = 102.5mm

6. Dedendum circle dia = PCD - 2(h_f)

   = 97.58-2(3.125)

   = 91.33mm

7. Circular thickness angle= (360^0/no of teeth)*0.5

   = (360^0/39)*0.5

   = 4.615^0

8. Circular thickness angle For teeth = 4.615/2

   = 2.3075^0

9. Circle (A) diameter = PCD/8

   = 97.58/8

   = 12.1975 (radius)

   = 24.395 (diameter)

IDLER 3:

Module = 2.5

PCD = 60

No of teeth =24

1. Addendum (h_a)= module(m)

   h_a = 2.5mm

2. Dedendum (h_f) = 1.25*m

   =1.25*2.5

   h_f = 3.125mm

3. Tooth thickness (circular thickness) = 1.5708*m

   = 1.5708*2.5

   = 3.927mm

4. Fillet radius = 0.4*m

   = 0.4*2.5

   = 1mm

5. Addendum circle dia = PCD + 2(h_a)

   = 60+2(2.5)

   = 65mm

6. Dedendum circle dia = PCD - 2(h_f)

   = 60-2(3.125)

   = 53.75mm

7. Circular thickness angle= (360^0/no of teeth)*0.5

   = (360^0/24)*0.5

   = 7.5^0

8. Circular thickness angle For teeth = 7.5/2

   = 3.75^0

9. Circle (A) diameter = PCD/8

   = 60/8

   = 7.5 (radius)

   = 15 (diameter)

8.4 FOR GEARBOX-MOTOR

8bolts

5 bolts - m12 – pitch – 1.75 3 bolts – m8 – pitch – 1.25

- M12 – 80N-m Torque required - 80*5 = 400N-m
- M8 – 25N-m Torque required – 25*3 = 75N-m 8 bolts = 475-m

F.O.S. = 1.8 Pitch = 1.4

Total torque = 475*1.8

= 855 N-m

For torque of 950 N-m Rpm= 14

Wattage = 1392.0667

HP = 1.8641

Motor conf. = 2HP

Gear bar ratio = 98.514 = 1380/14 Driver torque = torque*(rpm/power)

= 950* (14/1380)

= 9.63

9 CONCLUSION

Machine capable of performing special purpose of loosening 8 bolts of different sizes using appropriate mechanism to attain the mentioned objectives is designed and manufactured successfully.

10 ANNEXURE

[1] J. Puranen, "Induction motor versus permanent magnet synchronous motor in motion control applications: A comparative study," Lappeenranta University of Technology,Lappeenranta, 2006.

[2] T. Jokinen, "High-speed electrical machines, Conference on high speed technology,"Lappeenranta, 1988.

[3] N. Hashemnia and B. Asaei, "Comparative Study of Using Different Electric Motors in the Electric Vehicles," in International Conference on Electrical Machines,Tehran, 2008.

[4] J. Pyrhönen, T. Jokinen and V. Hrabovcov´a, Design of Rotating Electrical Machines, John Wiley & Sons, Ltd, 2008.

[5] Design of a Pressure Observer and its Application to a Low CostPneumatic Control System", Takahiro Kosaki and Manabu Sano, year 2011 , Int. J. of Automation TechnologyVol.5No 4.

[6] Design and applications of a pneumatic accelerator for high speed punching" ,Su¨leymanYaldız , HacıSag˘lam, Faruk U nsacar, HakanIsik , 2007, Materials and Design 28. 889–896.

[7] Development of a micro-forming system for micro-punching process of micro-hole arrays in brass foil" , JieXu, Bin Guo, Debin Shan, Chunju Wang, Juan Li , YanwuLiuc, DongshengQu , 2012 ,Journal of Materials Processing Technology 212
,2238– 2246.

[8] A new design method for single DOF mechanical presses with variable speeds and length-adjustable driving links" ,Ren-Chung Soong ,2010 ,Mechanism and Machine Theory 45, 496–510.

[9] Implementation of Zero Defect through Poka Yoke approaches in the assembly Line of compressor manufacturing industry Dr.R.Vinayagasundaran, Dr.C.Velmurugan

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