DESIGN OF CONCAVE SURFACE GRINDING ATTACHMENT TO SHAPING MACHINE FOR SRI VENKATESWARA INDUSTRIES

PROJECT WORK 1991 - 92

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DEPARTMENT OF MECHANICAL ENGINEERING

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CERTIFICATE

P-180

This is to certify that the report entitled

DESIGN OF CONCAVE SURFACE GRINDING ATTACHMENT TO SHAPING MACHINE FOR SRI VENKATESWARA INDUSTRIES

has been submitted by

Mr. ....

in partial fulfilment of the award of Bachelor of Engineering in Mechanical Engineering Branch of Bharathiar University, Coimbatore - 641 046 during the academic year 1991-92

______________________ Guide

______________________ Head of the Department

Certified that the candidate was Examined by us in the Project Work Viva Voce Examination held on ______________ and the University Register Number was ______________

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Date 31.3.92

CERTIFICATE

THIS IS TO CERTIFY THAT the following final year Mechanical Engineering Students of Kumaraguru College of Technology have successfully Carried out their Project in our Industry titled Design of Concave Surface Grinding Attachment to Shaping Machine.

M.KARTHIKEYAN

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V.SIVAPRAKASH

They had shown keen interest in designing the equipment. We wish them all success in their future career.

For Sri Venkateswara Industries

(T.KALIMUTHU)

MANAGING PARTNER.

ENGINEERING AND TEXTILE MACHINERY
CEMENT AND RICE MILL MACHINERY
SPACE SCIENCE EQUIPMENTS
HEAVY FAFRICATIONS AND MACHINING

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TNGST. No. 315689/14-5-71
C S T. No. 576217/14-5-71

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Directly or indirectly, many people have given their contribution for doing this project. What follows is a selective list of some who have helped us by giving freely their time and assistance.

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With deep respect, we express gratitude to **Mr. T. Kalimuthu**, Managing Partner, **Mr. T. Ramachandran** and **Mr. T. Govindharaju**, Partners, **M/s. Sri Venkateswara industries**, Coimbatore for sponsoring our project and supervising the progress of the same.

We are extremely thankful to our Staff members and friends who helped to do this project.

CONTENTS

SYNOPSIS

Our project deals with the design of a surface grinding attachment to a shapping machine, especially for concave surfaces since the carding drum plates have concave inner surfaces, sponsored by SRI VENKATESWARA INDUSTRIES, Coimbatore, who are leading and reputed manufacturers of various textile machinaries like carding machines. They also manufacture Space equipments, for Indian Space Research Organisation (ISRO).

Here in this grinding process, the workpiece is fixed and the grinding attachment hinged at a certain height is moved by the ram of the shaping machine through link.

The grinding attachment is designed such that it can carry out grinding operation on the concave surfaces having concave radius in between the range 620 - 800 mm.

Keeping an eye on increased productivity co-joined in with quality assurance, our attachment is designed to meet the required specification for speeding up the grinding rate with maximum reliability, minimum maintenance and economy in production.

INTRODUCTION

In recent years, newer fabrication techniques have been developed to satisfy the technological demands. However, emphasis is stressed on attachments. Attachments are used in various fields and machines, depending upon the needs to be fulfilled and mode of operation. They allow the use of existing machines for a different purpose and thereby eliminate the investment cost on a new machine which serves the same purpose.

Here the concave surface grinding attachment is to the shaping machine. It performs grinding operation with the attachment and also its usual shaping operation. By implementing this attachment to the shaping machine, the capacity of the machine can be increased and the process becomes economical.

STATEMENT OF PROBLEM

Carding machine is one of the most important textile machines. It convert cotton lape into sliver. The front top, bottom and middle plates are important elements of the machine which help to guide the cotton out from the smaller drum and also act as cover for the drum.

It is essential that the inner surfaces of plates should have high surface finish for easier guidance of cotton.

Hence an attempt has been made to design a profile grinding attachment which would help to grind the concave surfaces of the plates.

GRINDING PROCESS

GRINDING PROCESS

Grinding is a process of material removal in the form of small chips by the machanical action of abrasive particle bonded together in a grinding wheel. It is basically a finishing process employed for producing close dimensional and geometrical accuracies and smooth surface finish. However in some applications, the grinding process is also applied for high material removal rates and is referred to as abrasive machining.

As compared to metal removal by cutting tools of defined geometry, grinding has the following advantages

i. Abrasive mineral crystals with hardness much higher than that of workpieces.

ii. Abrasive crystals are less sensitive to heat and can sustain higher temperature than the conventional tool materials. This aspect permits abrasives to work at much higher cutting speeds than conventional tool materials.

iii. When the individual grains of the grinding wheel wear out during the abrasine action, the self sharpening properties of the bonded tool become effective by releasing the dulled grains and exposing new sharp ones, a process which is after supported by occational dressing or 'truing'.

iv. The simple dressing of the abrasive wheel, which is performed after the face wear has occured, aviods the significant effect of tool-edge dulling on size holdings, which generally accompanies the machining process performed with cutting tools.

v. The process integrated reconditioning of the abrasive wheel by truing with automatic position compensation, results in a degree of unattended dimensional accuracy of the work which makes it possible to achieve work size control better than that possible with conventional metal working tools.

vi. Work pieces in particular or even complex profiles, which otherwise require very expensive, specially made form cutting tools, can be produced accruately by grinding with relatively inexpensive truing templates.

vii. The depth of penetration of the abrasive grain into the work material can be held to a very small amount and, when necessary, chips of microscopic size can be easily removed. Thus, closer dimensional accuracies and smoother surface finish can be achieved.

viii. Cutting through the hard skin of certain raw materials or forging may require a minimum depth of cut for conventional tools, a condition which is not a factor to be considered in abrasive chip removal.

ix. There are some work materials, both in their untreated condition, and particularly after hardening, which cannot be worked by conventional tool materials.

The metal removal rate of the grinding process is much lower compared to the other machining processes working with a defined tool geometry. However grinding is necessary to produce work pieces of high accuracy and high surface quality

OPERATING CONDITION

The success of any grinding operation depends on the proper selection of verious operating conditions like wheel speed, work speed, traverse feed, in feed, area of contact, grinding fulids, balancing of grinding wheels, dressing etc.,

GRINDING WHEEL

It acts as a tool for the machining operation. These grinding wheels are composed by selectively sized abrasive grains held together by a binding agent. The properties of the grinding wheel are influenced by

i. type of abrasive

ii. grain size

iii. type of bond

iv. grade of the wheel

v. structure of the wheel

Selection of abrasive depends on the hardness of the material (i.e., work piece) Corundum, emery and diamond are mostly used abrasives. Aluminum oxide are used for grinding steels, silicon carbide for grinding nonferrous, cast irons and nonmatelic elements, diamond for grinding cemented carbide, ceramics, glass and stone.

Grain size influences the stock removal rate and the generated surface finish. It is classified as very coarse, coarse, medium fine, very fine, superfine and special.

Coarse grits are used for higher metal material removal and surface finish in not critical. Finer grits are used in operations where material to be removed is less and surface finish is important. Medium grit to get both, the material to be removed and the surface finish is used.

Recommended grain size for various surface finish

Grain Size	Surface finish
46	0.8
54	0.6 - 0.8
60	0.4 - 0.6
80	0.2 - 0.4
80-200 and finer	0. 05- 0.2

Accoridng to the kind of bond, the hardness of the wheel is denoted. More the bond content harder the wheel. Hardnesss of grinding wheel is classified as very soft, soft, medium, hard, and very hard and denoted by letter as shown below

Very soft	-	A	B	C	D	E	F	G
Soft	-	H	I	J	K			
Medium	-	L	M	N	O			
Hard	-	P	Q	R	S			
Very Hard	-	T	U	V	W	X	Y	Z

Stucture of the wheel indicates the density of the abrasive grain. These grains do not occupy the whole area. There are pores inbetween them. According to that, it is classified as compact, semicompact and porous groups. Porous groups for high stock removal, close or dense structured wheel for holding precision form and profiles.

WHEEL SPEED

If the wheel speed is increasing at a constant longitudinal or rotary feed rate, the size of the chips removed by a single abrasive grain is reduced. This reduces the wear of the wheel. If the wheel speed is reduced, the wear is increased. From this, it is clear that from the point of view of wear, it is better to operate at higher wheel speeds. However, this is limited by the allowable speeds at which the wheel can be worked, as well as the power and rigidity of the grinding machine. Normally, the grinding wheel speed ranges from 20-40m/sec. The wheel speed also depends upon the type of operation and the bond of grinding wheel. Here the workpiece is of mild steel. From CMTI(Pg.No.657) hand book the wheel speed is 28-32m/sec.

WORK SPEED

Work speed is the speed at which the work piece traverses across the wheel face. If the work speed is high, the wheel wear is increased, but the heat produced is reduced. On the other hand, if the work speed is low, the wheel wear decreases, but the heat produced is more. The ratio of wheel speed to work speed is of much important, and it should be maintained at the proper value. Low work speeds result in local over heating and bring about deformation or tempering of the hardened workpiece. This, in turn, affects the mechanical properties of the work piece. The increase in work speed is limited by premature wheel wear and vibrations induced by wear. Generally, if the wheel wear increases, the work speed should be reduced. If the heat produced is high and clogging occurs, especially with hard wheels, the work speed should be increased. From CMTI Hand Book Pg.No.657, for mild steel work piece, the work speed is 15 - 30m/min. Since the work piece is having concave surface, the work speed is reduced to 12 m/min.

DOWN FEED

If the down feed is high, the wheel wear increases and the surface finish deteriorates, thus affecting dimensional and geometrical accuracy of ground workpiece.

The material removal rate, however, increases if the downfeed is high. From CMTI Hand Book Pg.No.657, the down feed for MS with hardness 48-65 HRC is

Rough Grinding : 0.05 mm/pass

Finish Grinding: 0.0125 mm/pass

TRAVERSE FEED

The traverse-feed or cross feed rate is governed by the width of the wheel and workspeed. Normally the traverse feed rate is adjusted to 2/3 to 3/4 of the wheel width while grinding steels and 3/4 to 5/6 of the wheel width while grinding cast iron. Heavier cross feeds increase the wheel wear and produce rougher finish, and slower cross feeds reduce wheel wear and produce finer finish.

From CMTI Hand Book Pg.No.657,

Cross-Feed(Max) : 1/10 of wheel width/pass.

Here wheel width is 25mm

Therefore Cross Feed : 2.5 mm/pass.

GRINDING FLUIDS

During grinding, the surface of workpiece in contact with grinding wheel can develop considerable heat. The high temperatures developed at the contact of grinding wheel and the workpiece are not significantly reduced by the cooling mechanism. However the grinding fluids cool the workpiece to prevent excessive heating and also to flush the grinding wheel.

BALANCING OF GRINDING WHEEL

Vibration in grinding operation is critical from the point of view of wheel life and surface finish on the job. Assuming that the machine is rigid and the bearings are in good condition, vibration to a large extent are caused by out-of-balance and out-of-round wheels. Since the grinding wheel speeds are high, slight out-of-balance condition may give rise to large forces. This may result in excessive vibrations, poor surface finish, faster wheel breakdown and may even be dangerous to the operator. Therefore, particular attention should be paid for the balancing the wheels. Generally, balancing weight are provided on the mounting flange of the grinding wheels. By mounting the wheel on a static balance stand equipped with two rollers or pairs of overlapping discs, the wheel is brought to static balance by moving the weights. Then it is mounted on the grinding machine and dressed to concentricity. It is once again removed from the machine and rebalanced. It can now be used for grinding. For getting still better results, the wheel can be dynamically balanced while it is running on the machine.

EXISTING METHODS

No conventional machine exist to grind the concave surfaces with concave radius more than 500mm. The existing methods used are the following

In sri Venkateswara Industries, the plates are bent to the required radius. Then the inner concave surface of the plates are filed and rubbed with emery paper to get the required surface finish. This process is time consuming and requires heavy labour, power and skill, also the surface finish is not so near to the requirement.

The concave surfaces can also be ground with CNC grinding machine. But this process is expensive and a highly skilled operator is required to operate this machine.

THE ATTACHMENT

PRINCIPLE

In surface grinding process, usually the grinding wheel is fixed and the work piece fixed to the table is moved traversely. Since the work piece here has concave surface of radius more than 600mm, it is difficult to have and operate a grinding wheel of that radius.

Hence this attachment is designed incorporating an oscillating wheel mechanism.

The work piece is mounted on a special fixture which is bolted to the table. The horizontal feed to the table is given automatically. During the forward stroke of ram, the grinding wheel does grinding on an area with width equal to the width of the grinding wheel. During the return stroke, the horizontal feed takes place. In this stroke grinding is done diagnally with increasing width. But in the next stroke, the remaining area is ground.

The grinding wheel is attached to one end of an oscillating column such that its axis is parallel to the length of the workpiece. The other end of the column is hinged at the imaginary centre of the concave surface of the work piece.

The column is oscillated by the ram of the shaping machine through a link. The stroke length of the ram is adjusted according to the width of the work piece.

In order to ground work pieces of different concave radius, the oscillating column is made into a telescoping arrangement. The inner column of smaller diameter with square threads acts as a screw and the outer column with inner threads as a nut.

As the screw or inner column is rotated, the nut or the outer column to which the grinding wheel assembly is attached can be moved up or down.

The down feed is given by a worm and worm wheel mechanism. The worm wheel is attached to the top end of the inner column. This mechanism is also used to change the radius of the oscillating column according to the work pieces.

As the worm is rotated by a handle attached to its end, the worm wheel is rotated which inturn rotates the screw or the inner column. Hence the outer column moves up or down according to the direction of rotation of worm.

The outer column slides on a square slides of the guide block attached to the horizontal bar which supports the hinge in order to prevent the outer column rotating about its own axis during changing the radius or during downward feed.

The grinding spindle assembley is attached to the outer column with studs through the four holes in the spindle housing and four holes in the large portion of the outer column. The holes in the flange have no threads. The spindle assembley is held tightly and rigidly with the column by tightening the nut and washer on the threaded portion of the stud protruding out of the holes in the flange portion.

As it is difficult and unneccessary to have inner square threads throughout the length of the outer column, a nut having required sqare threads of smaller length is fixed tightly into the top inner portion of the outer column with the help of a square key.

The top end or the hinge part is supported by a horizontal square bar with round ends. The inner column is attached with the bar through a circular hole with 'close running fit'.

The horizontal bar is supported at its round ends by two plumber blocks on two vertical columns.

The power for the grinding wheel is given by the flexible shaft. The flexible shaft is attached with the grinding spindle by tightening the nut which is at the end of the flexible shaft to the threaded end portion of the grinding spindle.

The linkage lever has two arms at one end and a single arm at another end. The arms are provided with holes. The single arm of the lever is attached with clapper box of the ram and the two arms are attached with the guide block which is fixed with the horizontal bar with the help of bolts and nuts.

FIXTURE

Fixture is one which is used to hold the work piece while machining. The structure of the fixture depends on the shape of the work piece. Since the work piece is of concave surface, the fixture used to hold the work piece is having a concave surface. It is fixed to the T-Slots in the table by bolts and nuts.

The fixture is fixed to the shaping machine table. The horizontal movement of the table is given by the auto feed of the shaping machine.

The work piece has to have a number of holes of dia 7mm. So those holes are utilised to fix the work piece on the fixture. First holes of 5 mm dia are drilled and tapped to 6 mm. The work piece is held tightly and rigidly on the fixture by the bolts coming down from the fixture holding block. The height of the bolt is ensured so that it does not extrude out of the work piece.

DESCRIPTION OF VARIOUS UNITS

Construction of the spindle unit

The spindle is supported inside the housing by a pair of angular contact ball bearing in back-to-back form at its both ends, because in this grinding operation both axial thrust and radial forces are acting. The bearings are locked by the bearing caps, spindle housing and collet threaded with the spindle. The grinding wheel is mounted on one end of the spindle and clamped rigidly with the help of flanges at its both sides with a nut and washer.

The flexible shaft which rotates the spindle is connected to the other end of the spindle.

Different compenents of spindle unit

1. Spindle shaft
2. Bearing
3. Bearing caps.
4. Spindle housing
5. Grinding Wheel
6. Grinding Wheel clamps
7. Bush.
8. Collet

The spindle shaft is made out of steel. Further for accurate location, an accurately machined shoulder and journal are also provided.

SPINDLE

The main spindle serves to hold and drive the grinding stone. The machining accuracy mainly depends on the rotational accuracy of the spindle which transmits motion to the grinding wheel. The spindle is driven by motor through a flexible shaft.

The spindle shaft must also possess high Young's modulus to enable good elasticity of the unit. It should also possess rigidity, rotational accuracy, vibration proof properties, wear resistance, high specific stiffness, high dinamic stiffness and damping, high heat transmission capacity and cutting force while machining.

Material of the Spindle

The main requirement made to the great majority of the spindles is sufficient rigidity which depends in part upon the Young's modulus of the spindle material.

Based on application, the material for high strength machine parts like spindles, collets etc, is

EN 24 British specification

No Ni 2 Cr Mo 28 IS specification

This is taken from Pg.No.1.17 in PSG Design Data Book.

The composition of the spindle material is

	Metal	%
1.	Carbon (c)	0.35 - 0.45
2.	Silicon (Si)	0.1 - 0.35
3.	Maganese (Mn)	0.4 - 0.7
4.	Nickle (Nr)	1.25 - 1.75
5.	Chromium (Cr)	0.9 - 1.3
6.	Molybdenum (Mo)	0.2 - 0.35

Functions of the spindle

The spindle unit of the attachment performs the following important functions

1. Centering the grinding wheel
2. Clamping the grinding wheel and holding it rigidly during grinding operation
3. Imparting rotary motion of the grinding wheel.

BEARING

The deflection of spindle nose depends, besides other factors, upon the compliance of front and rear end spindle supports. The rotaional accuracy which is one of the basic functional requirements of the spindle is also greatly influenced by the choice of the bearing. Irrespective of the bearing, the common requirements of the spindle supports can be listed down as follows

1.Grinding accuracy

2.Ability to perform satisfactory under varying conditions of spindle operations.

3.High stiffness

4.Mininum heating to reduce deformation.

5.Vibration stability, which is governed mainly by clamping.

Antifriction bearing are mostly used. Standardised element in industry and their distinguishing features over sliding bearings are

1. Low frictional movement and heat generation
2. Low starting resistance
3. High load capacity per unit width of bearing and
4. Easy maintenance and less consumption of lubricants.

On the basis of shape of rolling elements, antifriction bearing either ball bearing or roller bearings. Roller bearing have high load capacity.

A machine tool spindle experiences both axial and raidal loads. Here the radial load is the grinding force. Axial load is the load acting during the horizontal movement of the work piece. These loads can be balanced either by bearings that take up radial and axial loads separately or both together. In this regard, angle contact ball bearing can take up large axial and radial loads with equal ease.

The number of possible combination of various antifriction bearings that can be employed in machine tool spindles, to fulfill the basic function of supporting axial and radial loads, is theoretically enormous. However the viability of each combination must be assessed by following parameters

1. Radial stiffness of spindle unit.
2. Axial stiffness of spindle unit.
3. Radial runout of spindle.
4. Axial runout of spindle.
5. Heat generation.
6. Maximum possible rotational speed, restricted by bearing wear and its heating.
7. Thermal deformation of spindle.
8. Ease of manufacture and assembly of spindle unit.

Considering all the principle factors above, we have selected angle contact ball bearing for supporting the spindle shaft.

Bearings are usually mounted with the rotating ring with 'press fit', whether it be the inner or outer ring.The stationery ring is then mounted with a 'push fit'. This permits the stationary to creep in its mounting slightly, bringing new portions of the ring into the load bearing zones to equalize wear.

SELECTION OF BEARING PAIRS

Duplexing

When maximum stiffness and resistance to shaft misalignment is desired, pairs of angular-contact ball bearings are often used in an arrangement called "duplexing".

Bearing manufactured for duplex mounting have their rings ground with an offset. So that when a pair of bearings is tightly clamped together, a preload is automatically established.

The three type of duplexing available are

1. face to face
2. Back to back.
3. Tandem

Face to Face is to take heavy radial thrust loads in both direction. Tandem is used to withstand extremely high thrust loads in one direction. Back to back is used to take heavy radial loads and thrust loads from either direction.

Back to back arrangement

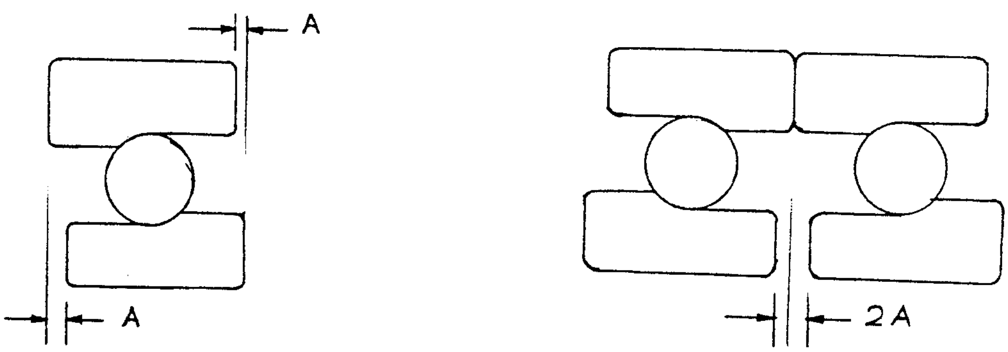
In this arrangement contact lines coverage outside of the bearing envelope resulting in a "effective spread" that is greater than the axial distance between both bearings consequently. This arrangement result in a very rigid assembly and provides greater resistance to shaft bending moments and deflections.

