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Productivity Improvement Through Re-Engineering

A Project Report

Submitted by

E.K.Arun Kumar - 71202114004
D. Sivashankar - 71202114048
D. Sounder - 71202114049

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COIMBATORE – 641 006

ANNA UNIVERSITY :: CHENNAI 600 025

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ANNA UNIVERSITY:: CHENNAI 600 025

BONAFIDE CERTIFICATE

Certified that this project report entitled "**Productivity Improvement Through Re-Engineering**" is the bonafide work of

Mr. E.K.Arun Kumar	-	Register No. 71202114004
Mr. D.Sivashankar	-	Register No. 71202114048
Mr. D.Sounder	-	Register No. 71202114049

Who carried out the project work under my supervision.

Signature of the Head of the Department
Dr.T.P. MANI
HEAD OF THE DEPARTMENT

Signature of the supervisor
Prof.T.KANNAN
SUPERVISOR

Internal Examiner 28/04/06
Dr. T.P. Mani
B.E., M.E., Ph.D., DML., MIE., MNIQR., MISTE.,
Dean & HoD / Dept. of Mech. Engg.
Kumaraguru College of Technology
Coimbatore - 641 006

External Examiner 28/4/06

DEPARTMENT OF MECHANICAL ENGINEERING

KUMARAGURU COLLEGE OF TECHNOLOGY

COIMBATORE – 641 006

Bimetal Bearings Limited

371, Maruthamalai Road, P.N. Pudur, Coimbatore - 641 041.

Telephones : 2438652
2432280, 2432033
Telegrams : BIMITE
Fax : 0422 - 2430483
E-mail : bblcbe@md5.vsnl.net.in

Manufacturers of BIMITE *Thinwall Bearings, Bushings and Thrust Washers*

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TO WHOMSOEVER IT MAY CONCERN

This is to certify that **MR.E.K.ARUNKUMAR, MR.D.SIVASHANKAR & MR.SOUNDER** Students of **KUMARAGURU COLLEGE OF TECHNOLOGY, COIMBATORE 641 006** have done a Project on **PRODUCTIVITY IMPROVEMENT THROUGH RE-ENGINEERING** in **BIMETAL BEARINGS LIMITED** for a period from **December 2005 to March 2006** in our Organization. They have been regular in their attendance during this period.

We found their performance and conduct Satisfactory.

WE WISH THEM ALL SUCCESS.

for BIMETAL BEARINGS LIMITED

S.JAYAKUMAR
MANAGER-HUMAN RESOURCES

ABSTRACT

This project deals with Re-engineering and Re-designing of an outdated chamfering machine which is used to chamfer both the sides of hydrodynamic bearings. The main aim of our project is to increase the productivity of the machine and reduce the overall production cost.

The existing chamfering machine consists of a spider with eight adapters to hold the work piece and there are eight stages of indexing. The finished workpiece is manually collected and placed in a conveyor. This method has a lot of disadvantages and increases the production cost.

The indexing mechanism is designed to convert the eight stations into two station chamfering machine. Also the design of a pick and place automation is made to collect the workpiece from the machine and place it on the conveyor. The fabrication of pick and place automation is successfully made.

By implementing this project the production cost is reduced, productivity is increased, machine set up time is reduced, labor cost is reduced, work in progress is eliminated, product damage due to gravity fall is eliminated and product mix up is eliminated.

ACKNOWLEDGEMENT

We are greatly obliged to one and all who have contributed to the shaping of this project. Highly selective lists of some who have helped us by giving freely their assistance are given below.

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We owe a considerable debt to our Dean and Head of the Department **Dr. T.P.Mani, PhD.** and our principal **Dr. K.K.Padmanabhan, PhD.** for their patronage and inspiration.

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With deep respects, we express our gratitude to **Mr. G.D.Prabhu, M.E, MBA** Plant Service Manager of M/s **Bimetal Bearings Pvt Ltd.** for sponsoring our project and helping us during the various phase of our project.

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ABBREVIATIONS

m	Mass of the spider along with adapters
r	Radius of the spider
d	Diameter of the spider
v	Peripheral velocity of the spider
a	acceleration of the spider
α	Angular acceleration
I	Mass moment of inertia of the spider
T	Torque
N	Speed
P	Power transmitted
σ_u	Ultimate strength
σ_y	Yield strength
M_t	Twisting moment
m	Module
σ_b	Bending stress
Z	No. of teeth
D	Diametral pitch
Φ	Pressure Angle

CHAPTER 1

INTRODUCTION

1.1 ABOUT THE PROJECT

Re-engineering is the fundamental rethinking and radical redesign of process to achieve dramatic improvements in critical contemporary measures of performance such as cost, quality, service and speed.

This project is on re-engineering of eight station chamfering machine which is used for chamfering the hydrodynamic bearings. It is an outdated machine belonging to the 60's. Earlier, the ratchet and pawl mechanism was used for indexing the machine. The maximum degree of indexing obtained in ratchet and pawl mechanism is 45° and hence eight station indexing is provided.

Earlier, the finished workpiece coming out of the machine was collected in a bin and it is aligned manually on the conveyor for further machining. This has a lot of disadvantages like workpiece damage due to gravity fall, product mix up and it also increases the production cost.

The aim of this project is to increase the productivity of the machine by reducing the production cost and machine setup time. Two solutions are identified to increase the productivity of the chamfering machine. They are designed and fabricated successfully.

The eight station chamfering machine was converted to two station chamfering machine and also the workpiece removal process has been automated. One of the labour was reduced through our project which has reduced the overall production cost to a greater extent. This project has improved the productivity of the machine and the quality of the bearing is also increased.

1.2 ABOUT THE COMPANY

This project work was carried out at Bimetal Bearings Ltd, Coimbatore. Bimetal Bearings Ltd is a member of the Amalgamations Group, established in 1961, in collaboration with CLEVITE Corps., USA and REPCO, Australia. They manufacture Engine Bearings, Bushes and Thrust Washers to all vehicle manufacturers in India like Tata, Leyland, Maruti (Suzuki), Hyundai, Tafe, Mahindra, Cummins, and Fiat etc.

All the plants of Bimetal Bearings Ltd are QS 9000 Certified. Raw material and finished products are exported to USA, Mexico , Argentina, Germany, UK, Austria, Italy, Iran, South Africa, Dubai, Srilanka, Bangladesh and South Korea and Indonesia.

1.3 PROBLEM DEFINITION

At present, the chamfering machine consists of a single spider which holds eight adapters. The adapters are used to hold the work piece during machining. All the adapters are not exactly unique due to the difference in their accuracy levels. So the finished work pieces coming out of each adapter doesn't have the same accuracy level. So the repeatability of the product is reduced. Also, since eight adapters are used, which is to be changed for new products, the production cost is increased.

The work piece coming out of each adapter is collected in a bin and it is manually aligned on the conveyor. This is because, as the ejected work piece falls on the conveyor, it gets scattered and hence it is manually aligned on the conveyor for further machining. So it requires a labor to do the above operation. This increases the production cost.

1.4 POSSIBLE SOLUTIONS

1.4.1 THE POSSIBLE SOLUTIONS THAT ARE ADOPTED

- Converting eight stations into two station chamfering machine.
- Automating the work piece removal from the machine.

1.4.2 BENEFITS OF TWO STATION CHAMFERING MACHINE

- ✓ Production cost will be reduced
- ✓ Repeatability will be increased
- ✓ Machine setup time will be reduced
- ✓ Productivity will be increased

1.4.3 BENEFITS OF PICK & PLACE AUTOMATION

- ✓ Reduction in labour cost
- ✓ Elimination of product damage due to gravity fall
- ✓ Work in progress can be eliminated
- ✓ Product mix up is reduced

CHAPTER 2

LITERATURE SURVEY

2.1 RE-ENGINEERING

Re-engineering is the fundamental rethinking and radical redesign of process to achieve dramatic improvements in critical contemporary measures of performance such as cost, quality, service and speed. The concept of Re-Engineering is shown in the fig 2.1.

Re-engineering design – an overview

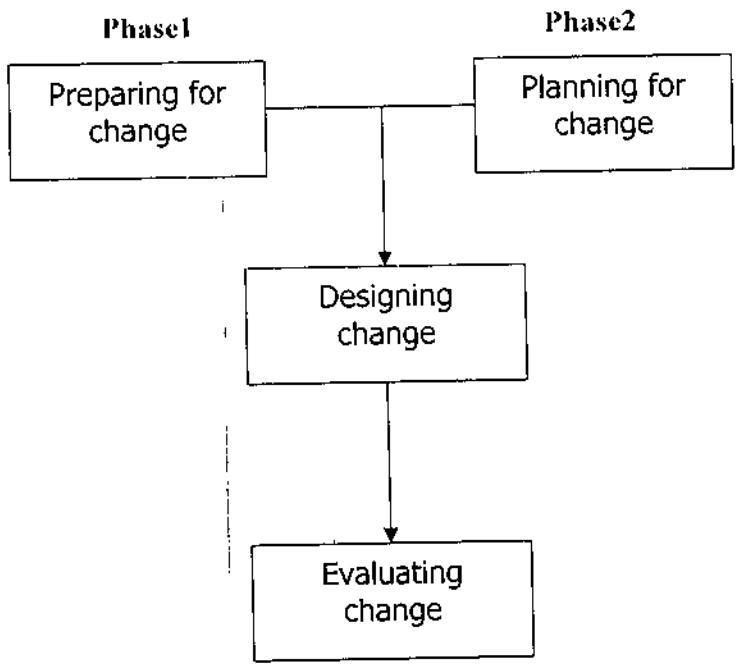

FIG 2.1 CONCEPT OF RE- ENGINEERING

2.1.1 PRINCIPLES OF RE-ENGINEERING

In original Manifesto reengineering was by definition radical; it could not simply be an enhancement or modification of what went before. It examined work in terms of outcomes, not tasks or unit functions, and it expected dramatic, rather than marginal improvements.

Following are seven principles of reengineering, suggested for streamline work processes, achieve savings, and improve product quality and time management.

1. Organization of around outcomes, not tasks.

2. Identification of all the processes in an organization and prioritize them in order of redesign urgency

3. Integration of information processing work into the real work that produces information.

4. Treating geographically dispersed resources as though they were centralized.

5. Linking parallel activities in the workflow instead of just integrating their results.

6. Keeping the decision point where the work is performed, and build control into the process.

7. Capturing information once and at the source.

2.1.2 THE BENEFITS OF RE-ENGINEERING

The hard task of re-examining mission and how it is being delivered on a day-to-day basis will have fundamental impacts on an organization, especially in terms of responsiveness and accountability to customers and stakeholders. The rewards of reengineering are many including:

- Empowering employees;
- Eliminating waste, unnecessary management overhead, and obsolete or inefficient processes.
- Producing often significant reductions in cost and cycle times;
- Enabling revolutionary improvements in many business processes as measured by quality and customer service
- Helping top organizations stay on top and low-achievers to become effective competitors.

2.1.3 SELECTING A PROCESS IN RE-ENGINEERING

Wise organizations will focus on those core processes that are critical to their performance, rather than marginal processes that have little impact. There are several criteria reengineering practitioners can use for determining the importance of the process:

- Is the process broken?
- Is it feasible that reengineering of this process will succeed?
- Does it have a high impact on the agency's strategic direction?

- Does it significantly impact customer satisfaction?
- Is it antiquated?
- Does it fall far below "Best-in-Class"?

2.1.4 FLOW PROCESS IN RE-ENGINEERING

The process flow in reengineering is shown in fig 2.2,

2.1.4.1 Define the framework

Define functional objectives; determine the management strategy to be followed in streamlining and standardizing processes; and establish the process, data, and information systems baselines from which to begin process improvement.

2.1.4.2 Analyze

Analyze business processes to eliminate non-value added processes; simplify and streamline processes of little value; and identify more effective and efficient alternatives to the process, data, and system baselines.

2.1.4.3 Evaluate

Conduct a preliminary, functional, economic analysis to evaluate alternatives to baseline processes and select a preferred course of action.

2.1.4.4 Plan

Develop detailed statements of requirements, baseline impacts, costs, benefits, and schedules to implement the planned course of action.

2.1.4.5 Approve

Finalize the functional economic analysis using information from the planning data, and present to senior management for approval to proceed with the proposed process improvements and any associated data or system changes.

2.1.4.6 Execute

Execute the approved process and data changes, and provide functional management oversight of any associated information system changes.

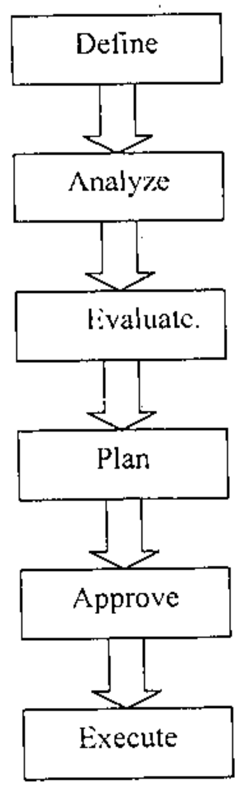

FIG 2.2 FLOW IN REENGINEERING

2.2 TYPES OF INDEXING MECHANISMS

2.2.1 GENEVA MECHANISM

Geneva mechanism consists of a Geneva wheel with a number of slots and a driving disc (crank) whose projected pin enters the slot and causes the intermittent rotation of the Geneva wheel. This mechanism is used in rotary tables and indexing turrets in machine tools and in automatic machines. The number of slots in the mechanism ranges from three to eight depending on the applications.

2.2.2 RATCHET AND PAWL MECHANISM

Ratchet and Pawl arrangement is used mostly in machines. The mechanism does not interfere while raising the load, but prevents the load coming down due to gravity. The mechanism consists of a ratchet 1 fitted to a shaft 2 of the drive, and a Pawl 3 whose pivot 4 is fixed to the frame. The pawl, engaging the ratchet arrests the clockwise rotation of the shaft. When rotation is reversed, the pawl gets disengaged and there is no interference to the counter clockwise rotation. Ratchet and Pawl mechanism is also used in some screw jacks for turning the screw rod and in shaping machines for turning the screw rod of the table.

2.3 FREE WHEEL CLUTCH

Freewheels are machine elements with unique characteristics:

In the one direction of rotation-

- There is no driving contact between inner and outer ring hence the freewheel is freewheeling.

In the other direction of rotation-

- There is driving contact between inner and outer ring, in this direction it is possible to transmit a high torque.

The characteristics allow freewheel to fulfill various functions completely automatically in the most diverse machines. No mechanical or hydraulic operating equipment is needed, as is the case with couplings or brakes for example

Freewheels are used as

- Indexing freewheels
- Overrunning couplings
- Backstops.

The freewheel as an automatic driving element is preferred to conventional solutions because of its decisive advantages offered in respect of

- Operating safety
- Economics
- Higher degree of automatisation

By no means do these advantages create higher costs; on the contrary: the application of freewheels leads to reduced costs compared with solutions using separately controlled coupling or brakes as there are no control costs.

2.3.1 APPLICATIONS AS INDEXING FREEWHEEL

The indexing freewheel replaces the older pawl type freewheel because it is precise and noiseless in its operation and permits a fine setting of the feed path.

For example it is used

- In material feed installations of dies, forging presses and wire processing machines.
- For producing fine feeds in packing, paper processing, printing and textile machines.
- As a reduction gear possibly with fine setting for the reduction in sowing (drilling) machines, continuous -heating furnaces, printing machines and high voltage current controls.
- For automatic compensation for the wear in brakes.
- As feed installation planning, shaping and grinding machines .

2.3.2 APPLICATION AS OVERRUNNING CLUTCH

When used as an overrunning coupling, the freewheel effects an automatic interruption of the connection between coupled machines and components if the direction of force changes in many cases it replace a clutch, e.g. :

- In barring drives it disengages the barring drive motor as soon as this is switched on.
- In starter, it disconnects the starter motor from the internal combustion engine as soon as this has started.
- In gears and planetary gearings it takes over the function of clutches and brakes.
- With two freewheels one can construct a two-speed drive without change speed clutch.

- This design is used in agitator drives for example, achieving a total of four speeds by using a two-speed motor.
- In ventilators and blowers it disconnects the driven parts from the drive that is switched off, and allows the gyrating mass of the ventilator to overrun the drive.
- In the powered roller beds of rolling mills, continuous-heating furnaces and conveyor installations, the freewheel allows the load to overrun the driving speed of the rollers.
- In multimotor drives it allows the automatic disengagement of the non-driving motors.

2.3.3 APPLICATION AS BACKSTOP

When used as a backstop the Freewheel distinguishes itself by its safe function and the immediate and steady response. Following are some application examples:

- In inclined conveyor load from running back when the motor is switched off or in case of power failure.
- In pumps, blowers and ventilators, to prevent reverse running due to the pressure from the flow medium after switching off.
- In or on gears, electric motors and gear motors for the drive of conveyor installations to prevent reverse running after switching off.
- In mobile equipment with electric drive – compressors, for example – to prevent starting in the wrong direction of rotation.
- In torque converters, to hold the guide wheel during converter operation.
- In controllable planetary gears as torque reaction point.
- In cranes, winches, building elevators and other lifting equipment.

2.4 TWO DIFFERENT DESIGNS OF FREEWHEELS

2.4.1 SPRAG FREEWHEELS AND ROLLER RAMP FREEWHEELS

The **Sprag Freewheel** has outer and inner rings with cylindrical races. Arranged in between are the individually sprung sprags, the drive mode is free from slip. Due to varying sprag shapes several types are possible and can be supplied for:

1. High torques.

2. High indexing accuracy.

3. Noncontact overrunning operation.

The **Roller Ramp Freewheel** is equipped with roller ramps on either the inner or the outer ring having a cylindrical race. The individually sprung rollers are arranged in between. The drive mode operates free from slip.

