DESIGN AND FABRICATION OF THREE AXIS PNEUMATIC TRAILER

A PROJECT REPORT

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in partial fulfillment for the award of the degree

of

BACHELOR OF ENGINEERING

in

MECHANICAL ENGINEERING

KUMARAGURU COLLEGE OF TECHNOLOGY

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APRIL - 2009

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BONAFIDE CERTIFICATE

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INTERNAL EXAMINER 27/4/2009

EXTERNAL EXAMINER 27/4/09

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ABSTRACT

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This project work titled "**DESIGN AND FABRICATION OF THREE AXIS PNEUMATIC TRAILER**" has been conceived having studied the difficulty in unloading the materials. Our survey in the regard in several automobile garages, revealed the facts that mostly some difficult methods were adopted in unloading the materials from the trailer.

Now the project has mainly concentrated on this difficulty, and hence a suitable arrangement has been designed. Such that the vehicles can be unloaded from the trailer in three axes without application of any impact force. By pressing the Direction control valve activated. The compressed air is goes to the pneumatic cylinder through valve. The ram of the pneumatic cylinder acts as a lifting the trailer cabin. The automobile engine drive is coupled to the compressor engine, so that it stores the compressed air when the vehicle running. This compressed air is used to activate the pneumatic cylinder, when the valve is activated.

ACKNOWLEDGEMENT

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First and foremost, we pay our sincere and humble salutations to the almighty for equipping us with all the strength and courage throughout our venture in the project work.

At this pleasing moment of having successfully completed our project, we wish to convey our sincere thanks and gratitude to our guide **Mr.S.R.Rajabalayanan**, Assistant Professor, Department of Mechanical Engineering, for his kind guidance and encouragement throughout our endeavour.

We are also grateful to **Dr.T.Kannan**, Head of the Department, for his constructive suggestions and encouragement during our project.

We would like to express our sincere thanks to **Prof. R.Annamalai,** Vice Principal, for forwarding us to do our project and offering adequate duration in completing our project.

We would like to express our sincere thanks to **Mr. Karuppuswamy** and **Mr. N.Sivakumar**, lab technicians for rending their guidance continuously in doing the project.

We shall be failing in our duty if we do not thank all the teaching and non teaching staff of the Mechanical Engineering Department and our friends for having encouraged us and supported us morally while doing the project. Finally, our humble gratitude is due to our parents who were a constant source of inspiration.

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LIST OF ABBREVIATIONS

Q	–	Volume flow rate through orifice m^3/s
C_0	–	A constant
A	–	Area of orifice opening m^2
P	–	Pressure drop across orifice (psi)
F_t	–	Tangential component
F_r	–	Radial component
M_t	–	Torque transmitted
Φ	–	Pressure angle
υ	–	Pitch line velocity
$N_{(1.2)}$	–	No of teeth on pinion and wheel
i	–	Speed ratio
k	–	Load concentration factor
k_d	–	Dynamic load factor
k_{bl}	–	Life factor in bending
k_σ	–	Stress concentration factor for fillet
n	–	Factor of safety
k_{cl}	–	Life factor for surface strength
ψ	–	Width to centre distance ratio
d_1	–	Pitch Circle Dia -driving gear (m)

d_2 – Pitch Circle Dia -driven gear (m)

ω_1 – Angular velocity of driver gear (Rads/s)

ω_2 – Angular velocity of driven gear (Rads/s)

z_1 – Number of teeth on driver gear

z_2 – Number of teeth on driven gear

η – Efficiency

σ – Tooth Bending stress (MPa)

b_a – Face width (mm)

Y – Lewis Form Factor

m – Module (mm)

CHAPTER – 1

CHAPTER-1

INTRODUCTION

Automation plays an increasingly important role in the global economy and in daily experience. Engineers strive to combine automated devices with mathematical and organizational tools to create complex systems for a rapidly expanding range of applications and human activities. Hydraulic jacks are used as end component in industrial robots in the process of automation. The jacks are usually powered by fluid power because a fluid system can transmit high power with minimal power losses and the load that can be taking is also high with less noise and vibration. The jacks that we have designed can be use to lift light load as fiber handling in textile and coir industries where the load that is being handled is light when compared to other production industries and agricultural sectors. The pneumatic cylinder used to power the trailer is placed below the trailer itself unlike other trailers where the cylinder is kept as an integral part of the jack. This is accomplished by using the trailer rectangular in shape and is operated with the help of links that transmit power from the piston to the trailer. The links also act as a turn table. This reduces the number of piston cylinder arrangement and thereby increasing the material handling abilityof the above mentioned industries and agricultural sectors.

1.1 WORKING PRINCIPLE

The compressed air from the compressor is used as the force medium for this operation. There are pneumatic double acting cylinders, Direction control valve; flow control valve used .The arm from the compressor enters to the floe control Valve.

The controlled air from the flow control valve enters to the Direction control valve. The function of direction control valve is used to move the double acting cylinder up/down depends upon the valve position. In one position air enter to the cylinder and pusses the piston, so that the truck is lifted.

The next position air enters to the other side of cylinder and pusses the piston return back, so that the releasing stroke is obtained. The speed of the cylinder stroke and releasing stroke is varied by the direction control valve manually.

The material is unloading process is done in three axis with the help of locking arrangement and pneumatic system. The compressed air is going to the pneumatic cylinder through the direction control valve. The direction control valve is used to control the flow direction of the pneumatic cylinder in both the direction. The pneumatic cylinder is mounted in the rotating table with locking arrangement.

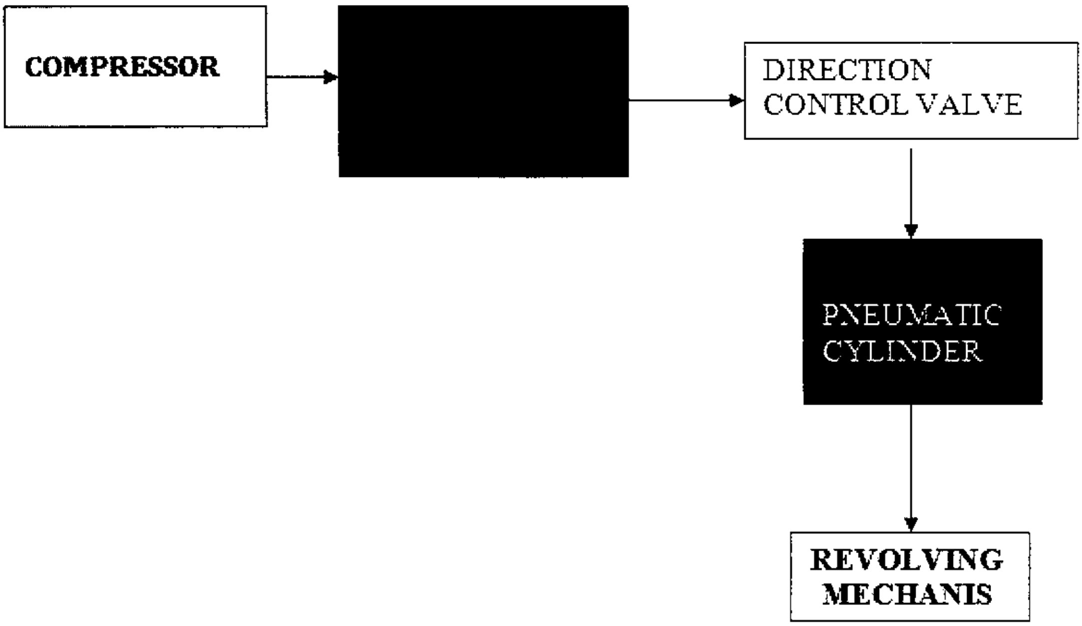

Fig: 1.1 Block Diagram

1.2 PRODUCTION OF COMPRESSED AIR

Pneumatic systems operate on a supply of compressed air, which must be made available, in sufficient quantity and at a pressure to suit the capacity of the system. When pneumatic system is being adopted for the first time, however it wills indeed the necessary to deal with the question of compressed air supply.

The key part of any facility for supply of compressed air is by means using reciprocating compressor. A compressor is a machine that takes in air, gas at a certain pressure and delivered the air at a high pressure.

Compressor capacity is the actual quantity of air compressed and delivered and the volume expressed is that of the air at intake conditions namely at atmosphere pressure and normal ambient temperature.

Clean condition of the suction air is one of the factors, which decides the life of a compressor. Warm and moist suction air will result in increased precipitation of condense from the compressed air. Compressor may be classified in two general types.

1. Positive displacement compressor.
2. Turbo compressor

Positive displacement compressors are most frequently employed for compressed air plant and have proved highly successful and supply air for pneumatic control application.

CHAPTER – 2

CHAPTER-2

LITERATURE SURVEY

Ole Granning et al. (1964) This invention relates to a pneumatic lift system for a tractor-trailer hitch mechanism, and more particularly to a pneumatic lift system employing flexible air bags, the system including means for protecting the air bags against lateral deformation to thus prevent damage to the bags. The present invention is particularly adapted for use on truck trailers utilized as yard trucks in freight terminals. Yard trucks are provided in freight terminals to move semi-trailers to different positions within the terminal. In a typical situation, an over-the-road truck tractor may deliver a loaded semi-trailer to .the terminal. The semi-trailer may first be parked to await unloading. As is well known, semi-trailers are provided with a retractable landing gear. The landing gear is conventionally of the hand-crank type and must be cranked downwardly to engage the ground to support the semitrailer when the truck tractor is unhitched. When the over-the-road truck tractor has parked the semi-trailer, it is normally dispatched to perform other duties. The yard truck tractor is subsequently utilized to move the semi-trailer within the terminal as necessary. In the illustrative case, the yard truck tractor will be called upon to move the semi-trailer to the freight dock for unloading and subsequently to park the semi-trailer in a suitable location within the terminal or possibly to another position on the dock for reloading. The semi-trailer may thus be moved several times within the terminal before it is again hitched to an over-the-road truck tractor for transport to a new destination. Each time that the semi-trailer is moved within the terminal area, the landing gear must be retracted to lower the semi-trailer onto the hitching device provided on the yard truck and must be again extended when the semitrailer is parked and the yard truck is unhitched. As will be appreciated, considerable time is consumed in cranking the landing gear in and out of its ground engaging position. The time consumed in this cranking operation is not only reflected in the wages of the driver but also is reflected in the requirement for a considerable number of yard trucks to perform the necessary movement of semi-trailers in the terminal. It has been proposed in the past to provide an hydraulically actuated hitching device on the truck tractor which can be raised and lowered when engaged with the semi-trailer to lift the front end of the trailer and avoid the necessity of retracting the landing gear. Such hydraulic devices have been operable but are expensive. I have solved this problem by providing a simple, inexpensive pneumatic lift system for the truck tractor hitch.