Shaft bending or housing misalignments can be avoided by selecting this arrangement.

Preloading

The object of preloading is to remove internal clearence usually found in bearings, to increase the fatigue life, and to decrease the shaft slope at the bearing.

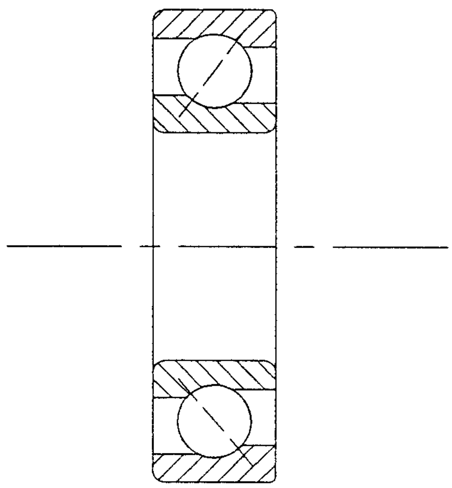
Ball bearings are usually preloaded by the axial load builtin during assembly. However, the bearings back to back mounting are preloaded in assembly because of the difference in width of the inner and outer rings.



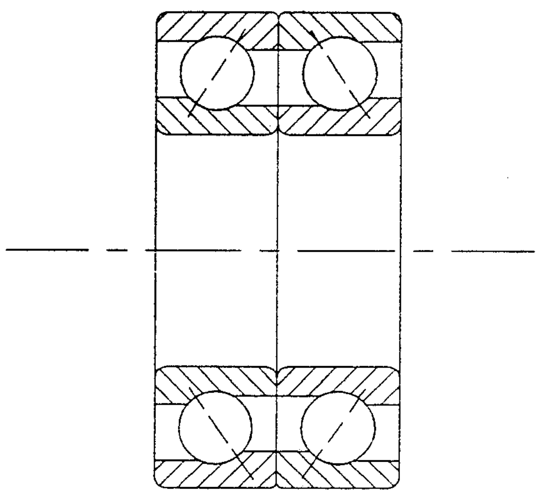
Face Stickout

The bearings are made with all initial internal looseness which is necessary to obtain angular contact. They become rigid when loaded axially and have contact angles ranging between 15° to 40°. The higher contact angle bearings can support greater axial loads but at reduced radial loads.

For high speed application the contact angle should not exceed 30°.



SINGLE ROW ANGULAR CONTACT BALL BEARING



BACK TO BACK ARRANGEMENT

BEARING CAPS

The bearing caps are important members to support and to lock the bearing and also for enclosing the spindle unit. These are machined componants designed to specifications required. The bearing cap also has provision for holding and fixing the oil seal.

SPINDLE HOUSING

The spindle housing is the enclosing unit for the spindle. The housing provides the base for mounting the sliding column.

The spindle housing also has to bear cutting forces and thrust due to motor drive. The material selected should possess high elasticity and high strength.

COLLAR

It is used to preload the bearing. It remove internal clearence usually found in bearing, it increase the fatigue life and decrease the shaft slope at the bearing.

GRINDING WHEEL

The work piece here used is Mild Steel. The surface finish is the main requirement and also some removal of metals. Hence we look for the grinding wheel which must have alminimum oxide abrasive, medium grain size, soft grade. Considering the surface finish the type of bond is vitrified.

On seeing the above condition the grinding stone selected is A46IV.

A - Aluminium abrasive

46 - Grain size (Medium)

I - Grade (Soft)

V - Type of bond (Vitrified)

GRINDING WHEEL FLANGE

Flanges are collars or discs or plates between which wheels are mounted and are referred to as adapted, sleeve or back-up type. The flanges should not be less than one-third the diameter of the wheel.

There are two major stresses in grinding wheels. These stresses are caused by wheel rotation and from the heat of grinding. Since they combine and become the greatest at the whole, they cause this to be area of extreme stress. It is, therefore, important that stress (compresive stress)developed due to mounting and driving torque stress act as far from the whole as practicable. This is best accomplished by using flanges. Flanges should be of minimum diameter specified, identical in diameter and radial bearing surface to avoid cross bending pressures and stresses in wheel structure.

These flanges should be checked periodically for flatness, burrs and wear.

There are two types of flanges

a. Straight flanges

b. Protection flanges

Straight flanges are used where some standarad form of protection is employed.

Protection flanges can be used where no other standarad form of protection is employed. They shall be used only with wheels designed to fit the flanges.

The material for flanges shall be steel or other materials with tensile strength not less than 460 MN/sq.m

Both flanges between which wheel is mounted should be well balanced and of uniform diameter.

By considering above aspects we have selected straight flanges.

BUSH

It is to fill the radial clearence between the spindle and the grinding wheel so that the grinding wheel is clamped rigidly, also the center of the grinding wheel and the spindle are made same.

MOTOR

The capacity of the motor, and size of electric motor is determined by the grinding speed, feed and type of tool employed as also the duty cycle of the drive.

Two basic consideration are involved in fixing the size of motor.

1. The motor should be capable of delivering the load torque requirements.
2. The temperature raise of the motor should be with in the safe value of the insulation class.

Acording to the mentioned condition and the requirement of power and torque, motor with the following specifications is used.

POWER	:	2 HP
VOLTAGE	:	440 V
SPEED	:	2880 rpm
INSULATION TYPE	:	A type

FLEXIBLE SHAFT

Flexible shaft is used to transmit power from the motor to the spindle assembly. In order to reduce the weight of wheel head, the motor is mounted separately. Since the wheel head i.e., spindle assembly is oscillating, we have to go for the flexible shaft.

COUPLING OF FLEXIBLE SHAFT

The coupling of flexible shaft with the spindle and the other end with the motor shaft is done by the following method. A nut is provided at the end of the motor shaft. The flexible shaft is brazed to the nut. Similarly the flexible shaft is coupled with the grinding wheel spindle.

SLIDING COLUMN

Sliding column is the vertical and tubular in construction. It holds the spindle assembly. The nut for the power screw is fitted to this. Therefore it lifts the spindle assembly up and down according to the rotation of the power screw. Material of the sliding column is C-45 steel.

GUIDE BLOCKS

It is the main part of the attachment. It is used to guide the sliding column to move up and down. The oscillatory motion of the unit is given by this block which is connected to ram of the Shaping machine by means of a lever. Since it bears load the material used is EN 24.

POWER SCREW

It is the main element for the attachment. It is used to adjust the radius to which the work piece to be ground. It can also used to give feed. It holds the spindle unit and also vertical coloumn. The worm wheel is fixed to the spindle so that the defined depth can be given.

HORIZONTAL BAR

It is used to hold the main parts of the assembly. The assembly oscillates with the horizontal bar as the axis. It is supported by the plumber blocks at both the ends.

PLUMBER BLOCK

Plumber block is one which is used to provide the free oscillatory movement with out any friction. The standard plumber block for outer dia of the bearing is available.

FRAMES

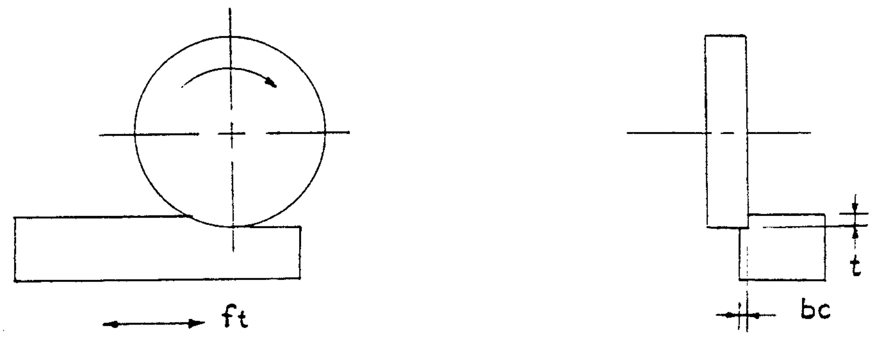
The frame structures are used to hold all the mountings of the concave surface grinding attachment. It gives rigidity for the whole attachement.

FIXTURE

The fixture is to hold the work piece. The size and structure of fixture depends on the size of the work piece.

DESIGN OF VARIOUS ELEMENTS

POWER CALCULATION



Cutting condition

For work piece material of Mild Steel and hardness of 48 - 65 HRC

Wheel speed, V - 28 - 32 m/sec.

Table speed, f_t - 12 m/min.

Down feed, t - rough - 0.05 mm/pass.

finish - 0.0125 mm/pass.

Cross field, b_c - 2.5 mm/pass.

Wheel - A46IV

Power and force requirements in machining

The following formulae used in the Power and Force requirements calculation are taken from the CMTI Hand Book, Pg.No.647

Let n be the rpm of grinding wheel

and D be the diameter of grinding wheel

Take Wheel speed, $v = \dfrac{\pi D n}{60}$

$n = 2880$ rpm

$\therefore 28 = \dfrac{\pi \times D \times 2880}{60}$

$\therefore D = 0.186$ m

$= 186$ mm

Standardising the grinding wheel as per IS 2324 - 1971

Diameter - 200 mm

Thickness - 25 mm

Bore - 32 mm

$\therefore$ Wheel speed, $v = \dfrac{\pi \times 0.200 \times 2880}{60}$

$v = 30.16$ m/sec.

Metal removal rate, $Q = b_c \cdot t \cdot f_t \ mm^3/min.$

$= 2.5 \times 0.05 \times 12000$

$= 1500 \ mm^3/min.$

$= 1.5 \ cm^3/min.$

From the CMTI Hand Booh Pg.No.651

For the downfeed of 0.05 mm/pass.

Average unit power, $U = 0.7 \ KW/cm^3/min.$

Power at the spindle, $N = U.Q$ KWatts

$= 0.7 \times 1.5$

$= 1.05$ KWatts

Efficiency of transmission, $E = 95\%$

$= 0.95$

Power of the motor, N_{el} $= N/E$

$= 1.05/0.95$

$= 1.105$ KWatts

$= 1.503$ HP

By considering the load fluctuations, We are selecting the 2 HP motor to drive the grinding wheel.

Tangential cutting force, P_z $= 102\ N/v$

$= 102 \times 1.05/30.16$

$= 3.55$ Kgf

$= 35$ N

Dowanward force, P_y $= 3\ P_z$

$= 3 \times 3.55$

$= 10.65$ Kgf

$= 105$ N

Torque at the spindle, T_s $= 975\ N/n$

$= 975 \times 1.05/2880$

$= 0.355$ Kgf - m

$= 3.5$ N - m

CALCULATION OF RAM SPEED

The width of the work piece is 170 mm.

The oscillating graınding wheel has to cover a horizontal distance of 250 mm, including 40 mm on either side of the work piece for relief.

The velocity of oscillation is = 12 m/min.

12 m/min = 12/60

= 0.2 m/sec.

1 stroke = 0.25 + 0.25

= 0.5 m

Stroke time = 0.5/0.2

= 2.5 sec.

No of strokes per minute = 60/2.5

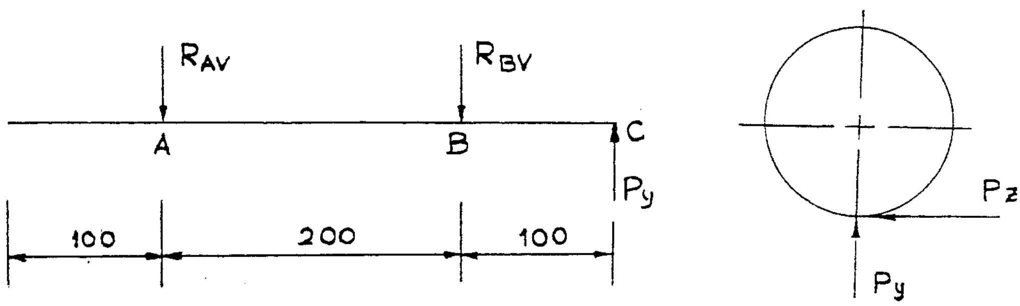
= 24

The nearest number of strokes per minute available in a standard shaping machine is 20, with a stroke length of 300 mm.

CALCULATION OF SPINDLE DIAMETER

VERTICAL

Free body diagram of spindle



Weight of the shaft is neglected.

$$P_y = 105 \text{ N}$$

$$R_{AV} + R_{BV} = 105 \text{ N}$$

Taking moment about A

$$R_{BV} \times 200 = P_y \times 300$$

$$R_{BV} = \frac{105 \times 300}{200}$$

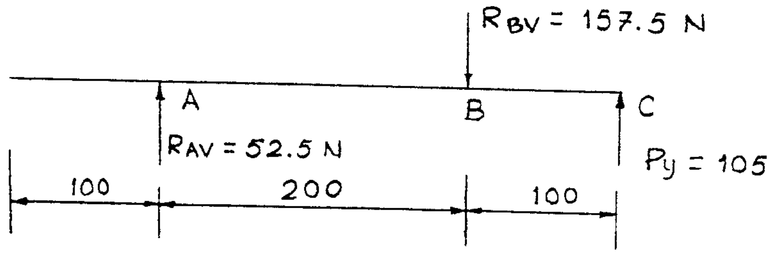
$$R_{BV} = 157.5 \text{ N}$$

$$R_{AV} + R_{BV} = 105 \text{ N}$$

$$\therefore R_{AV} = 105 - 157.5$$

$$R_{AV} = -52.5 \text{ N}$$

Hence the free body diagram becomes



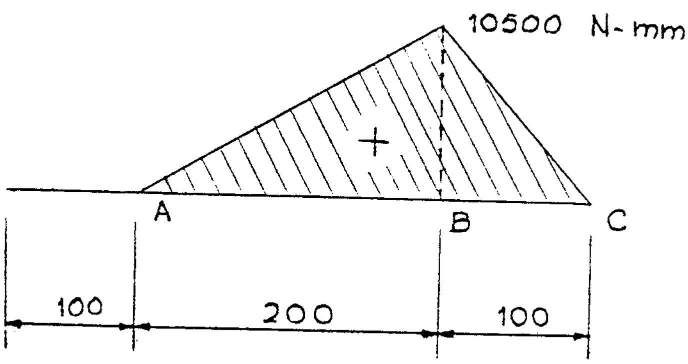
Bending moment diagram

Bending moment at A = 0

Bending moment at B = 105 x 100

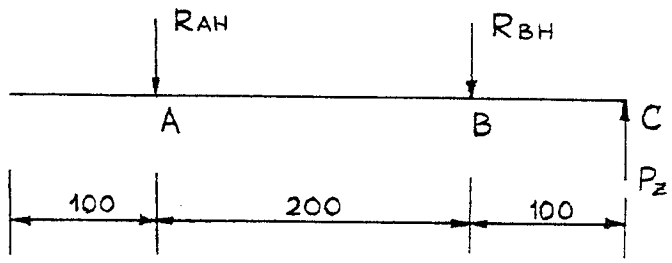
= 10500 N-mm

Bending moemnt at C = 0



HORIZONTAL

Free body diagram



$P_z = 35$ N

$R_{AH} + R_{BH} = 35$ N

Taking moment about A

$R_{BH} \times 200 = P_z \times 300$

$\therefore \quad R_{BH} = \dfrac{35 \times 300}{200}$

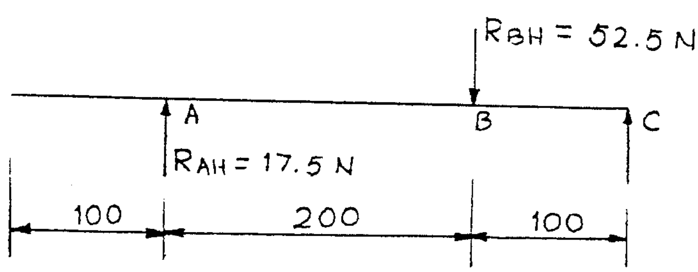
$R_{BH} = 52.5$ N

$R_{AH} + R_{BH} = 35$ N

$\therefore \quad R_{AH} = 35 - 52.5$

$R_{AH} = -\ 17.5$ N

Hence the free body diagram becomes



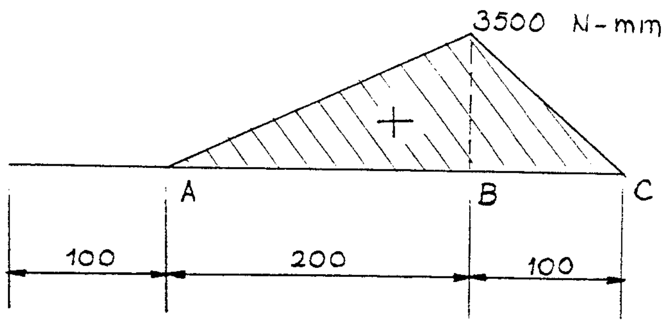
Bending moment at A = 0

Bending moment at B = 35 x 100

= 3500 N-mm

Bending moment at C = 0

Bending moment diagram



Resultant bending moment = $M_1^2 + M_2^2$

$= 10500^2 + 3500^2$

M = 11068 N-mm

Power, P $= \dfrac{2\pi NT}{60}$ Watts

$1471 = \dfrac{2 \times \pi \times 2880 \times T}{60}$

∴ T = 4.877 N-m

T = 4877.44 N-mm

From P.S.G Design data book, Pg No.7.21

For minor shock loads

$K_m = 2$

and $K_t = 1.5$

Torque equalant, $T_e = \sqrt{(K_m M)^2 + (K_t T)^2}$

$= \sqrt{(2 \times 11068)^2 + (1.5 \times 4877.44)^2}$

$T_e = 23313.7$ N-mm

Material of spindle - EN 24

Shear stress = Yield stress/2

= 42/2

= 21 kg/mm^2

f_s = 206.01 N/mm^2

(P.S.G. Design Data Book Pg.No. 1.9)

Take Factor of safety, n = 10

Torque equalant, $T_e = \frac{\pi}{16} \frac{f_s}{n} d^3$

d = 17.93 mm

Equalant bending moment, $M_e = 1/2 \left(K_m M + \sqrt{(K_m M)^2 + (K_t T)^2} \right)$

$= 1/2 \left((2 \times 11068) + \sqrt{(2 \times 11068)^2 + (1.5 \times 4877.44)^2} \right)$

M_e = 22724.9 N-mm.

Bending stress, f_b = 0.66 x Yield stress

= 0.66 x 42

= 27.72 kg/mm^2

f_b = 271.93 N/mm^2

Equalant Bending moment, $M_e = \frac{\pi f_b}{32 n} \times d^3$

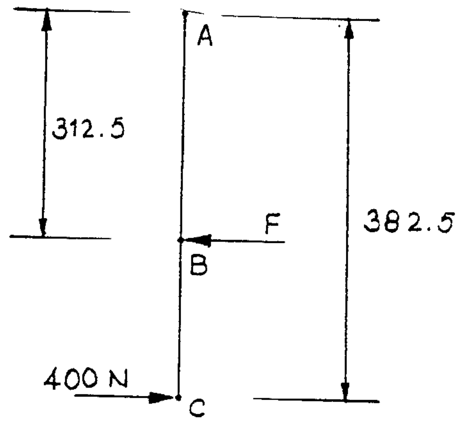
$$\therefore \quad 22724.9 = \frac{\pi \times 271.93}{32 \times 10} \times d^3$$

$$\therefore \quad d = 20.42 \text{ mm}$$

Standardising the diameter,

$$d = 24 \text{ mm}$$

GUIDE BLOCK



Load acting on the projection area :

Taking moment about A

$$F \times 312.5 = 400 \times 382.5$$

$$F = 400 \times 382.5/312.5$$

$$F = 490\ N$$

Take the length of the projection area = 100 mm

In this case the type of load acting is Repeated cycle. Hence we take Soderberg equation to find the thickness value.

Soderberg Equation

$$\frac{1}{n} = \frac{\tau_m}{\tau_y} + \frac{\tau_a}{\tau_{-1}}$$

Where n - Factor of safety

τ_m - Mean shear stress

τ_y - Yield shear stress

τ_a - Shear stress amptitude

τ_{-1} - Endurance limit stress in shear

$$\text{Shear stress} = \frac{\text{Load}}{\text{Shear area}}$$

τ_{max} - Maximum shear stress = 490/100t

τ_{min} - Minimum shear stress = - 490/100t

$\therefore \tau_m = (\ _{max} + \ _{min})/2$

$= (490 - 490)/2 \times 100 \times t$

$\tau_m = 0$

$\tau_a = (\ _{max} - \ _{min})/2$

$= (490 + 490)/2 \times 100 \times t$

$= 4.9/t \ N/mm^2$

From the P.S.G. Design Data Book Pg. No. 1.9

Yield Stress = 36 kgf/mm^2

$\tau_y = 18 \ kgf/mm^2$

$= 177 \ N/mm^2$

From page no. 1.42

For repeated cycle and for torsion

$\tau_{-1} = 0.22 \ _u$

From page no. 1.9

τ_u - ultimate tensile strength = 65 kgf/mm^2

$\tau_{-1} = 140 \ N/mm^2$

Take factor of safety = 5

Substituting

$$\frac{1}{5} = \frac{0}{177} + \frac{4.9}{t \times 140}$$

$$t = 1.75 \text{ mm.}$$

So we are taking the size of the projected area as 100 x 10 x 10, enough to meet the maximum force acting on either side.