2.5 TYPES OF FREE WHEEL

2.5.1 P-GRINDING

It is the P-grinding which given the RINGSPANN ELECON Sprag freewheel its outstanding quality as an indexing element. The outer track of the sprag is not circular ground but polygon shaped. This effects the distance between the outer race and inner race to differ at various points of the circumferences. As the sprags move slowly in a circumferential direction during operation, their wedging angle changes continually. The line of contact on the sprag keeps changing back and forth. This ensures that the wear on the sprag is spread over a greater area but the contour of the sprag is retained which is ital functioning . The sprag remains functional despite wear. The P-grinding is used in the indexing freewheels because it not only gives a longer life but also improves the indexing accuracy considerably.

2.5.2 RIDUVIT-SPRAGS

RINGSPANN ELECON sprags are manufactured from chromium steel, as used for ball and roller bearings. The high pressure resistance, elasticity and resilience of this material is necessary for the sprags during the locked stage. During freewheeling, however, all depends on maximum resistance to wear at the contact points sprag/inner ring. All these requirements are fulfilled to maximum effect by a chromium steel sprag with RIDUVIT coating. RIDUVIT coating gives the sorag a hard metal type wear resistance. The technology applied here is based on the most recent findings of tribology research. RIDUVIT sprags are used in overrunning clutches and increases the operating life considerably

2.5.3 CENTRIFUGAL LIFT-OFF Z

Centrifugal lift-off Z is used with overrunning clutches in the cases when the outer ring of the freewheel rotates at high speed during the overrunning function (freewheeling) and when the speed is low during driving. During the overrunning function (freewheeling) the centrifugal force Fc causes the sprags to lift from the inner race. The centrifugal force Fc acting upon the centre of gravity S of the sprag has turned the sprag anti-clockwise and located it against the outer ring thus creating the clearance a; the freewheel is operating with out contact.

When the speed of the outer ring drops sufficiently to reduce the effect of the centrifugal force onto the sprag to less than the spring force, the sprag returns to the inner ring and the freewheel is ready to lock. For this the driving speed should not exceed 40% of the lift-off speed.

2.5.4 CENTRIFUGAL LIFT-OFF X

Centrifugal lift-off X(DBP end foreign Patenis) is used in overrunning clutches in the cases when the inner ring of the freewheel (shaft) rotates at a high speed during the overrunning function (freewheeling) and when the speed is low during driving. Here the centrifugal force Fc cause the sprag to lift off the outer race during freewheeling. In this operating condition the freewheel operates without friction, i.e. with limitless life.

The sprags and the support ring rotate with the inner ring. The centrifugal force Fc has turned the sprag clockwise and located it against the support ring. This has created the clearance a between the sprag and the outer race, the freewheel operates without contact.

When the speed of the inner ring has dropped sufficiently to reduce the effect of the centrifugal force onto the spring force, the sprag returns to tis location on the outer ring and the freewheel is ready to lock. The driving speed during this should not exceed 440% of the lift-off speed.

2.6 FLUID POWER

2.6.1 INTRODUCTION

Fluid power technology is a means to convert, transmit, control and apply fluid energy to perform useful work. Since a fluid can be either a liquid or a gas, fluid power in genera includes hydraulics and pneumatics. Oil hydraulics employs pressurized liquid and pneumatics employs compressed air.

2.6.2 ADVANTAGES OF FLUID POWER SYSTEMS

The advantages of fluid power systems are,

- The utilization of electrical materials is limited by the fact that the ferromagnetic materials saturate at a low flux density, i.e. only a certain amount of torque can be obtained by a kilogram of iron present in the motor armature. But the limitation in the hydraulic drives relates to the ultimate tensile strength of the material. By selecting a material of higher tensile strength, a system's working pressure can be increased and correspondingly higher torque can be achieved. Thus, the amount of moving mass less in case of hydraulics drive. The fluid power drives are more compact than a mechanical drive because eliminate the need for links like cams and gears.
- Multiplication of small forces to achieve greater forces for performing work.
- It easily provides infinite and step less variable speed control which is difficult to obtain from other drives.
- Accuracy in controlling small or large forces with instant reversal is possible with hydraulic systems.
- Constant force is possible in fluid power system regardless of special motion requirements, whether the work output moves a few millimeters or serves meters per minute.
- As the medium of power transmission is a fluid, it is not subjected to any breakage of parts as in a mechanical transmission.
- The parts of hydraulic system are lubricated with the hydraulic liquid itself.

2.6.3 HYDRAULIC FLUIDS AND PROPERTIES

Hydraulic fluid is the life blood of the system, the one element that ties everything together. There is no universal or ideal hydraulic fluid for all applications. One major reason is the imposing list of fluid characteristics considered important by users, system designers and manufactures. So selection of a proper fluid for a given application is always a compromise. To do its job well a hydraulic fluid must be able to perform at least the following the following functions.

- Transfer fluid power efficiently.
- Lubricants the moving parts.
- Absorb, carry and transfer the heat generated within the system.
- Be compatible with hydraulic components.
- Remain stable against a wide range of possible physical and chemical changes, both during storage and while in use.

2.7 PNEUMATICS

Pneumatic systems use pressurized air to transmit and control power. Air is used as the fluid because it is safe, less expensive and is readily to the atmosphere and a return line is not necessary as with hydraulics.

Pneumatics has a variety of uses in the industry. It is an indispensable source of power for various tools like pneumatic hammers, pneumatic drills, pneumatic wrenches and runners, Pneumatic grinders etc. Moreover, pneumatic is widely used for material handling operations, high speed clamping and in robotic power drives for arms and grippers. Pneumatics is used widely in industries like food, pharma, textile, engineering, automobile etc.

2.7.1 COMPARISION OF PNEUMATIC SYSTEM WITH HYDRAULIC SYSTEM

1. Liquid exhibit greater inertia than gases. Therefore, in hydraulic systems, the weight of oil is a potential problem when accelerating and decelerating the actuators and when suddenly opening and closing the valves. In accordance with Newton's law of motion, the force required to accelerated

oil is many times greater than that that required to accelerate an equal volume of air.

2. Liquid also exhibit greater viscosity than gases. This résults in large frictional pressure and power losses.

3. Since hydraulic systems use a fluid foreign to the atmosphere, they require reservoirs and a no-leak system design. Pneumatic system use air which is exhausted directly back into the surroundings environment. Generally, pneumatic systems are less expensive than hydraulic systems.

4. Due to compressibility of air, it is impossible to obtain a precise control of actuator velocities in pneumatic systems. In applications where the actuator travel is to be smooth and steady against a variable load, the air exhaust from the actuator is normally metered.

5. While pneumatic pressures are quite low due to compressor design, hydraulic pressures are high. Thus, hydraulic can be used in high power systems whereas pneumatics are confined to low power applications.

2.7.2 BASIC PNEUMATIC SYSTEM

In pneumatic systems, compressors are used to compress and supply the necessary quantity of air. Basically a compressor increases the pressure of a gas by reducing its volume as described by gas laws. Pneumatic systems normally use a centralised air compressor which is considered to be infinite air source. This pressurised air can be piped from one source to the various locations. The air is piped to each circuit though an air filter, to remove contaminants which might harm the pneumatic components such as valves and cylinders.

The air then flows through a pressure regulator which reduces the pressure to the desired level for the particular circuit application.

Since air is not a good lubricant, pneumatic systems require a lubricator to inject a fine mist of oil into the air discharge from the pressure regulator. This prevents the wear of parts in the pneumatic components. Free air in the atmosphere contains varying amounts of moisture. This moisture can be harmful since it can wash away lubricants and thus cause excessive wear and corrosion. Hence air dries are needed to remove this undesirable moisture.

Since pneumatic systems exhaust into the atmosphere, they are capable of generating excessive noise. Therefore, mufflers are mounted on the exhaust ports of air valves and actuators to reduce the noise.

2.8 PNEUMATIC ACTUATORS

Pneumatic systems make use of actuators (linear and rotary) in a fashion similar to that of hydraulic systems. But these differ very little from the hydraulic applications because air is used rather than hydraulic oil; pressure are either low or medium and a lighter construction is encountered. Pneumatic cylinder construction makes extensive use of aluminum and other non-ferrous alloy materials to reduce the weight and the corrosive effects of air and to improve heat transfer capabilities.

2.9 PNEUMATIC CYLINDERS

The pneumatic power is converted into straight-line reciprocating motions by pneumatic cylinders. The various industrial applications for which air cylinder are used can be divided duty-wise into three groups: light duty, medium duty and heavy duty.

According to the operating principle, air cylinder can be classified as follows.

2.9.1 SINGLE ACTING CYLINDER

It has a single air inlet line. When this line is pressurized, the piston extends. The return movement of the piston is affected by a built-in spring mounted on the rod side of the piston or by application of an external force like gravity. Single acting cylinders with a return spring are limited in stroke, because the spring force that must be overcome while extending increase with the stroke.

The advantage of a single acting cylinder lies in its reduced air consumption, since air is not wasted while retracing the piston.

2.9.2 DOUBLE ACTING CYLINDER

The force exerted by the compressed air moves the piston in two direction in a double acting cylinder produces less force during retraction, because the piston rod's cross-sectional area is subtracted from the piston area under pressure.

They are used particularly when the piston is required to perform work not only on the advance movement but also on the return movement. In principle, the stoke length is unlimited, although buckling and bending must be considered before we select a particular size of piston diameter, rod length and stroke length.

Advantages of a double acting cylinder over a single acting cylinder,

- In a single acting cylinder, the compressed air is fed only on one side. Hence, this cylinder can produce work only in one direction. But the compressed air moves the piston in two directions in a double acting cylinder, so they perform work in both directions.
- In a single acting cylinder, the stroke is limited by the compressed length of the spring. But in principle, the stroke length is unlimited in a double acting cylinder.
- While the piston moves forward in a single acting cylinder, the air has to overcome the pressure of the spring and hence some power is lost before the actual stroke of the piston starts. But this problem is not present in a double acting cylinder.

2.9.3 TANDEM CYLINDER

It consists of two pistons operating in separate sections along the same axis with a common piston rod. Since the available force is doubled, this design is useful when larger forces are required, but a single cylinder with a larger diameter cannot be accommodated.

2.9.4 THREE POSITION CYLINDER

It is quite similar to the tandem cylinder, except that the left piston rod is not connected to the right piston and left cylinder is shorter than the right one. With the left piston extended, the retraction of the right piston is limited to an intermediate position which is determined by the ability of the right piston to retract fully.

2.9.5 THROUGH ROD CYLINDER

Here the piston rod extends to both ends of the piston. This will ensure equal force and speed on both sides of the cylinder.

2.9.6 ADJUSTABLE STROKE CYLINDER

The cylinder stroke can be adjusted by screwing the left hand piston in or out. By using the shortest possible stroke needed for a given job, better rapid cycling is achieved and air consumption is reduced.

2.9.7 TELESCOPING CYLINDER

When pressure is applied to the left side, the inner cylinder acts as a piston and extends. Once it reaches the end of its stroke, the innermost piston begins to extend. The available stroke is almost double when compared to a normal cylinder having the same retracted length.

2.10 INSTALLATION OF PNEUMATIC SYSTEMS

In most plants, the air compressor is positioned at a distance away from the main shop and installation area due to reasons of airborne noise problem or reasons related to machine safety etc. The compressed air is stored in an air receiver, from which the air is drawn into the consumer point by means of a pipeline. It has been observed that pipeline fitting and joints are mostly responsible for drop in pressure. During installation of pneumatic systems, it is of vital importance that the pressure drop between generation and consumption of compressed air is kept low. So it is very essential that the maintenance personnel of pneumatic systems should take utmost care while selecting pneumatic pipes and other installations.

- Install the air main such that it can be accessible from all sides for ease of inspection.
- If possible do not embed the lines in brickwork or in narrow ducts.
- Horizontal runs of air line should be sloped one or two percent towards the flow direction.
- Do not terminate the vertical main line at a point where further consumer branching-off of the lines takes place.
- A water trap is to be fitted at the end of each branch line.
- Branch lines should always be started from the top of the main line.

2.10.4 INSTALLATION OF COMPRESSOR

- The compressor intake should be taken from the outside air and not be located in an enclosed courtyard.
- The open end of the intake pipe of the compressor must be well-hooded and screened to prevent rain and dirt from entering.
- The intake pipe should be as short as possible with a direct connection to the unit.
- The compressor discharge line should either be the full size of the compressor outlet or larger and it should run directly to an after cooler. If there is no after cooler, the should directly run to the receiver tank.
- The piping should be sloped away from the compressor with sufficient pitch to prevent the condensate or oil drainage back into the compressor.

2.11 MATERIAL SELECTION

2.11.1 INTRODUCTION

The knowledge of materials and their properties of great significance for a design engineer. The machine elements should be made of such a material which has properties suitable for the conditions of operation. In addition to this, a design engineer must be familiar with the effects which the manufacturing process and heat treatment have on the properties of the materials. Now we shall discuss the commonly used engineering materials and their properties in machine design.

2.10.1 INSTALLATION OF FRL UNIT

- The filter is installed upstream from the other conditioning components. This protects the regulator from harmful contaminants and avoids fouling the lubricator reservoir.
- It is a common practice to install a filter in each branch.
- Regulators are installed at branches which require a specified pressure setting. Some pressure regulators are designed to be mounted on the valve manifolds.
- Lubricators are installed at the downstream end of the FRL unit just after the regulator and should be placed close to the equipment that they serve.

2.10.2 INSTALLATION OF PNEUMATIC CYLINDER

- Cylinder mounts should be securely fixed and evenly fastened. A cylinder that is not properly mounted will throw an undue strain on the mounting plate, often snapping off the mountings.
- The cylinder should be perfectly aligned for efficient and trouble free operation.
- A proper support should be placed at the end of the rod and this support should be exactly in line with the center line of the cylinder. This will relieve strain on gland packing, rod packing and will increase their life.
- Tie rods connecting the covers should be tightened with equal tension to avoid strain on the rods.
- Seals and packing of cylinder should not be stored in extremely hot places. This is to protect them from drying out.
- Care is to be taken to ensure that the cylinders are properly lubricated. Lack of lubricated causes loss of power due to friction, greatly reduces the life of the rod and damages the piston packings.

2.10.3 INSTALLATION OF PIPELINES

- While installation the pneumatic system, it is essential to place an adequate filter between the main and the circuit. This will ensure that all water and undesirable foreign matter will be separated out at this stage.

2.11.2 CLASSIFICATION OF ENGINEERING MATERIALS

The engineering materials are mainly classified as:

- Metals and their alloys, such as iron, copper, Aluminum etc.
- Non-metals, such as glass, rubber, plastic etc.

The metals may be further classified as:

- Ferrous metals,
- Non-ferrous metals.

The ferrous metals are those which have the iron as their main constituent, such as cast iron, wrought iron and steel.

The non-ferrous metals are those which have a metal other than iron as their main constituent, such as copper, aluminum, brass, tin, etc.

2.11.3 SELECTION OF MATERIAL FOR ENGINEERING PURPOSE

The selection of a proper material, for engineering purpose, is one of the most difficult problem for the designer. The best material is one which serves the desired objective at the minimum cost. The following factors should be considered while selecting the material:

- Availability of the materials.
- Suitability of the material for the working conditions in service,
- The cost of the materials.

The important properties, which determined the utility of the material, are physical, chemical and mechanical properties. We shall now discuss the physical and mechanical properties of the material in the following:

2.12 MATERIAL REQUIREMENTS

The material selection for any fabrication is an important aspect. It should satisfy the following requirements.

1. Fabrication requirements.
2. Service requirements.
3. Economic requirements.

2.12.1 FABRICATION REQUIREMENTS

The material chosen should have the following properties, according to the fabrication requirements:

2.12.1.1 Machinability

It is the property of a material which refers to a relative case with which a material can be cut. The machinability of a material can be measured in a number of ways. By comparing the tool life for cutting different materials of thrust required to remove the material at some given rate or the energy required to remove a unit volume of the material. It may be noted that brass can be easily machined than steel.

2.12.1.2 Ductility

It is the property of a material enabling it to be drawn into wire with the application of a tensile force. A ductile material must be both strong and plastic. The ductility is usually measured by the terms, percentage elongation and percentage reduction in area. The ductile material commonly used in engineering practice (in order of diminishing ductility) are mild steel, cooper, aluminum, nickel, zinc, tin and lead.

2.12.1.3 Malleability

It is a special case of ductility which permits materials to be rolled or hammered into thin sheets. A malleable material should be plastic but it is not essential to be so strong. The materials commonly used in engineering practice (in order of diminishing malleability) are lead, soft steel, wrought iron, copper and aluminum.

2.12.2 SERVICE REQUIREMENTS

The material selected for the purpose must stand up to the service demands such as:

2.12.2.1 Strength

It is the ability of a material to resist the externally applied force without breaking or yielding.

2.12.2.2 Stiffness

It is the ability of a material to resist deformation under stress. The modulus of elasticity is the measure of stiffness

2.12.2.3 Toughness

It is the property of a material to resist fracture due to high impact loads like hammer blows. The toughness of the material decreases when it is heated. It is measured by the amount of energy that a unit volume of the material has absorbed after being stressed upon the point of fracture.

CHAPTER 3

DESCRIPTION OF PARTS

3.1 INDEXING MECHANISM

The indexing mechanism we have designed is shown in fig 3.1.,

The various parts of our indexing mechanism are described separately as follows,

- Rack and pinion
- Pneumatic cylinder
- Freewheel
- Adapter
- Rack guide.
- Four legged stand

3.1.1 PNEUMATIC CYLINDER

The pneumatic cylinder is used to transmit power to the pinion. The pneumatic cylinder used is FESTO: DN50*125*PPV. The maximum stroke of the cylinder is 125 mm and bore diameter is 50 mm. The force available at the rod end is 1080 N.

