Design and fabrication of Low Cost Positive, Infinitely Variable (piv) Drive

(for M/s Sakthi Drives, Ondipudur, CBE)

A Project Report 1998-99

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IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF **BACHELOR OF ENGINEERING IN MECHANICAL ENGINEERING** OF THE BHARATHIAR UNIVERSITY COIMBATORE

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CERTIFICATE

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Certified that this is the Bonafide Record of the Project work done by

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Ref No. ________________ Date 05-03-99

CERTIFICATE.

This is to certify that this Project Report titled **"DESIGN AND FABRICATION OF LOW COST POSITIVE,INFINITELY VARIABLE (PIV) DRIVE"**. Is a bonafide record of work done by

P-365

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of Final year B.E (Mechanical Engineering) Students from **"KUMARAGURU COLLEGE OF TECHNOLOGY", COIMBATORE-6.** During the Academic year 1998-1999.

This Students put their sincere efforts to complete the Project and We wish them All success in their future endeavors.

Date : 05-03-1999.

Place : Ondipudur-CBE.

For SAKTHI DRIVES.

(Kanda Swamy K.)

Office : 82, WEAVER'S COLONY, ONDIPUDUR, COIMBATORE - 641 016.

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SYNOPSIS

The project deals with design and fabrication of low cast, positive infinitely variable drive. Variable speed drive can be used in numerous industrial applications. The unit is highly efficient which brings infinitely variable speed to countless industrial applications where low cast, space saving and wide ratios are essential consideration.

The unit can be used in all the machine tool where the power transmission is between 1 H.P to 15 H.P. For practical purposes we are attaching the drive unit on a drilling machine with 1 H.P motor.

The project is being sponsored by M/s. SAKTHI DRIVES, COIMBATORE. In the present drilling machine the v-belt speed reduction is used and speed can be changed only in steps. When fitted with PIV drive unit stepless speed variation with in a given range can be obtained. The drive unit can be used in all the places where we require stepless speed variation.

In this report, the design and manufacturing details are given in detail. A detailed cost estimation for the variation components of the drive has also been worked out. The unit was fabricated and fitted to a pillar drilling machine of 25mm drill capacity and found to be working satisfactorily.

CONTENTS

1. INTRODUCTION

SAKTHI DRIVES is a small scale industry making gears and gearboxes. It caters to the needs of Neyveli lignite corporation, Electronic corporation of India Ltd. Etc.

Our project "Design and Fabrication of low cost positive infinitely variable drive" impressed them and on trial basis, they wanted to implement it on one of their drilling machines.

The use of PIV drives is more pronounced in case of continuous processing industries like cement plants, sugar plants, paper mills, food processing machines and also in textile machinery and cranes.

The Company is keen on developing a PIV drive attached to a gear box and which is used in the above applications so that wide range of speeds could be obtained. When a three speed gear box is attached to the PIV drive unit the speed can be varied from 100 rpm to 4000 rpm.

Objectives of the Report

1. To design & fabricate low cost PIV drive.

2. To install the fabricated drive unit on a drilling machine to get stepless speed variation within a given range of 95 rpm to 946 rpm.

2. DESCRIPTION OF THE DRIVE UNIT

The drive unit consists of two variable speed (tapered) pulleys and a belt. One pulley is mechanically operated and the other is spring loaded. Both the pulleys work together on a fixed center distance.

The spring loaded pulley is mounted on to the output or driven shaft. I.e., the spindle of the drilling machine. The mechanically adjustable pulley is mounted on to the input or driving shaft, i.e., motor shaft.

The characteristics of the spring loaded pulley is such that an ideal pressure is exerted on the variable speed belt ensuring transmission of maximum power.

To ensure true running of the belt at all speeds it is important to see that the fixed halves of the expanding pulleys are on the opposite sides.

To maintain the same center distance and belt tension when one pulley moves out the other pulley should move in. The movement of pulley is done on the motor side using screw spindle arrangement. In the other side, the pulley is moved automatically due to the spring load.

When the mechanically adjusted pulley is moved out, the belt slips and falls into the lower diameter. When the mechanically adjusted pulley is moved in, the belt climbs and seats in the upper diameter.

When the belt runs at the minimum diameter on the motor side, it runs at the maximum diameter on the spindle side and vice versa.