SLIDING COLUMN

In the sliding column

Length of the grove = 290 mm

The length is fixed according to the range of radius of workpiece and also the length of projected area of the guide block.

Size of the Square Slot = 10 x 10 mm

In order to provide stability for the unit, the thickness of the sliding column is fixed as 20 mm.

Tensil Stress = Force/Area

$$= \frac{250}{\pi/4 \times (90^2-50^2)-10 \times 10 \times 2}$$

Actual Tensile Stress, $f_{s\ (actual)}$ = 0.8 N/mm^2

Allowable Tensile Stress, $f_{s\ (allowable)}$ = 630 N/mm^2

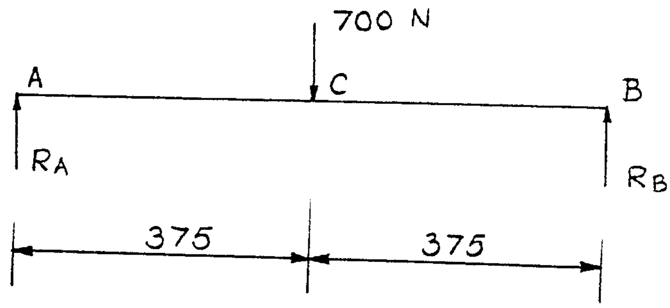
Since $f_{s\ (actual)} < f_{s\ (allowable)}$

The design is safe.

HORIZONTAL BAR

Downward Load = 700 N (approx.)

Length of the Horizontal Bar = 750 mm



Maximum Bending Moment $= \dfrac{WL}{4}$

$= \dfrac{700 \times 750}{4}$

Maximum Bending moemnt, M_B = 131250 N-mm

We know

$$\frac{M_b}{I} = \frac{\sigma_b}{y}$$

Therefore $\sigma_b = \dfrac{M_b y}{I}$

Where σ_b - Bending stress

y - Distance from the neutral axis to the outside fibre

I - Moment of Inertia

Material : En8

From P.S.G. Design Data Book Pg.No.1.9

Yield stress = 36 Kgf/mm^2

Bending stress, σ_b = yield stress x 0.66

= 36 x 0.66 x 9.81

σ_b = 233 N/mm^2

y = D/2

I = $D^4/64$

Taking a factor of safety 5

$$\frac{233}{5} = \frac{131250 \times D \times 64}{2 \times \quad \times D^4}$$

D = 30.613 mm

= 31 mm

From P.S.G. Design Data Book Pg.No. 6.5

Maximum Deflection, ymax, at the centre = $\frac{PL^3}{48EI}$

From Pg.No. 1.1,

Young's Modulus, E, = 2.06×10^4 N/mm^2

$$y_{max} = \frac{700 \times 750^3 \times 64}{48 \times 2.06 \times 10^4 \times \pi \times (31)^4}$$

y_{max} = 5.8 mm

To minimise the maximum deflection at the centre, the diameter of the horizondal bar is taken as 65 mm.

NUT

Height of Nut $h = 100$ mm

Pitch $p = 6$ mm

Major dia of Nut $d_o = 32$ mm

Minor dia of Nut $d_i = 26$ mm

No. of threads in contact with the screw rod $n = h/p$

$= 100/6$

$= 16.7$

$= 16$

Allowable Bearing pressure $P_{b\ (allowable)} = 65\ Kgf/mm^2$

$P_{b\ (allowable)} = 638\ N/mm^2$

$$P_{b\ (actual)} = \frac{W}{\pi/4\ (d_o^2 - d_i^2)}$$

$$= \frac{390}{\pi/4\ (32^2 - 26^2)}$$

$P_{b\ (actual)} = 1.5\ N/mm^2$

Since $P_{b\ (actual)} < P_{b\ (allowable)}$,

The design is safe

DESIGN OF STRUCTURE

Design of Beams 2 and 4

Self Weight of A	= 25 Kg
Load on A	= 135 Kg
Total load on A	= 160 Kg

Therefore Total load on Beam 2 = 160/2 = 80 Kg

The maximum bending moment , M, occurs at the centre.

$$M = Wl/4$$

$$= \frac{80 \times 0.75}{4} = 15 \text{ Kg-m}$$

Take the value of yield stress for structural steel as 200 N/mm^2

Maximum permissible stress in compression, $\sigma_{bc} = 0.66 f_y$

$= 0.66 \times 250$

$\sigma_{bc} = 165 \ N/mm^2$

Therefore Section moduless required = $Z_{yy} = M/\sigma_{bc}$

$$= \frac{15 \times 10 \times 1000}{165}$$

$= 909.1 \ mm^3$

Trial section modulus $= 1.5 \times 909.1$

$= 1363.64 \ mm^3$

$= 1.363 \ cm^3$

From steel section tables, try

ISJC 100, @ 5.8 Kg/m

Section modules. $Z_{yy} = 4.8 \ cm^3 = 4.8 \times 10^3 \ mm^3$

Thickness of Web, t_w = 3 mm

Thickness of flange, t_f = 5.1 mm

Depth of section, h = 100 mm

Width of flange, b = 45 mm

Beams 1 and 3

Hence there is no heavy load on these beams, provide **ISA 80 x 50 x 6 mm @ 5.9 Kg/m**

Design of columns 5,6,7, and 8

Self weight of beam 1 = 1 x 5.9 = 5.9 Kg

Self weight of beam 2 = 0.7 x 5.8 = 4.35 Kg

Load on column 7
(due to the load on beam 2 $= \frac{80}{2} = 40$ Kg

Therefore Total load on column 7 $= 40 + \frac{5.9}{2} + \frac{4.35}{2}$

= 45.125 Kg.

Length of Column = 2 m

Effective length of column = l = 0.85 x 2 x 1000

= 1700 mm

The slenderness ratio for the single angle section and the value of yield stress for the steel may be assumed as 120 and 260 N/mm^2 respectively.

Allowable stress in compression for column, σ_{ac} = 64 N/mm^2
(From steelcode IS800-1984)

$$\text{Effective sectional area required} = \frac{\text{Load}}{\text{Stress}}$$

$$= \frac{45.125 \times 10}{64}$$

$$= 7.05 \text{ mm}^2$$

Adopt

ISA 30 x 30 x 5 mm @ 1.4 Kg/m

Provide a base plate of size 100 x 100 x 6 mm, four anchor bolts of dia 12 mm for each base plate and a concrete footing of 100 x 100 x 150 mm depth.

DESIGN OF WORM AND WORM WHEEL

Material Worm Wheel : C.I. (Grade 20)

Worm Shaft : En8

Transmission Ratio = 20

(or) Gear ratio (i) = 20

From Data Book (P.S.G.) Pg.No. 8.47 for centre distance 63 mm and transmission ratio 20, the following values are recommended.

Number of starts = Z = 2

Number of teeth on wheel = z = 39

Diameter factor = q = 11

Axial Module = M_x = 2.5 mm

Bottom clearance (C)

$C = 0.2 \text{ to } 0.3\ m_x$

Let $C = 0.2\ m_x$

$= 0.2 \times 2.5$

$= 0.5$ mm

Height Factor (f_o)

Normally $f_o = 1$

Axial Pitch (P_x)

$P_x = \pi\ m_x$

$= \pi \times 2.5$

$= 7.85$ mm

Design of Worm

Reference Dia (d_1)

$d_1 = q\ m_x$

$= 11 \times 2.5$

$= 27.5$ mm

Tip Dia (d_{a1})

$d_{a1} = d_1 + 2\ F_o m_x$

$= 27.5 + (2 \times 1 \times 2.5)$

$= 32.5$ mm

Root Dia (d_{f1})

$d_{f1} = d1 - 2 f_o m_x - 2c$

$= 27.5 - (2 \times 1 \times 2.5) - (2 \times 0.5)$

$= 21.5$ mm.

Pitch Dia (d_1')

$d_1' = m_x\ (q + 2x)$

$= 2.5\ [11 + (2 \times 0.2)]$

$= 30$ mm.

Pitch of Helix, lead (P_z)

$P_z = Z\ P_x$

$= 2 \times 7.85$

$= 15.7$ mm

Pressure Angle in Axial Section (α)

$\alpha = 20^\circ$ (from data book)

Lead Angle on the reference cylilnder (γ)

$\tan \gamma = z/q$

$\gamma = \tan^{-1} (z/q)$

$= \tan^{-1} (2/11)$

$= 10^\circ \; 18'$

Face width of the wheel (b_1)

From design data book page no. 8.48

for the value of z = 2

$b = 0.75 \; d_1$

$b = 0.75 \times 27.5$

$= 20.625$ mm

Outer Dia (d_{e2})

From design data book pg no. 8.48

For value of z = 2

$d_{e2} = d_{a2} + 1.5 \; m_x$

$= 103.5 + 1.5 \times 2.5$

$= 107.25$ mm.

Design of Worm Wheel

Reference dia (d_z)

$d_z = f.M_x$

$= 39 \times 2.5$

$= 97.5$ mm

Addendum Modification Co-efficient (X)

$$X = \frac{a}{m_x} - 0.5\,(q + z)$$

$$= \frac{63}{2.5} - 0.5\,(11+39)$$

$$= 0.2$$

Tip Dia (d_{a2})

$$d_{a2} = (z + 2f_o + 2X)\,m_x$$

$$= (39 + 2 \times 1 + 2 \times 0.2)\,2.5$$

$$= 103.5 \text{ mm}$$

Root Dia (d_{f2})

$$d_{f2} = (z - 2_{fo})\,m_x - 2C$$

$$= (39 - 2 \times 1)\,2.5 - (2 \times 0.5)$$

$$= 91.5 \text{ mm}$$

Pitch Dia (d_2')

$$d_2' = d_2$$

$$= 97.5 \text{ mm}$$

Throat Tip Radius (R_1)

$$R_1 = d_1/2 - f_o\,m_x$$

$$= \frac{27.5}{2} - (1 \times 2.5)$$

$$= 11.25 \text{ mm}$$

Throat Root Radius (R_2)

$$R_2 = d_1/2 + f_o\, m_x + C$$

$$= \frac{27.5}{2} + (1 \times 2.5) + 0.5$$

$$= 16.45 \text{ mm}$$

Lead Angle on the Pitch cylinder (γ')

$$\tan \gamma' = \frac{Z}{q + 2X}$$

$$\text{Therefore } \gamma' = \tan^{-1} \frac{Z}{q + 2X} = \tan^{-1} \frac{2}{11 + (2\times0.2)}$$

$$= 9^\circ 57'$$

Tip relief radius (r_1)

$$R_1 = 0.1\, m_x$$

$$= 0.1 \times 2.5$$

$$= 0.25 \text{ mm}$$

Root relief radius (r_2)

$$r_2 = 0.2\, m_x$$

$$= 0.2 \times 2.5$$

$$= 0.5 \text{ mm}$$

Normal tooth thickness on Reference Diameter (S)

$$S = \pi\, m_x/2$$

$$= \pi \times 2.5/2$$

$$= 3.92 \text{ mm}$$

Normal tooth thickness on reference diameter in Normal Section (S_n)

$$S_n = (\pi/2)\ m_x \cos \gamma$$

$$= (\pi \times 2.5/2) \cos 10^{\circ}18'$$

Length of Worm (L)

For correction factor +0.5,

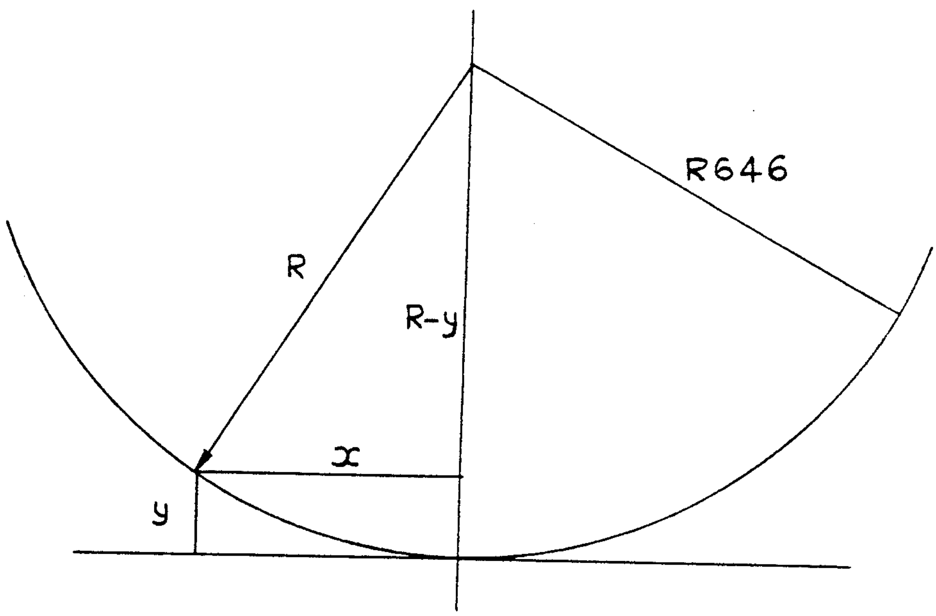
$$L = (11 + 0.1\ Z)\ m_x$$

$$= (11 + 0.1 \times 39)\ 2.5$$

$$= 37.25 \text{ mm}$$

FIXTURE

The depth of the work piece various from place to place with respect to width. The fixture must also have the same shape. Therefore the depth from the top of the fixture various similarly to that of the work piece. So, for manufacturing fixture we are in need of depth at various place. The depth at various place is calculated as follows



From the above figure

$$R^2 = (R - y)^2 + x^2$$

$$(R - y)^2 = R^2 - x^2$$

$$R - y = \sqrt{R^2 - x^2}$$

$$y = R - \sqrt{R^2 - x^2}$$

Width of the plate = 170 mm

Therefore x = 85 mm

R - Radius of the plate = 646 mm

$$y = 646 - \sqrt{646^2 - 85^2}$$

$$= 5.616 \text{ mm}$$

MACHINING PROCESS OF VARIOUS PARTS

NAME OF THE COMPONENT	: Outer sliding column
MATERIAL	: C 45
QUANTITY	: 1
RAW MATERIAL SIZE	: O 190 x 400
MACHINES REQUIRED	: Lathe Drilling Machine Vertical milling machine Boring Machine Slotting Machine

Raw material of size dia 190 x 400 is taken and turned and faced using a lathe to the dimension dia 186 x 380. Then for a length of 355 mm, turning is done upto a diameter of 90 mm. Then center bore of diameter 50 mm is taken using a boring machine. The key way of size 3.5 x 4 x 25 is taken on the inner side of coloumn as per drawing, using a slotting machine. Then two square grooves directly opposite to each other of size 10 x 10 x 290 are taken on the pheriphery of the coloumn using a vertical milling machine.

The bottom part, which resembles the flange is machined to a rectangle of size 92 x 130 using a slotting machine. Then four holes of dia 10 mm is drilled in the position shown in the drawing.

drilled as per drawing using a drilling machine. In the same axis a square hole of size 31 mm is taken using a milling machine.

NAME OF THE COMPONENT : Screw rod

MATERIAL : EN 8

QUANTITY : 1

RAW MATERIAL SIZE : O 35.5 x 520

MACHINES REQUIRED : Lathe
Vertical milling machine

Raw material of size dia 35.5 x 520 is taken and turned to a dia of 32 mm throughout its length using lathe. Then a key way of size 3.5 x 4 x 20 is taken on the top portion of the work piece as per drawing using a vertical milling machine. Also another key way of size 3.5 x 4 x 20 is taken as per drawing. Then the work piece is square threaded on the bottom portion with the dimention of pitch 6 mm through a length of 325 mm.

NAME OF THE COMPONENT : Nut

MATERIAL : EN 8

QUANTITY : 1

RAW MATERIAL SIZE : O 53 x 110

MACHINE REQUIRED : Lathe
Drilling Machine
Vertical Milling Machine

NAME OF THE COMPONENT : Horizontal bar

MATERIAL : EN 8

QUANTITY : 1

RAW MATERIAL SIZE : O 95 x 570

MACHINES REQUIRED : Lathe
Milling Machine
Drilling Machine

Raw material of size dia 95 x 570 is taken and turning is done on two ends of length 120 mm each to a dia of 65 mm, using a lathe. Then the major middle portion is shaped to a square bar of dimention 65 x 65 x 330 using a milling machine. Then a hole of dia 33 mm is drilled in the middle of the square portion of the bar. Also two horiziontal holes of dia 12 mm are drilled in the square bar as shown in the drawing.

NAME OF THE COMPONENT : Guide block

MATERIAL : EN 8

QUANTITY : 2

RAW MATERIAL SIZE : O 125 x 470

MACHINES REQUIRED : Milling Machine
Drilling Machine

Raw material of size dia 125 x 470 is taken and shaped to rectangular bar of size 115 x 40 x 465 using milling machine. Then the work piece is machined to dimentions as per drawing using the milling machine. Then hole of dia 15 mm is

Raw material of size dia 53 x 100 is taken and turned to a dia of 50 mm using lathe. Then a hole of dia 26 mm is drilled on the work piece as per drawing using a lathe. Then inner square threads of pitch 6 mm are made on the work piece as per drawing using the lathe.Then a key way of size 3.5 x 4 x 25 is taken on the work piece using a vertical milling machine.

COMPONENT NAME	:	Spindle
MATERIAL	:	EN 24
QUANTITY	:	1
RAW MATERIAL SIZE	:	O 45 x 400
MACHINES REQUIRED	:	Lathe Cylinderical Grinder

The raw metrial size dia 45 x 400 is taken and length is reduced to 380 mm by facing both the ends. The cylinderical surface of the shaft is reduced for dia 40 mm to the whole length by straight turning. Finish turing is carried out for a depth of 0.1 mm. One side, leaving 61 mm from the centre of the turned rod, step turn is carried out for dia 30r6, dia 24, dia 28, dia 24h7, dia 18, dia 20mm for a length of 31, 5, 15, 46, 2, 30mm respectively. Using form tools, having 1mm radius, an undercut is taken for a depth of 1mm leaving space of 61mm from the centre. Thread cutting operation is carried out on dia 28 mm step cut. The pitch of the thread is 3 mm.

Then the thread cutting operation is carried out on dia 20 mm step cut. The pitch of the thread is 2 mm.

On the other side of the spindle, leaving 107 mm from the centre, the step turning is carried out for dia 30r6, dia 5, dia 15, dia 21, dia 24 mm for length of 31, 5, 15, 2, 30 mm respectively.Using form tool having 1 mm radius, an under cut is taken for a depth of 1 mm, leaving a space of 107 mm from the center.Then the thread cutting operation is carried out on dia 28 mm stepcut, on dia 28 mm stepcut and on dia 24 mm step cut. The pitch of the thread is 2 mm.Then the chamffering is done at the end of dia 40 mm step and the end of the spindle on both side, as specified in the drawing.

Then the cylinderical grinding operation is carried out for the whole length of the spindle except the threaded portion using the cylinderical grinding machine. The surface finish on the dia 36r6 mm step cut is 0.8 um roughnees and is 1.6 um on the dia 24 mm step.

COMPONENT NAME	:	Bearing Cap
MATERIAL	:	C.I
QUANITITY	:	2
RAW MATERIAL SIZE	:	92 X 92 X 15
MACHINES REQUIRED	:	Lathe Shaping Machine Drilling Machine Grinding Machine

The size of the C.I. square plate in 92mm and thickness of the plate is 15mm. The thickness of the plate is reduced to 10mm using shaping machine. Then the plate is fixed in the lathe and a hole of dia $42^{+0.2}$mm is made at the centre of the plate and it is finished to 3.2um roughness. Then the groove of width 6mm is made for a depth of 5mm. The diameter of the inner edge of groove is $72^{+0.2}$mm.

Then four holes of dia 6mm are drilled on P.C.D. 92mm by leaving equal space between them using drilling machine. Then that holes are countersinked for a dia of 12mm and for a depth of 3mm.

Then both the sides of the bearing cap are ground using surface grinding machine to obtain the surface finish of 3.2um roughness.

COMPONENT NAME	:	Flange
MATERIAL	:	C.I.
QUANTITY	:	2
RAW MATERIAL SIZE	:	O 105 X 20
MACHINES REQUIRED	:	Lathe

The flange material is having an outer dia of 105mm and thickness of 20mm. This is placed on the lathe chuck and a hole of dia 24mm is made for whole 20mm thickness. Then the work piece is held on the lathe chuck using this hole. Then the facing operation is done on the both sides to obtain the thickness of 12mm. Then the outer dia is turned and reduced to dia 100mm. Then the taper turning operation is carried out on one side for an angle of 79°33' from the horizontal plan by leaving 12mm on either sides from the centre of the hole and the end is finished to the radius of 5mm. On the other side the turning operation is done for the depth of 2mm for an outer dia of 76mm as specified in the drawing. Then the chamferring is done on the one end of dia 24mm hole for a depth of 1.5mm with an angle of 45° as specified in the diagram. Then both the sides of the flange are ground using surface grinding machine.