3.1.2 RACK AND PINION

The rack and pinion shown in the fig 3.2 and fig 3.3 is used to convert the translational motion from the pneumatic cylinder to rotational motion. The rotational motion transmitted to the pinion is used to rotate the spider which holds the work piece. The rack is attached with a T-coupling at the end which is used to couple to the piston rod. The pinion is drilled with eight holes so that it can be screwed to the adapter. The rack and the pinion detailed drawings are shown in fig 12.3 and fig 12.4.

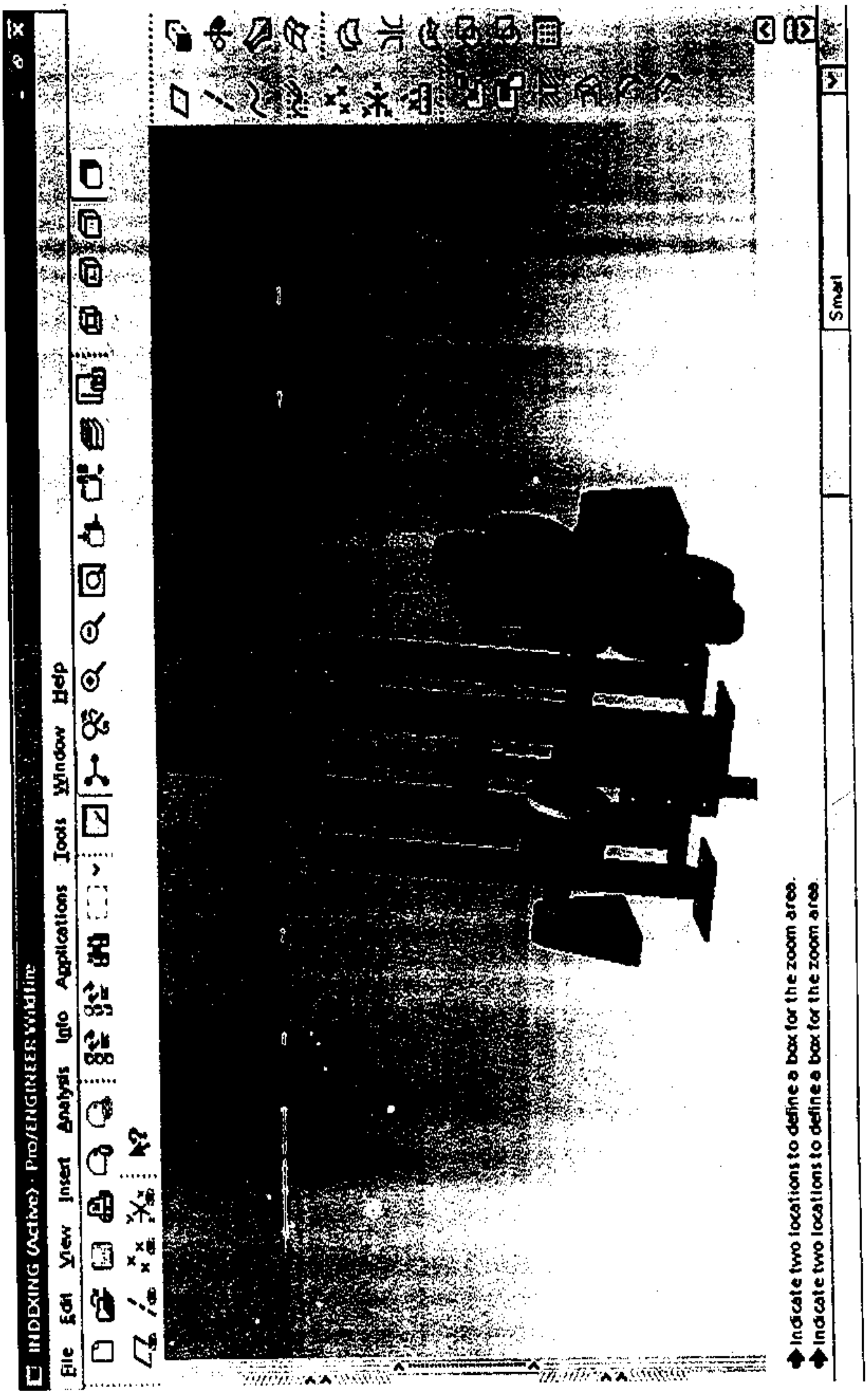

FIG 3.1 INDEXING MECHANISM

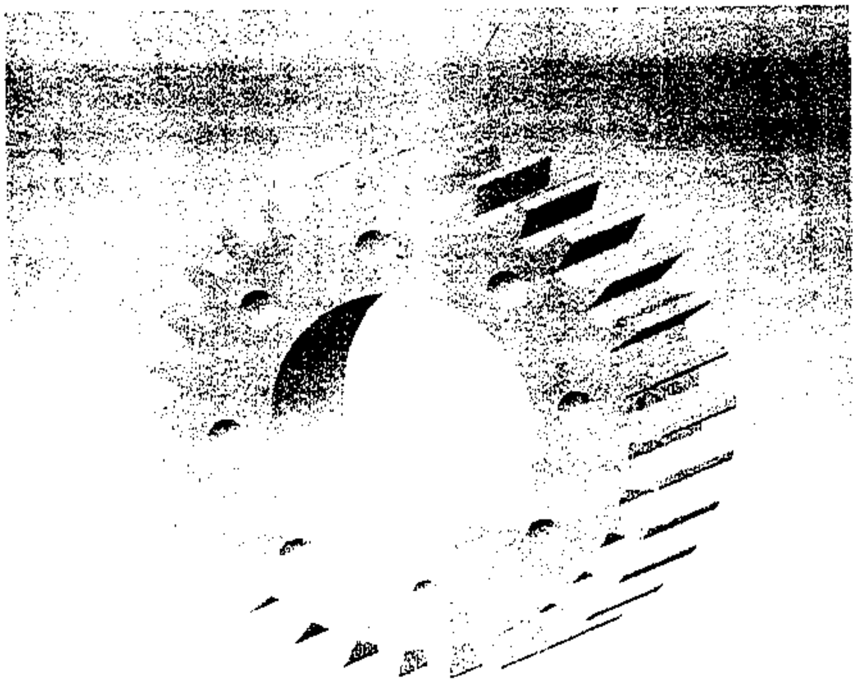

FIG 3.2 PINION

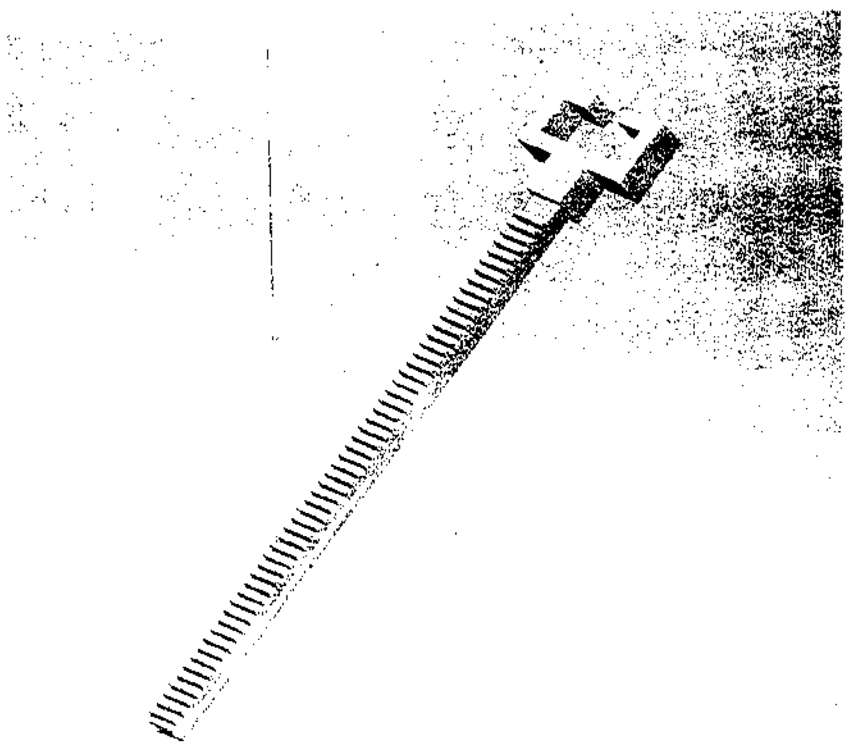

FIG 3.3 RACK

3.1.3 FREE WHEEL

Freewheels are machine elements with unique characteristics. In the one direction of rotation there is no driving contact between inner and outer ring hence the freewheel is freewheeling. In the other direction of rotation there is driving contact between inner and outer ring, in this direction it is possible to transmit a high torque. Freewheel used here is p-grinding sprag type freewheel, this type is used for transmitting high torque. The free wheel is shown in fig 3.4.

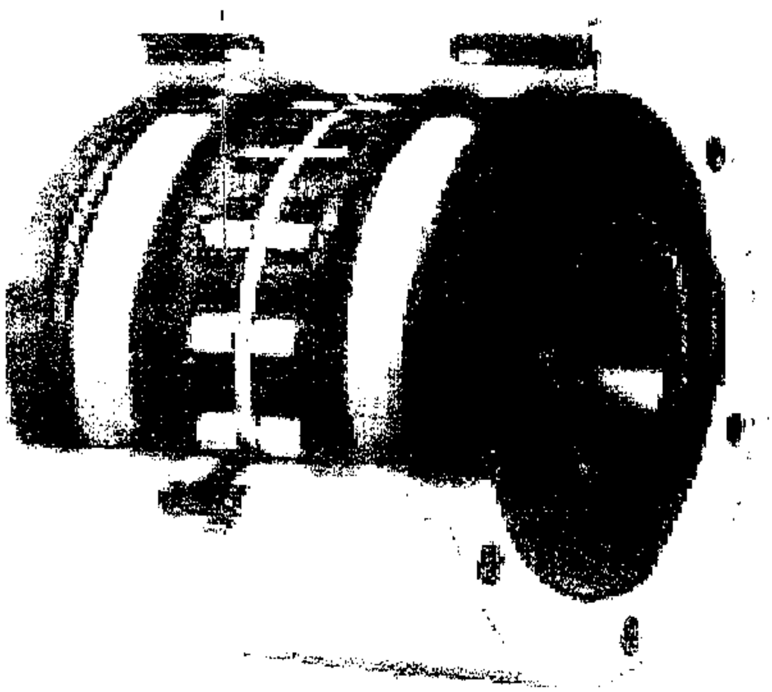

FIG 3.4 FREEWHEEL (RINGSPANN ELECON)

3.1.4 ADAPTER

It is used to couple the pinion and the freewheel. Since the diameter of the freewheel is more than the pinion, it cannot be directly connected. So that a connecting plate is designed to connect the pinion and free wheel. It is screwed to the outer ring of the free wheel. The adapter we have designed is shown in fig 3.5and fig 12.1.

3.1.5 RACK GUIDE

It is used to guide the rack in linear motion. It acts as a rigid support to the rack and prevents the rack from bending. It is fixed to the machine body. Grooves are cut by the sides of the rack which is inserted into the rack guide. The rack guide we have designed is shown in the fig 3.6 and fig 12.2.

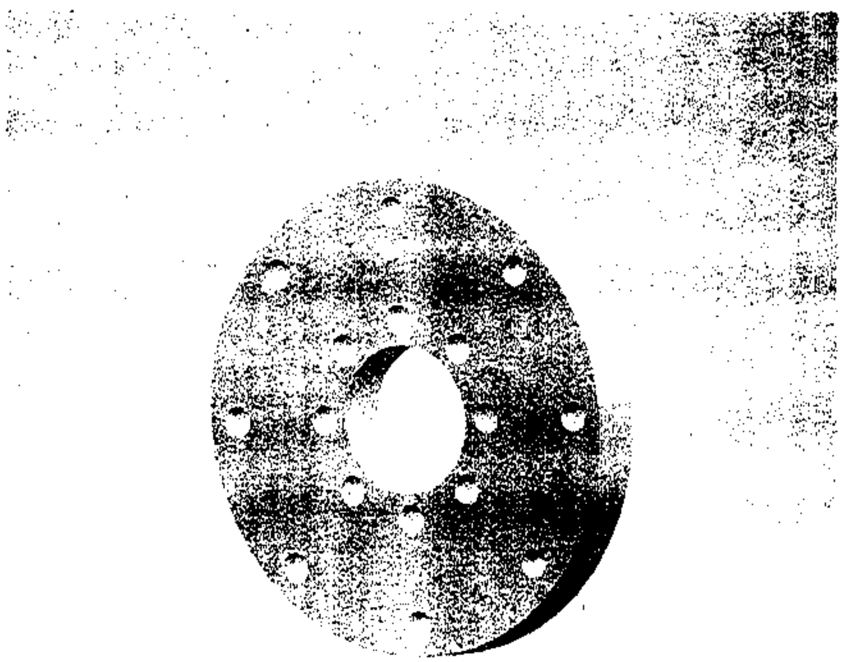

FIG 3.5 ADAPTER

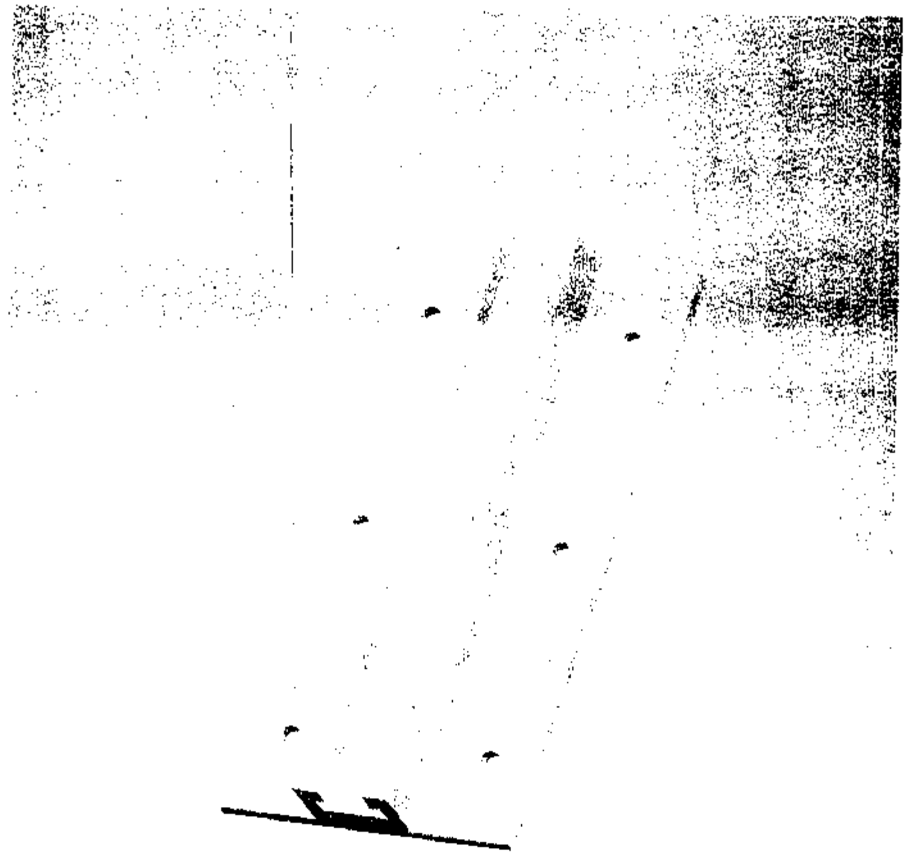

FIG 3.6 RACK GUIDE

3.1.6 FOUR LEGGED STAND

The four legged stand is used to support the pneumatic cylinder. It has a drilled hole at the top through which the piston rod passes. The stand is rigidly fixed to the machine body. It is shown in the fig 3.7 and fig 12.5.

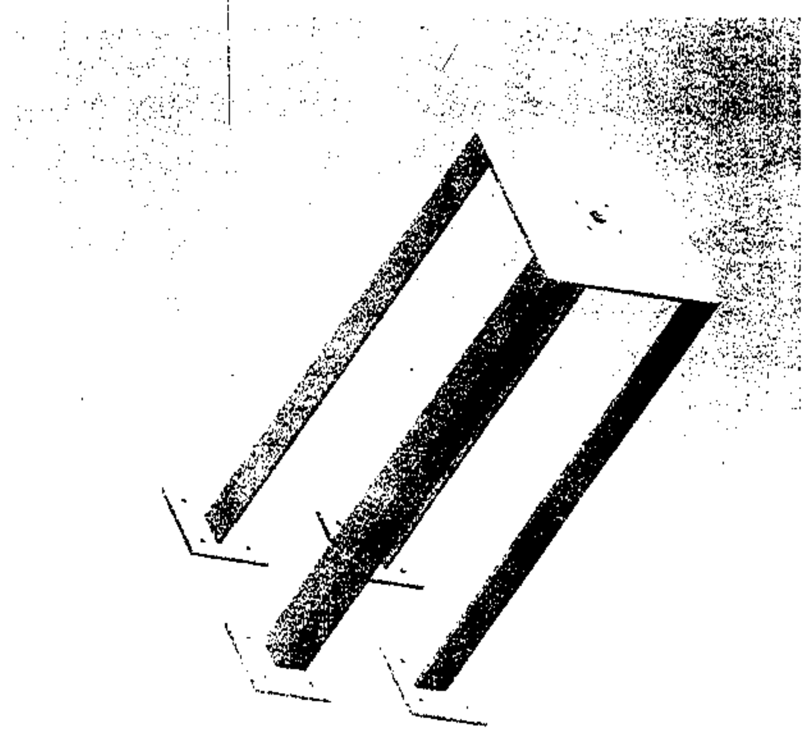

FIG NO: 3.7 FOUR LEGGED STAND

3.2 PICK AND PLACE AUTOMATION

The pick and place automation we have designed is shown in the fig 3.8,

The various parts of pick and place automation are follows,

- Rod less pneumatic cylinder
- Pneumatic cylinder
- Base plate
- L angled plate
- Rack and pinion
- Electromagnet
- Square plate
- Connecting rod
- Holder
- Holding cup
- Connecting pin

3.2.1 ROD LESS PNEUMATIC CYLINDER

The rod less pneumatic cylinder is used so that the base plate and whole setup is assembled on the sliding part of the cylinder. There is no rod in this cylinder in turn it has a sliding body. The cylinder used is 50 mm stroke and 25 mm bore diameter. The cylinder is fixed to the conveyor body by using L angled plates. The cylinder is controlled by 3*2 valve.