An object of the invention is thus to provide a pneumatic lift system for a tractor-trailer hitch.

Another object of the invention is to provide a plurality of inflatable flexible bags for raising and lowering the truck tractor hitch element, this element being referred to as a fifth wheel .A further object of the invention is.to provide a support platform for the fifth wheel, the support platform, being secured to the upper ends of the pneumatic bags.

A still further object of the invention is to provide a rigid pivotal element for securing the support platform against movement along the longitudinal axis of the tractor. Another object of the invention is to provide a hinge structure extending between the underside of the support platform and the truck tractor frame to secure the support platform against movement transverse to the longitudinal axis of the tractor.

A still further object of the invention is to provide locking means engageable with the support platform when this platform is in its lowermost position to supplement the normal locking means against the severe jars occasioned when the truck tractor is backed into engagement with the semi-trailer. A yet further object of the invention is to provide a lift system which is securable to the frame members of existing truck tractor designs without having any structure which extends into the space between the frame members, this space being reserved for structure forming part of the truck tractor design. A further object of the invention is to provide a stop structure for engaging the leaf springs of the truck tractor to prevent the springs from deflecting when a load is applied to the truck tractor, thus preventing the extended landing gear of the semi-trailer from being lowered by the truck tractor springs to a position where it again would engage the ground.

Oscar Oswald et al. (1968) A pneumatic jack assembly is pivotally secured to the tongue of a single axle trailer to assist an operator in lifting the tongue for engagement with the coupling member of a tow truck. The jack assembly includes a ground-engaging strut pivotally secured to the tongue and a pneumatic power assembly transversely disposed with respect to the tongue. The power assembly includes a cylindrical housing for receiving compressed air and a piston operably coupled to the housing for transmitting a mechanical force in response to power derived from the compressed air. The housing is pivotally secured to the tongue and the piston is pivotally secured to the strut to permit rotational movement of the housing and tongue relative to each other and relative to the strut as the tongue is lifted by the force exerted by the piston. In a preferred embodiment, the penumatic power assembly derives its operating energy from a source of compressed air carried by the trailer.

CHAPTER - 3

CHAPTER-3

DESCRIPTION OF COMPONENTS

3.1 SPUR GEAR

A gear is a component within a transmission device that transmits rotational force to another gear or device. A gear is different from a pulley in that a gear is a round wheel which has linkages ("teeth" or "cogs") that mesh with other gear teeth, allowing force to be fully transferred without slippage. Depending on their construction and arrangement, geared devices can transmit forces at different speeds, torques, or in a different direction, from the power source. Gears are a very useful simple machine. The most common situation is for a gear to mesh with another gear, but a gear can mesh with any device having compatible teeth, such as linear moving racks. A gear's most important feature is that gears of unequal sizes (diameters) can be combined to produce a mechanical advantage, so that the rotational speed and torque of the second gear are different from that of the first. In the context of a particular machine, the term "gear" also refers to one particular arrangement of gears among other arrangements (such as "first gear"). Such arrangements are often given as a ratio, using the number of teeth or gear diameter as units. The term "gear" is also used in non-geared devices which perform equivalent tasks

The smaller gear in a pair is often called the *pinion*; the larger, either the *gear*, or the *wheel*.

Speed ratio = [(Speed A * Number of teeth A) = (Speed B * Number of teeth)]

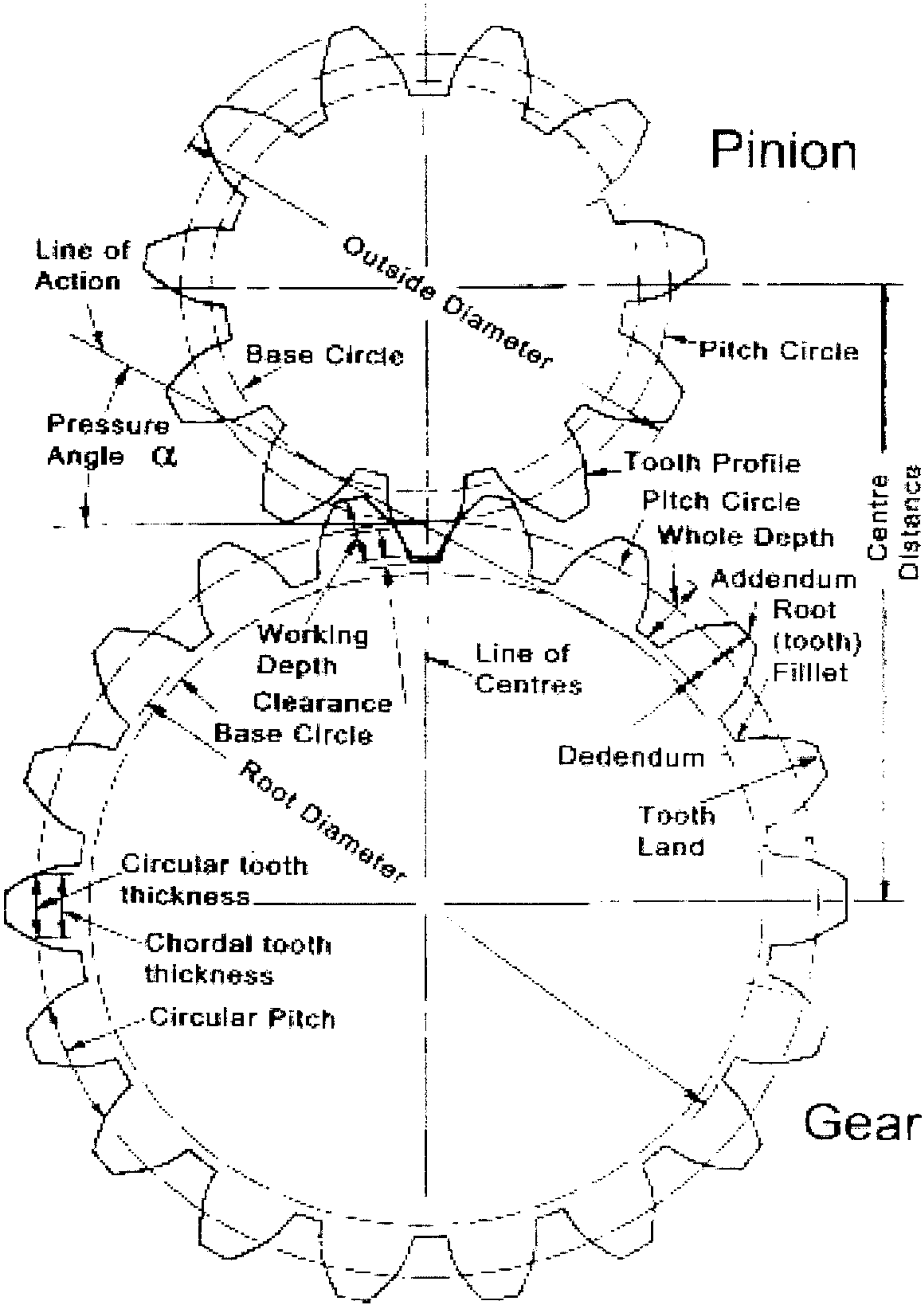

Fig : 3.1 Gear and Pinion

Gears are machine elements used to transmit rotary motion between two shafts, normally with a constant ratio. The pinion is the smallest gear and the larger gear is called the gear wheel.. A rack is a rectangular prism with gear teeth machined along one side- it is in effect a gear wheel with an infinite pitch circle diameter. In practice the action of gears in transmitting motion is a cam action each pair of mating teeth acting as cams. Gear design has evolved to such a level that throughout the motion of each contacting pair of teeth the velocity ratio of the gears is maintained fixed and the velocity ratio is still fixed as each subsequent pair of teeth come into contact. When the teeth action is such that the driving tooth moving at constant angular velocity produces a proportional constant velocity of the driven tooth the action is termed a conjugate action. The teeth shape universally selected for the gear teeth is the involutes profile.