COMPONENT NAME	: Collar
MATERIAL	: C.I.
QUANTITY	: 2
RAW MATERIAL SIZE	: O 80 X 25
MACHINES REQUIRED	: Lathe Grinding machine

The circular plate is fixed on the chuck and both the sides are faced so that the thickness is reduced to 20.5mm. Then a hole of dia 25mm is made at the centre for the whole thickness. Then the plate is clamped on the lathe chuck using this hole. The finishing operation is done to obtain dia $75^{-0.1}$ for a length of 8mm and dia $71^{-0.1}$ for the remaining length. Then the turning operation is done on the the dia 71mm side to obtain the specification given in the drawing. Then the knurling operation is done on the dia 75mm step for the length of 8mm. Then the internal threading operation is carried out on the dia 25mm hole. The pitch of the thread is 3mm. Then both the sides are ground using surface grinding machine. The surface finish of the collar side which is having contact with the bearing is 0.8 um roughness.

COMPONENT NAME	:	Spindle housing
MATERIAL	:	C.I.
QUANTITY	:	1
RAW MATERIAL SIZE	:	240 X 95 X 92
MACHINES REQUIRED	:	Milling Machine Boring Machine Drilling Machine

The raw material of size 240 X 95 X 92 is reduced to 232 X 92 X 92 using a Milling machine. Initially the housing is having a hole of dia 40mm. This hole is increased to dia 44mm using a horizontal boring machine. Then on the both sides, the diameter is increased to 62mm for the length of 32mm. Then the diameter is increased to a diameter of 66mm for a length of 2mm on both the sides.

Four holes of dia 5 mm is drilled and tapped to 6 mm on the both sides of the housing. And another four holes of dia

10.2 mm is drilled and tapped to 12 mm. The hole locations are mentioned in the drawing.

COMPONENT NAME	:	Bush
QUANTITY	:	1
MATERIAL	:	C45
RAW MATERIAL SIZE	:	O 35.5 X 30
MACHINE REQUIRED	:	Lathe

The raw material of size dia 35.5 X 30mm is fixed on the lathe chuck and facing is done on both sides to reduce the length to 25mm. Then the component is fixed in the lathe between centres and the turning operation is carried out to reduce the outer dia from 35.5mm to 32mm. Then the work piece is placed on the chuck and the centre hole is made for a dia of 24mm for the whole length of the bush.

COST ESTIMATION

FABRICATED COMPONENTS

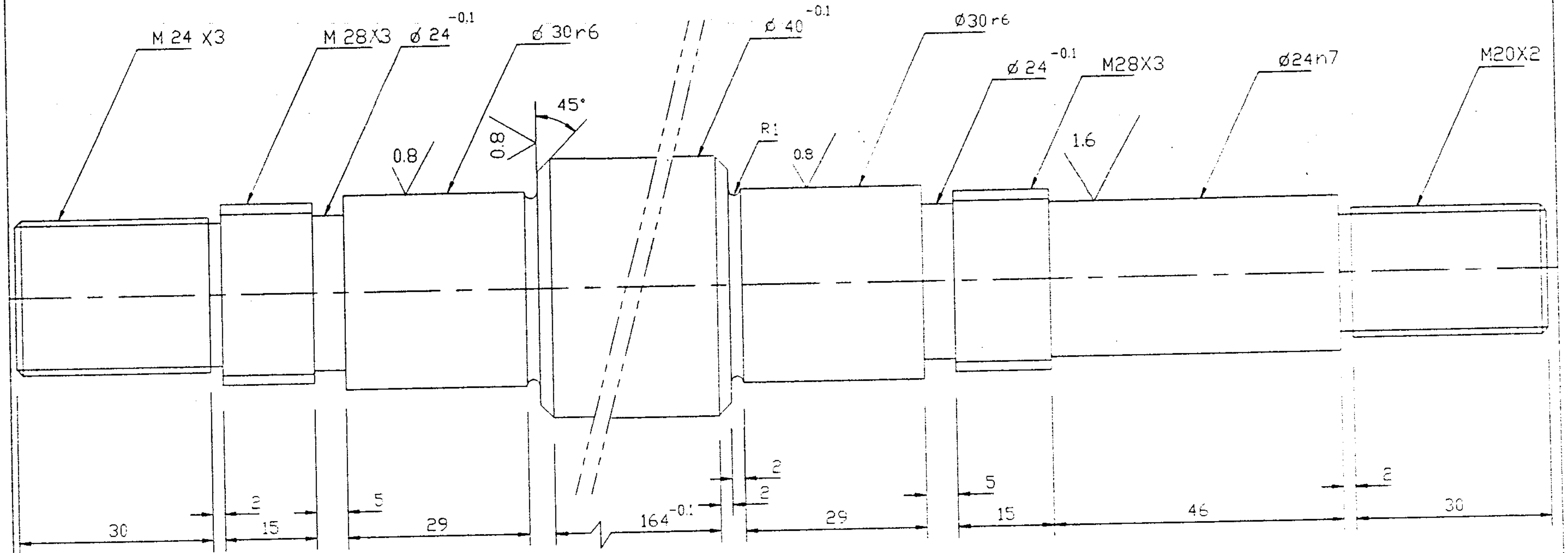
S.NO.	COMPONENT	MATERIAL	QTY.	Wt. (Kgs)	MATERIAL COST (Rs)	MACHINES USED	MACHINING TIME (Hrs)	MACHINING COST (Rs)	TOTAL (Rs)
1.	SCREW ROD	EN 8	1	4.3	100	LATHE MILLING	5 1/2	95	195
2.	SLIDING COLUMN	C 45	1	80	1600	LATHE DRILLING MILLING SLOTTING	10	300	1900
3.	NUT	EN 8	1	2	48	LATHE MILLING	4	75	123
4.	GUIDE BLOCK	EN 8	2	6	140	MILLING DRILLING	3 3/4	135	275
5.	LINKAGE LEVER	C I	1	2	30	SHAPING MILLING DRILLING	2 3/4	80	110
6.	HORIZONTAL BAR	EN 8	1	18	435	MILLING LATHE DRILLING	3 1/2	118	553
7.	GUIDING SPINDLE	EN 24	1	4.75	128	LATHE GRINDING	4 1/2	130	258
8.	HOUSING	C I	1	12	68	MILLING BORING DRILLING	4	145	213

S.NO.	COMPONENT	MATERIAL	QTY.	Wt. (Kgs)	MATERIAL COST (Rs)	MACHINES USED	MACHINING TIME (Hrs)	MACHINING COST (Rs)	TOTAL (Rs)
9.	BEARING CAP	C I	2	2	28	SHAPING LATHE DRILLING MILLING	3 1/2	105	133
10.	COLLAR	C I	2	1.8	26	LATHE GRINDING	2 1/2	60	86
11.	FLANGE	C I	2	2.5	36	LATHE	1 1/2	23	59
12.	WORM WHEEL	C I	1	3	42	LATHE MILLING SLOTTING	5	150	192
13.	WORM SHAFT	EN 8	1	2	48	LATHE MILLING	4 1/2	140	188
14.	FIXTURE	C I	1	18.5	257	MILLING DRILLING GRINDING	8	450	707
15.	HOLDING BLOCK	C I	2	6	90	MILLING GRINDING DRILLING	7	330	420
						PATTERN MAKING COST		-	1500
						ASSEMBLY CHARGE		-	750
						TOTAL COST		-	7662

PURCHASED ITEM

S.NO.	COMPONENT	MATERIAL	QTY.	TOTAL COST (Rs)
1.	MOTOR	-	1	2800
2.	GRINDING WHEEL (A 46 I V)	-	1	110
3.	FLEXIBLE SHAFT	-	1	450
4.	PLUMBER BLOCK	-	2	320
5.	C - CHANNEL	ROLLED STEEL	11.6 Kg	232
6.	L - ANGLES	ROLLED STEEL	16.5 Kg	329
7.	ANGULAR CONTACT BALL BEARING	Std (7206B SKF)	4	1700
8.	BALL BEARING	Std (6013 SKF)	2	790
9.	HARDWARE ITEMS	-	-	400
		CIVIL WORK		300
		TOTAL		7431

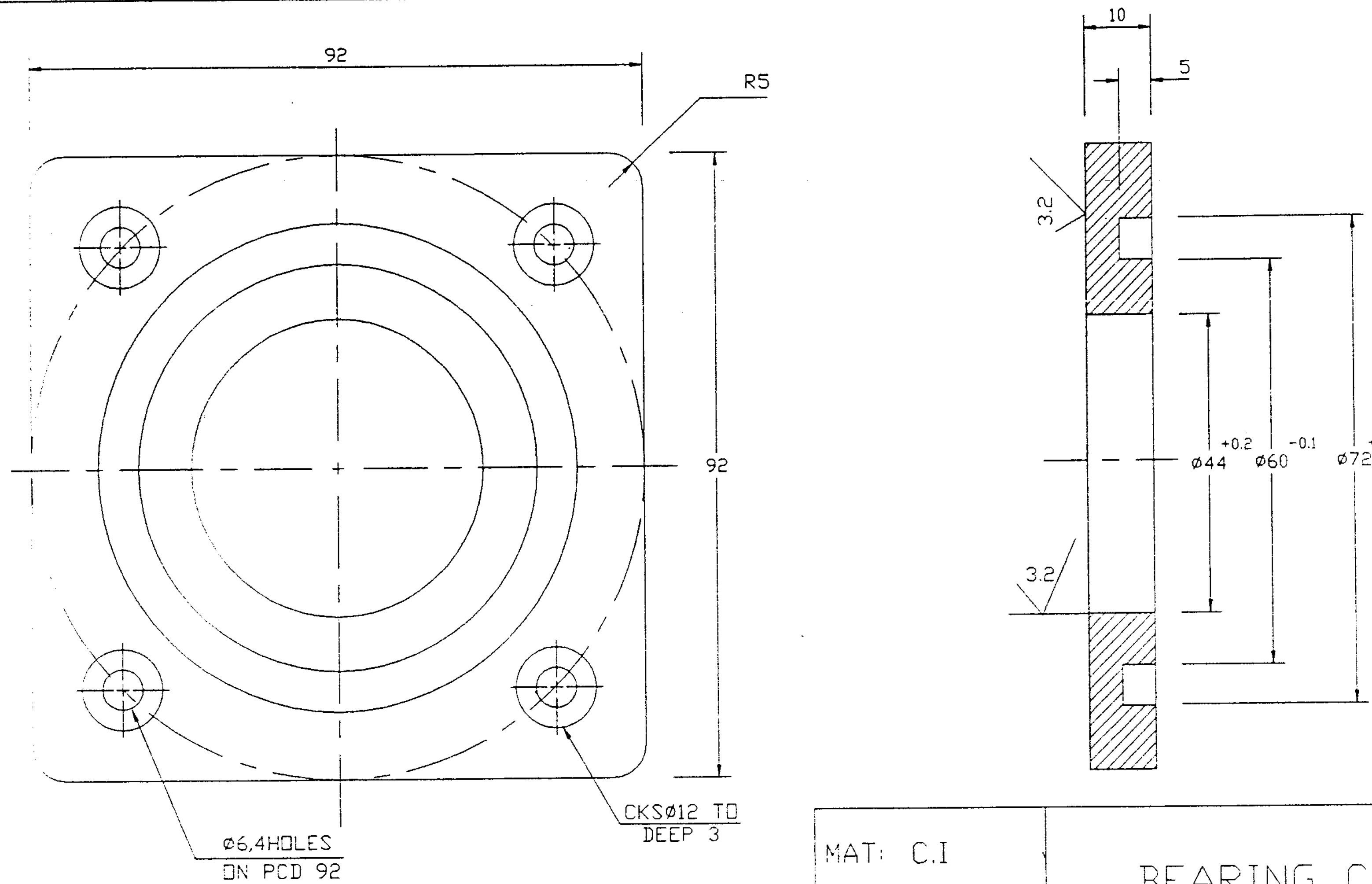
NET AMOUNT = 7662 + 7431 = Rs.15093



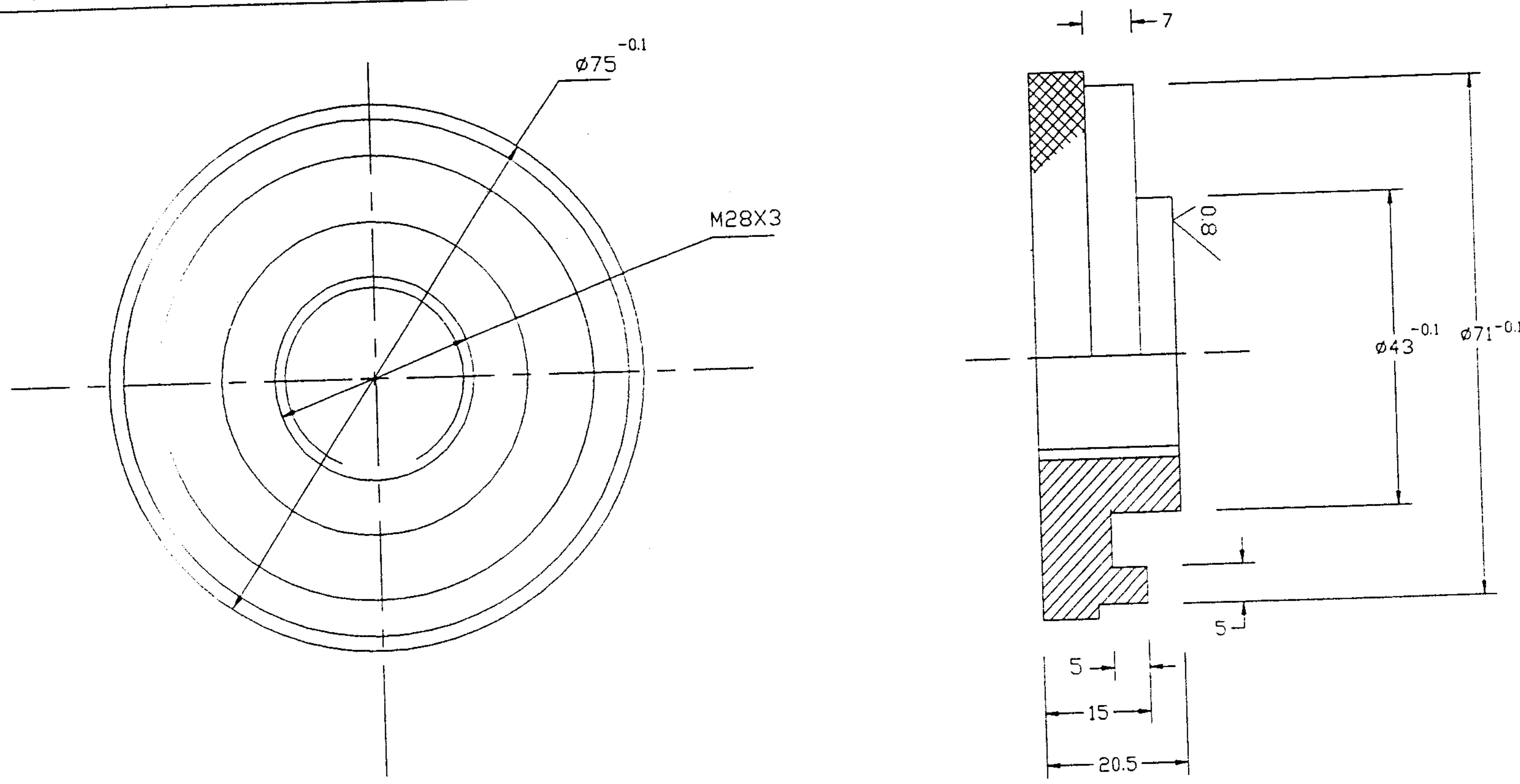
Ø 30r6 $^{+0.041}_{+0.028}$

Ø 24h7 $^{-0.000}_{-0.021}$

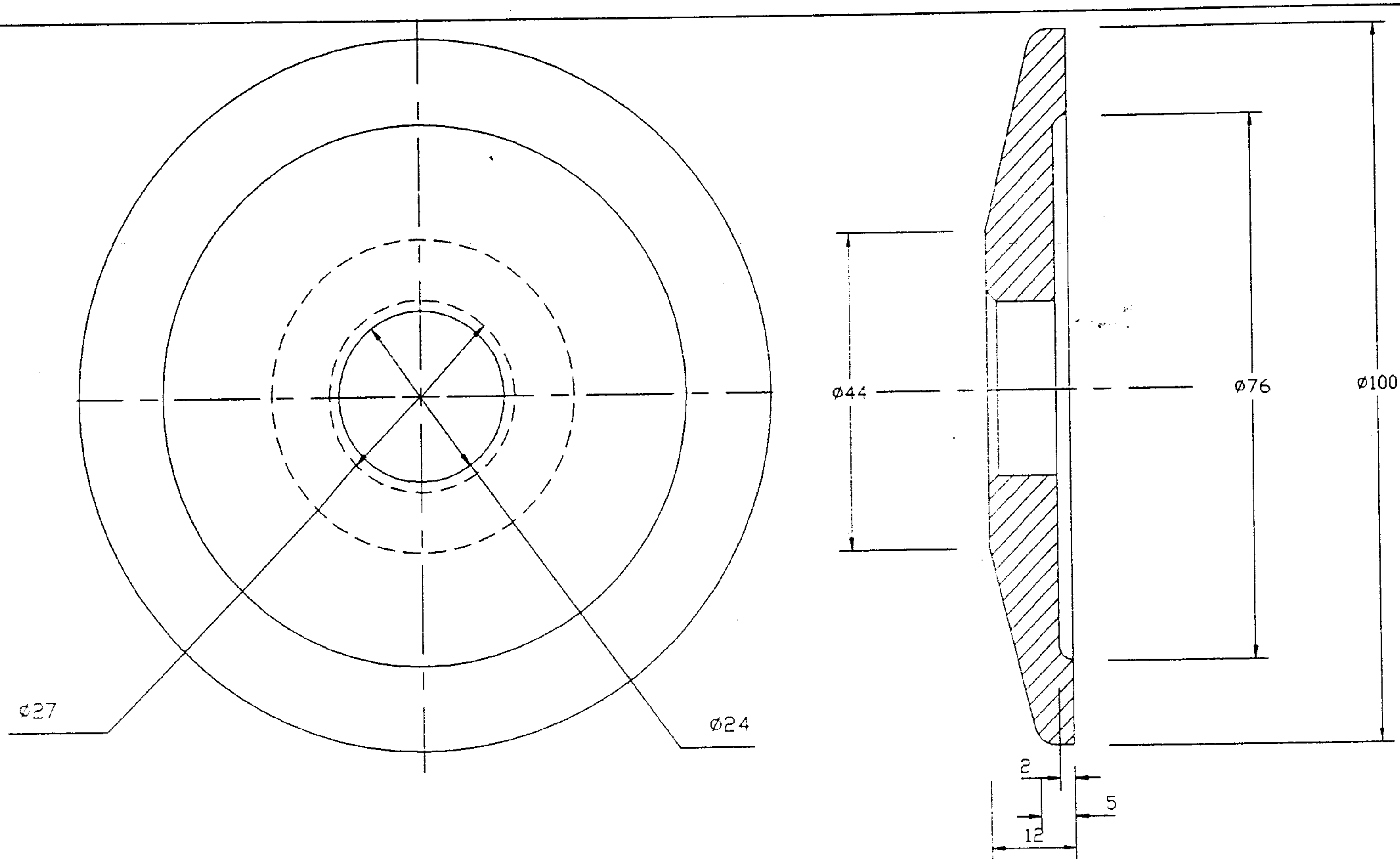
MAT: EN 24	SPINDLE
SIZE: Ø45X400	
QTY: 1	SPINDLE ASSLY
SCALE: 1:1	KCT BE PROJECT
DRG NO: 01-01	



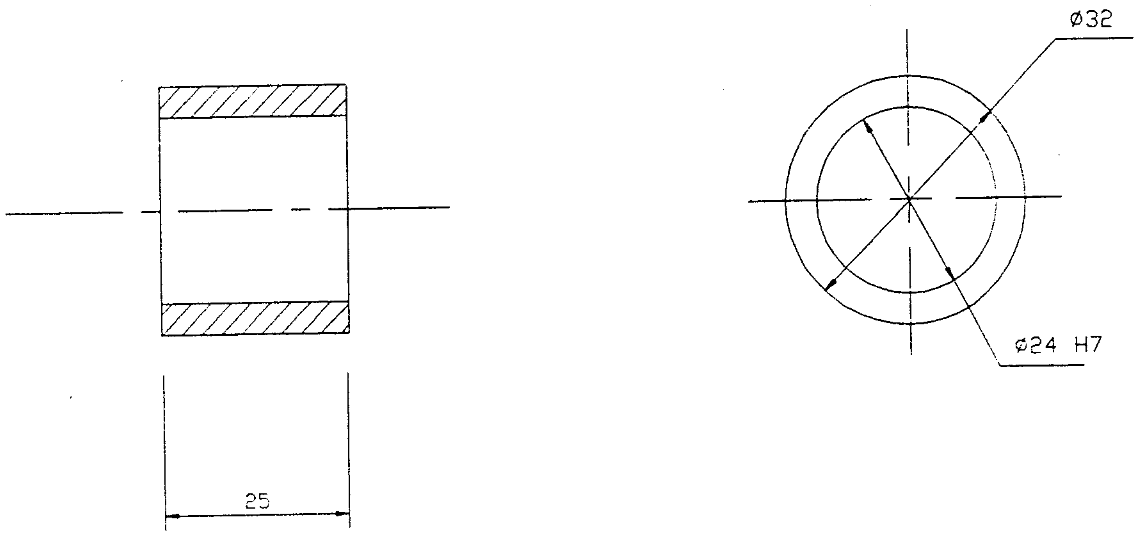
MAT: C.I	BEARING CAP	
SIZE:92X92X15		
QTY: 2	SPINDLE ASSLY	
SCALE: 1:1	KCT BE PROJECT	
DRG NO: 01-02		