3.2.2 PNEUMATIC CYLINDER

The double acting cylinder used is of 50 mm stroke and 25 mm bore diameter. The pneumatic cylinder is fixed to the base plate. This pneumatic cylinder is controlled by using 5*3 valve.

3.2.3 L -ANGLED PLATE

The L angled plate is used to fix the rod less pneumatic cylinder to the machine body. There are two such plates fixed to the opposite ends of the rod less cylinder. It is made of 2 mm thick plate. The plate is shown in the fig 3.9 and fig 12.8.

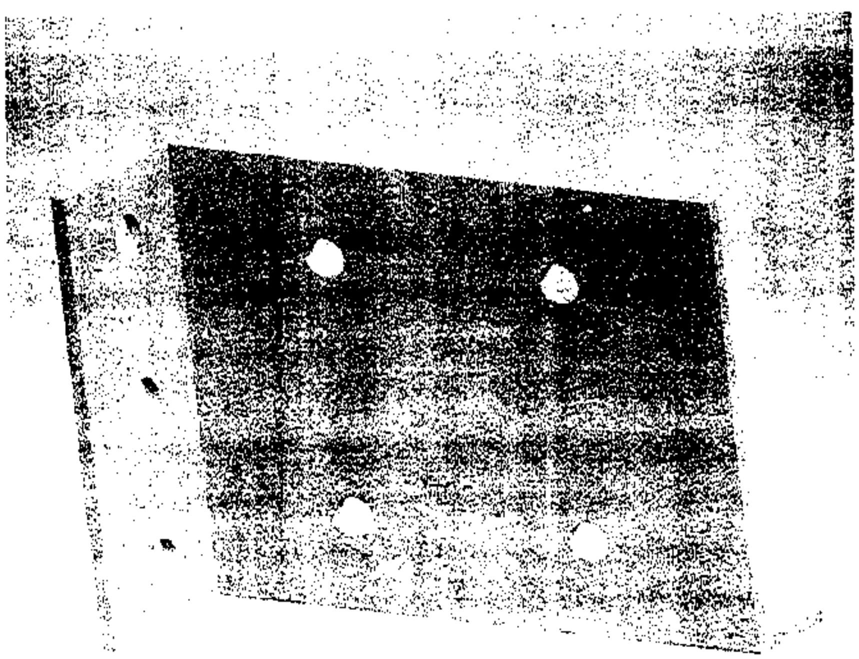

FIG 3.9 L-ANGLED PLATE

3.2.4 BASE PLATE

The base plate is fixed to the moving part of the rod less cylinder. To which the double acting cylinder is attached. It has slots on it so that it can be easily screwed to the moving body of the rod less cylinder. The base plate is shown in the fig 3.10 and fig 12.6.

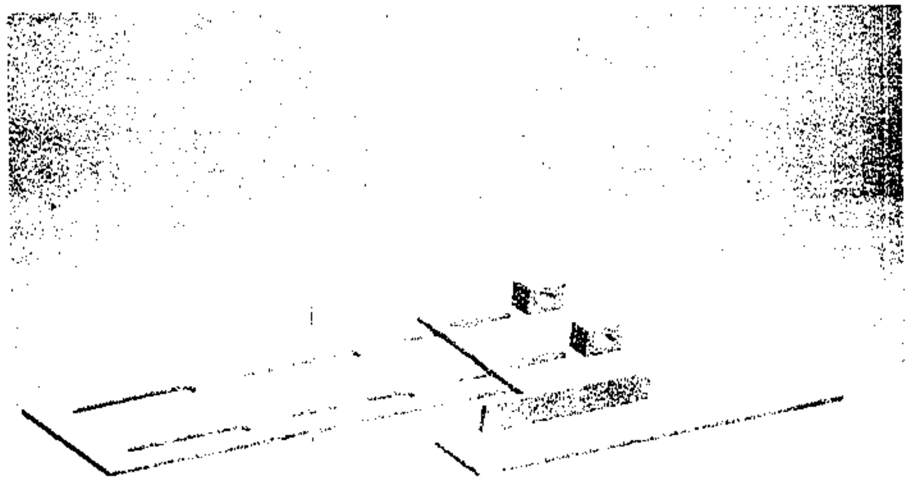

FIG 3.10 BASE PLATE

3.2.5 RACK AND PINION

The rack and pinion used here is of module 1mm and number of teeth on the pinion is 40 and the pitch circle diameter is also 40 mm. The pinion is attached to the connecting rod which is connected to the base plate. At the end of the rack a coupling is welded so that it can be fixed to the piston rod. The rack and is shown in the fig 3.11 and fig 3.12. and detailed drawings are given in fig 12.11.

3.2.6 CONNECTING ROD

The connecting rod is used to connect the pinion and the square plate. At the middle of the rod a mechanical stopper is attached to adjust the stroke of the pneumatic cylinder. Holes are drilled at the end of the rod to fix the square plate. The connecting rod is shown in the fig 3.12 and fig 12.9.

3.2.7 HOLDER

The holder is fixed to the end of the base plate. The pneumatic cylinder is fixed to the holder by using four screws. It consists of a hole in the middle so that the piston rod passes through it. The holder is shown in the fig 3.13 and fig 12.7.

FIG 3.13 HOLDER

3.2.8 ELECTROMAGNET

The electromagnet is used to hold the finished work piece coming out of the adapter. The electromagnet used is 1W and 2V D.C type. The electromagnet get energized and holds the work piece and it gets demagnetized and leave the workpiece on the conveyor.

3.2.9 HOLDING CUP

It is attached to the square plate shown in fig 12.10 and it is used to support the work piece from either side of the electromagnet. So that when the electromagnet leaves the work piece on the conveyor, it is placed without any miss alignment. The holding cup is shown in the fig 3.14.

FIG 3.14 HOLDING CUP

P-1660

CHAPTER 4

DESIGN DETAILS

4.1 DESIGN ANALYSIS FOR INDEXING MECHANISM

4.1.1 TORQUE CALCULATION

Mass of the spider along with adapters, m = 25 Kg.

Perimeter of the spider = 1.15 m.

Radius of the spider, r = 0.183 m.

Diameter of the spider, d = 0.366 m.

Time to be taken for 180° indexing = 0.5 S

Required peripheral velocity of the spider, v = 0.575/0.5 = 1.15 m/s.

Required acceleration of the spider, a = 1.15/0.5 = 2.3 m/s^2.

Angular acceleration, $\alpha = a/r$

$= 2.3/0.183$

$\alpha = 12.56$ rad/s^2.

Mass moment of inertia of the spider, $I = md^2/8$

$= (25*0.366^2)/8$

I = 0.419 Kg/m^2.

Torque required to rotate the spider, $T = I*\alpha$

$= 0.419*12.56$

T = 5.26 Nm.

Factor of safety mentioned by the company = 6.

The design torque, T = 6*5.26 = 26.03 Nm.

Speed of revolution of the spider, N = 60 rpm.

Power to be transmitted, $P = 2\pi NT/60$

$= 2*\pi*N*T/60$

P = 264 W.

4.1.2 PNEUMATIC CYLINDER:

Available cylinder: **FESTO: DN50*125*PPV**

Piston Diameter, d = 50mm.

Stroke Length = 125mm

Available Air Pressure, P = 5.5bar.

Area of the blank end = $\pi d^2/4 = 0.00196\ m^2$

Force available = P*A = 1080 N.

4.1.3 DESIGN OF PINION

STEP1: MATERIAL SELECTION

C45 surface hardened to 55 HRC

(From PSG Design Data Book)

Ultimate strength, σ_u = 720 N/mm^2

Yield strength, σ_y = 360 N/mm^2

Brinell hardness number = 350 BHN

STEP2: CALCULATION OF DESIGN STRESS

$$[\sigma_b] = \frac{1.4*K_{bl}*\sigma_{-1}}{n*K_\sigma}$$

$\sigma_{-1} = 0.25(\sigma_u + \sigma_y)+50$

$= 0.25(720+360)+50$

$= 320$ N/mm^2

n = 2.5 (for surface hardened steel)

K_σ = 1.5 (for surface hardened steel)

K_{bl} = 1 (for HB<=350)

K_{cl} = 0.585 (for life cycle>=$25*10^7$)

$$[\sigma_b] = \frac{1.4*1*320}{2.5*1.5}$$

$= 119.5\ N/mm^2$

$\sigma_c = C_R * HRC * K_{cl}$

$= 23*55*0.585$

$= 740\ N/mm^2$

STEP3: DESIGN TWISTING MOMENT

$[M_t] = K_o*K*K_d*M_t$

$$m_t = \frac{P*60}{2*\pi*N}$$

$$= \frac{264*60}{2*\pi*60}$$

$= 42\ Nm$

$\Psi = 0.3,\ K*K_d = 1.3,\ K_o = 1,\ E = 2.1*10^5\ N/mm^2$

$[M_t] = 1*1.3*42 = 55.02\ Nm$

STEP4: MODULE CALCULATION

Assume Z = 38

m = D/Z

= 66.5/38 = 1.75 mm

Assume Ψ = 0.4 (recommended value)

$b = \Psi*a = 0.4*66.5$

b = 26 mm

STEP5: REVISED $[M_t]$

$[M_t] = K_o*K*K_d*M_t$

$\Psi_p = b/d = 0.39$

Hence K = 1, K_d = 1.3, K_d = 1

= 1*1.3*42

$[M_t]$ = 55.02 Nm

STEP6: CHECKING FOR INDUCED BENDING STRESS

$$\sigma_b = \frac{(i+1)\,[M_t]}{a*m*b*y}$$

y = 0.485

= (1+1)*55.02*10^3

σ_b = 75 N/mm^2 < $[\sigma_b]$ = 119.5 N/mm^2

STEP7: CHECKING FOR INDUCEDCOMPRESSIVE STRESS

$$\sigma_c = 0.74\frac{(i+1)}{a}\sqrt{\frac{(i+1)}{i*b}*E[M_t]}$$

$$= 0.74\,\frac{(1+1)}{66.5}\sqrt{\frac{(1+1)}{26}*2.1*10^5*55*10^3}$$

σ_c = 663.37 N/mm^2 < $|\sigma_c|$ = 740 N/mm^2

So the design is safe.

4.1.4 SPECIFICATIONS:

Pinion material: C45

Number of teeth= Z= 38

Pitch circle diameter= D= 66.5 mm

Module= 1.75 mm

Height Factor, f_0 = 1, for 20^0 full depth

Bottom clearance, C= 0.25m= 0.25*1.75 = 0.43 mm

Tooth depth, h= 2.25m= 2.25*1.75 = 2.6 mm

4.2 DESIGN ANALYSIS FOR PICK AND PLACE AUTOMATION

4.2.1 TORQUE CALCULATION

Mass of the arm, m = 1 Kg.

Diameter of the rod, d = 10 mm.

Time to be taken for 45° turning = 0.5 s

Required peripheral velocity of the rod, v = 0.00785/0.5 = 0.0157 m/s.

Required acceleration of the spider, a = 0.0157/0.5 = 0.0314 m/s^2.

Angular acceleration, $\alpha = a/r$

$$=0.0314/0.005$$

$$\alpha = 6.28 \text{ rad/s}^2.$$

Mass moment of inertia of the spider, $I = md^2/8$

$$= (25*0.01^2)/8$$

$$I = 0.0003125 \text{ Kg/m}^2.$$

Torque required to rotate the spider, $T = I*\alpha$

$$= 0.000135*6.28$$

$$T = 0.000049 \text{ Nm.}$$

Factor of safety mentioned by the company = 6.

The design torque, T = 6*0.000049 = 0.00029 Nm.

Speed of revolution of the rod, N = 30 rpm.

Power to be transmitted, $P = 2\pi NT/60$

$$= 2*\pi*N*T/60$$

$$P = 0.054 \text{ W.}$$

4.2.2 PNEUMATIC CYLINDER

Available cylinder: **FESTO: DN25*50*PPV**

Piston Diameter, d =25mm.

Stroke Length = 50mm

Available Air Pressure, P = 5.5bar.

Area of the blank end = $\pi d^2/4$ = 0.00049 m^2

Force available = P*A = 269.5 N.

4.2.3 RODLESS PNEUMATIC CYLINDER

Piston Diameter, d =25mm.

Stroke Length = 50mm

Available Air Pressure, P = 5.5bar.

Area of the blank end = $\pi d^2/4$ = 0.00049 m^2

Force available = P*A = 269.5 N.

4.2.4 DESIGN OF PINION

STEP1: MATERIAL SELECTION

C45 surface hardened to 55 HRC

Ultimate strength, σ_u = 720 N/mm^2

Yield strength, σ_y = 360 N/mm^2

Brinell hardness number = 350 BHN

STEP2: CALCULATION OF DESIGN STRESS

$$[\sigma_b] = \frac{1.4 * K_{bl} * \sigma_{-1}}{n * K_\sigma}$$

$$\sigma_{-1} = 0.25(\sigma_u + \sigma_y) + 50$$

$= 0.25(720+360)+50$

$= 320\ N/mm^2$

n = 2.5 (for surface hardened steel)

$K_\sigma = 1.5$ (for surface hardened steel)

$K_{bl} = 1$ (for HB<=350)

$K_{cl} = 0.585$ (for life cycle> $25*10^7$)

$$[\sigma_b] = \frac{1.4*1*320}{2.5*1.5}$$

$= 119.5\ N/mm^2$

$\sigma_c = C_R* HRC*K_{cl}$

$= 23*55*0.585$

$= 740\ N/mm^2$

STEP3: DESIGN TWISTING MOMENT

$[M_t] = K_o*K*K_d*M_t$

$$m_t = \frac{P*60}{2*\pi*N}$$

$$= \frac{0.054*60}{2*\pi*60}$$

$= 0.0085$ Nm

$\Psi = 0.3$, $K*K_d = 1.3$, $K_o = 1$, $E = 2.1*10^5\ N/mm^2$

$[M_t] = 1*1.3*0.0085 = 0.01105$ Nm

STEP4: MODULE CALCULATION

Assume Z = 40

m = D/Z

=40/40 = 1 mm

Assume $\Psi = 0.4$

$b = \Psi * a = 0.4 * 66.5$

$b = 26$ mm

STEP5: REVISED $[M_t]$

$[M_t] = K_o * K * K_d * M_t$

$\Psi_p = b/d = 0.39$

Hence $K = 1$, $K_d = 1.3$, $K_d = 1$

$= 1*1.3*0.0085$

$[M_t] = 0.01105$ Nm

STEP6: CHECKING FOR INDUCED BENDING STRESS

$$\sigma_b = \frac{(i+1)\,[M_t]}{a*m*b*y}$$

$y = 0.485$

$\sigma_b = 22 \text{ N/mm}^2 < [\sigma_b] = 119.5 \text{ N/mm}^2$

STEP7: CHECKING FOR INDUCEDCOMPRESSIVE STRESS

$$\sigma_c = 0.74\frac{(i+1)}{a}\sqrt{\frac{(i+1)}{i*b}*E[M_t]}$$

$$= 0.74\,\frac{(1+1)}{20}\sqrt{\frac{(1+1)}{26}*2.1*10^5*0.01105*10^3}$$

$\sigma_c = 31.26 \text{ N/mm}^2 < [\sigma_c] = 740 \text{ N/mm}^2$

So the design is safe.

4.2.5 SPECIFICATIONS FOR PINION

Pinion material: C45

Number of teeth= Z= 40

Pitch circle diameter= D= 40 mm

Module= 1 mm

Height Factor, $f_0 = 1$, for 20^0 full depth

Bottom clearance, C= 0.25m= 0.25*1= 0.25 mm

Tooth depth, h= 2.25*1= 2.25 mm

CHAPTER 5

FABRICATION

5.1 FABRICATION OF INDEXING MECHANISM

Every component that has to be finished to the required shape, size and accuracy specifications to suit our project requirements should be taken trough various processes like machining, forming, heat treatment etc., This is collectively known as fabrication.

The coupling, rack guide and the four legged support are fabricated in the company and other parts are purchased from outside. The coupling is fabricated by drilling 16 holes in a 10 mm thick plate. The 8 holes at the inner ring is used to screw the pinion and the remaining 8 holes at the outer ring is used to screw to the free wheel. The coupling is made of C45 steel. The rack guide is also made of C45 steel and it is used to guide the rack. It is fabricated using the milling machine by T-slot cutter.

The four legged support used to hold the pneumatic cylinder is made of steel plates and the legs are joined to the base plate by welding process.

5.2 FABRICATION OF PICK AND PLACE AUTOMATION

The L angled plate, square plate, connecting rod and base plate are fabricated in the company and the other components are purchased from outside. The L angled plate is used to hold the rod less pneumatic cylinder and it is made from a steel plate of 3 mm thick. The square plate is used to hold the electromagnet and it is drilled to screw the electromagnet to the plate. The four holes drilled are of 4 mm diameter.