Consider one end of a piece of string is fastened to the OD of one cylinder and the other end of the string is fastened to the OD of another cylinder parallel to the first and both cylinders are rotated in the opposite directions to tension the string(see figure below). The point on the string midway between the cylinder P is marked. As the left hand cylinder rotates CCW the point moves towards this cylinder as it wraps on . The point moves away from the right hand cylinder as the string unwraps. The point traces the involutes form of the gear teeth. The lines normal to the point of contact of the gears always intersects the centre line joining the gear centers at one point called the pitch point. For each gear the circle passing through the pitch point is called the pitch circle. The gear ratio is proportional to the diameters of the two pitch circles. For metric gears (as adopted by most of the world's nations) the gear proportions are based on the module.

m = (Pitch Circle Diameter (mm)) / (Number of teeth on gear).

d_p = (Number of Teeth) / Diametrical Pitch (inches)

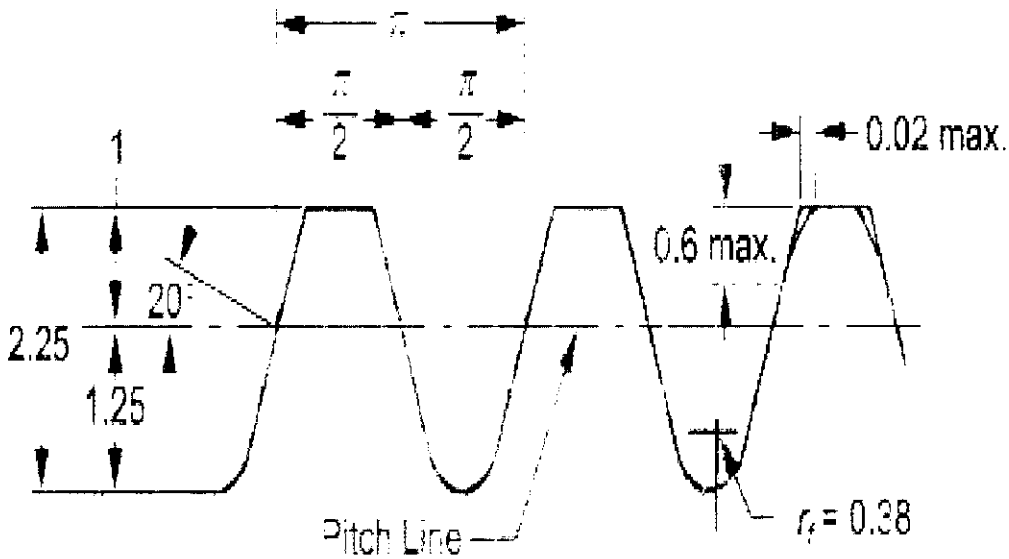

Fig : 3.2 Spur Gear Module

Profile of a standard 1mm module gear teeth for a gear with Infinite radius (Rack).Other module teeth profiles are directly proportion.
e.g. 2mm module teeth are 2 x this profile

Many gears trains are very low power applications with an object of transmitting motion with minimum torque e.g. watch and clock mechanisms, instruments, toys, music boxes etc. These applications do not require detailed strength calculations.

The torque ratio can be determined by considering the force that a tooth of one gear exerts on a tooth of the other gear. Consider two teeth in contact at a point on the line joining the shaft axes of the two gears. In general, the force will have both a radial and a circumferential component. The radial component can be ignored: it merely causes a sideways push on the shaft and does not contribute to turning. The circumferential component causes turning. The torque is equal to the circumferential component of the force *times radius*. Thus we see that the larger gear experiences greater torque; the smaller gear less. The torque ratio is equal to the ratio of the radii. This is exactly the inverse of the case with the velocity ratio. Higher torque implies lower velocity and vice versa. The fact that the torque ratio is the inverse of the velocity ratio could also be inferred from the law of conservation of energy. Here we have been neglecting the effect of friction on the torque ratio. The velocity ratio is truly given by the tooth or size ratio, but friction will cause the torque ratio to be actually somewhat less than the inverse of the velocity ratio.

3.2 PNEUNATIC JACK (PISTON CYLINDER ARRANGEMENT)

A pneumatic cylinder consists of the following parts:

3.2.1 Cylinder barrel

The cylinder barrel is mostly a seamless thick walled forged pipe that must be machined internally. The cylinder barrel is ground and/or honed internally.

3.2.2 Cylinder Bottom or Cap

In most pneumatic cylinders, the barrel and the bottom are welded together. This can damage the inside of the barrel if done poorly. Therefore some cylinder designs have a screwed or flanged connection from the cylinder end cap to the barrel. (See "Tie Rod Cylinders" below) In this type the barrel can be disassembled and repaired in future.

3.2.3 Cylinder Head

The cylinder head is sometimes connected to the barrel with a sort of a simple lock (for simple cylinders). In general however the connection is screwed or flanged. Flange connections are the best, but also the most expensive. A flange has to be welded to the pipe before machining. The advantage is that the connection is bolted and always simple to remove. For larger cylinder sizes, the disconnection of a screw with a diameter of 300 to 600 mm is a huge problem as well as the alignment during mounting.

3.2.4 Piston

The piston is a short, cylinder-shaped metal component that separates the two sides of the cylinder barrel internally. The piston is usually machined with grooves to fit elastomeric or metal seals. These seals are often O-rings, U-cups or cast iron rings. They prevent the pressurized pneumatic oil from passing by the piston to the chamber on the opposite side. This difference in pressure between the two sides of the piston causes the cylinder to extend and retract. Piston seals vary in design and material according to the pressure and temperature requirements that the cylinder will see in service. Generally speaking, elastomeric seals made from nitrile rubber or other materials are best in lower temperature environments while seals made of Viton are better for higher temperatures. The best seals for high temperature are cast iron piston rings.

3.2.5 Piston Rod

The piston rod is typically a hard, chrome-plated piece of cold-rolled steel which attaches to the piston and extends from the cylinder through the rod-end head. In double rod-end cylinders, the actuator has a rod extending from both sides of the piston and out both ends of the barrel. The piston rod connects the pneumatic actuator to the machine component doing the work. This connection can be in the form of a machine thread or a mounting attachment such as a rod-clevis or rod-eye. These mounting attachments can be threaded or welded to the piston rod or, in some cases, they are a machined part of the rod-end.

3.2.6 Rod Gland

The cylinder head is fitted with seals to prevent the pressurized oil from leaking past the interface between the rod and the head. This area is called the rod gland. It often has another seal called a rod wiper which prevents contaminants from entering the cylinder when the extended rod retracts back into the cylinder. The rod gland also has a rod bearing. This bearing supports the weight of the piston rod and guides it as it passes back and forth through the rod gland. In some cases, especially in small pneumatic cylinders, the rod gland and the rod bearing are made from a single integral machined part.

3.2.7 Other parts

- Cylinder bottom connection
- Seals
- Cushions

A pneumatic cylinder should be used for pushing and pulling only. No bending moments or side loads should be transmitted to the piston rod or the cylinder. For this reason, the ideal connection of a pneumatic cylinder is a single clevis with a spherical ball bearing. This allows the pneumatic actuator to move and allow for any misalignment between the actuator and the load it is pushing.

3.3 FRAME

A frame is a structural system that supports other components of a physical construction. The whole arrangement rests on the frame along with the tool holding setup. The frame is the support of the entire arrangement and is designed to carry the load of the entire setup. This provides the base on which the motor is mounted. The thickness of the frame is 3mm.The size of the frame is 11/2 inches X ¼ inches. The frame is made up of Mild Steel.

3.4 TRAILER BODY

The trailer body is made up of mild steel sheet metal. This frame is look like a small model trailer.

3.5 DIRECTIONAL CONTROL VALVE

The number of the valve positions is equal to the number of the compartments within the envelope of the DCV. Double Acting Cylinders are most commonly controlled by the three way valve. This device has three ports (one inlet from pump, two outlets) and also requires some form of pressure relief during retraction of the cylinder. Four- way valve is used to control a double acting cylinder. This type of valve has four ports (one inlet from pump, 3 outlets). The neutral is available in various configurations.

To control the to and fro motion of cylinder, the fluid energy has to be regulated, controlled and reversed with a predetermined sequence in a pneumatic system.

Similarly one may have to control the quantity of pressure and flow rate to generate the desired level of force and speed of actuators. To achieve these functions, valves are used. Valves are fluid power elements used for controlling and regulating the working medium.

The main functions of the valves are,

- Start and stop the fluid energy
- Control the direction of flow of compressed air
- Control the flow rate of the fluid
- Control the pressure rating of the fluid.

3.5.1 Direction Control Valve Types:

Directional control valves start, stop or change the direction of flow in compressed air applications. Many manufacturing companies apply compressed air as the power to operate tools and equipment. which are used to make the products they offer. To understand the different applications of compressed air and how valves are used, one must first have a knowledge of the kinds and types of valves used by industries. Valves are designed for different applications and a factory may use several different types of valves with each being suited for a particular job. These designs fall into the following categories: spool –bonded and lapped; poppet; a combination of spool and poppet; sliding seal; rotary and diaphragm.

3.5.1.1 Four-Way Valves

Four-way valves use two 3-way valve functions operated at the same time, one normally closed and one normally open. These valves have two outlet ports that alternate between being pressurized and exhausted. Four-way valves are used to operate double acting air cylinders, control bi-directional air motors and in air circuitry. Also two single acting cylinders can be operated with one 4-way Valve.

3.5.1.2 Spool Valves, 4-Way, 5-Port

The 4-way spool valve can be controlled by using two operators, one on each end or by a spring return and a single operator. The flow path when actuated at the 14 end of the valve is from port 1 to port 4 and from port 2 to port 3. Port 5 is blocked. When the valve is actuated from the 1 2 end, the flow path is from port 1 to port 2 and from port 4 to port 5. Port 3 is blocked. Each cylinder port has a separate valve. As shown in the fig. 3.3 and fig. 3.4.