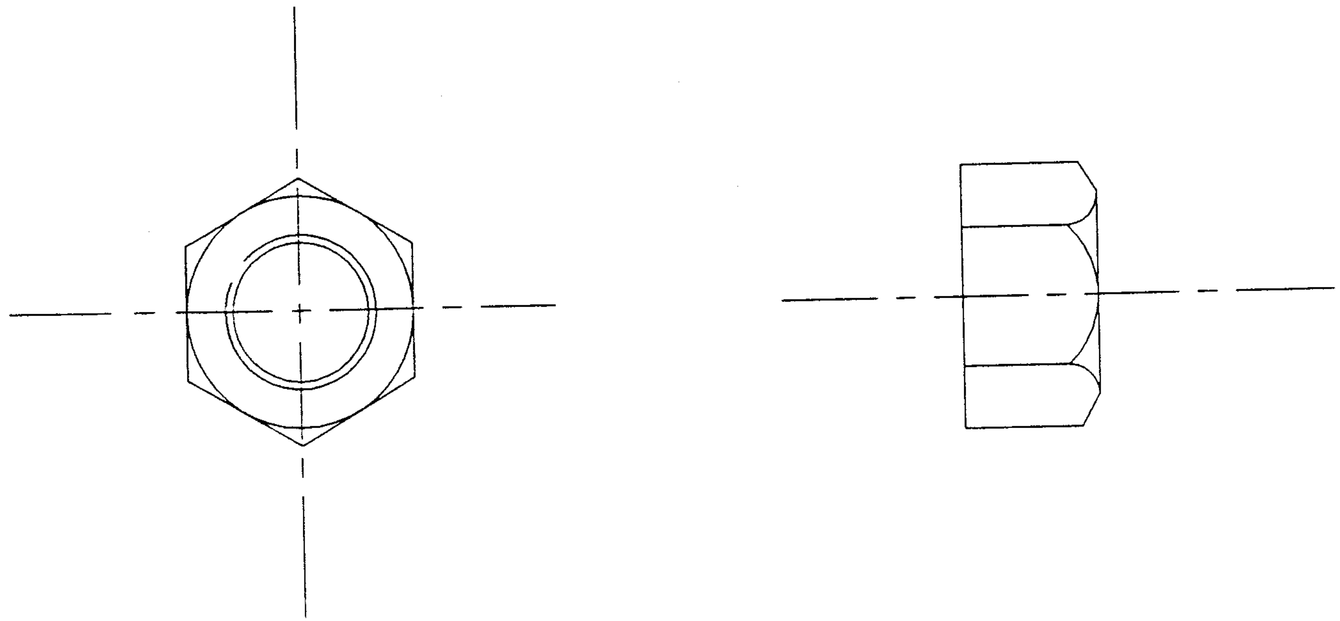
MAT: C.I	COLLAR	
SIZE: ø80X25		
QTY: 2	SPINDLE ASSLY	
SCALE: 1:1	KCT BE PROJECT	
DRG NO: 01-03		



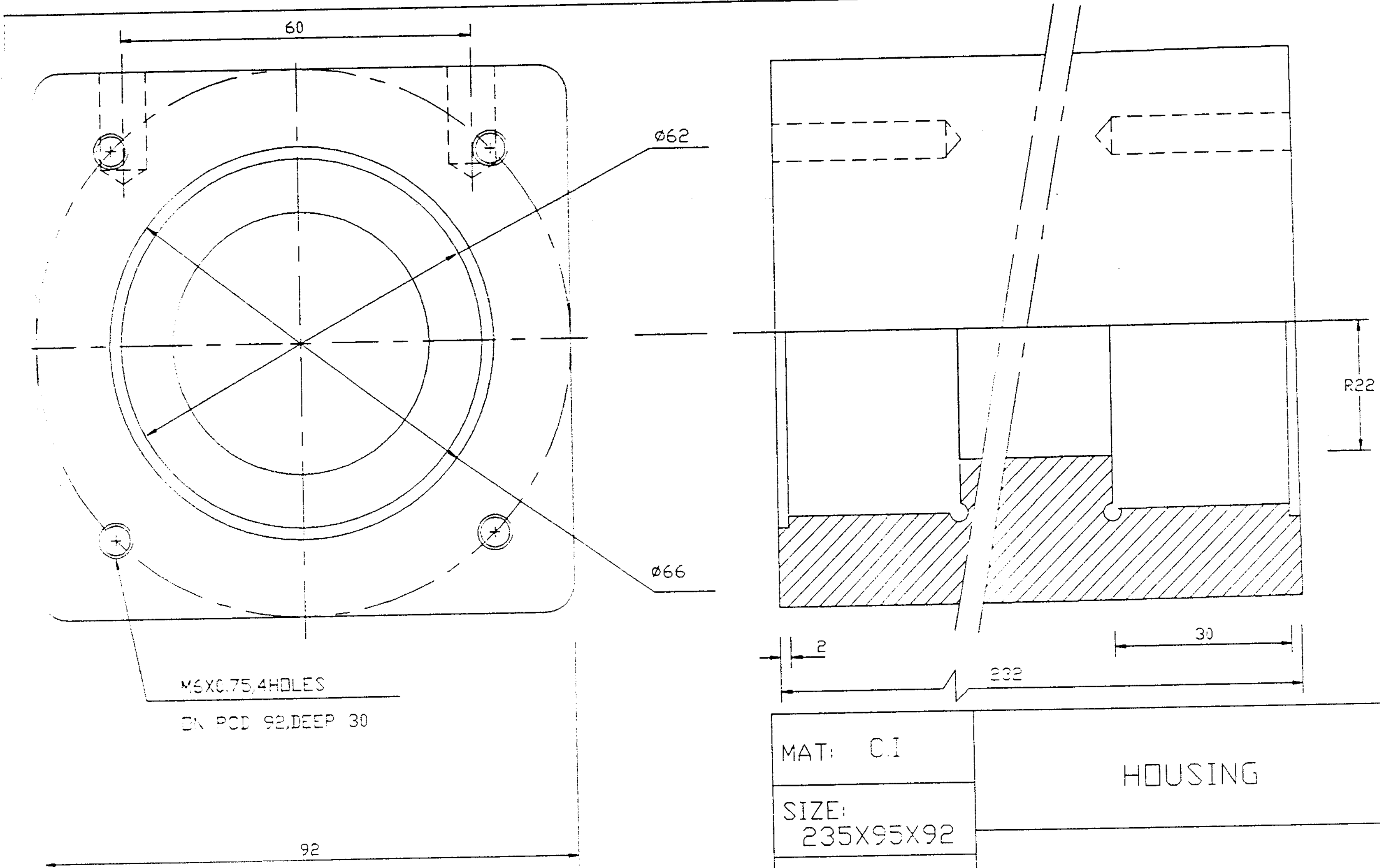
MAT: C.I	FLANGE	
SIZE: Ø105X20		
QTY: 2	SPINDLE ASSLY	
SCALE: 1:1	KCT BE PROJECT	
DRG NO: 01-04		



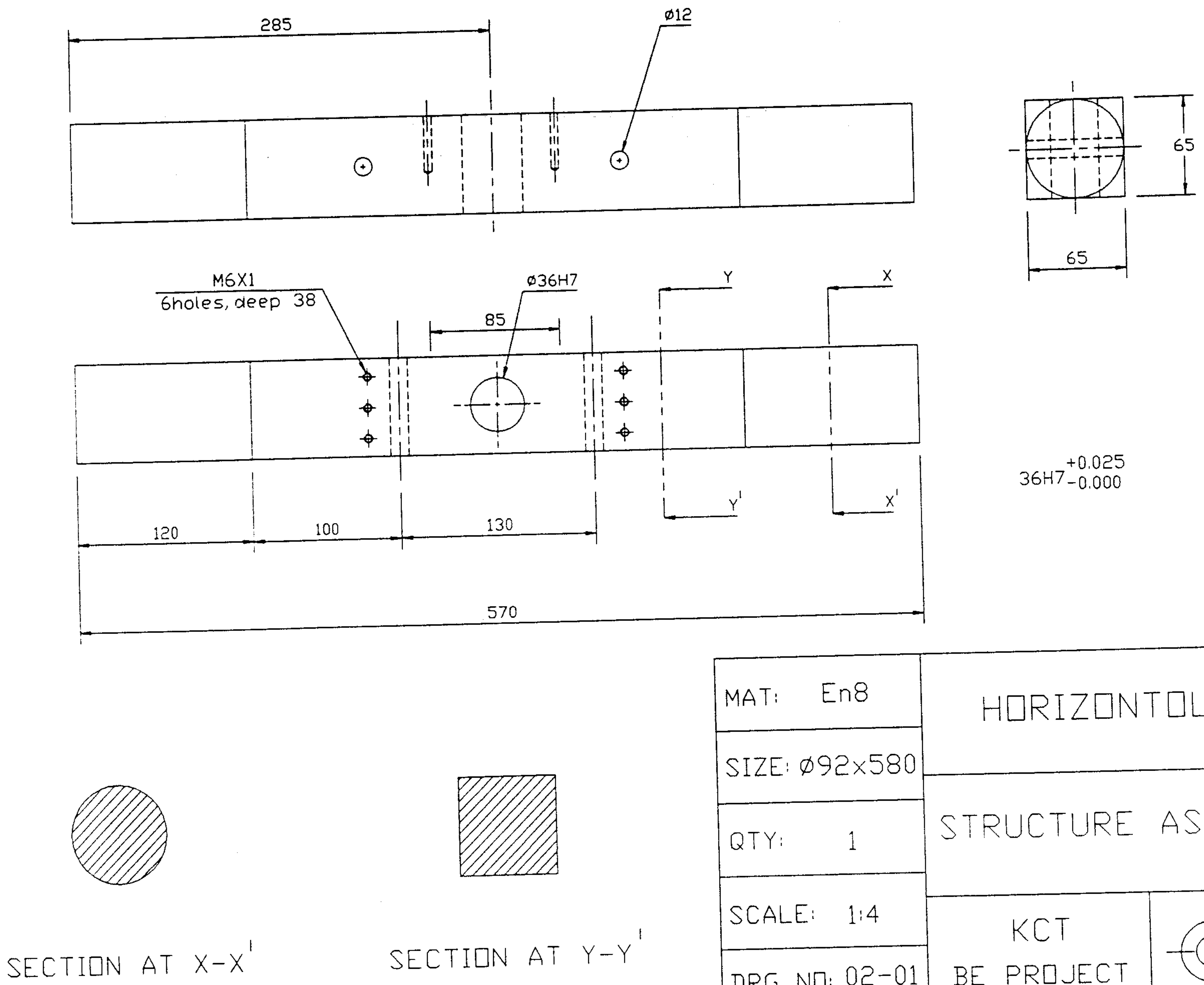
MAT: M.S	BUSH	
SIZE: Ø35.5X30		
QTY: 1	SPINDLE ASSLY	
SCALE: 1:1	KCT BE PROJECT	
DRG NO: 01-05		



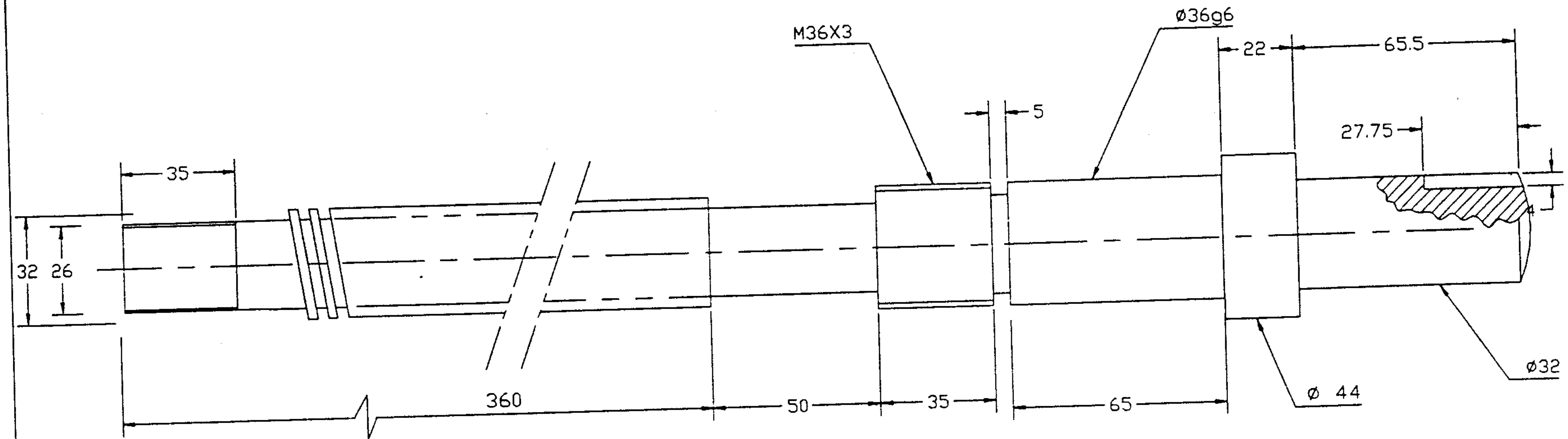
MAT: STD	NUT	
SIZE: M 20X2		
QTY: 1	SPINDLE ASSLY	
SCALE: 1:1	KCT	
DRG NO: 01-06	BE PROJECT	



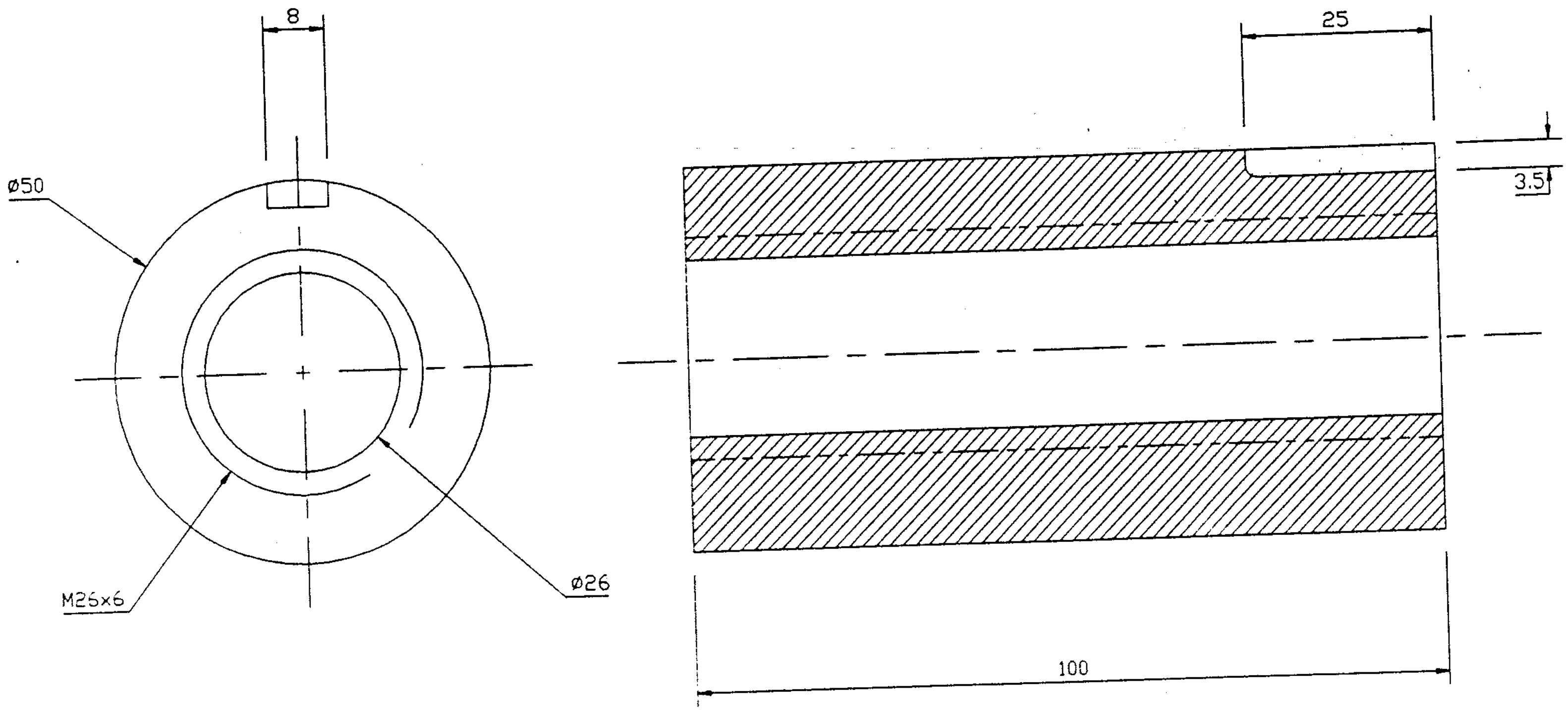
MAT: C.I	HOUSING	
SIZE: 235X95X92		
QTY: 1	SPINDLE ASSLY	
SCALE: 1:1	KCT BE PROJECT	
DRG NO: 01-07		



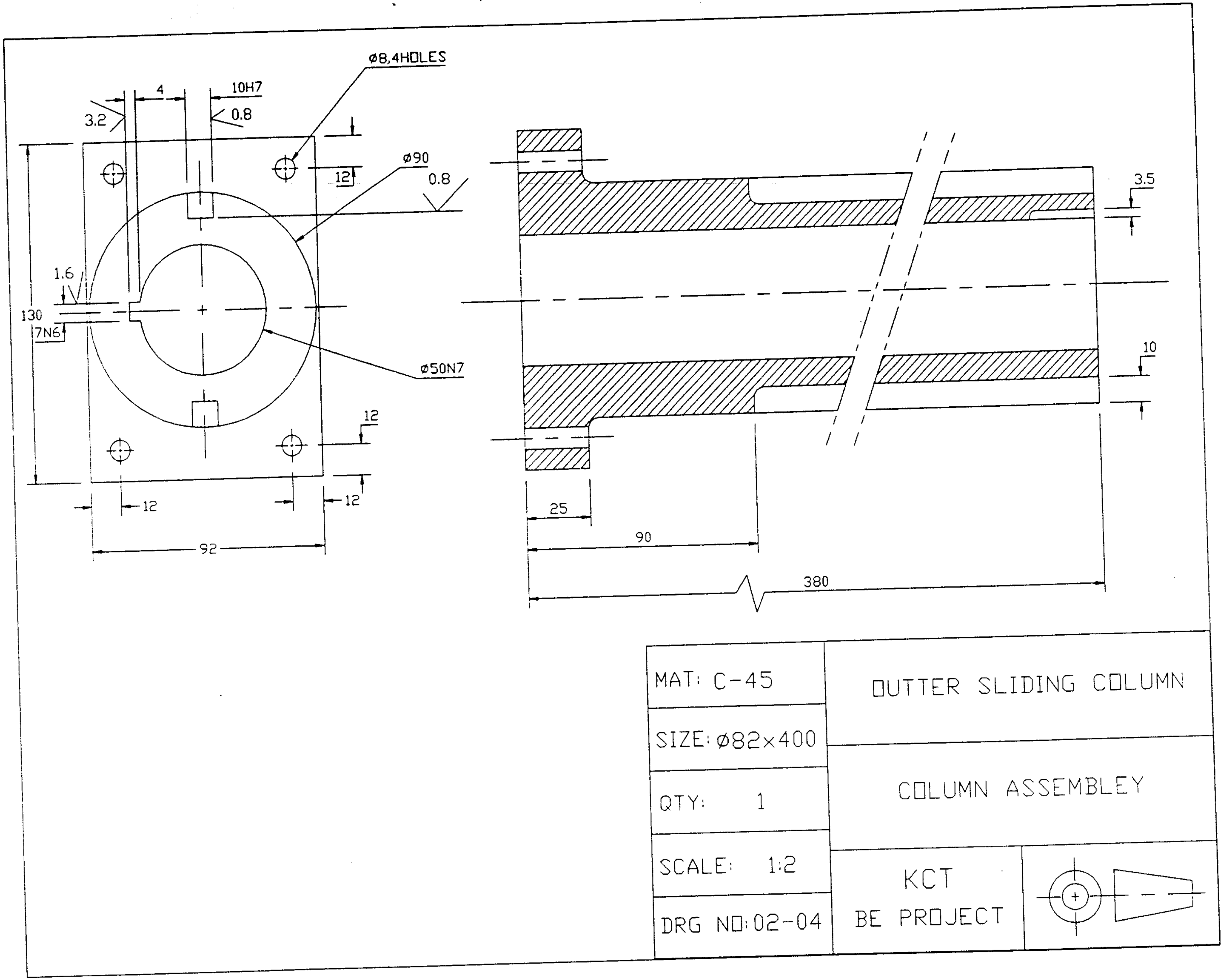
MAT: En8	HORIZONTOL ROD
SIZE: ø92x580	STRUCTURE ASSEMBLEY
QTY: 1	
SCALE: 1:4	KCT BE PROJECT
DRG NO: 02-01	