The base plate is also made of steel plate of 3 mm thick. The plate is drilled with 6 mm dia holes. A rectangular plate is welded to the side of base plate over which the rack slides. The connecting rod connects the pinion and the square plate. The rod is dilled with two 4 mm holes at the middle and at the end. The rod is also made of C45 steel.

CHAPTER 6

ASSEMBLY

6.1 ASSEMBLY OF INDEXING MECHANISM

The free wheel is attached to the pinion using the coupling. They are screwed and fixed tightly. Then the whole assembly is inserted into the machine shaft and it is locked in the key way of the shaft. Then the four legged stand is fixed to the machine above the shaft by screwing. The piston rod end is attached to the rack end using the T-coupling. The piston rod end is threaded so that it can be easily fixed to the T-coupling. The rack end welded to the T-coupling. The rack guide is fixed to the machine body with four 6 mm screws. The piston is fixed to the top of the four legged stand and the piston pass through the hole at the top of the stand. The rack is aligned to engage exactly with the pinion and the rack guide.

6.2 ASSEMBLY OF PICK AND PLACE AUTOMATION

The L-angled plate is fixed to the machine body below the conveyor. Then the rodless cylinder is rested on the angled plate. Now the base plate is screwed to the body of the rodless cylinder. Then another pneumatic cylinder is fixed to the base plate through the holder which is fixed to the base plate. The rack is then fixed to the piston rod and screwed. Now the connecting rod and pinion is fixed to the base plate and the connecting pins are screwed to the rod end. The square is then fixed to the rod and the electromagnet is screwed to the square plate. Then the holding cup is fixed on either side of the electromagnet. The electromagnet is inclined at an angle of 23^0 to the horizontal since the work piece which is coming out of the adapter is inclined by 23^0 . The fully assembled view of the pick and place automation is shown in the photo 3, photo 4 and photo 5 of the annexure.

CHAPTER 7

WORKING PRINCIPLE

7.1 WORKING OF INDEXING MECHANISM

The indexing mechanism we have is similar to the working of the cycle back wheel. As we pedal the cycle in front the chain drives the sprocket at the back and hence the wheel rotates but as we pedal the cycle in back, the sprocket doesn't engage and hence the wheel is stationary.

The pneumatic cylinder is controlled by the signals from the sensors used for feeding the work pieces. The pneumatic cylinder pushes the rack which is coupled to it. The freewheel rotates the machine shaft as it rotates in one direction and in other direction the outer ring of free wheel rotates freely.

As the piston moves down, the pinion rotates. The pinion is attached to the outer ring of the coupling. Hence the outer ring of the free wheel also rotates which engage with the inner ring and in turn rotates the machine shaft. The shaft rotates for 180° and hence the spider gets indexed.

As the piston moves up, the pinion rotates in opposite direction. In the other direction the outer ring of the free wheel doesn't engage with the inner ring and hence the machine shaft is stationary. So the spider is stationary as the piston moves upward.

When machining operation is finished the signal is sent to the pneumatic cylinder and once again the spider gets indexed for 180° and the process repeats as mentioned above.

7.2 WORKING OF PICK AND PLACE AUTOMATION

The whole pick up arm setup is assembled on the rod less pneumatic cylinder. The pneumatic cylinders are controlled by the signals from the sensors. When the work piece is pushed out, it is caught by the electromagnet. Then the rodless cylinder retracts back.

Now another pneumatic cylinder gets activated and the piston extends and hence the rack attached to it also moves forward. The pinion rotates and the arm gets indexed for 90^0. Now the electromagnet gets demagnetized and drops the workpiece on the conveyor.

Next the piston retracts and the arm is again indexed for 90^0, then the rodless cylinder moves forward towards the work piece and the arm cylinder again extends and index the arm by 90^0. The electromagnet again gets energized and the process repeats as mentioned above.

The work piece which is placed on the conveyor is two half circles arranged as a single circular piece. It should be separated into two half circles. This is done by placing a pin on the side of conveyor so that as the work piece moves on the conveyor it hits the pin and get separated into two separate pieces. So that it is sent to next machine for machine for further machining.

The chamfering machine before and after the project is shown in the photo1 and photo2 in annexure.

7.3 MAINTANENCE OF PNEUMATIC SYSTEM

7.3.1 MAINTENANCE SCHEDULE:

- Operator tasks (to be carried out during the operation of the plant)
    - Check condensate traps in air main lines
    - Detection and arrest of leakage of air in FRL unit
    - Drain condensate from filter

- Periodic maintenance (weekly or monthly etc.)
    - Detection and arrest of leakage of air in the main line, control valve, air cylinders and air motors
    - Check for any cuts and holes in lines
    - Check pressure rating of pressure regulator
    - Check leakage of air through the on and off valve and house fitting
    - Check actuating handle of valve

- Check solenoids and its electrical parameters
- Inspect the cylinder for force and speed accuracy
- Check for any mechanical damage in the piston rod
- Check rpm, torque and vibration produced by the motor
- Check mechanical line to the power source for looseness etc.

➢ Quarterly or Half-yearly Maintenance

- Inspection of union, bends tees, elbows, coupling etc.
- Check pressure rating at strategic points
- Check automatic draining rating of condensate in pipelines
- Cleaning of filter cartridge
- Calibrate pressure gauge
- Clean up oil jet passage in lubricator
- Arrest oil leakage in lubricator and adjust oil jet
- Check for possible seal failure in control valve
- Inspect actuating element of control valves
- Check valve adjustment
- Check tie rod connection of pistons
- Inspect the mechanical support and the mountings of cylinders
- Replace cup seal of piston
- Inspect silencers

➢ Annual maintenance

- Change oil in the lubricator after through cleaning of the bowl
- Check spring and valve actuators
- Check the mechanical damage to valves and their parts
- Check alignment of piston and piston rod

CHAPTER 8

BENEFITS OF THE PROJECT

8.1 BENEFITS OF INDEXING MECHANISM

- Production cost will be reduced
- Repeatability will be increased
- Machine setup time will be reduced
- Productivity will be increased

8.2 REDUCTION IN MACHINE SETUP TIME

- Setup time for 1 adapter= 5 min
- Setup time for 8 adapters= 8*5= 40 min
- Setup time after converting into 2 stations= 2*5= 10 min

Total savings in setup time/batch= 30 min

8.3 COST REDUCTION BY INDEXING MECHANISM

8.3.1 TOTAL EXPENDITURE WITH 8 ADAPTERS

- No of varieties= 118
- Fast usage= 20 varieties
- No of adapters= 20*8= 160
- Average life= 4 years
- No of adapter replaced/year (approx)= 40
- Cost of 1 adapter= R.s 5000
- Average replacement cost/year= 5000*40= 200000
- New development= 3/year
- New development cost/year= 3*8*5000= Rs. 120000
- Maintenance cost = R.s 50/adaptor/3 months
- Total maintenance cost /year= 184*50*4= Rs. 36800

Total expenditure/year= Rs. 356800

8.3.2 TOTAL EXPENDITURE WITH 2 ADAPTERS

- Average replacement cost/year= Rs 50000
- New development cost/year= Rs 30000
- Maintenance cost/year= Rs 9200

- Total expenditure/year= R.s 89200

Total savings/year= Total expenditure/year with 8 adapters – Total expenditure/year with 2 adapters

Total savings/year = 356800-89200= R.s 267600

8.4 BENEFITS OF PICK & PLACE AUTOMATION:

- Reduction in labour cost
- Elimination of product damage due to gravity fall
- Work in progress can be eliminated
- Product mix up is reduced

8.5 COST REDUCTION BY PICK &PLACE AUTOMATION

- No of labors to be reduced= 1/shift
- Total no of shifts= 3/day
- Total Labor cost/month= 5000*3*1= Rs 15000

Total labor cost reduced/year = 15000*12= Rs180000

8.6 TOTAL SAVINGS

- Cost reduction by conversion of eight station to two station machine= **Rs. 267000/year**
- Cost reduction by pick & place automation= **Rs. 180000/year**

Total savings to the company/year= Rs. 447000/-

CHAPTER 9

COST ANALYSIS

9.1 COST ANALYSIS FOR TWO STATION CHAMFERING MACHINE

The total cost for implementing the indexing mechanism and the pick and place automation is shown on the table 9.1 and table 9.2.

TABLE 9.1 BILL OF MATERIALS FOR TWO STATION CHAMFERING MACHINE

S.No	MATERIAL	QUANTITY	COST(Appx)Rs
1	Pneumatic cylinder Φ50mm. stroke length 150mm	1	3000
2	Rack and pinion	1 Set	2000
3	Free wheel	1	12000
4	Pneumatic valve 3-1/4-with coil+insert	1	2000
5	Flow control	2	2000
6	Reed Switch	2	2000
7	Linear Guide 200(L)	1	7500
8	Fabrication of Frame	L.S	7500
9	Pneumatic Accessories	L.S	1000
10	Electrical Accessories	L.S	1000
11	Guard for the system	L.S	1000
12	Un Forseen	L.S	2500
	EXPECTED COST		Rs.40000

9.2 COST ANALYSIS FOR PICK AND AUTOMATION

TABLE 9.2 BILL OF MATERIALS FOR PICK AND AUTOMATION

S.No	MATERIAL	QUANTITY	COST (Rs)
1	Pneumatic cylinder Φ25mm, stroke length 50mm	1	1080
2	Rodless Pneumatic cylinder Φ25mm, stroke length 100mm	1	12162
3	Electromagnet	1	500
4	Pneumatic accessories	LS	10000
5	Electrical Accessories	LS	5000
6	Fabrication Cost	LS	5000
	TOTAL COST		Rs. 33742

9.3 TOTAL PROJECT COST

The total worth of our project is shown below,

Total cost for indexing mechanism = Rs. 40000

Total cost for pick and place automation = Rs. 33742

Total cost of the project = Rs. 73742

CHAPTER 10

RESULTS AND DISCUSSIONS

10.1 RESULT

Thus the projects "Productivity Improvement through Re-Engineering" have been successfully completed. The pick and place automation has been designed and fabricated. The indexing mechanism also has been designed for the conversion of eight stations into two station chamfering machine.

The design is of low cost, more reliable, occupies less space and easy to maintain. The fabricated pick and place mechanism works according to our expectation without any error.

Due to this project the labour cost is reduced, workpiece damage due to gravity fall is eliminated, work in progress is eliminated and product mix up is eliminated. The production cost is also reduced.

On testing it was found that maintenance of the machine is very easy and it is very safe to work with the machine. Thus our project gives more benefits to the company and it is more useful.

10.2 ADVANTAGES

The advantages of the project are follows.

10.2.1 ADVANTAGES OF INDEXING MECHANISM:

- Production cost will be reduced
- Repeatability will be increased
- Machine setup time will be reduced
- Productivity will be increased

10.2.2 ADVANTAGES OF PICK & PLACE AUTOMATION:

- Reduction in labour cost
- Elimination of product damage due to gravity fall
- Work in progress can be eliminated
- Product mix up is reduced

10.3 FUTURE DEVELOPMENT

Some of the future plans are follows.

- The pick and place automation we have designed is of great success and it is working to our expectations. So it will be implemented in all other similar machines in the future.
- Due to the late delivery of the free wheel clutch which is purchased from outside, we are not able to fabricate the indexing mechanism which will be fabricated soon.
- The spider which holds the adapters will not changed and the same spider will be used with two adapters. In the future the design of spider itself will be changed to hold only two adapters.
- The indexing mechanism will be implemented in other similar machines also.

CHAPTER 11

CONCLUSIONS

11. CONCLUSIONS

We are immensely happy to conclude the project work "Productivity improvement through reengineering" as we have completed the project successfully and gained a lot of experience during this period. We have gained a lot of knowledge regarding planning and designing. The project built a bridge between our theoretical and practical knowledge.

The indexing mechanism we have designed will reduces the total production cost to a greater extent and increase the quality of the bearings manufactured. The overall machine setup time will also reduce considerably.

The pick and place automation we have fabricated works successfully and it satisfies the company's requirement. We hope that we have provided a better alternative replacing the human labour. Our project is of greater benefit to the company and we have increased the productivity of the machine.

CHAPTER 12

DRAWINGS

12.1 DETAILED DRAWINGS

The detailed drawings with dimensions of various parts of indexing mechanism and pick and place automation are shown from fig 12.1 to fig 12.5 and fig 12.6 to fig 12.11.

The adapter, guide, pinion, rack-1 and stand belonging to indexing mechanism are shown in the fig 12.1, fig 12.2, fig 12.3, fig 12.4, fig 12.5 respectively.

The base plate, holder, L-plate, pinion and connecting rod, square plate and rack-2 of the pick and place automation are shown in the fig12.6, fig 12.7, fig 12.8, fig 12.9, fig 12.10, fig 12.11 respectively.