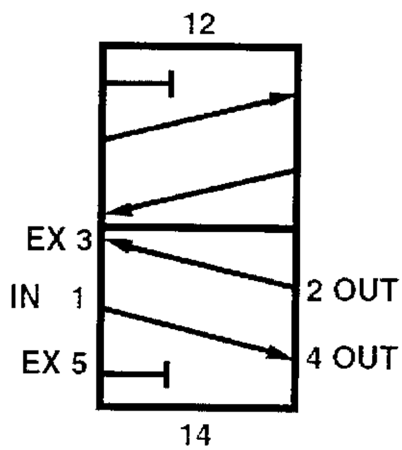

Fig : 3.3 DCV symbol

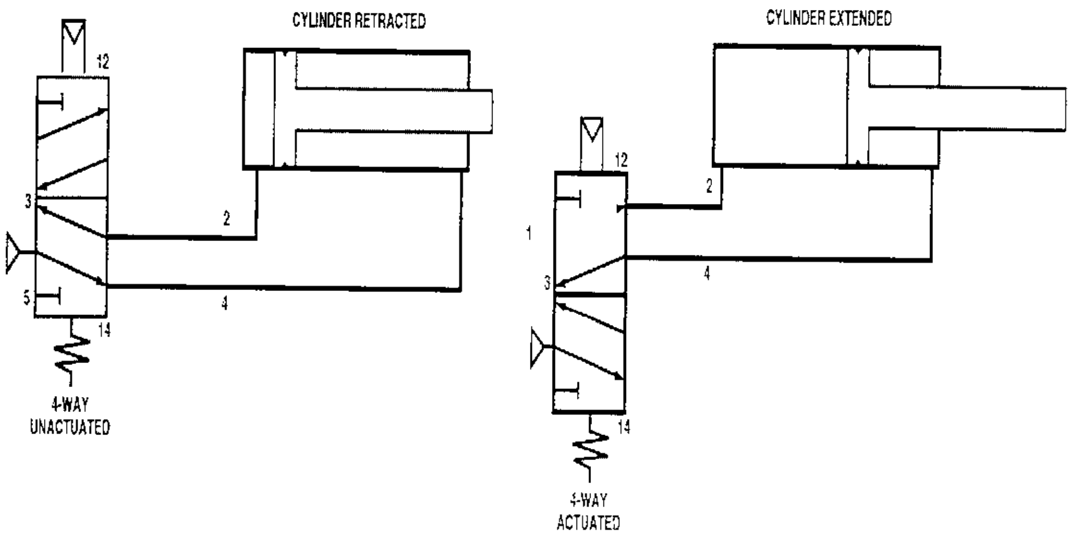

Fig : 3.4 Pneumatic circuit diagram

3.5.1.3 Cylinder Speed Control

Cylinder speed control requirements are defined by the load being moved or work done on extension. As shown in the Fig : 3.5

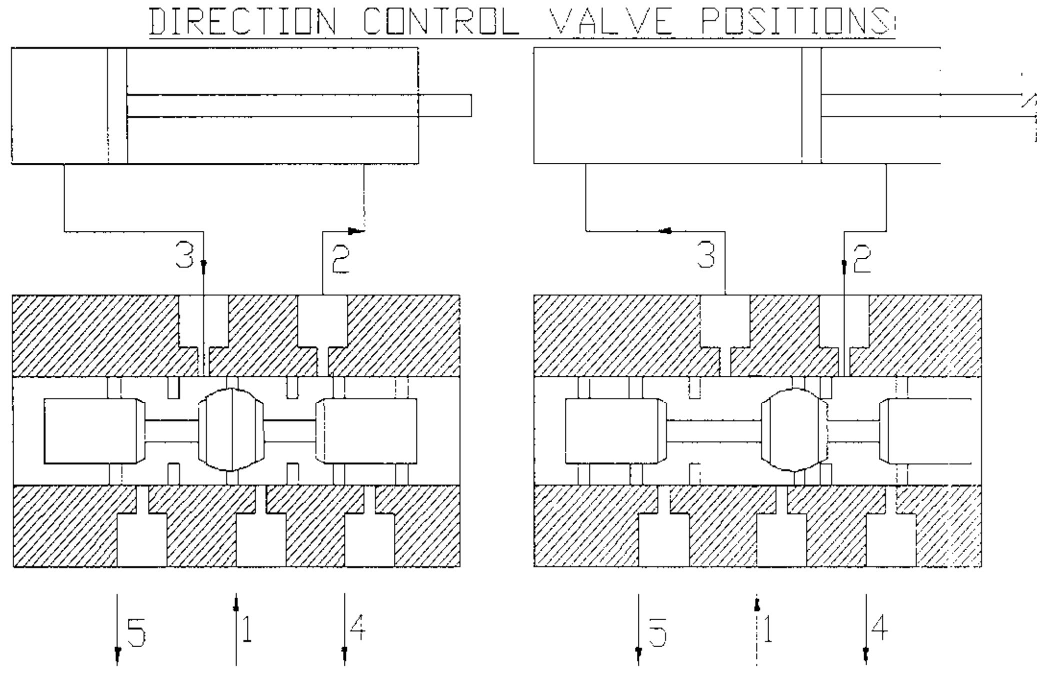

Fig : 3.5 Direction control valve positions

3.6 FLOW CONTROL VALVE

Flow control valve are used to regulate the speed of pneumatic cylinders and motors by controlling the flow rate to these actuators. They may be simple as fixed orifice or an adjustable needle valve. Needle valves are designed to give fine control of flow in small diameter piping. The flow control valve is easy to read and adjust. The stem has several color rings which in conjunction with the numbered knob, permits reading of a given opening. For a given opening position, needle valve behaves as an orifice.

The pressure drop versus flow rate relationship of an orifice is given below as

$$Q= C_0 * A * (P/ Sg)$$

Where

Q	–	Volume flow rate through orifice m^3/s
C_0	–	a constant
A	–	Area of orifice opening m^2
P	–	Pressure drop across orifice (psi)

3.7 DC STEPPER MOTOR

A stepper motor (or step motor) is a brushless, synchronous electric motor that can divide a full rotation into a large number of steps. The motor's position can be controlled precisely, without any feedback mechanism (see open loop control). Stepper motors are similar to switched reluctance motors (which are very large stepping motors with a reduced pole count, and generally are closed-loop commutated).

3.8 BEARING WITH BEARING CAP

The bearings are pressed smoothly to fit into the shafts because if hammered the bearing may develop cracks. Bearing is made upof steel material and bearing cap is mild steel. Ball and roller bearings are used widely in instruments and machines in order to minimize friction and power loss. While the concept of the ball bearing dates back at least to Leonardo da Vinci, their design and manufacture has become remarkably sophisticated. This technology was brought to its present state of perfection only after a long period of research and development. The benefits of such specialized research can be obtained when it is possible to use a standardized bearing of the proper size and type.

However, such bearings cannot be used indiscriminately without a careful study of the loads and operating conditions. In addition, the bearing must be provided with adequate mounting, lubrication and sealing. Design engineers have usually two possible sources for obtaining information which they can use to select a bearing for their particular application:

a) Textbooks

b) Manufacturers'

Catalogs Textbooks are excellent sources; however, they tend to be overly detailed and aimed at the student of the subject matter rather than the practicing designer. They, in most cases, contain information on how to design rather than how to select a bearing for a particular application. Manufacturers' catalogs, in turn, are also excellent and contain a wealth of information which relates to the products of the particular manufacturer. These catalogs, however, fail to provide alternatives – which may divert the designer's interest to products not manufactured by them. Our Company, however, provides the broadest selection of many types of bearings made by different manufacturers.

For this reason, we are interested in providing a condensed overview of the subject matter in an objective manner, using data obtained from different texts, handbooks and manufacturers' literature. This information will enable the reader to select the proper bearing in an expeditious manner. If the designer's interest exceeds the scope of the presented material, a list of references is provided at the end of the Technical Section. At the same time, we are expressing our thanks and are providing credit to the sources which supplied the material presented here.

3.8.1 Types of Bearings

There are many types of bearings, each used for different purposes. These include ball bearings, roller bearings, ball thrust bearings, roller thrust bearings and tapered roller thrust bearings.

Ball Bearings

Ball bearings 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

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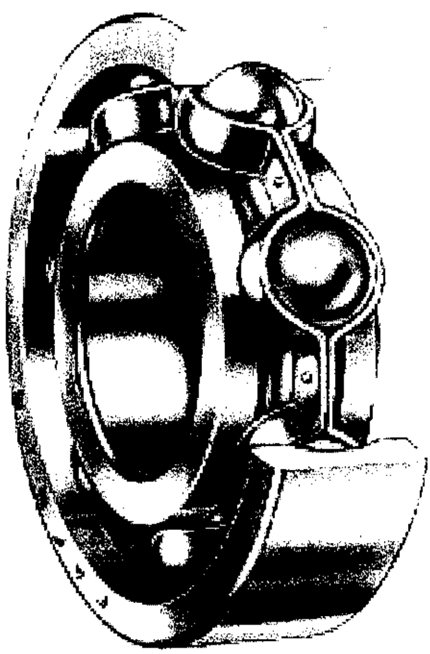

Fig : 3.6 Cutaway view of a ball bearing

3.8.1.1 Angular contact

An angular contact ball bearing uses axially asymmetric races. An axial load passes in a straight line through the bearing, whereas a radial load takes an oblique path that tends to want to separate the races axially. So the angle of contact on the inner race is the same as that on the outer race. Angular contact bearings better support "combined loads" (loading in both the radial and axial directions) and the contact angle of the bearing should be matched to the relative proportions of each. The larger the contact angle (typically in the range 10 to 45 degrees), the higher the axial load supported, but the lower the radial load. In high speed applications, such as turbines, jet engines, dentistry equipment, the centrifugal forces generated by the balls will change the contact angle at the inner and outer race. Ceramics such as silicon nitride are now regularly used in such applications due to its low density (40% of steel - and so significantly reduced centrifugal force), its ability to function in high temperature environments, and the fact that it tends to wear in a similar way to bearing steel (rather than cracking or shattering like glass or porcelain).

Most bicycles use angular-contact bearings in the headsets because the forces on these bearings are in both the radial and axial direction.

3.8.1.2 Axial

An *axial* ball bearing uses side-by-side races. An axial load is transmitted directly through the bearing, while a radial load is poorly-supported, tends to separate the races, and anything other than a small radial load is likely to damage the bearing.

3.8.1.3 Deep-groove

A *deep-groove* radial bearing is one in which the race dimensions are close to the dimensions of the balls that run in it. Deep-groove bearings have higher load ratings for their size than shallow-groove, but are also less tolerant of misalignment of the inner and outer races. A misaligned shallow-groove bearing may support a larger load than a similar deep-groove bearing with similar misalignment.

3.8.1.4 Roller Bearings

Roller bearings like the one illustrated below are used in applications like conveyer belt rollers, where they must hold heavy radial loads. In these bearings, the roller is a cylinder, so the contact between the inner and outer race is not a point but a line. This spreads the load out over a larger area, allowing the bearing to handle much greater loads than a ball bearing. However, this type of bearing is not designed to handle much thrust loading.

A variation of this type of bearing, called a needle bearing, uses cylinders with a very small diameter. This allows the bearing to fit into tight places.

3.8.1.5 Thrust Ball Bearing

Thrust ball bearings like the one shown below are mostly used for low-speed applications and cannot handle much radial load.