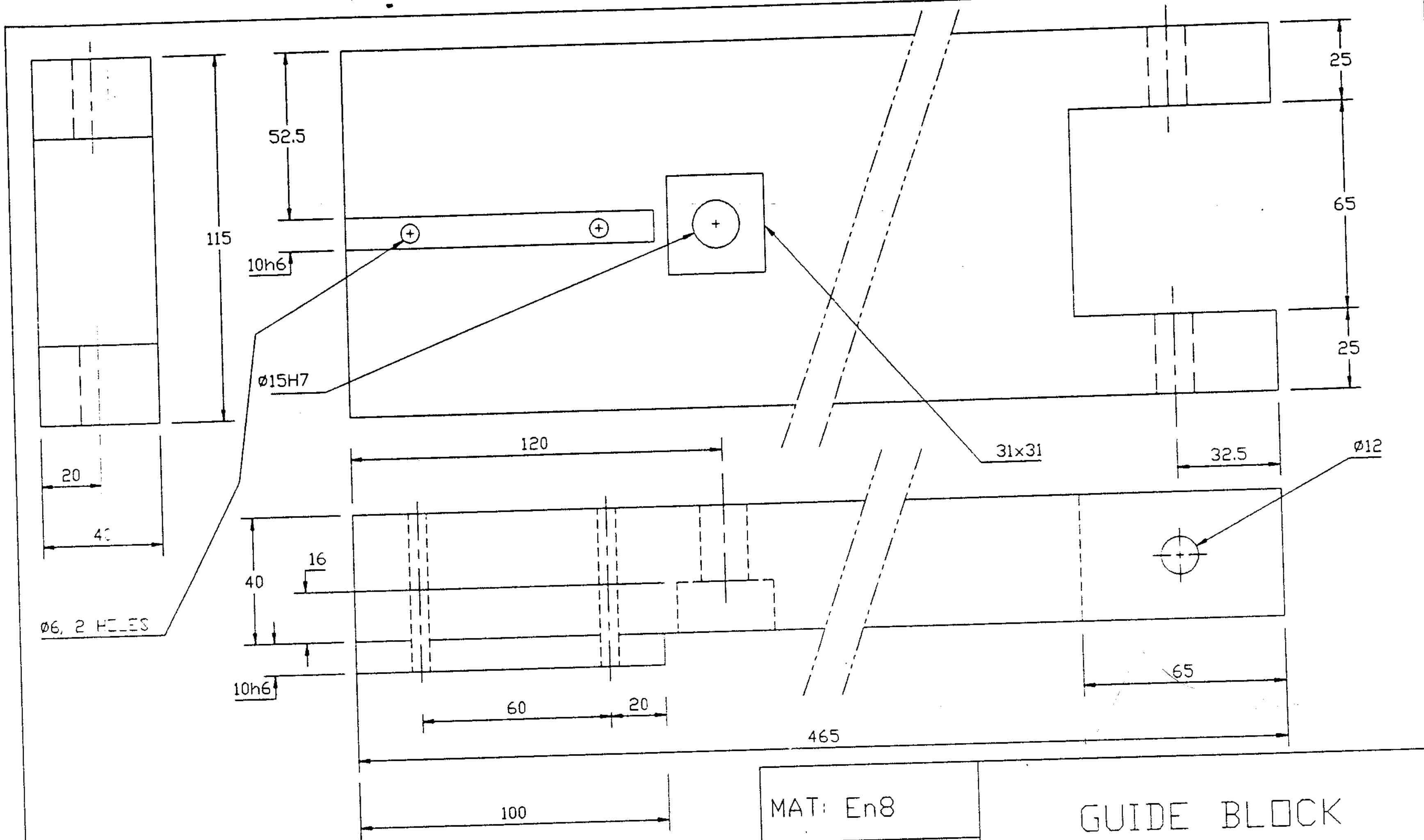


MAT: En8	SCREW ROD	
SIZE:Ø45X575		
QTY: 1	COLUMN ASSEMBLEY	
SCALE: 1:2	KCT BE PROJECT	
DRG NO:02-02		



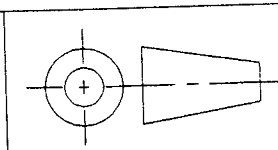
MAT: En8	NUT	
SIZE: ø53×110		
QTY: 1	COLUMN ASSEMBLEY	
SCALE: 1:1	KCT	
DRG NO: 02-03	BE PROJECT	


ø8,4HOLES
10H7
0.8
4
3.2
12
ø90
0.8
1.6
130
7N6
ø50N7
12
12
12
92
3.5
10
25
90
380
MAT: C-45
SIZE: ø82×400
QTY: 1
SCALE: 1:2
DRG NO: 02-04
OUTTER SLIDING COLUMN
COLUMN ASSEMBLEY
KCT
BE PROJECT

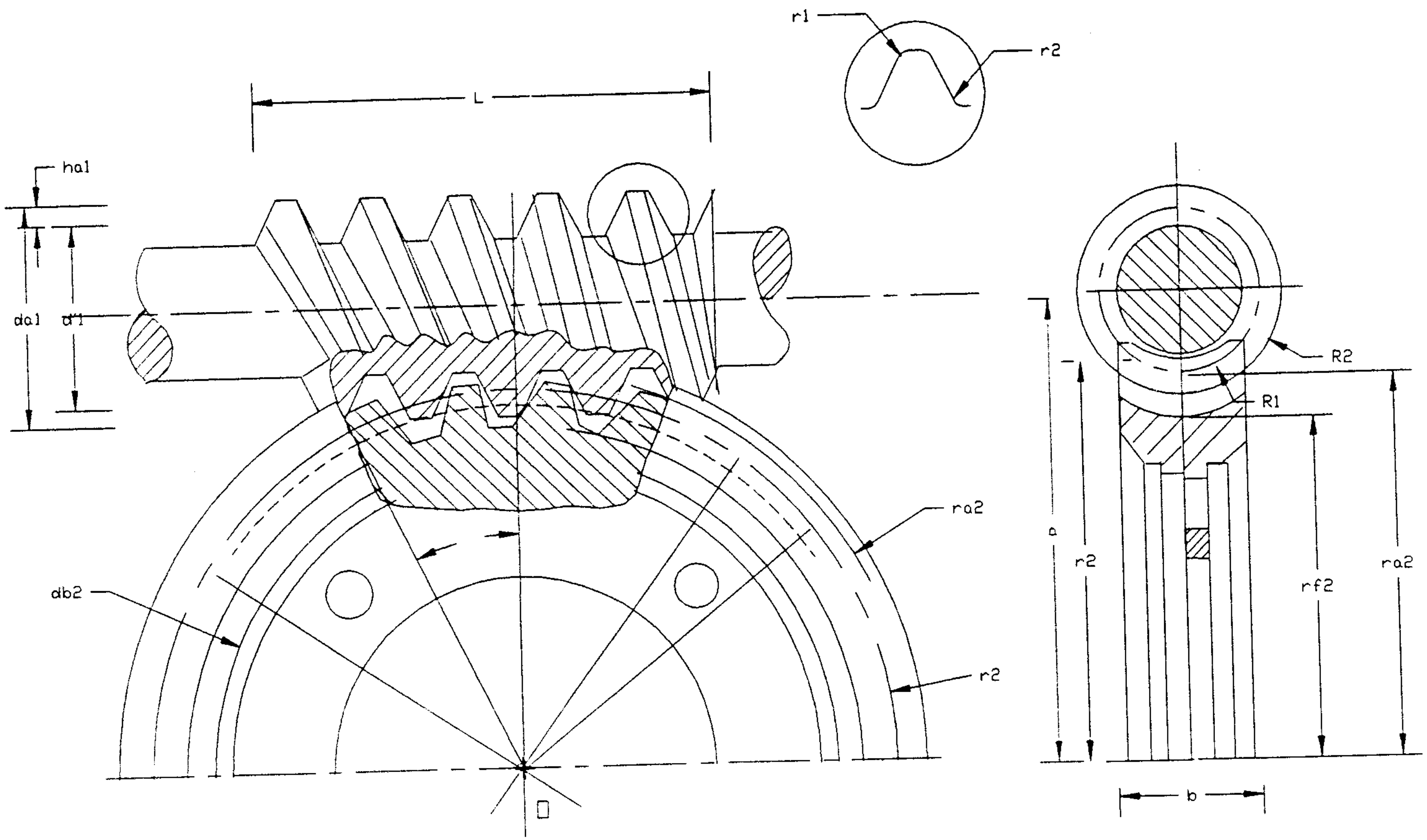


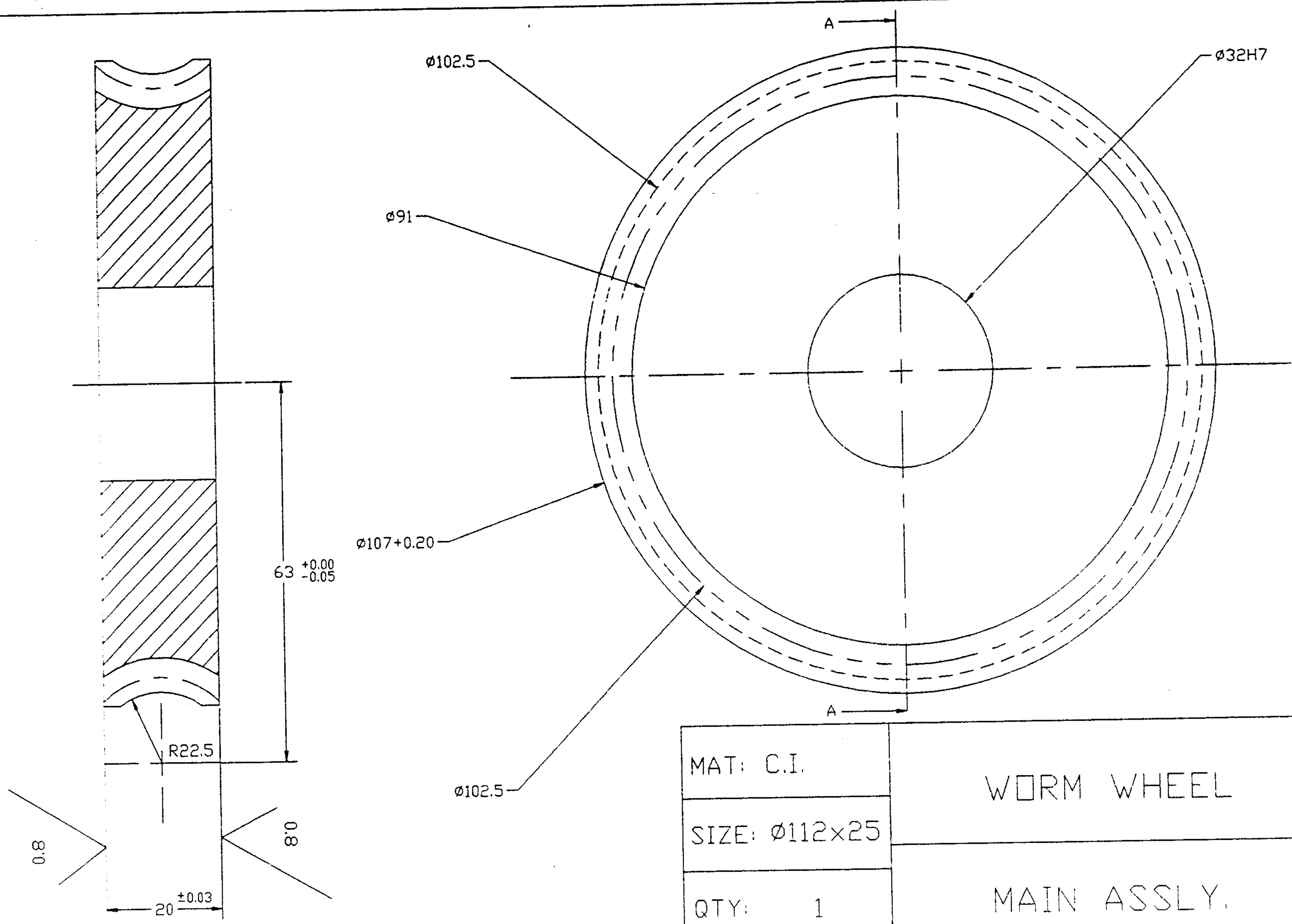
$10h6^{-0.000}_{-0.009}$

$15H7^{+0.018}_{-0.000}$

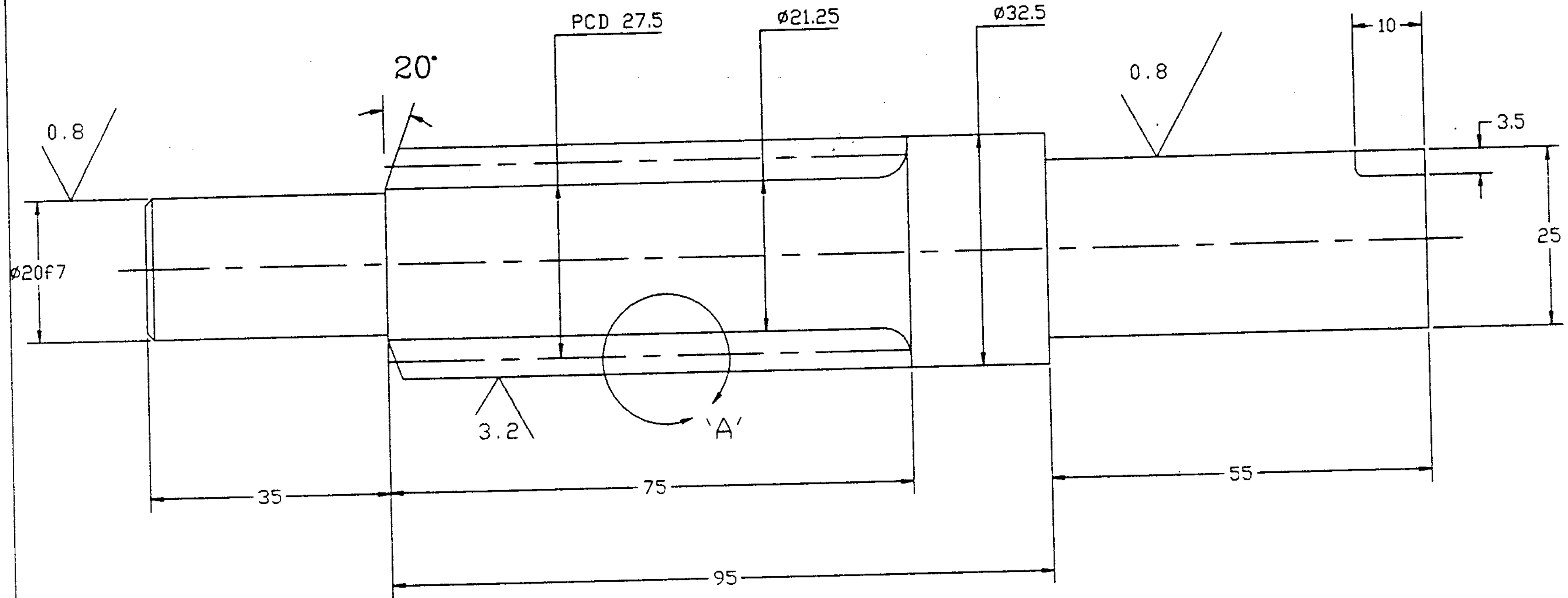
MAT: En8	GUIDE BLOCK	
SIZE: 96x52		
QTY: 2	COLUMN ASSEMBLEY	
SCALE: 1:2	KCT BE PROJECT	
DRG NO: 02-05		

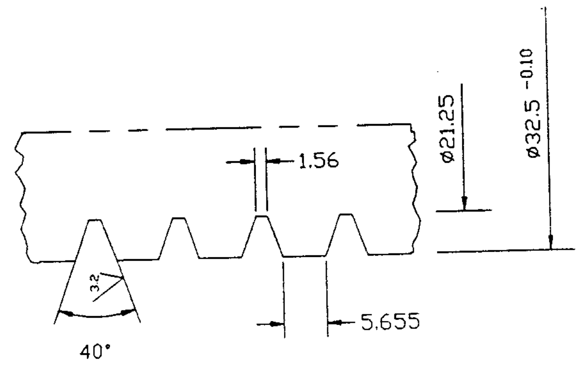
GEAR NOMENCLATURE





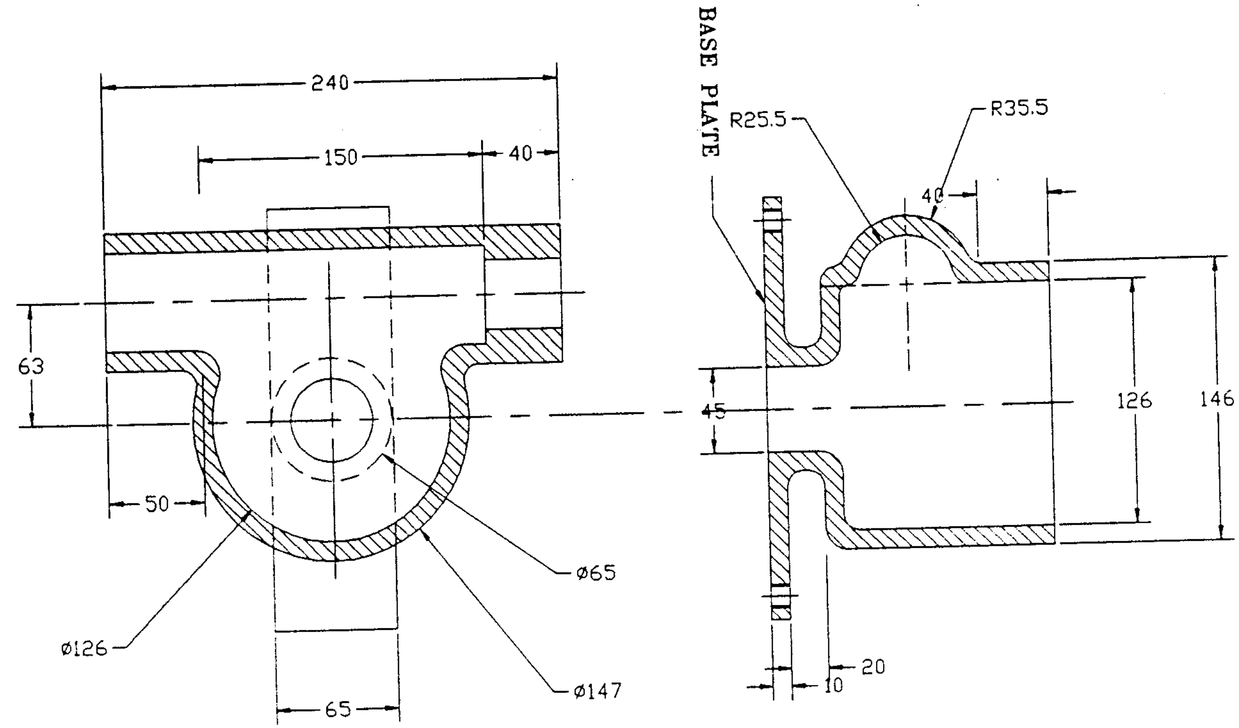
MAT: C.I.	WORM WHEEL
SIZE: Ø112×25	
QTY: 1	MAIN ASSLY.
SCALE: 1:1	KCT BE PROJECT
DRG NO: 02-06	



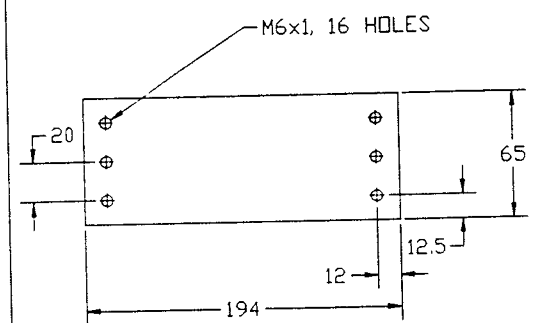


DETAIL 'A'