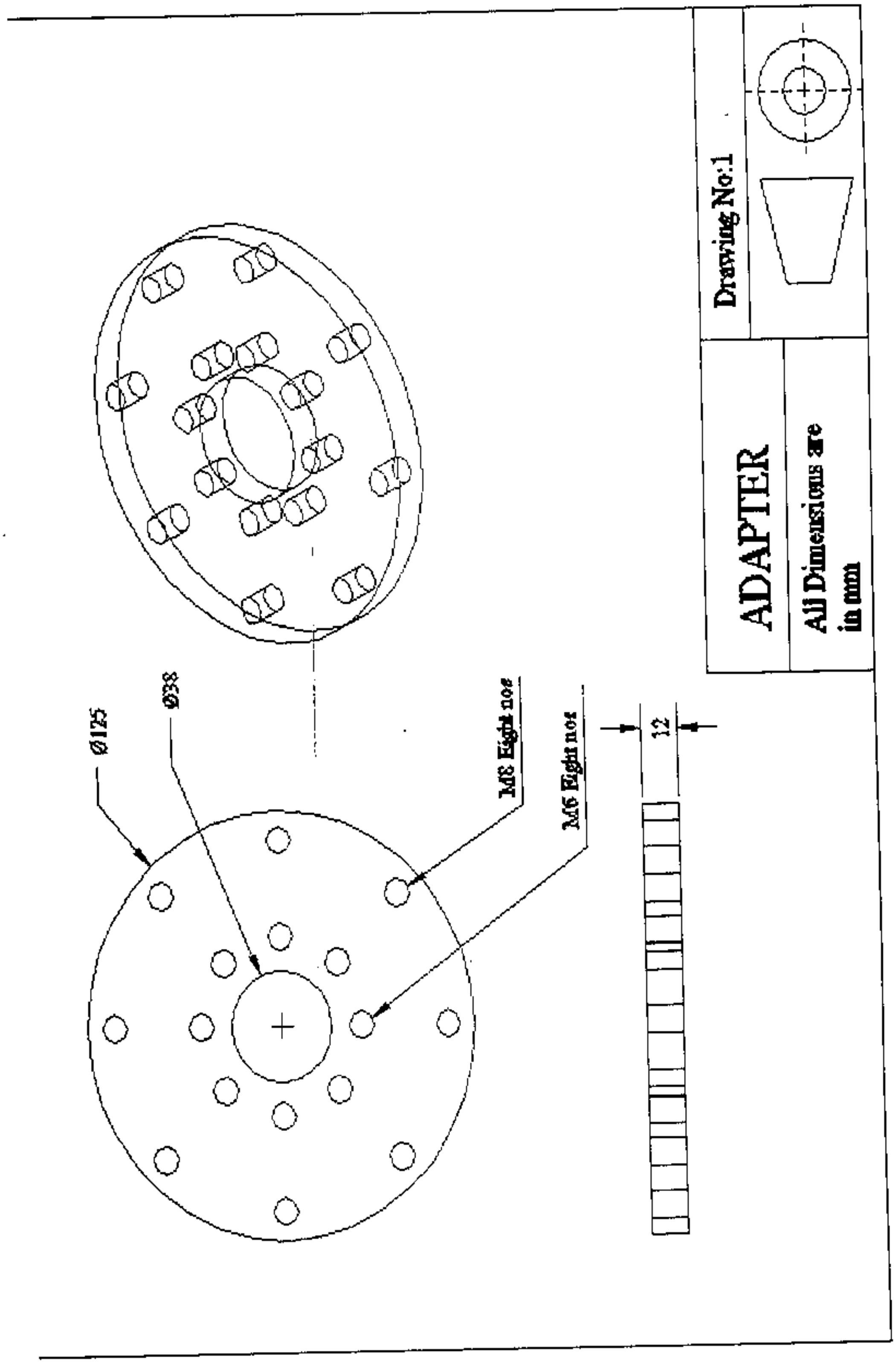

FIG 12.1 ADAPTER DRAWING

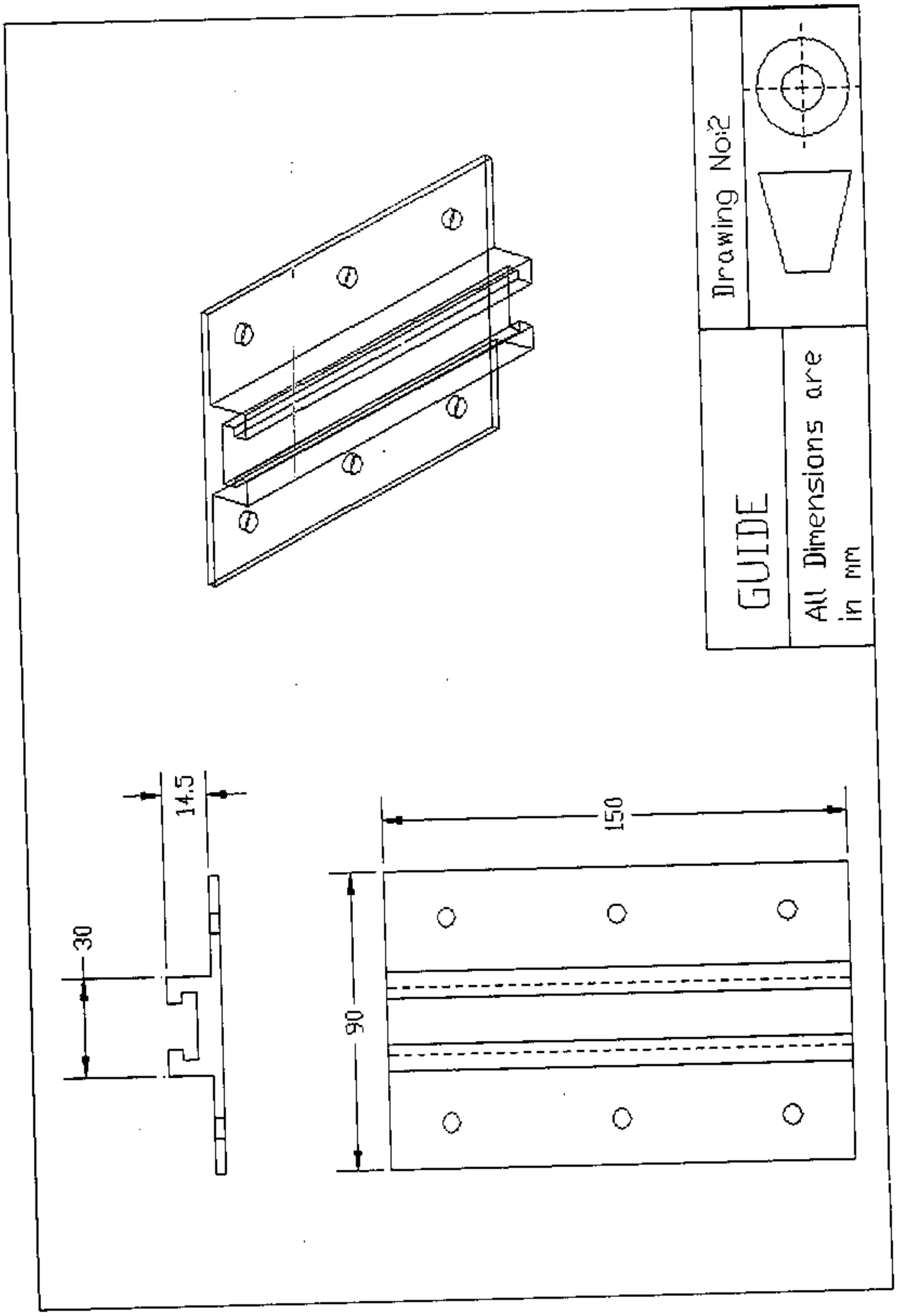

FIG 12.2 GUIDE DRAWING

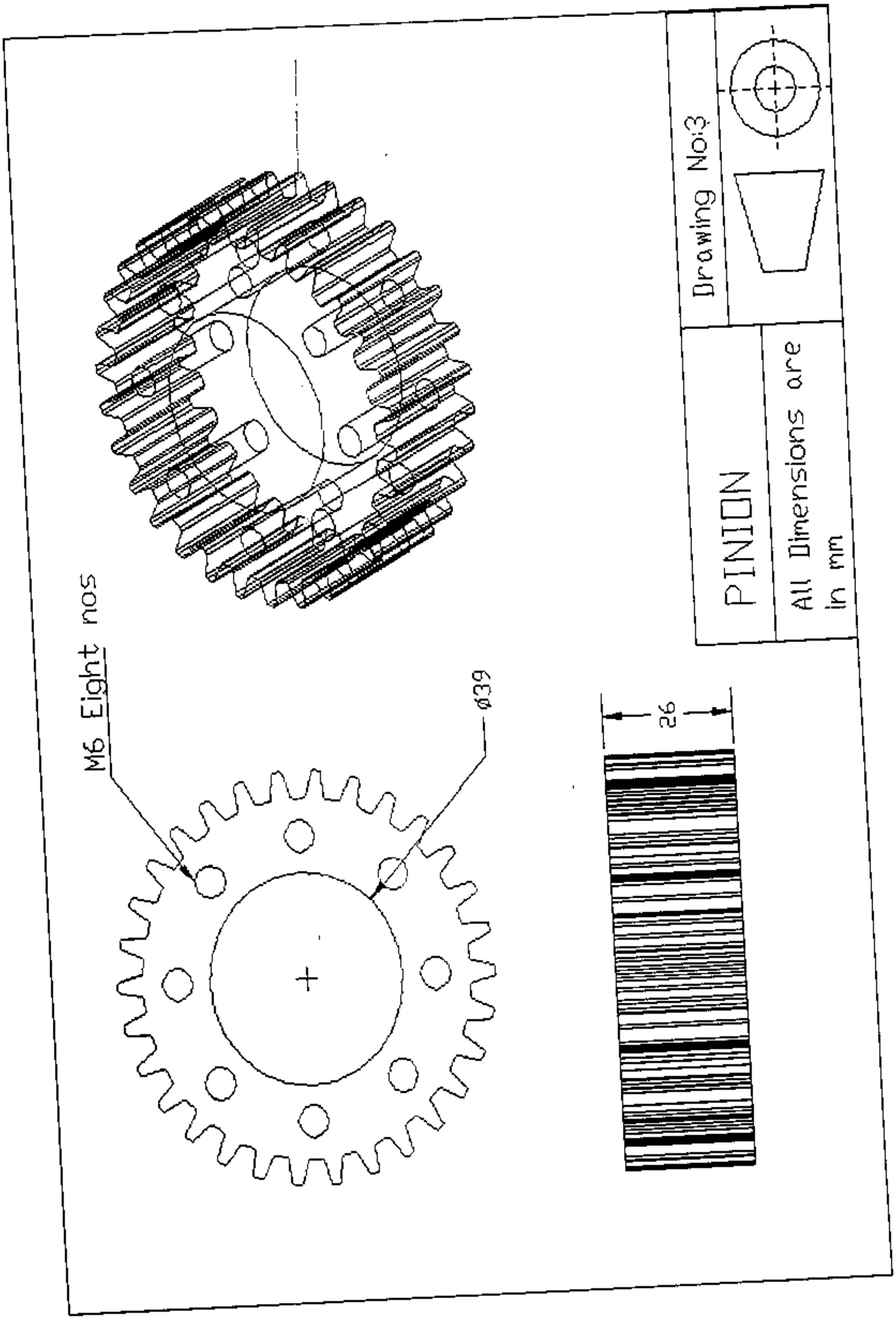

FIG 12.3 PINION DRAWING

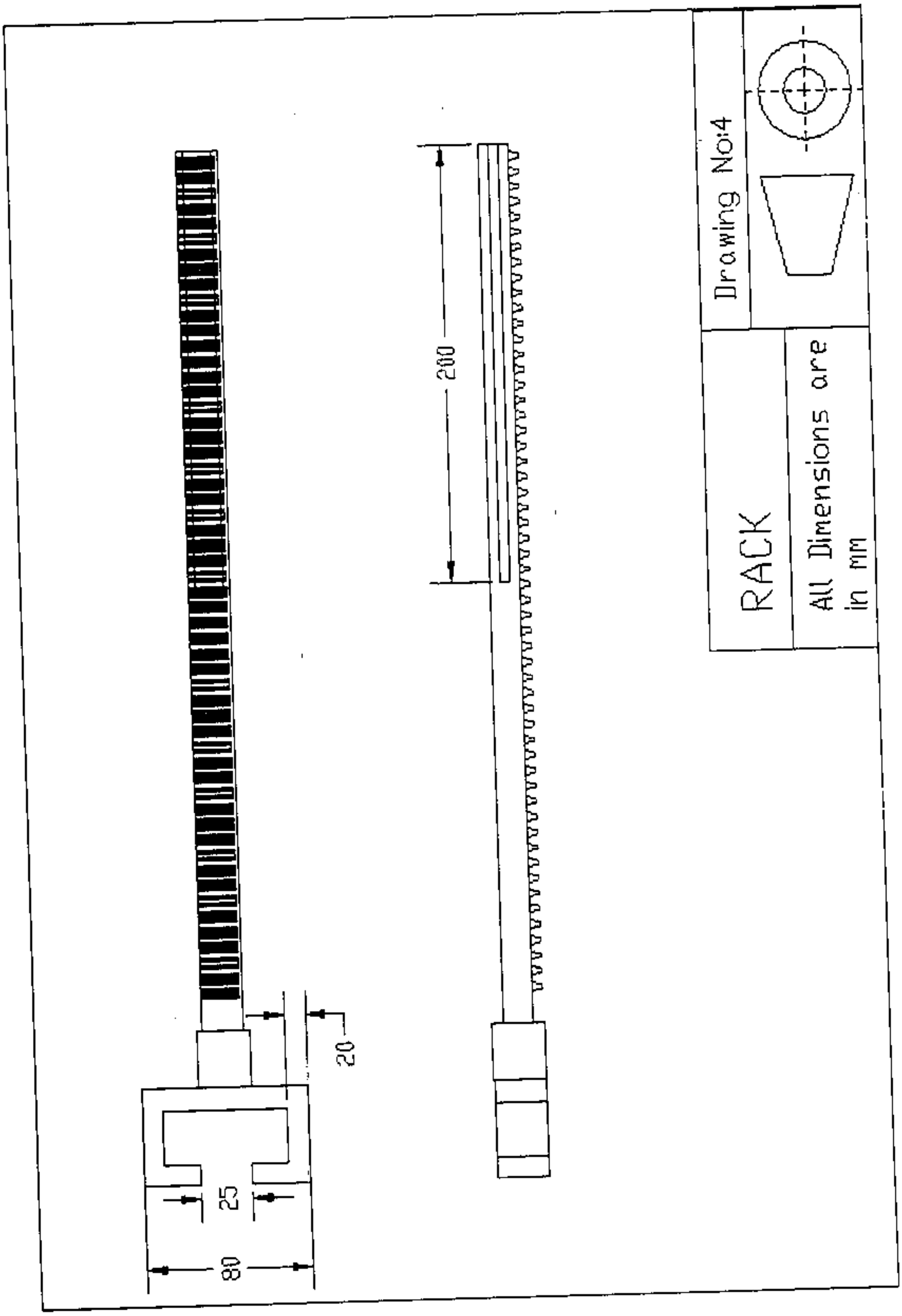

FIG 12.4 RACK-1 DRAWING

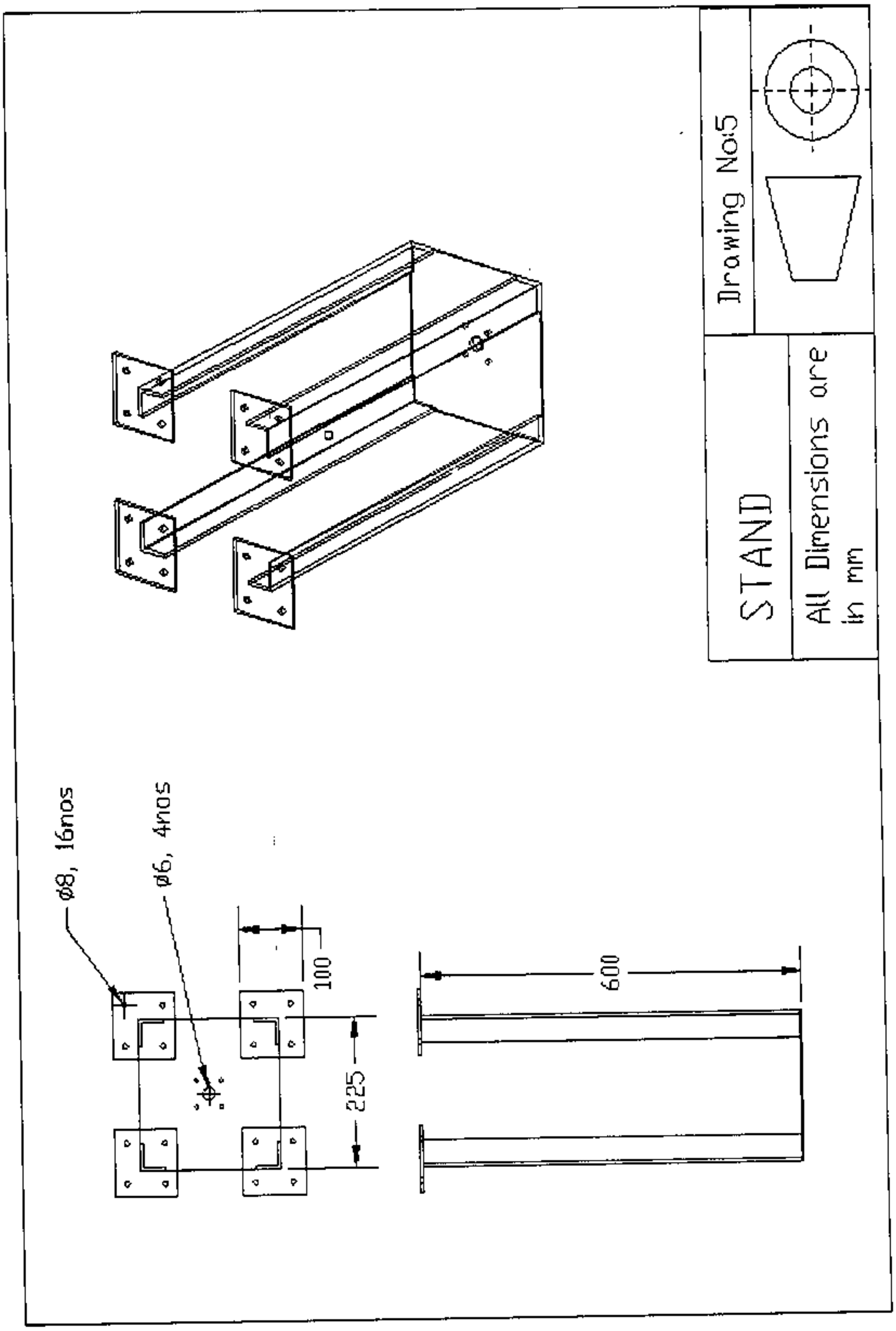

FIG 12.5 STAND DRAWING

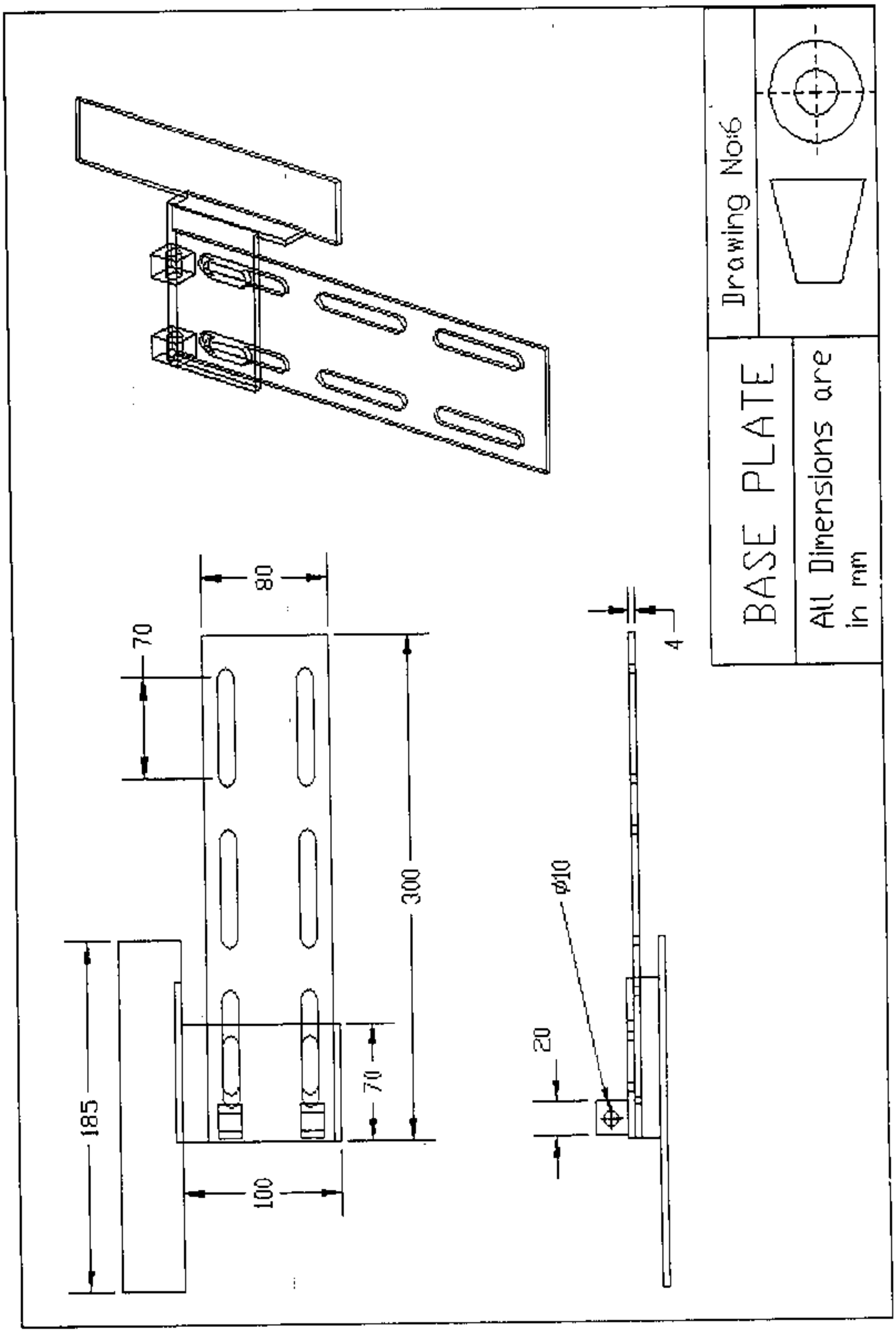

FIG 12.6 BASE PLATE DRAWING