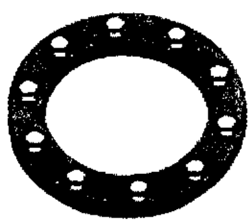

Fig : 3.7 Thrust ball bearing

3.8.1.6 Roller Thrust Bearing

Roller thrust bearings like the one illustrated below can support large thrust loads. They are often found in gearsets like car transmissions between gears, and between the housing and the rotating shafts. Thehelical gears used in most transmissions have angled teeth -- this causes a thrust load that must be supported by a bearing.

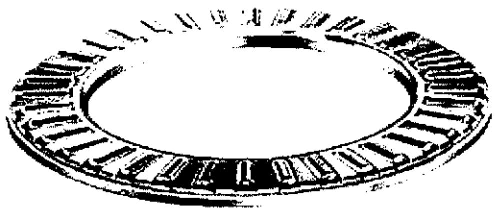

Fig : 3.8 Roller Thrust bearing

3.8.1.7 Tapered Roller Bearings

Tapered roller bearings can support large radial and large thrust loads

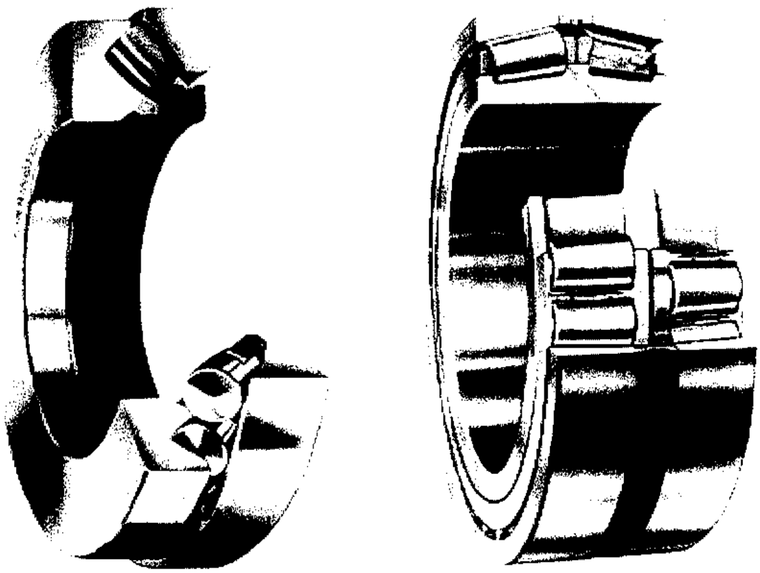

Fig : 3.9 Cutaway view of (left) a spherical roller thrust bearing and (right) a radial tapered roller bearing

Tapered roller bearings are used in car hubs, where they are usually mounted in pairs facing opposite directions so that they can handle thrust in both directions.

CHAPTER - 4

CHAPTER - 4

DESIGN PROCEDURE OF SPUR GEAR

PROCEDURE:

Tangential component (F_t)

F_t = Transmitted load (W_t)

Radial component (F_r)

Torque transmitted (M_t)

$M_t = (60 * P) / 2\pi N$

P – power transmitted in KW

$M_t = (F_t * d/2)$

Radial component $F_r = F_t * \tan \varphi$

Φ – pressure angle

$F = (F_t^2 + F^2_r)^{0.5}$

Pitch line velocity (υ)

$N_{(1.2)}$ - No of teeth on pinion and wheel

i - Speed ratio

$i = (N_1 / N_2) = (Z_2 / Z_1)$

Initial design torque

$[M_t] = M_t \; k_d \, k$

k – load concentration factor

k_d – dynamic load factor

Calculation of ($\mathbf{E_{eq}}$), [$\boldsymbol{\sigma_b}$] and [$\boldsymbol{\sigma_c}$]

Design bending stress

$$[\boldsymbol{\sigma_b}] = (1.4\, k_{bl} / (n \,.\, k_\sigma)) * \sigma_{-1}$$

k_{bl} – life factor in bending

k_σ – stress concentration factor for fillet

n – factor of safety

Design contact stress

$$[\, \boldsymbol{\sigma_c} \,] = C_B \,.\, HB \,.\, k_{cl}$$

$$= C_R \,.\, HRC \,.\, k_{cl}$$

HB or HRC = Brinell or Rockwell Hardness number

k_{cl} – life factor for surface strength

Calculation of centre distance (a):

$$a = (i + 1) ((0.74 / [\, \boldsymbol{\sigma_c} \,])^2 \,.\, ((E_{eq}) \,.\, [\, M_t \,] / i\, \psi))^{1/3}$$

ψ – width to centre distance ratio

Revision of centre distance

$$a = m(Z_1 + Z_2) / 2$$

Calculation for Face width (b)

$$b = \psi . a$$

Pitch diameter of pinion (d_1)

Calculation to check for bending stress:

$$\boldsymbol{\sigma_b} = ((i + 1) / (a . m . b . y)) * [\mathbf{M}_t] < [\boldsymbol{\sigma}_b]$$

Calculation to check for wear strength

$$\boldsymbol{\sigma_c} = (0.74 (i + 1) / a ((i + 1) / i b . E_{eq} . [\mathbf{M}_t])^{0.5}) < [\boldsymbol{\sigma_c}]$$

if the above two conditions are satisfied then the **design is safe.**

CHAPTER - 5

CHAPTER - 5

DIMENSIONAL CALCULATIONS

5.1 SPUR GEAR

The spur gear is is simplest type of gear manufactured and is generally used for transmission of rotary motion between parallel shafts. The spur gear is the first choice option for gears except when high speeds, loads, and ratios direct towards other options. Other gear types may also be preferred to provide more silent low-vibration operation. A single spur gear is generally selected to have a ratio range of between 1:1 and 1:6 with a pitch line velocity up to 25 m/s. The spur gear has an operating efficiency of 98-99%. The pinion is made from a harder material than the wheel. A gear pair should be selected to have the highest number of teeth consistent with a suitable safety margin in strength and wear. The minimum number of teeth on a gear with a normal pressure angle of 20 Degreesis18.

The preferred number of teeth is as follows

12 13 14 15 16 18 20 22 24 25 28 30 32 34 38

40 45 50 54 60

64 70 72 75 80 84 90 96 100 120 140 150 180

200 220 250

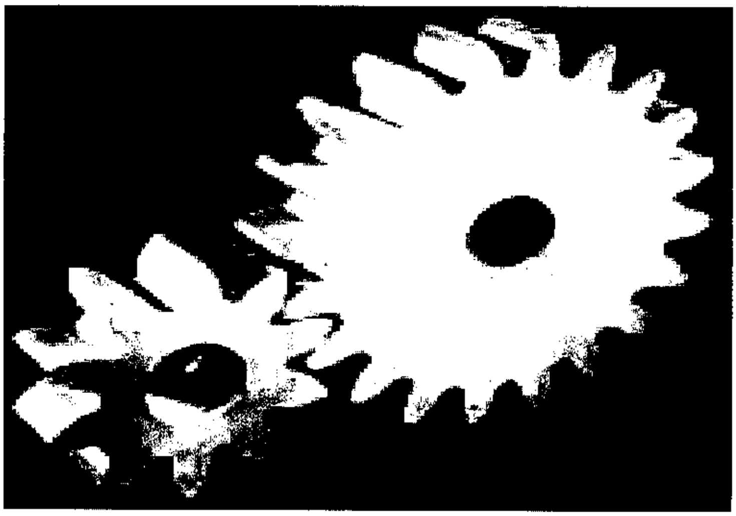

Fig : 5.1 Spur gear

5.1.1 Materials used for gears

Mild steel is a poor material for gears as it has poor resistance to surface loading. The carbon content for unhardened gears is generally 0.4 %(min) with 0.55 %(min) carbon for the pinions. Dissimilar materials should be used for the meshing gears - this particularly applies to alloy steels. Alloy steels have superior fatigue properties compared to carbon steels for comparable strengths. For extremely high gear loading case hardened steels are used the surface hardening method employed should be such to provide sufficient case depth for the final grinding process used.

Table: 5.1 Materials used for gears

Material	Notes	applications
Ferrous metals		
Cast Iron	Low Cost easy to machine with high damping	Large moderate power, commercial gears
Cast Steels	Low cost, reasonable strength	Power gears with medium rating to commercial quality
Plain-Carbon Steels	Good machining, can be heat treated	Power gears with medium rating to commercial/medium quality
Alloy Steels	Heat Treatable to provide highest strength and durability	Highest power requirement. For precision and high precision
Stainless Steels (Austenite)	Good corrosion resistance.	Corrosion resistance with low power ratings. Up to

	Non-magnetic	precision quality
Stainless Steels (Marten site)	Harden able, Reasonable corrosion resistance, magnetic	Low to medium power ratings Up to high precision levels of quality
Non-Ferrous metals		
Aluminum alloys	Light weight, non-corrosive and good mach inability	Light duty instrument gears up to high precision quality
Brass alloys	Low cost, non-corrosive, excellent mach inability	low cost commercial quality gears. Quality up to medium precision
Bronze alloys	Excellent mach inability, low friction and good	For use with steel power gears. Quality up to high precision

5.2 PNEUMATIC CYLINDERS

5.2.1 Sizes

Air cylinders are available in a variety of sizes and can typically range from a small 2.5mm air cylinder, which might be used for picking up a small transistor or other electronic component, to 400mm diameter air cylinders which would impart enough force to lift a car. Some pneumatic cylinders reach 1000mm in diameter, and are used in place of hydraulic cylinders for special circumstances where leaking hydraulic oil could impose an extreme hazard.

Pressure, radius, area and force relationships

Although the diameter of the piston and the force exerted by a cylinder are related, they are not directly proportional to one another. Additionally, the typical mathematical relationship between the two assumes that the air supply does not become saturated. Due to the effective cross sectional area reduced by the area of the piston rod, the in stroke force is less than the outstroke force when both are powered pneumatically and by same supply of compressed gas.The relationship, between force on outstroke, pressure and radius, is as follows:

$$F = p(\pi r^2)$$

Where:

F represents the force exerted

r represents the radius

π is pi, approximately equal to 3.14159.