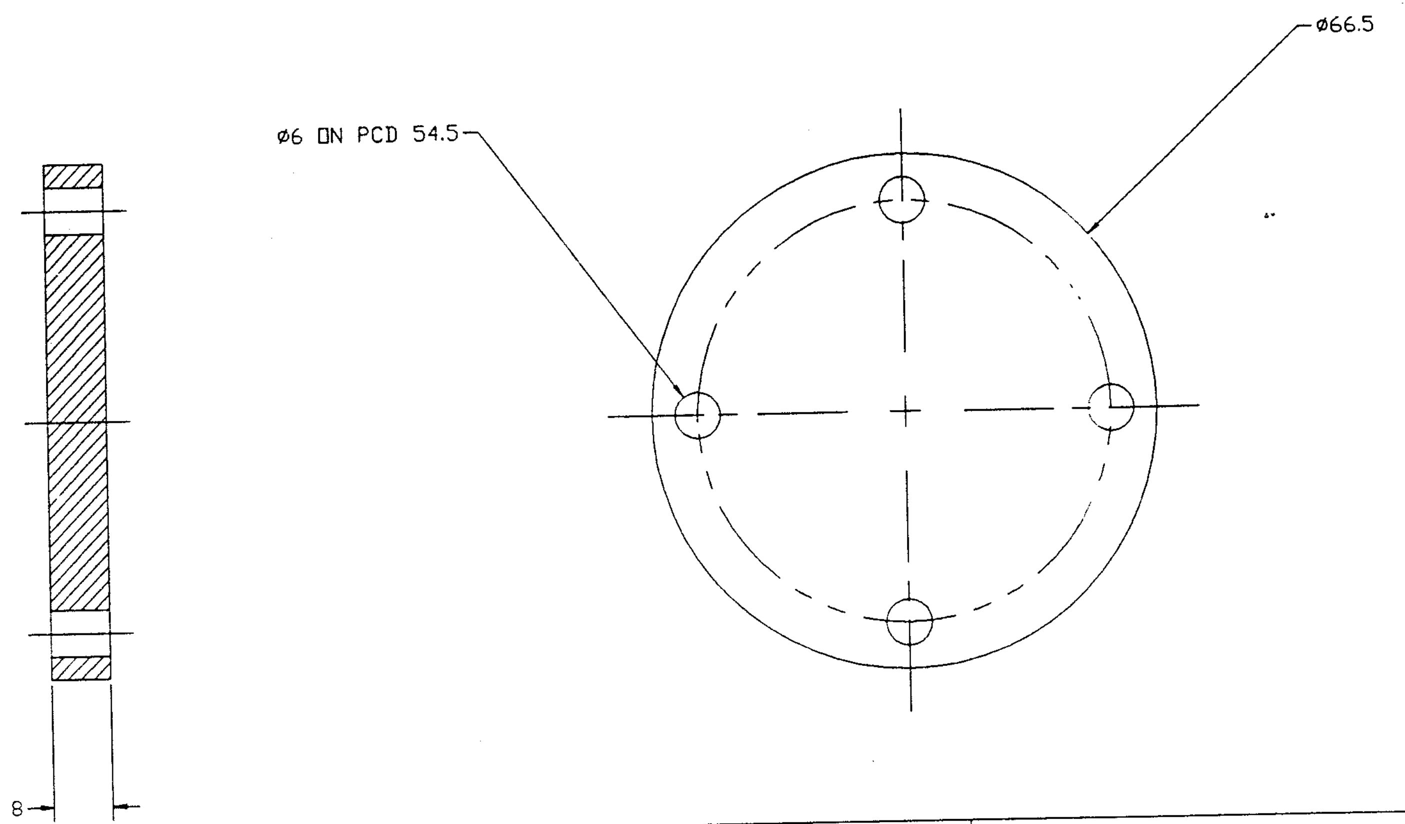
MAT: EN8	WORM SHAFT	
SIZE: ø35.5X195		
QTY: 1	MAIN ASSLY	
SCALE: 1:1	KCT	
DRG NO: 02-07	BE PROJECT	



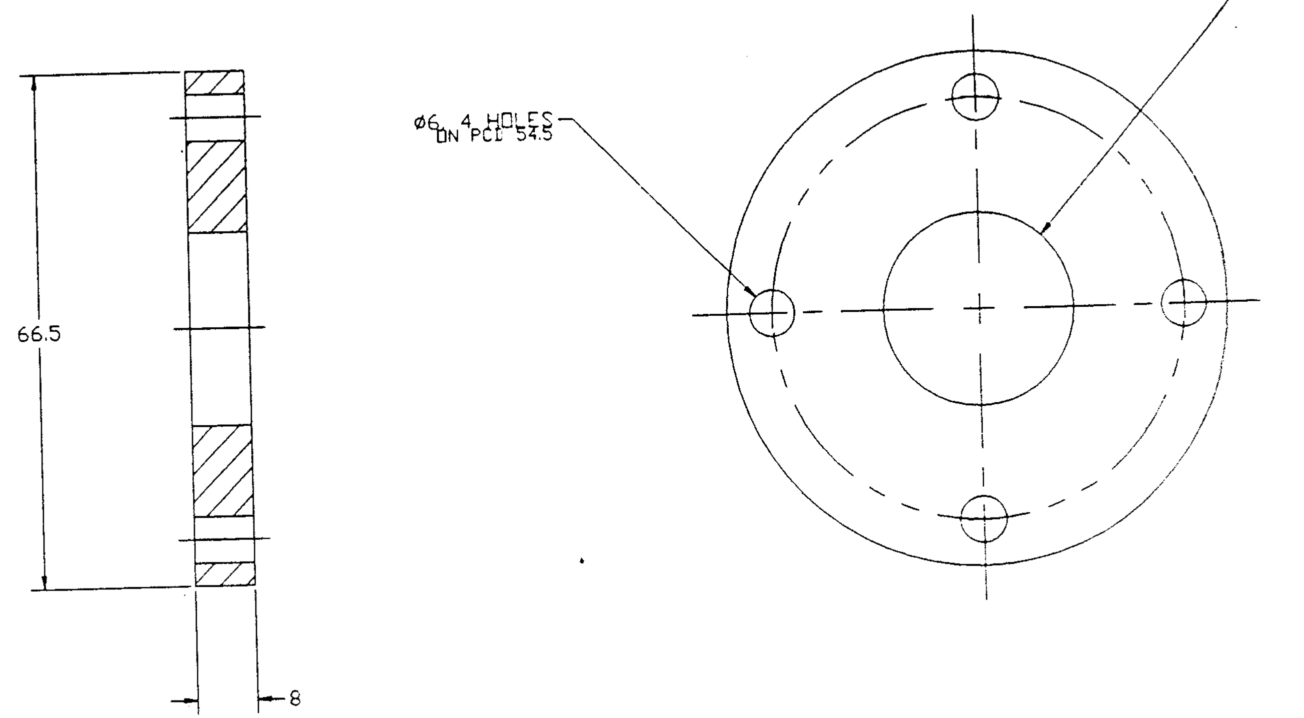
DETAILS OF BASE PLATE



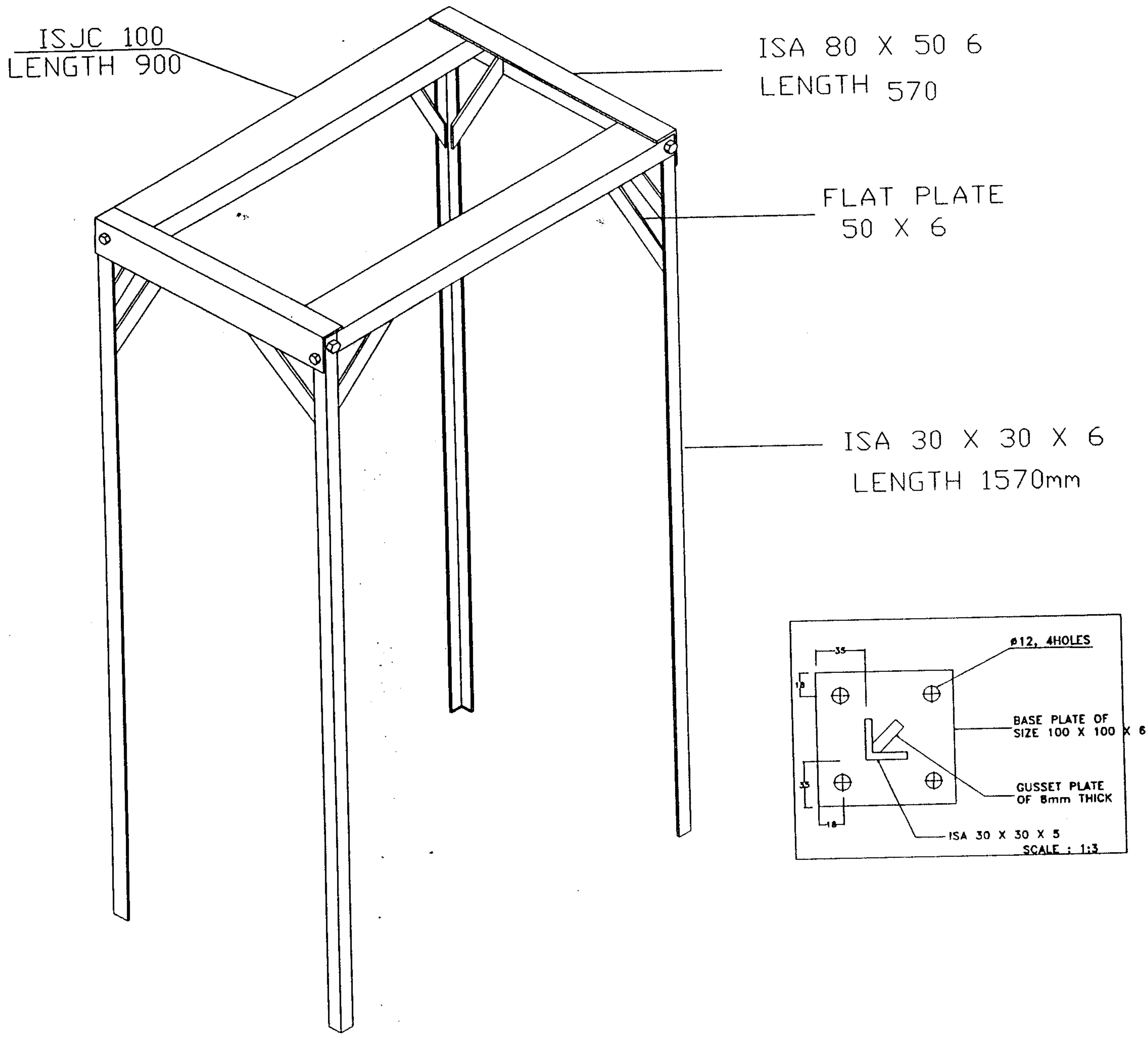
MAT: C.I	WORM HOUSING	
SIZE: 250X180		
QTY: 1	MAIN ASSLY	
SCALE: 1:4	KCT BE PROJECT	
DRG NO: 02-08		



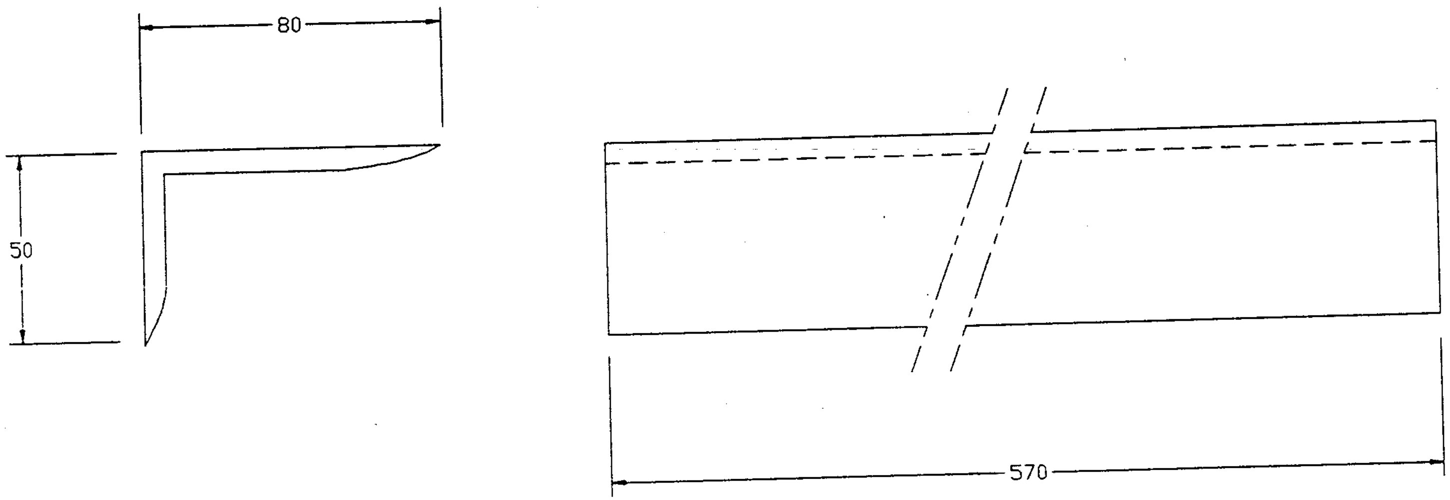
MAT: C.I	WORM CAP
SIZE:Ø70 X 10	
QTY: 1	MAIN ASSLY
SCALE: 1:1	KCT
DRG NO:02-09	BE PROJECT



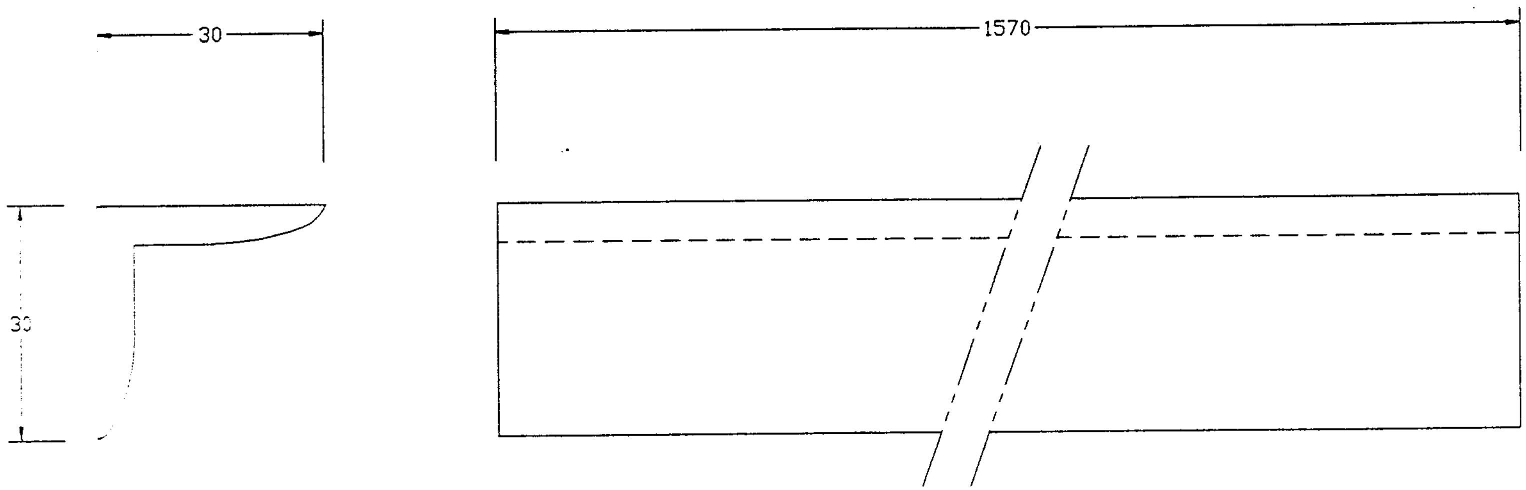
MAT: C.I	WORM CAP	
SIZE: Ø70 X 10		
QTY: 1	MAIN ASSLY	
SCALE: 1:1	KCT	
DRG NO:02-09a	BE PROJECT	



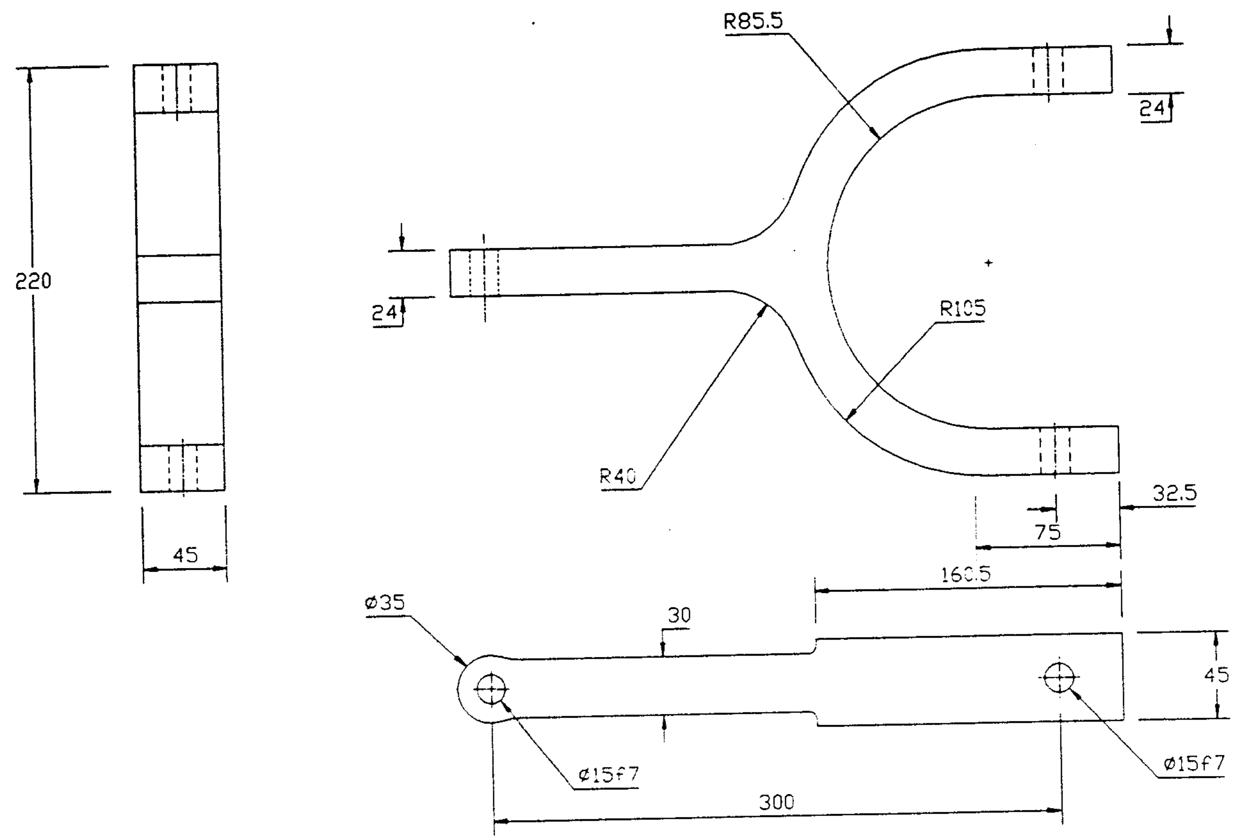
STRUCTURE OF SUPPORTING FRAMES



MAT: R.S.J	L-ANGLE	
SIZE: ISA 80X50X6		
QTY: 2	STRUCTURE ASSLY	
SCALE: 1:2	KCT BE PROJECT	
DRG NO: 02-10		

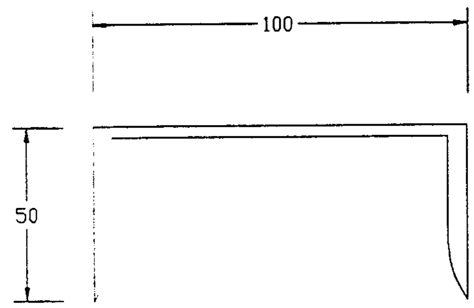


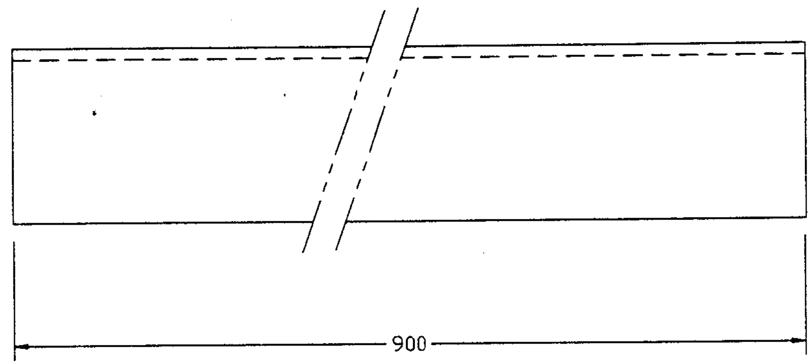
MAT: R.S.J	L-ANGLE	
SIZE: ISA 30X30X5		
QTY: 4	STRUCTURE ASSLY	
SCALE: 1:1		
DRG NO: 02-11	KCT BE PROJECT	