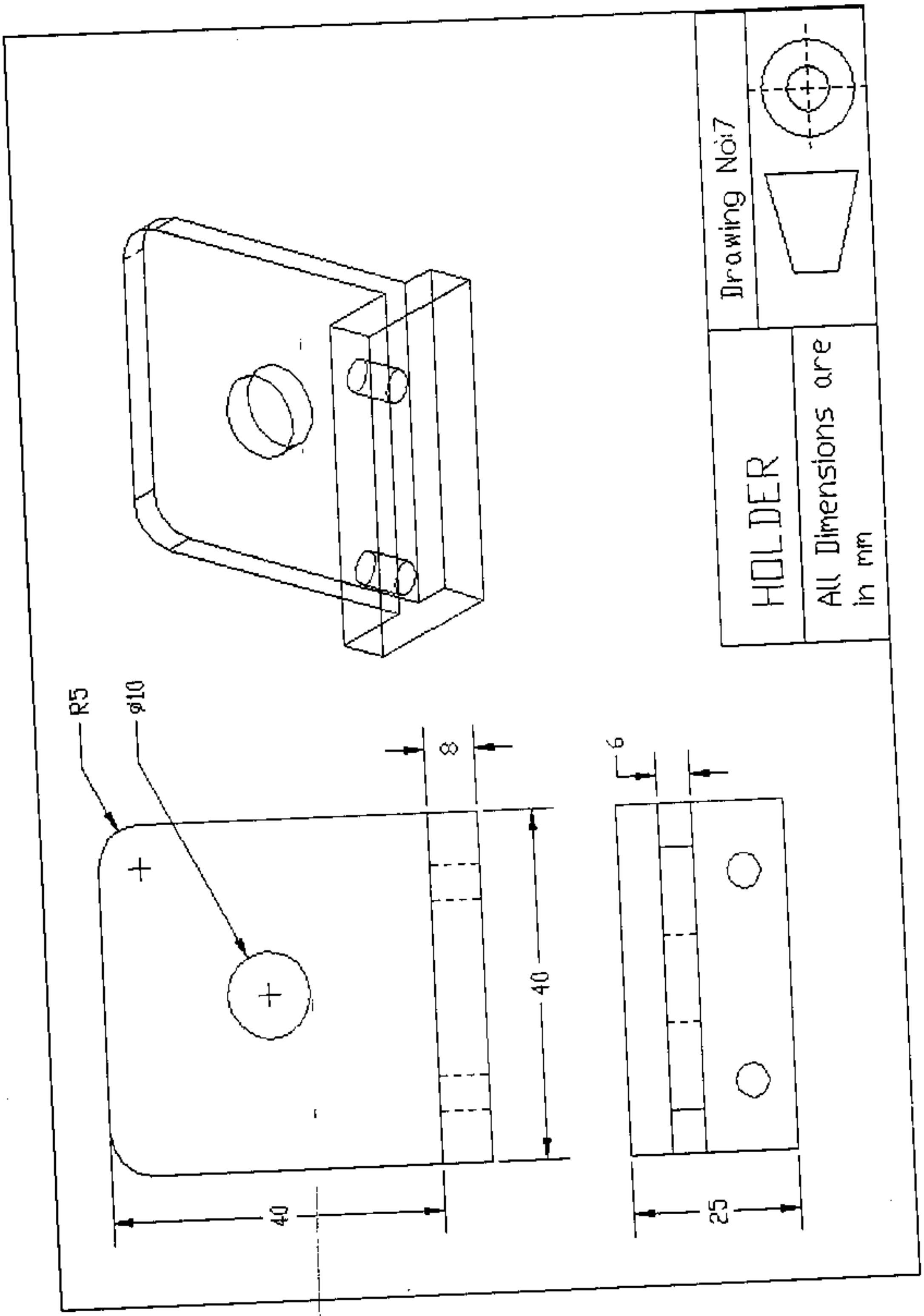

FIG 12.7 HOLDER DRAWING

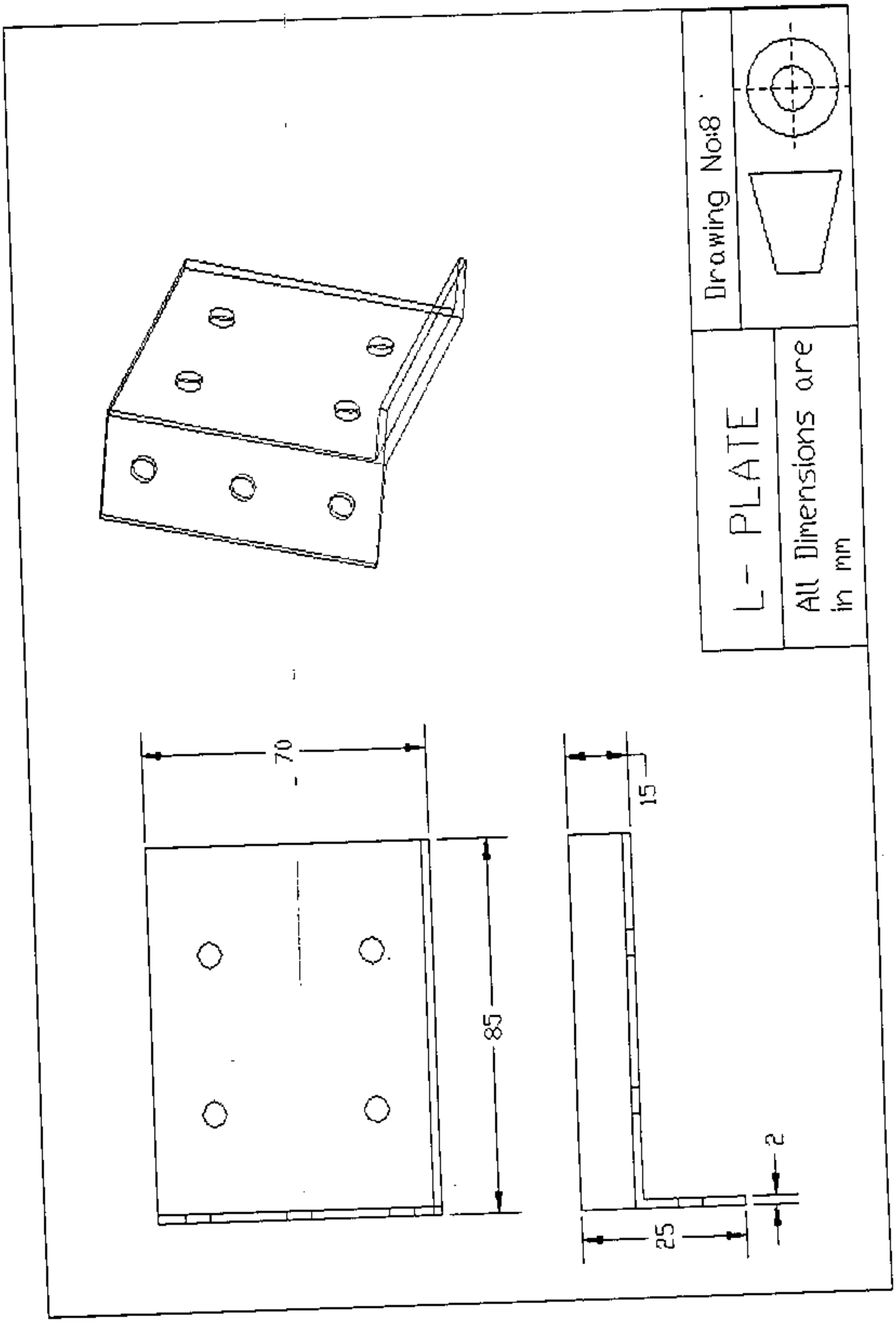

FIG 12.8 L-PLATE DRAWING

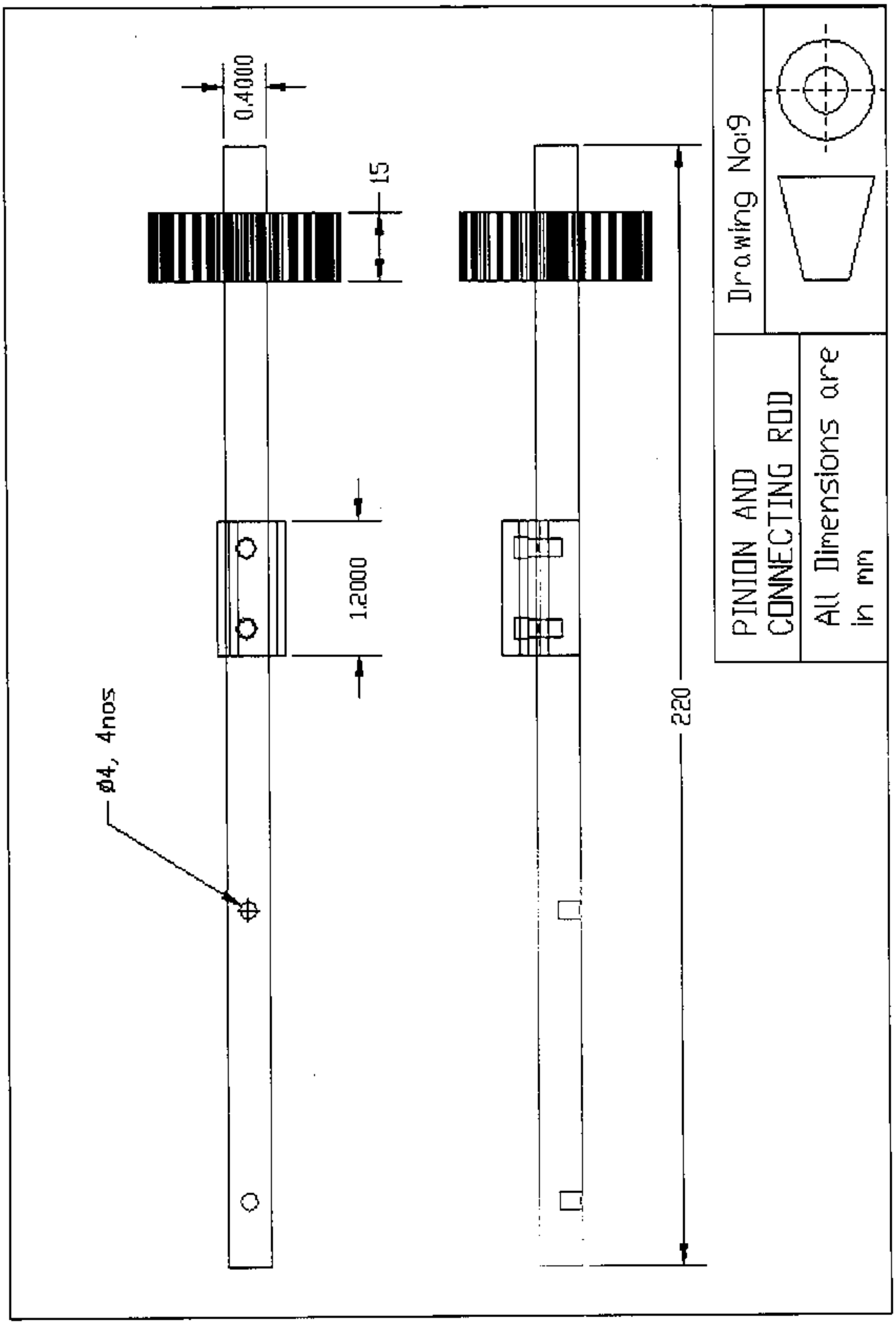

FIG 12.9 PINION AND CONNECTING ROD DRAWING

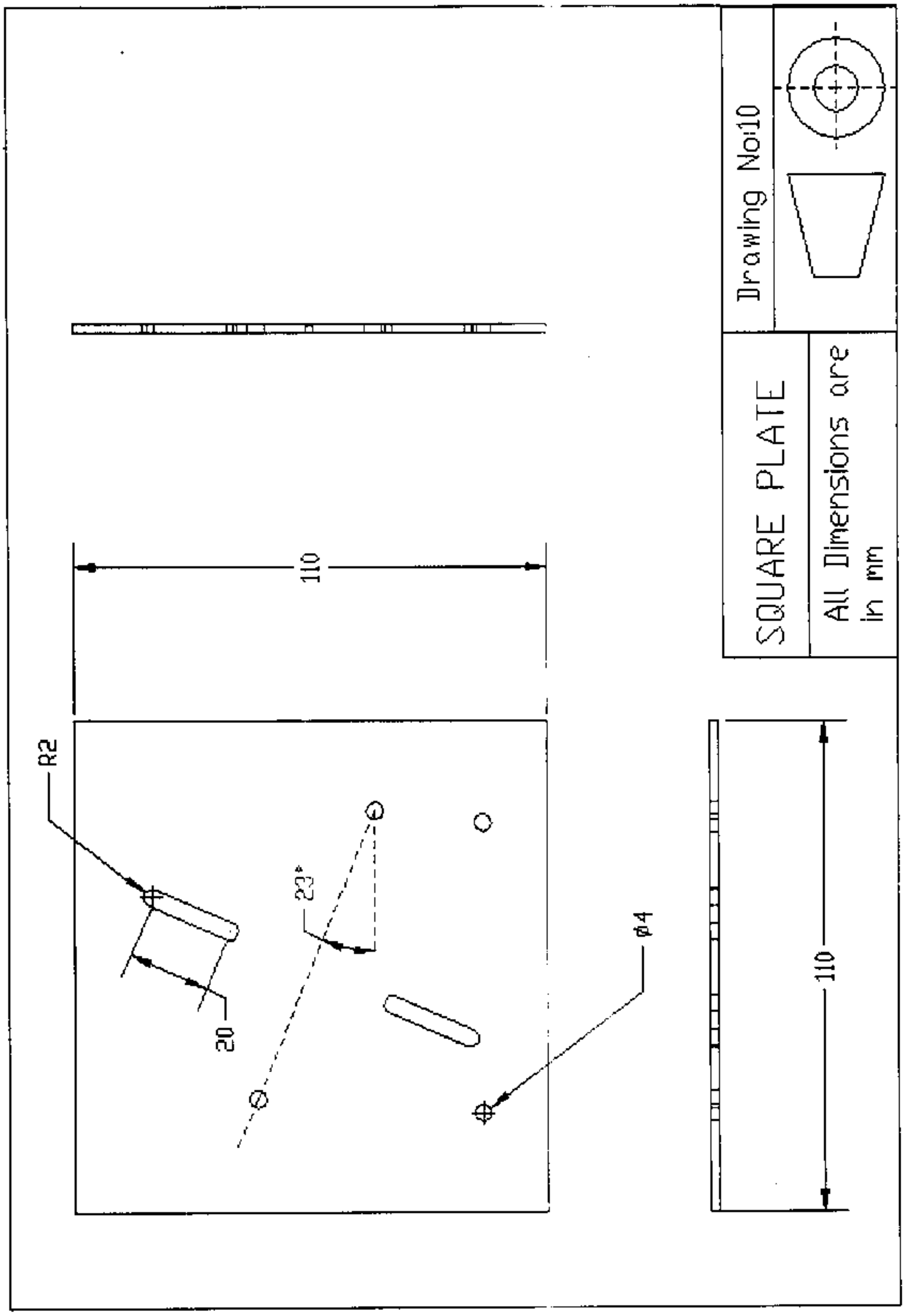

FIG 12.10 SQUARE PLATE DRAWING

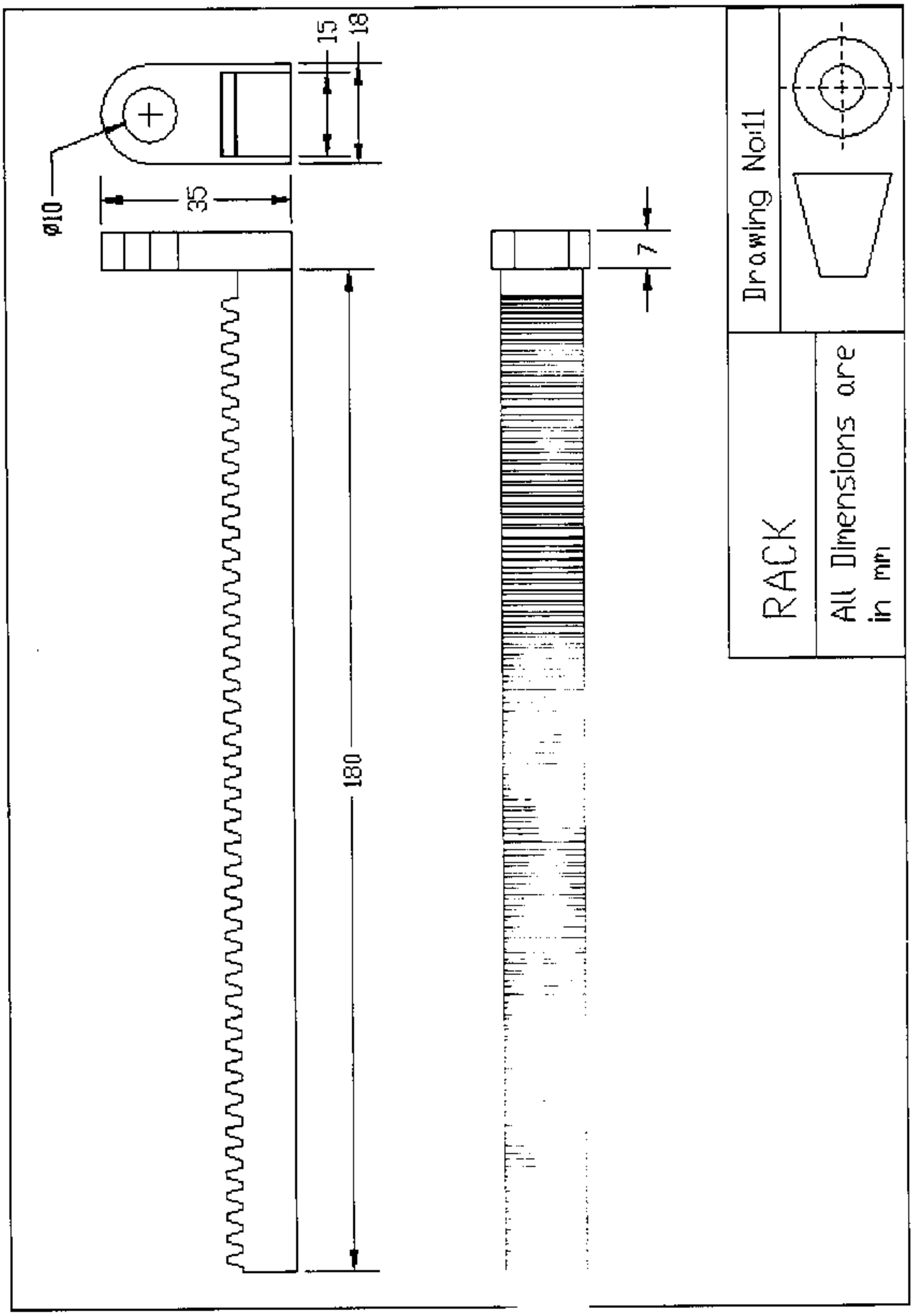

FIG 12.11 RACK-2 D[illegible]NG

ANNEXURE

PHOTOGRAPHS