This is derived from the relationship, between force, pressure and effective cross-sectional area, which is:

$F = pA$

With the same symbolic notation of variables as above, but also A represents the effective cross sectional area.

On instroke, the same relationship between force exerted, pressure and effective cross sectional area applies as discussed above for outstroke. However, since the cross sectional area is less than the piston area the relationship between force, pressure and radius is different. The calculation isn't more complicated though, since the effective cross sectional area is merely that of the piston less that of the piston rod.

For in stroke, therefore, the relationship between force exerted, pressure, radius of the piston, and radius of the piston rod, is as follows:

$$F = p(\pi r_1^2 - \pi r_2^2) = p\pi(r_1^2 - r_2^2)$$

Where:

F represents the force exerted

r_1 represents the radius of the piston

r_2 represents the radius of the piston rod

π is Both pneumatics and hydraulics are applications of fluid power. Pneumatics uses an easily compressible gas such as air or a suitable pure gas, while hydraulics uses relatively incompressible liquid media such as oil. Most industrial pneumatic applications use pressures of about 80 to 100 pounds per square inch (psi) (500 to 700 kilopascals). Hydraulics applications commonly use from 1,000 to 5,000 psi (7 to 35 MPa), but specialized applications may exceed 10,000 psi (70 MPa).

5.2.2 Advantages of pneumatics

5.2.2.1 Simplicity of Design And Control

Machines are easily designed using standard cylinders & other components. Control is as easy as it is simple ON - OFF type control.

5.2.2.2 Reliability

Pneumatic systems tend to have long operating lives and require very little maintenance.

Because gas is compressible, the equipment is less likely to be damaged by shock. The gas in pneumatics absorbs excessive force, whereas the fluid of hydraulics directly transfers force.

5.2.2.3 Storage

Compressed Gas can be stored, allowing the use of machines when electrical power is lost.

5.2.2.4 Safety

Very small fire hazards (compared to hydraulic oil).

Machines can be designed to be overload safe.

5.3 FRAME:

The Length of frame is 51 centimeters. The breadth of frame is 55 centimeters.

The height of frame is 38 centimeters. The thickness of the frame is 3mm.

The size of the frame is 3.84 centimeters X 0.64 centimeters. The frame is made up of Mild Steel. (Refer Apendix1)

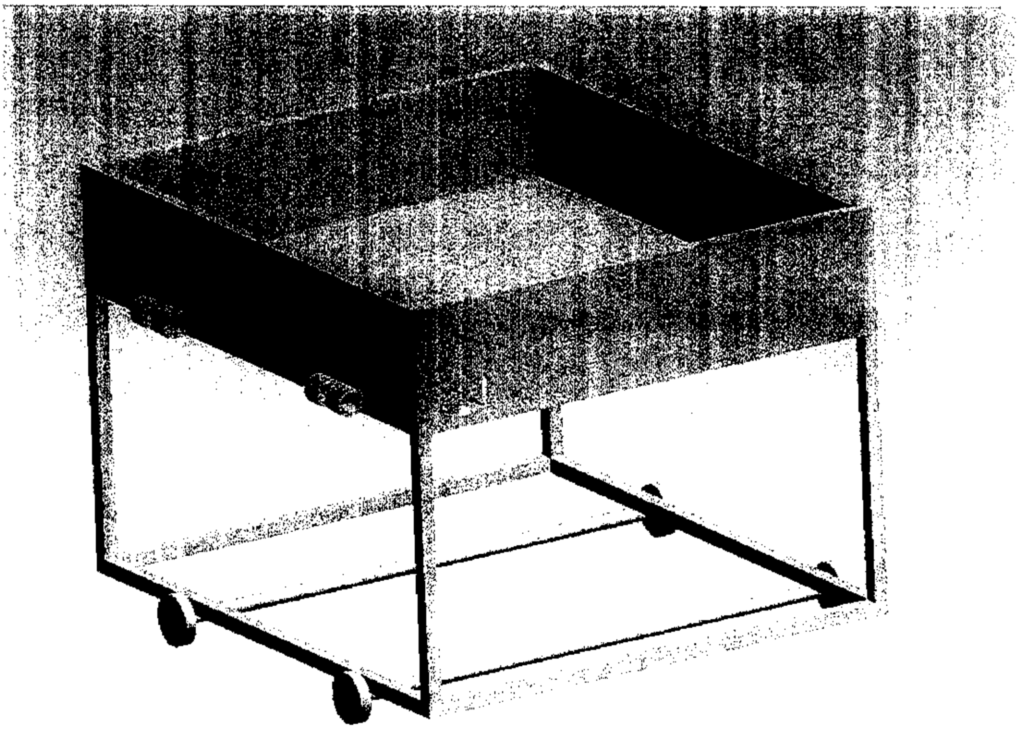

Fig : 5.3 Modeled Frame

CHAPTER - 6

CHAPTER – 6

FABRICATION

6.1.FRAME :

The material of the frame is Mild Steel Grad EN8.En8 is a general purpose high strength steel for applications that require additional strength and superior tensile properties to normal bright mild steel. The joints of the frame are welded together by Gas Metal Arc Welding. GMAW is the most common industrial welding process, preferred for its versatility, speed and the relative ease of adapting the process. The filler rod used is bought from Thulasi Electrode E6013.The welding is carried from right to left.

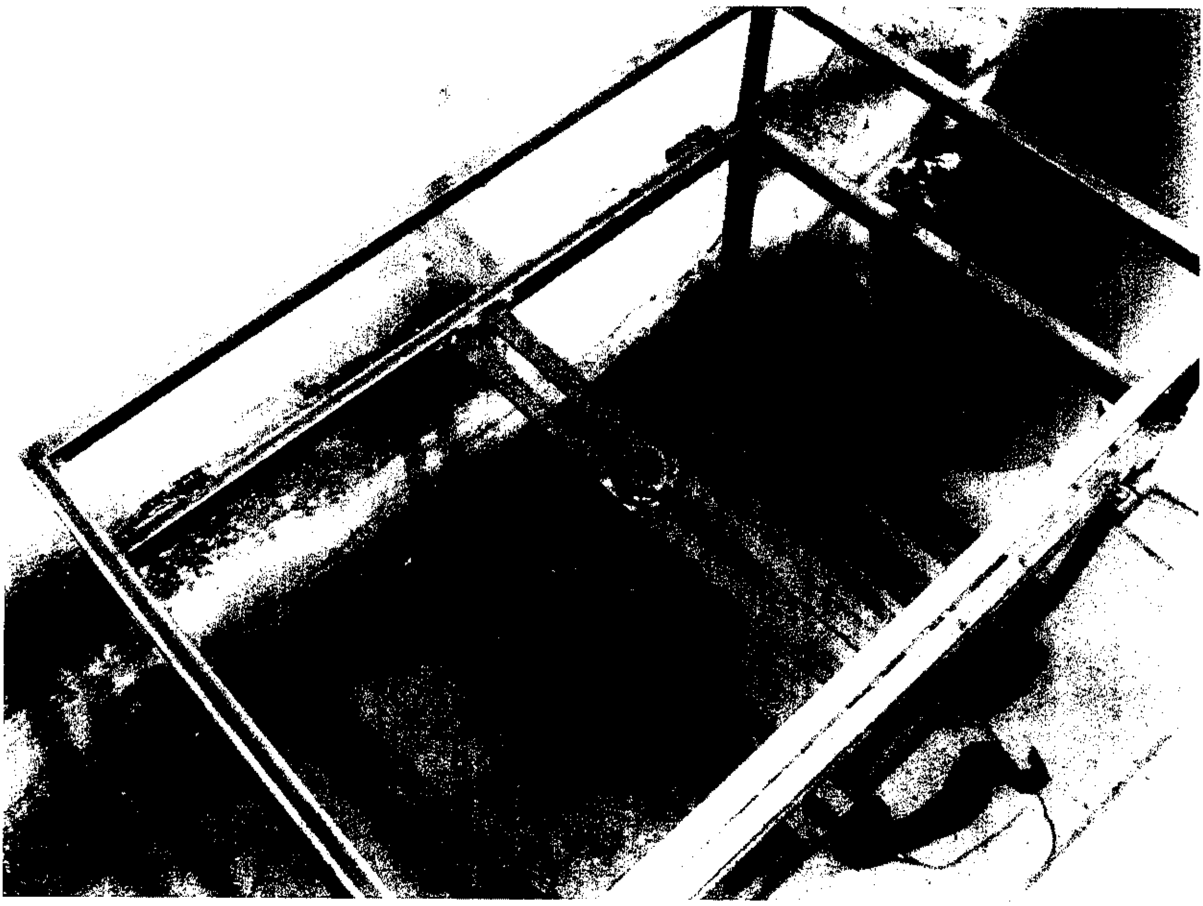

Fig : 6.1 Fabricated Frame

6.2 MOTOR:

The motor used in our project is a stepper motor bought from the Laxmi Motors.

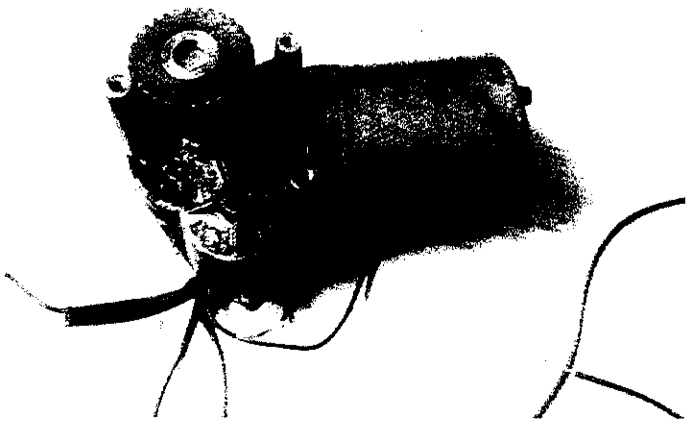

Fig: 6.2 D.C. Motor

6.3 GEAR :

The spur gear is used for power transmission.