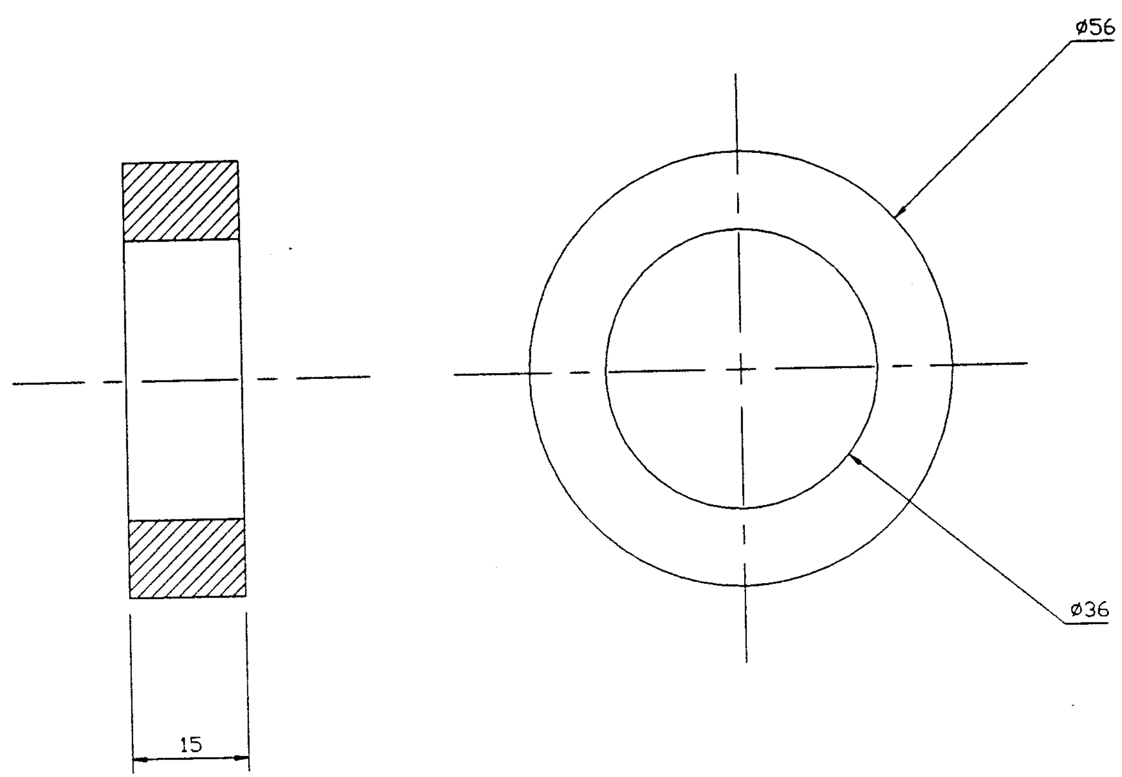
$15\ f7^{-0.016}_{-0.038}$

MAT: C.I.	LINKAGE LEVER
SIZE:375X220X50	
QTY 1	COLUMN ASSEMBLEY
SCALE: 1:4	KCT BE PROJECT
DRG NO: 02-12	

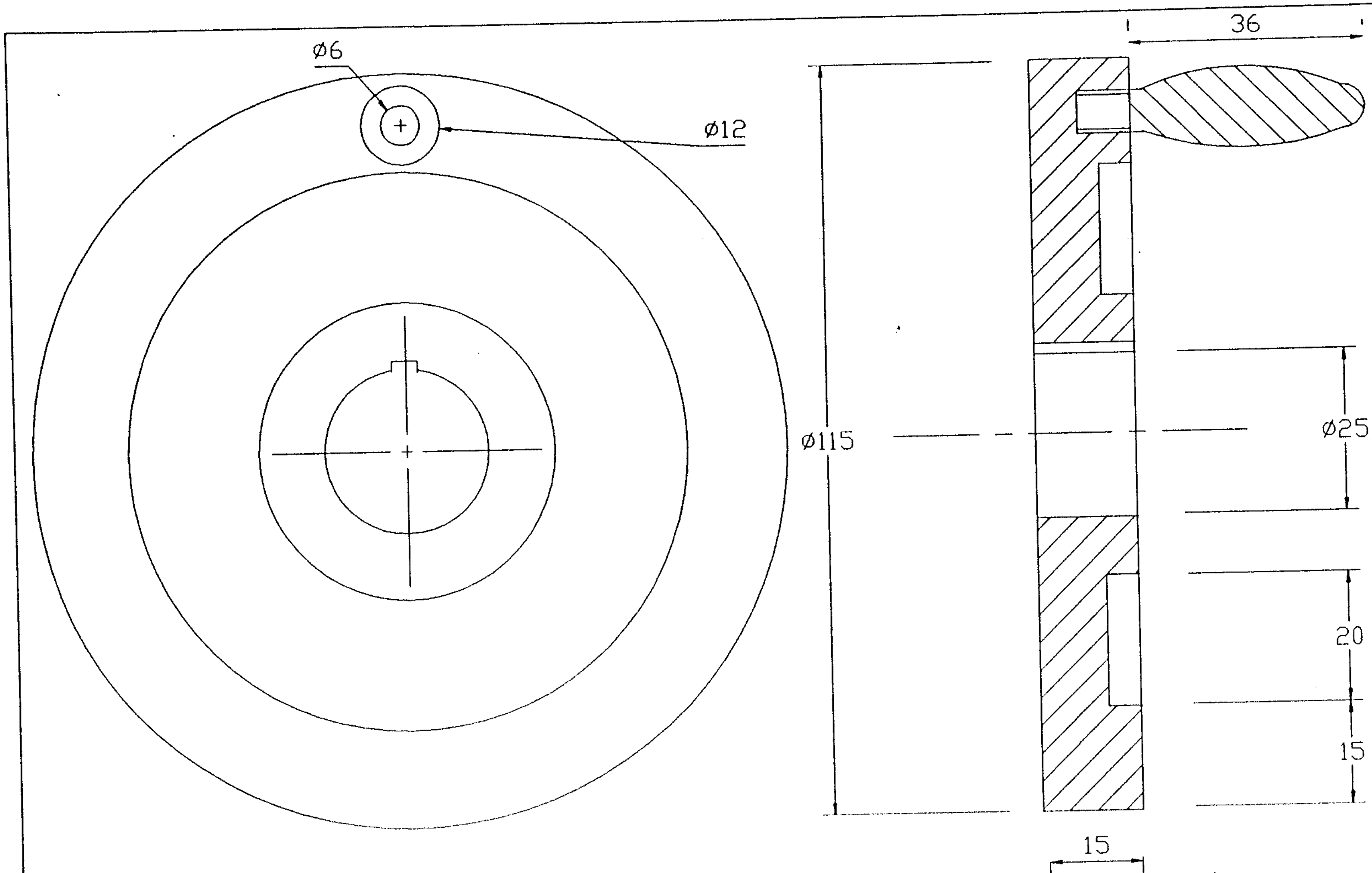




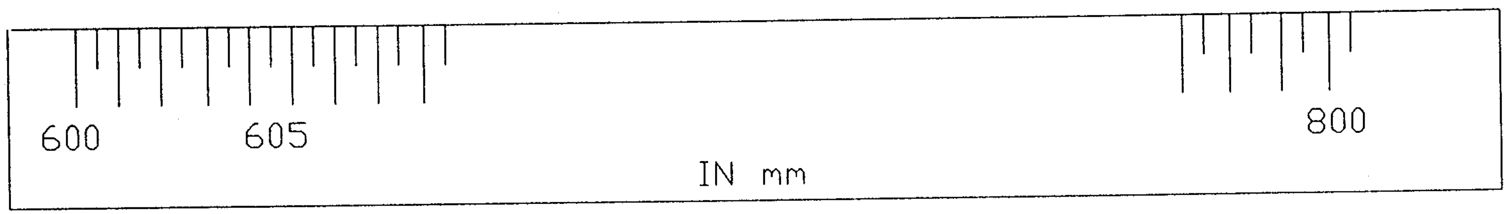
MAT: R.S.J	C-CHANNEL	
SIZE: ISA 100X50X5.1		
QTY: 2	STRUCTURE ASSLY	
SCALE: 1:2		
DRG NO: 02-13	KCT BE PROJECT	



MAT: M.S.	COLLAR
SIZE: Ø50x18	
QTY: 1	COLUMN ASSEMBLEY
SCALE: 1:1	KCT BE PROJECT
DRG NO: 02-14	



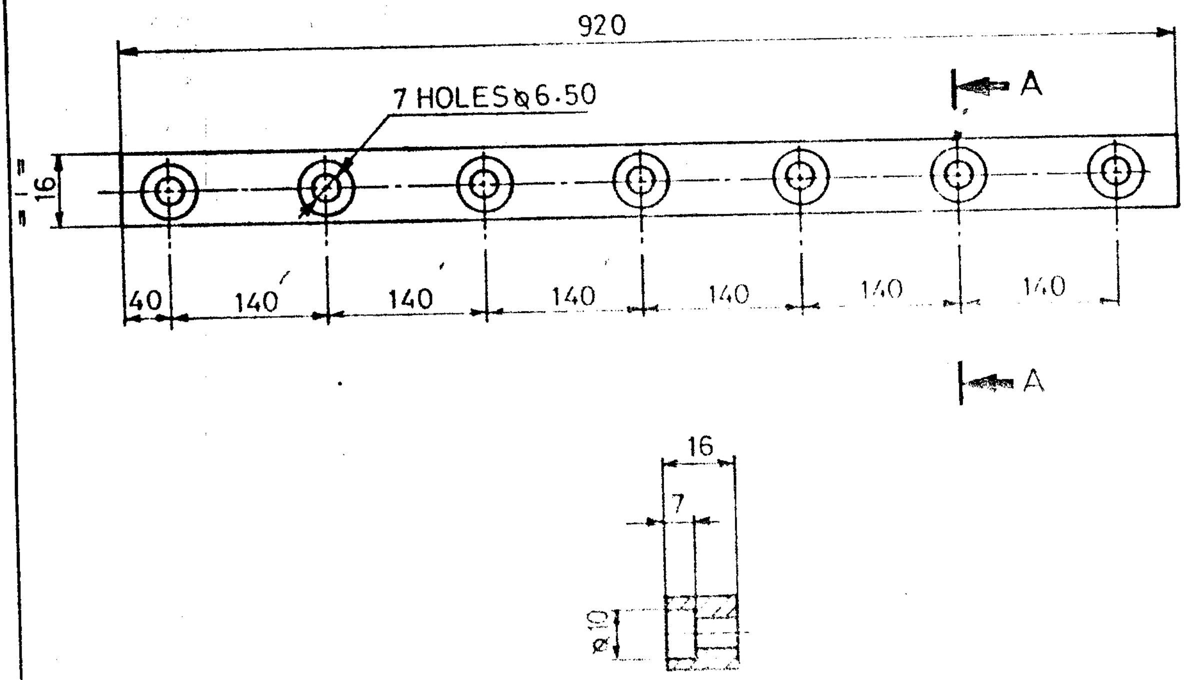
DRG No: H1	HAND WHEEL
QTY: 01	MAIN ASSLY
SCALE: 1:1	KCT BE PROJECT
MAT: C.I	



REFERENCE SCALE USED TO GIVE DEPTH OF CUT

REVISIONS

REV. No.	DATE	DESCRIPTION	W.E.M.C. No	DGN AIL	APPD
01	3-3-92	DESIGN ALTERED	126	(signature)	



SEC AA

POS	QTY	MATL	SIZE	REMARKS
51	2	MS	16 SQ x 924	

MACHING SYMBOLS	MACHINE GRIND	FINE	ROUGH	HAND GRIND
	0.8 √	3.2 √	12.5 √	50 √

TITLE

SQUARE BAR
(FOR MIDDLE PLATE)

SCALE: NTS

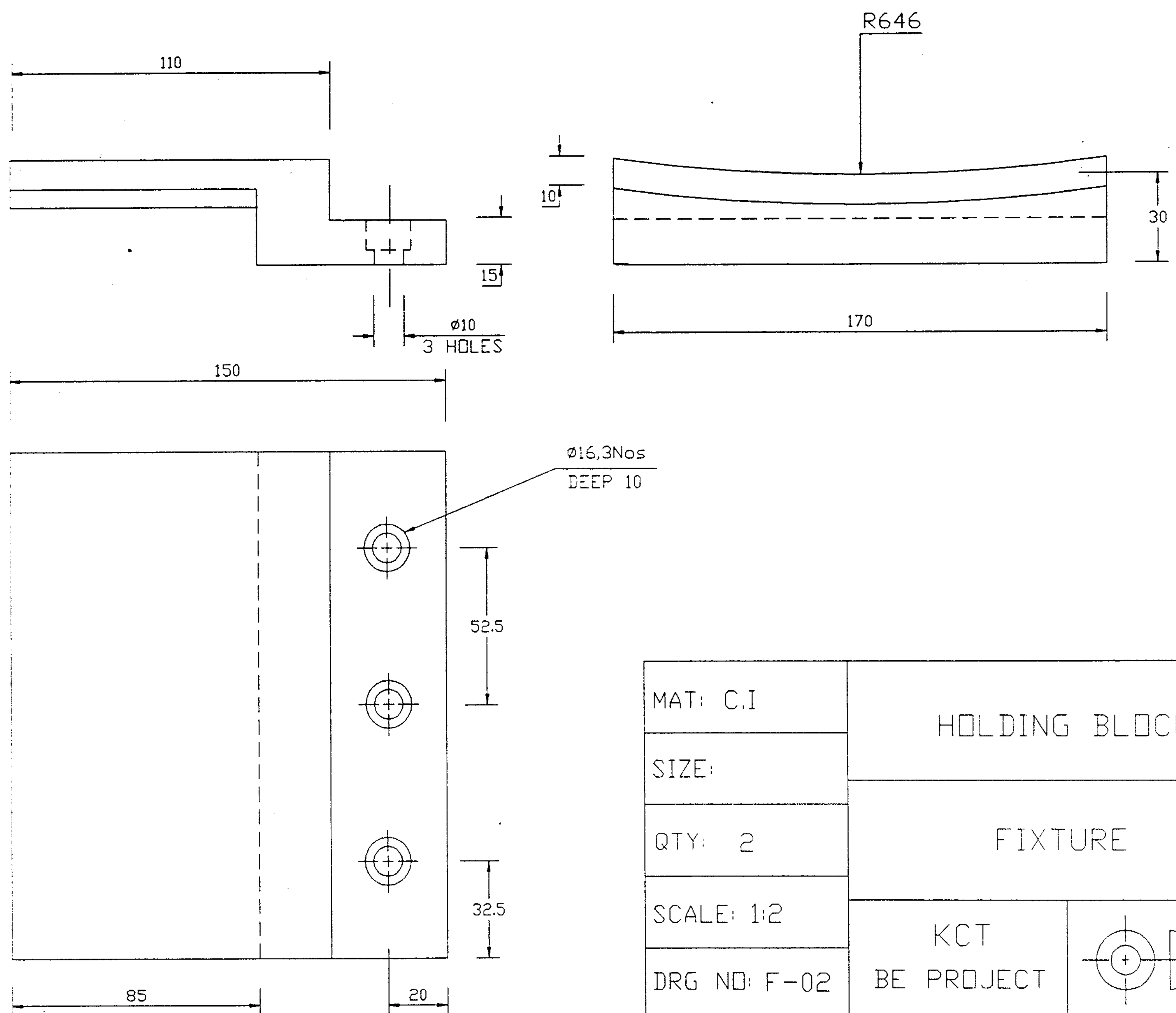
Wt. Kgs:

DIMENSIONS ARE IN M.M. & AS NOTED DEVIATION & TOLERANCES AS PER ISI. REMOVE UNNECESSARY EDGES AND CORNERS

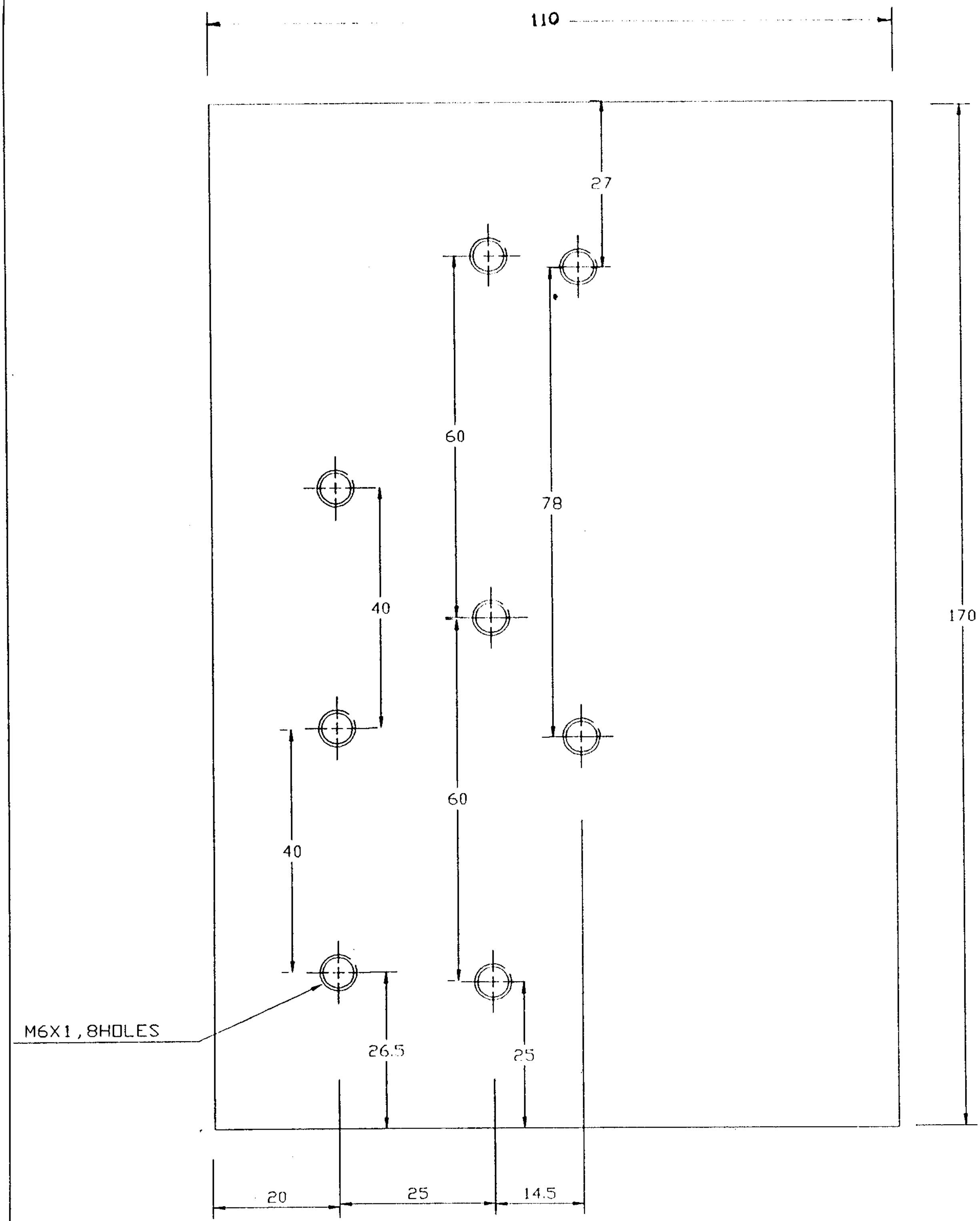
SRI VENKATESWARA ENGINEERS
COIMBATORE

DGN	—	—
DRN	N-RAYA	03-03-92
CHD	(signature)	28/03/92
APPD		

SUB ASSY	GROUP	DRG. No.	SHEET
CARD BEND	CARDING	SV 03-51	01
TYPE: SV HPC 1	REF:		01



MAT: C.I	HOLDING BLOCK	
SIZE:		
QTY: 2	FIXTURE	
SCALE: 1:2	KCT BE PROJECT	
DRG NO: F-02		



LOCATION OF HOLES ON HOLDING BLOCK (RIGHT SIDE)

CONCLUSION

Our attachment allow the use of existing machine, the shaping machine, for grinding operation and thereby eliminates the investment cost on a new machine which serves the same purpose.

The shaping machine can also be used for doing its usual operations.

The time for completing grinding on a work piece using conventional methods is approximately three hours. With our attachment, it will be 50 minutes. Hence the production rate is increased by 70%.

The attachment can grind any other workpieces having concave surfaces, not only carding drum cover plates. Its radius must fall in the range of 620 to 800 mm.

BIBLIOGRAPHY

Machine Tool Design Hand Book - Cmti

Design Data Book - P.S.G. Institution

Machine Design - R.S. Kurumi

Machine Design - Aaron D. Deutschman
Walter J. Michels &
Charles E. Wilson

Mechanical Engineering Design - Joseph Edward Shigley

Machine Tool Design - N.K. Metha

Strength of Materials - Ramamrutham

Machine tool design - N. Chernov

PART LIST FOR SPINDLE ASSEMBLEY

Qty. : 1 No　　　　Drg. No : 01-00

P.NO.	PART NAME	QTY.	MAT.	SIZE
00	SPINDLE ASSLY.			
01	SPINDLE	1	EN 24	ø45x400
02	HOUSING	1	C.I.	235x95x92
03	BEARING CAP	2	C.I.	92x92x15
04	COLLAR	2	C.I.	ø80x25
05	BEARING	4	STD	7206 B
06	GRINDING WHEEL	1	STD	ø200x25xø32
07	FLANGE	2	C.I.	ø105x20
08	BUSH	1	M.S.	ø33.5x30
09	WASHER	1	STD	ø20
10	NUT	1	STD	M20x2

PART LIST FOR MAIN ASSEMBLY

Qty : 1

DWG No:02-00

P.NO.	PART NAME	QTY.	MAT.	SIZE
00	MAIN ASSEMBLY	01	---	-------
01	WORM SHAFT	01	EN8	ø35.5X195
02	BALL BEARING	02	STD	6013 (SKF)
03	C-CHANNEL	02	RSJ	ISA 100X50X5.1
04	LINKAGE LEVER	01	C.I	375X220X50
05	SCREW ROD	01	EN8	ø45X575
06	FLEXIBLE SHAFT	01	STD	STD
07	FIXTURE	01	C.I	1275X175X75
08	WORM CAP	01	C.I	ø70X10
09	WORM HOUSING	01	C.I	250X180
10	WORM WHEEL	01	C.I	ø112X25
11	PLUMBER BLOCK	02	C.I	STD
12	GUIDE BLOCK	02	EN8	96X52
13	NUT	01	EN8	ø53X110
14	SLIDING COLUMN	01	C-45	ø82X400
15	L-ANGLE	02	RSJ	ISA 30X03X6
16	SPINDLE ASSEMBLY	01	--	---------
17	WORK PIECE	01	--	---------
18	SHAPPER TABLE	01	--	---------
19	L-ANGLE	02	RSJ	ISA 80X50X6