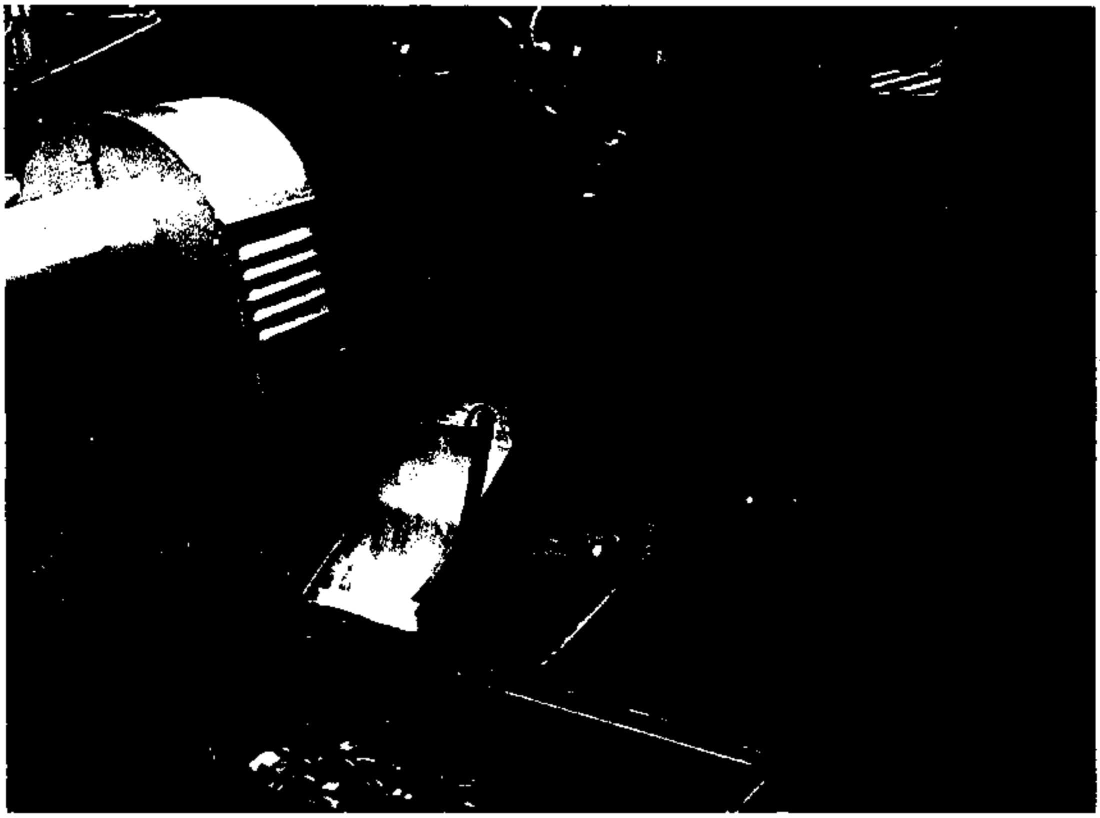

PHOTO 1. BEFORE IMPLEMENTING THE PROJECT

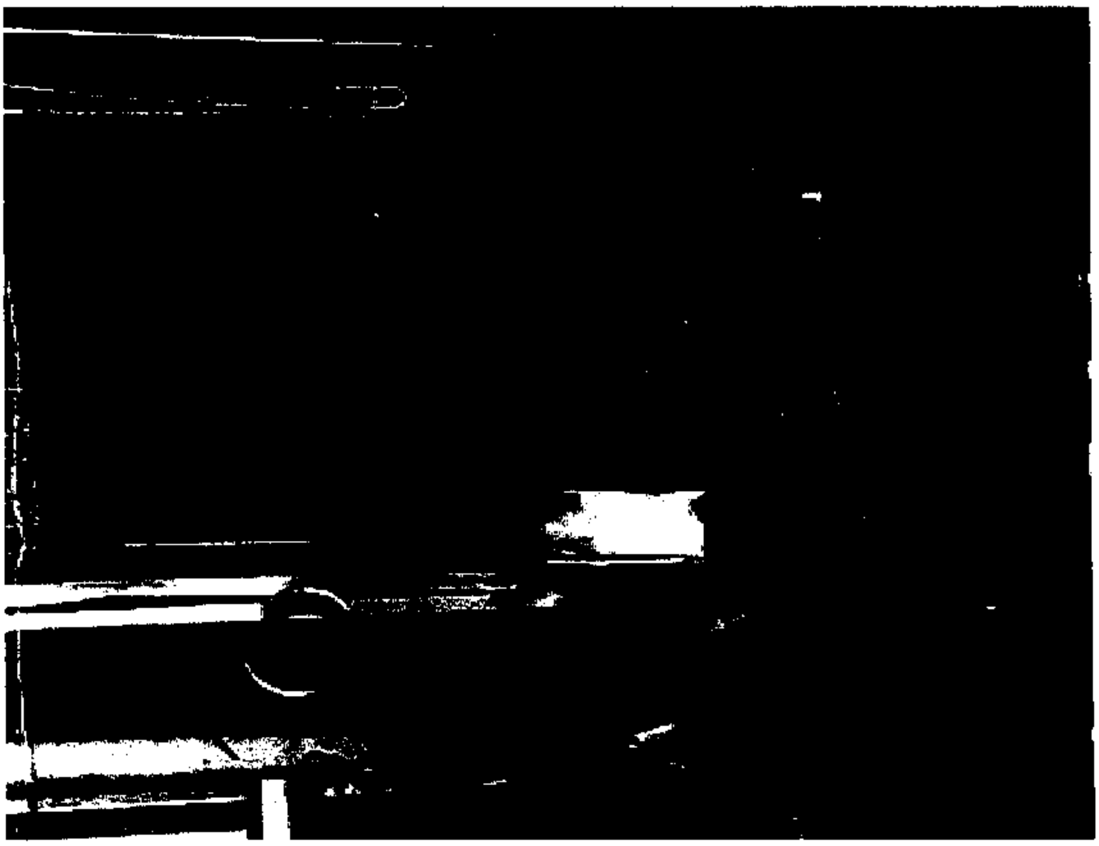

PHOTO 2. AFTER IMPLEMENTING THE PROJECT

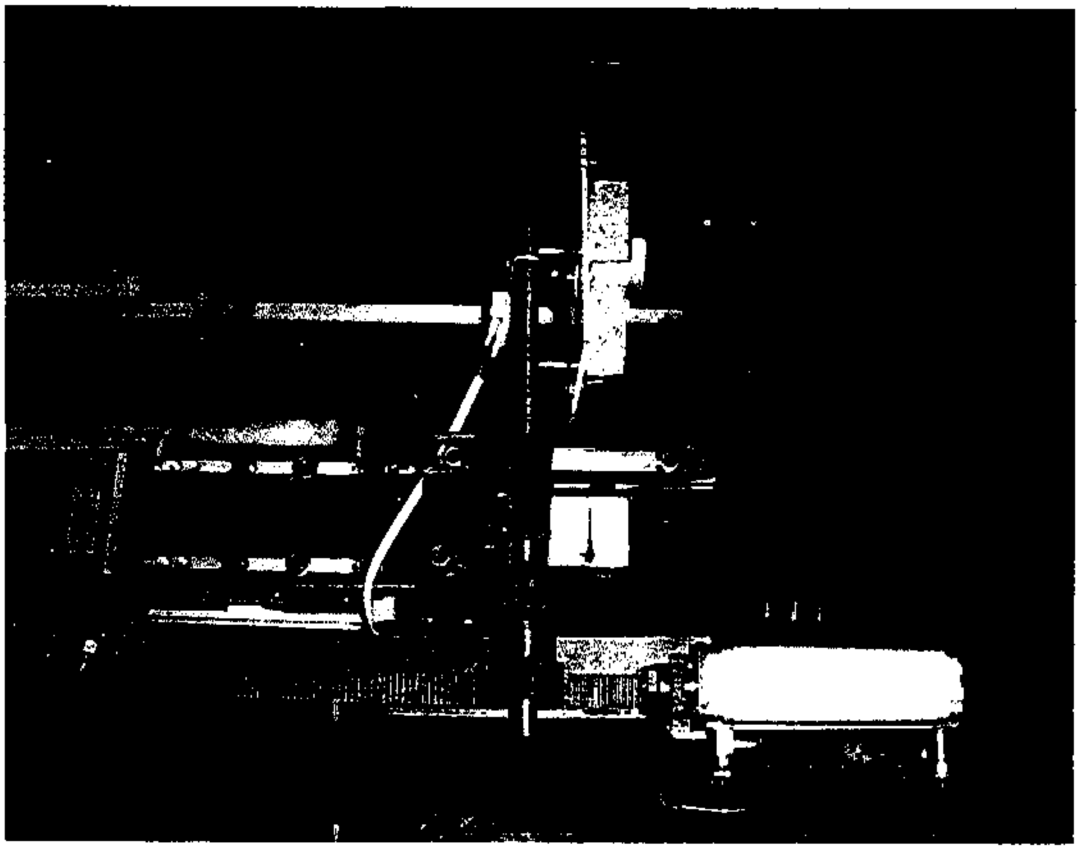

PHOTO 3. TOP VIEW

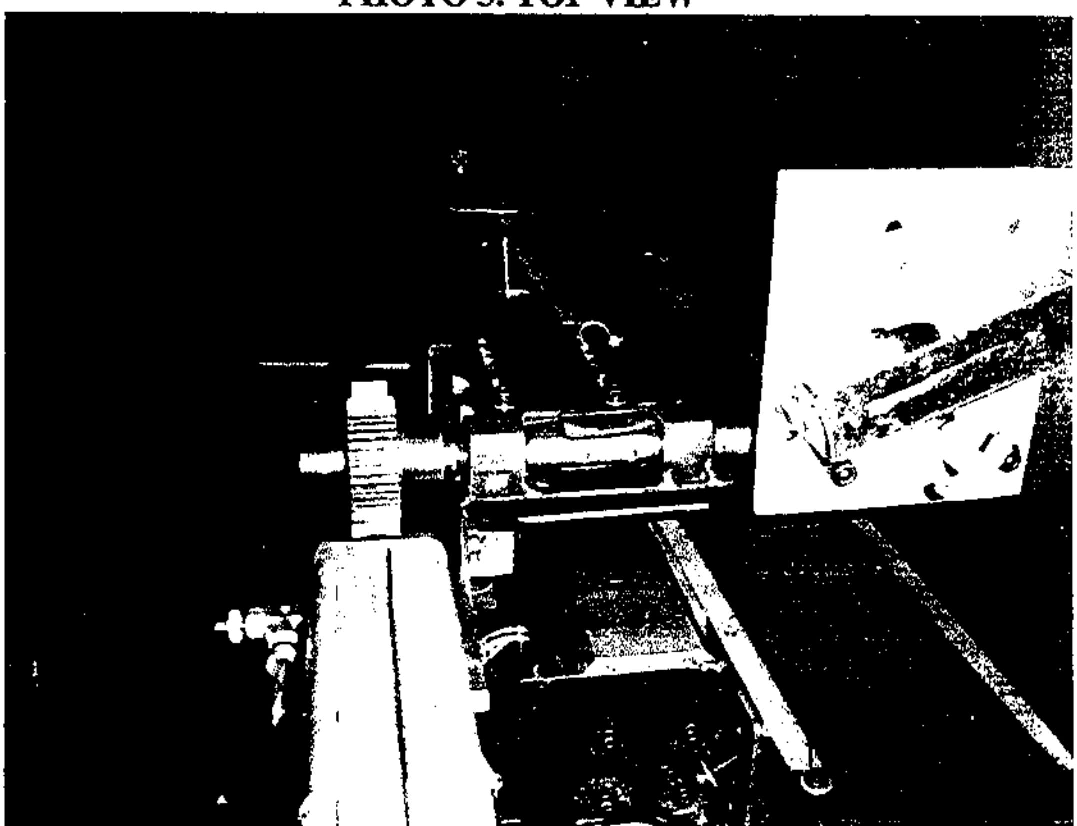

PHOTO 4. SIDE VIEW

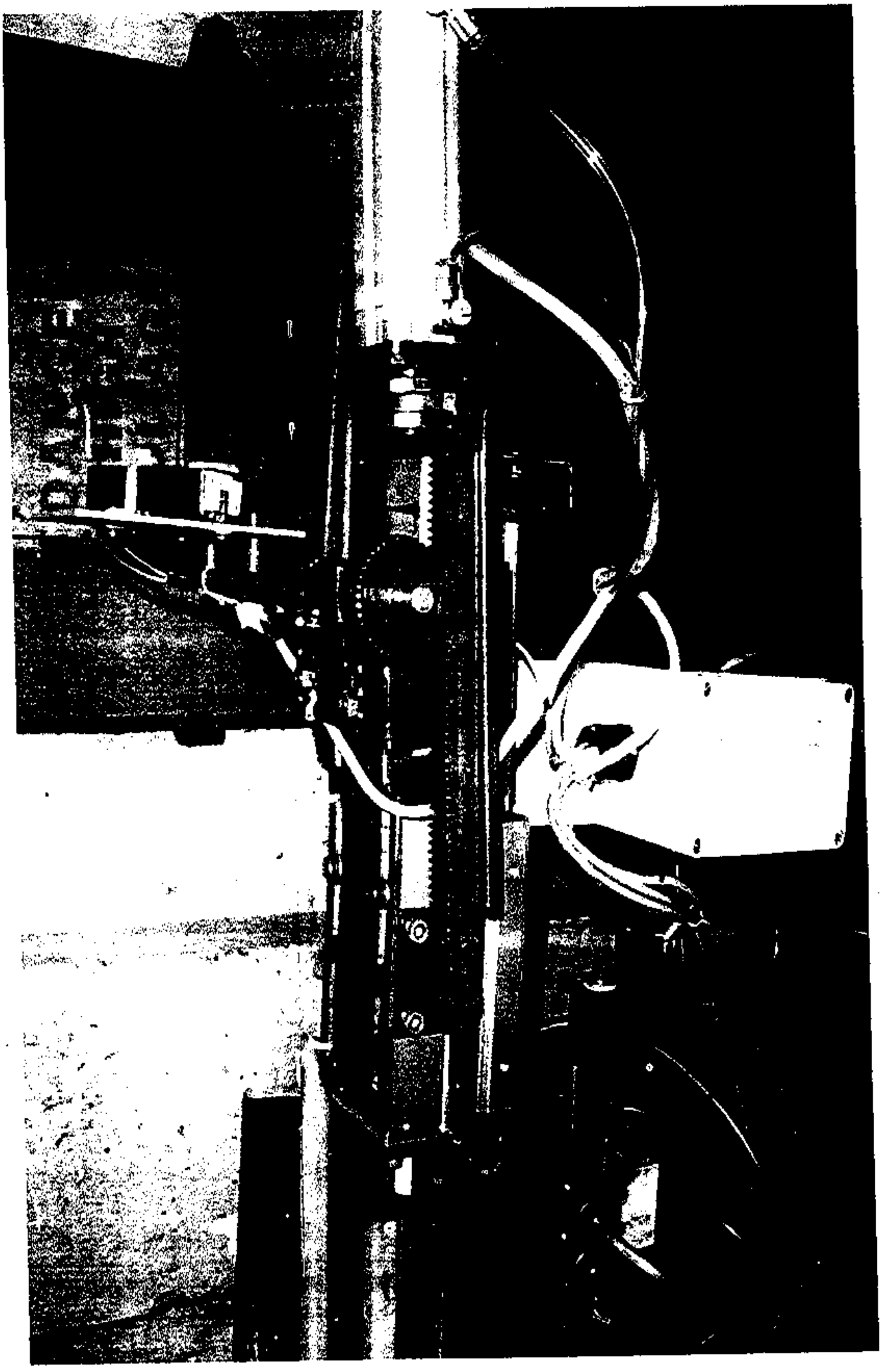

PHOTO 5. FRONT VIEW

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