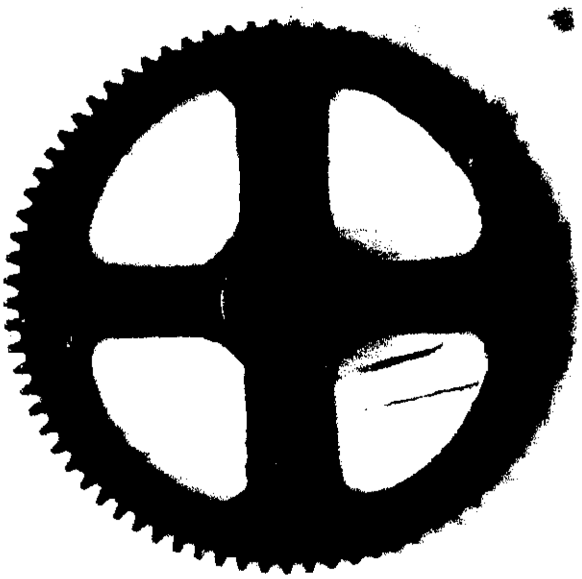

Fig : 6.3 Spur Gear

CHAPTER - 7

CHAPTER – 7

COST ESTIMATION

7.1 LIST OF MATERIALS

Table : 7.1 list of materials

Sl. No.	PARTS	Qty.	Material
i.	Pneumatic Double Acting Cylinder	1	M.S
ii.	Direction Control Valve	1	Aluminium
iii.	Flow Control Valve	1	Aluminium
iv.	Wheel	4	Rubber
v.	Bearing with Bearing Cap	6	Fiber
vi.	Polyethylene Tube	1	Polyurethene
vii.	Hose Collar and Reducer	6	Brass
viii	Stand (Frame)	1	Mild steel

7.2 MATERIAL COST :

Table 7. 2 : Material Cost

Sl. No.	PARTS	Qty.	Material	Amount (Rs)
i.	Pneumatic Double Acting Cylinder	1	M.S	1600
ii.	Direction Control Valve	1	Aluminium	950
iii.	Flow Control Valve	1	Aluminium	450
iv.	Wheel	4	Rubber	360
v.	Bearing with Bearing Cap	6	Fiber	600
vi.	Polyethylene Tube	1	Polyurethene	50
vii.	Hose Collar and Reducer	6	Brass	120
viii	Stand (Frame)	1	Mild steel	2000

TOTAL COST : Rs.6130

7.3 LABOUR COST:

Lathe, Drilling, Welding, Grinding, Power Hacksaw, Gas Cutting:

Cost = **Rs. 1250**

7.4 OVERHEAD CHARGES

The overhead charges are arrived by "Manufacturing cost"

Manufacturing Cost = Material Cost + Labour cost

= 6130 + 1250

= Rs. 7380

Overhead Charges = 20% of the manufacturing cost

= Rs. 1476

7.5 TOTAL COST

Total cost = Material Cost + Labour cost + Overhead Charges

= 6130 + 1250 + 1476

= 8856

Total cost for this project = Rs. 8856

CHAPTER - 8

CHAPTER – 8

AUTOMATION

8.1 AUTOMATION

Automation (ancient Greek: = self dictated), industrial automation or numerical control is the use of control systems such as computers to control industrial machinery and processes, replacing human operators. In the scope of industrialization, it is a step beyond mechanization. Whereas mechanization provided human operators with machinery to assist them with the physical requirements of work, automation greatly reduces the need for human sensory and mental requirements as well.

Automation plays an increasingly important role in the global economy and in daily experience. Engineers strive to combine automated devices with mathematical and organizational tools to create complex systems for a rapidly expanding range of applications and human activities.

There are still many jobs which are in no immediate danger of automation. No device has been invented which can match the Eye [human eye] for accuracy and precision in many tasks; nor the human ear. Even the admittedly handicapped human is able to identify and distinguish among far more scents than any automated device. Human pattern recognition, language recognition, and language production ability is well beyond anything currently envisioned by automation engineers.

Specialized hardened computers, referred to as programmable logic controllers (PLCs), are frequently used to synchronize the flow of inputs from (physical) sensors and events with the flow of outputs to actuators and events. This leads to precisely controlled actions that permit a tight control of almost any industrial process.

Human-machine interfaces (HMI) or computer human interfaces (CHI), formerly known as man-machine interfaces, are usually employed to communicate with PLCs and other computers, such as entering and monitoring temperatures or pressures for further automated control or emergency response. Service personnel who monitor and control these interfaces are often referred to as stationary engineers.

Another form of automation involving computers is test automation, where computer-controlled automated test equipment is programmed to simulate human testers in manually testing an application. This is often accomplished by using test automation tools to generate special scripts (written as computer programs) that direct the automated test equipment in exactly what to do in order to accomplish the tests

Finally, the last form of automation is software-automation, where a computer by means of macro recorder software records the sequence of user actions (mouse and keyboard) as a macro for playback at a later time.

8.2 CURRENT EMPHASIS IN AUTOMATION

Currently, for manufacturing companies, the purpose of automation has shifted from increasing productivity and reducing costs, to broader issues, such as increasing quality and flexibility in the manufacturing process.

The old focus on using automation simply to increase productivity and reduce costs was seen to be short-sighted, because it is also necessary to provide a skilled workforce who can make repairs and manage the machinery. Moreover, the initial costs of automation were high and often could not be recovered by the time entirely new manufacturing processes replaced the old. (Japan's "robot junkyards" were once world famous in the manufacturing industry.)

Automation is now often applied primarily to increase quality in the manufacturing process, where automation can increase quality substantially. For example, automobile and truck pistons used to be installed into engines manually. This is rapidly being transitioned to automated machine installation, because the error rate for manual installment was around 1-1.5%, but has been reduced to 0.00001% with automation. Hazardous operations such as oil refining, the manufacturing of industrial chemicals and other forms of metal working were always early contenders for automation.

Another major shift in automation is the increased emphasis on flexibility and convertibility in the manufacturing process. Manufacturers are increasingly demanding the ability to easily switch from manufacturing Product A to manufacturing Product B without having to completely rebuild the production lines

8.3 TYPES OF AUTOMATION

Automated machines can be subdivided into two large categories—open-loop and closed-loop machines, which can then be subdivided into even smaller categories. Open-loop machines are devices that, once started, go through a cycle and then stop. A common example is the automatic dishwashing machine. Once dishes are loaded into the machine and a button pushed, the machine goes through a predetermined cycle of operations: pre-rinse, wash, rinse, and dry, for example. A human operator may have choices as to which sequence the machine should follow—heavy wash, light wash, warm and cold, and so on—but each of these operations is alike in that the machine simply does the task and then stops. Many of the most familiar appliances in homes today operate on this basis. A microwave oven, a coffee maker, and a CD player are examples.

Larger, more complex industrial operations also use open-cycle operations. For example, in the production of a car, a single machine may be programmed to place a side panel in place on the car and then weld it in a dozen or more locations. Each of the steps involved in this process—from placing the door properly to each of the different welds—takes place according to instructions programmed into the machine.

CONCLUSION

CONCLUSION

This project work has provided us an excellent opportunity and experience, to use our limited knowledge. We gained a lot of practical knowledge regarding, planning, purchasing, assembling and machining while doing this project work. We feel that the project work is a good solution to bridge the gates between institution and industries.

We are proud that we have completed the work with the limited time successfully. The "**DESIGN AND FABRICATION OF THREE AXIS PNEUMATIC TRAILER"** is working with satisfactory conditions. We are able to understand the difficulties in maintaining the tolerances and also quality. We have done to our ability and skill making maximum use of available facilities. In conclusion remarks of our project work, let us add a few more lines about our impression project work.

Thus we have developed a "**DESIGN AND FABRICATION OF THREE AXIS PNEUMATIC TRAILER**" which helps to know how to achieve low cost automation. The operating procedure of this system is very simple, so any person can operate. By using more techniques, they can be modified and developed according to the applications.

SCOPE FOR FUTURE DEVELOPMENT

- The whole process carried out can be fully automated with the help of PLC and its control elements.
- The productivity of the process can be increased further
- This system can also be implemented to other process in the foundry so as to increase the productivity.
- It has an extensive usage in railways
- It has a broad area of application in construction industries
- It's applications include
  - Logistics
  - Port applications
  - Material handling systems

APPENDIX

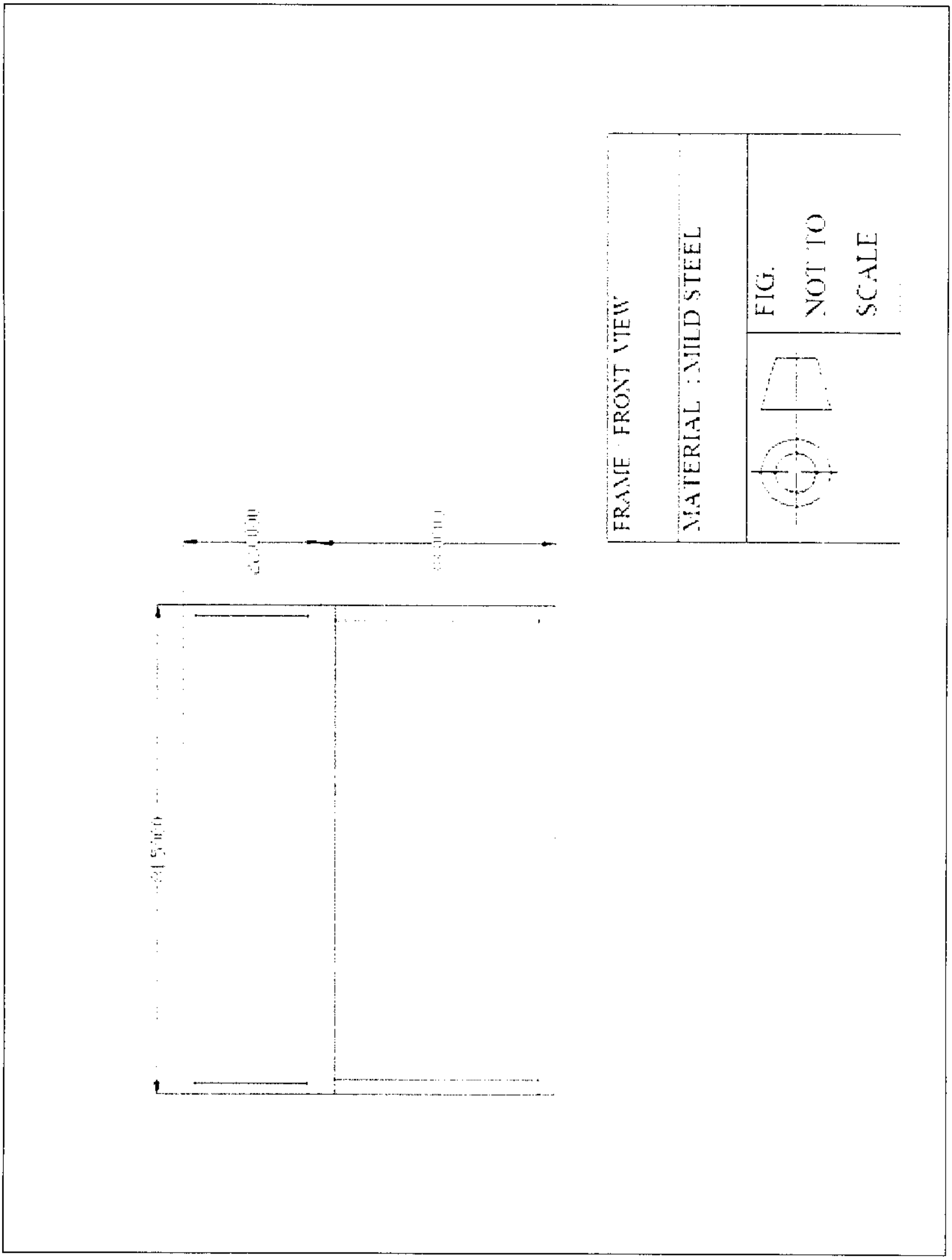

Fig : A.1 Front View of Frame

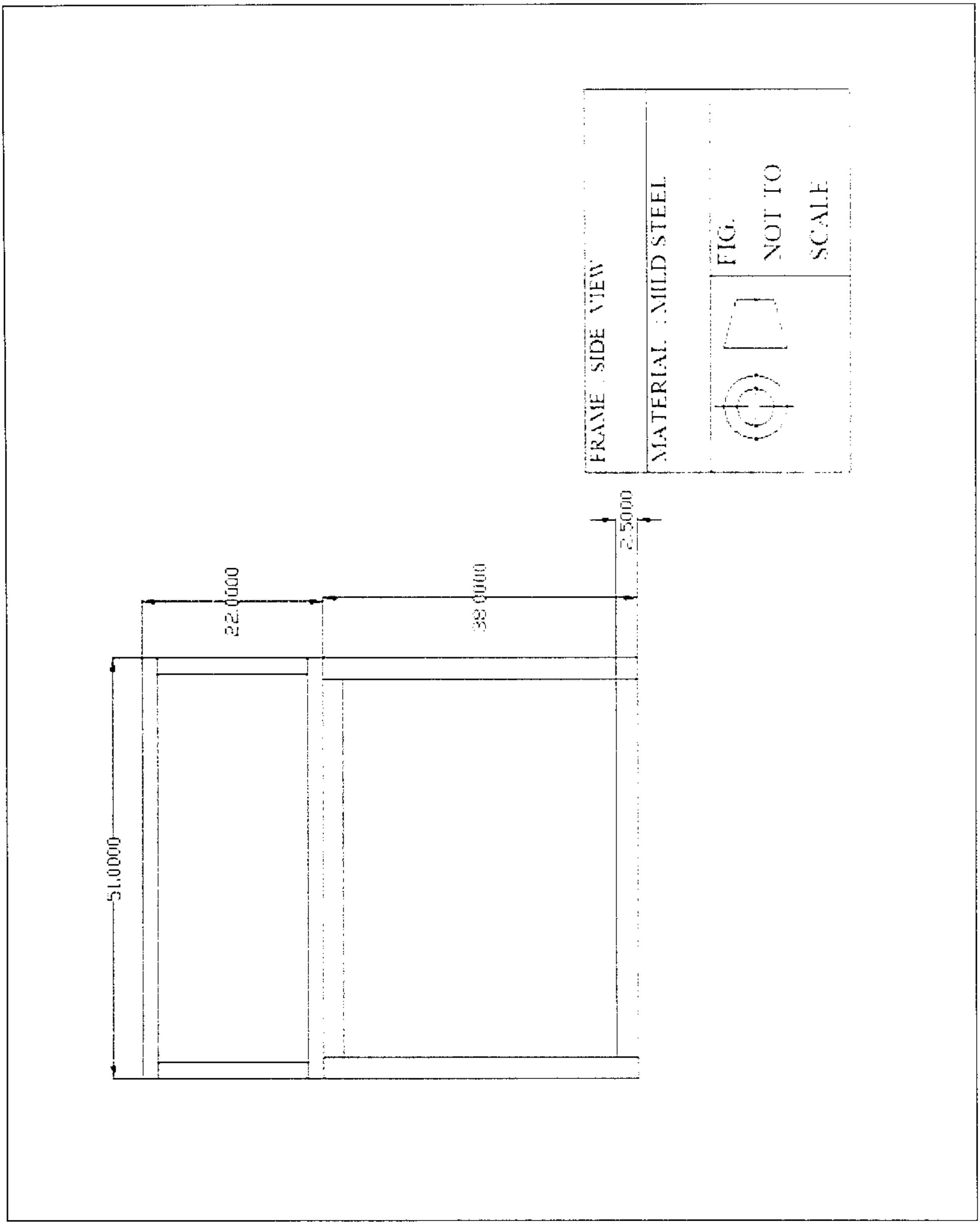

Fig : A.2 Side View of the Frame

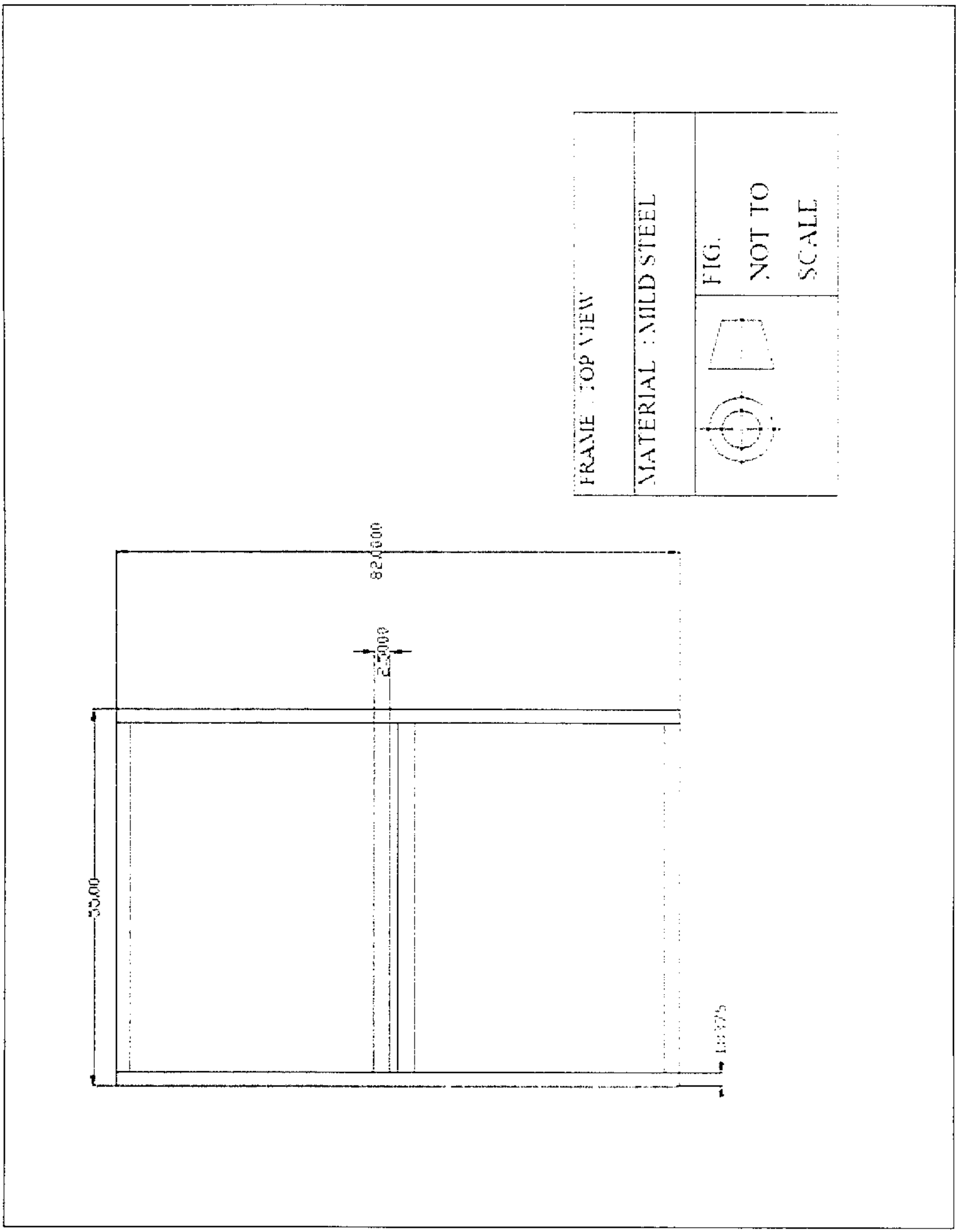

Fig : A.3 Top View of the Frame

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