Due to this variation in diameter the output speed changes. We can stop the belt at practically at all positions of diameter within a range. So we can get the speed variation within the range of 95 rpm to 946 rpm.

Specification

Power to be transmitted	=	1 HP
Center Distance	=	250mm
Minimum output speed	=	0.317 x Input speed
Maximum output speed	=	3.15 x Input speed
Input speed	=	300 rpm
∴ Minimum output speed	=	95 rpm
Maximum output speed	=	946 rpm
Speed ratio	=	9.9

3. DESCRIPTION OF MAIN PARTS

3.1 Motor Sleeve *(Refer DRG No : PIV 01)*

Motor sleeve is a hollow shaft. The motor sleeve is inserted into the motor shaft. The power is transmitted from the motor shaft to the sleeve through key. In the outer diameter of the hollow shaft the adjustable pulley moves. The power is transmitted from the sleeve to adjustable pulley through keys. To limit the maximum extension of the adjustable pulley a circlip is provided at the top end of the sleeve.

There is a boss at the bottom end with four holes. The fixed pulley is inserted into the motor sleeve and is fixed to the sleeve by four bolts through which the power is transmitted.

The motor sleeve material is mild steel – C45.

3.2 Adjustable Pulley on Motor side *(Refer DRG No : PIV 02)*

Adjustable pulleys are made of cast iron. The adjustable pulley move on the motor sleeve. The extreme movement on the motor sleeve is arrested by a circlip.

The weight is reduced in the pulley by providing taper on outside faces of the pulley. This is taken care to reduce the unnecessary moment of inertia produced by the rotating mass.

The power is transmitted from the motor sleeve to adjustable pulley through key. A bearing is provided in the boss provided at the extension of the pulley. The bearing is used between the rotating pulley and the non-rotating pulley moving mechanism. The bearing is arrested by providing circlip on the pulley hub.

3.3 Fixed pulley (on both motor side & spindle side)

(Refer DRG No : PIV 03)

Fixed pulley are also made of cast iron. The fixed pulley is fixed to the sleeve using four bolts. The power is transmitted from the motor sleeve to the fixed pulleys through the bolts.

Similarly in the fixed pulleys also the unnecessary weight is reduced so as to reduce the moment of inertia produced by the rotating mass.

The fixed pulley has a bore through which it is inserted into the sleeve. The taper angle provided with the vertical is 14^0.

3.4 Spindle sleeve *(Refer DRG No : PIV 04)*

Spindle sleeve is a hollow shaft that is inserted over The spindle of the drilling machine. It is made of mild steel c45. The power is transmitted from the spindle to the sleeve by key. The fixed pulley is fixed to the spindle sleeve by bolts. The power is transmitted from the spindle sleeve to the adjustable pulley through key. The spring hub is inserted into the spindle sleeve. The further movement of spring is arrested by providing a circlip The adjustable pulley moves on the outer surface of the sleeve and the spring presses the adjustable pulley towards fixed pulley.

3.5 Adjustable pulley on spindle sleeve *(Refer DRG No : PIV 05)*

Adjustable pulley is made of cast iron. The pulley has a bore through which the pulley is inserted over the sleeve. The pulley has a small boss. The adjustable pulley moves over the spindle sleeve. The adjustable pulley is moved towards the fixed pulley due to the pressing action of spring. The adjustable pulley moves away from the fixed pulley against the spring force.

Similarly in this pulley the taper angle is 14° to the vertical and the unnecessary weight is reduced in the pulley to reduce the moment of inertia produced by the rotating masses.

3.6 Main housing *(Refer DRG No : PIV 06)*

Main housing is fixed over a bearing which is fixed on the adjustable pulley on the motor shaft. The main housing is made of c45 material and a steel plate is welded on the other side of the housing. The steel plate that is bent in the shape of 'U' with the nut at the center. The nut and bore of the housing are though.

There is a circlip groove on the bore of the housing to fix a cirdip The circlip prevents the housing from sliding over the bearing. The housing moves up and down there by moving the adjustable pulley care is to be taken at the time of machining so that the nut and the bore of the housing is through.

Two holes are provided on the outer diameter so that the grub screw on the screw spindle housing can be loosened so that the unit can be totally lifted up at the time of dismantling.

3.7 Motor side collar *(Refer DRG No : PIV 07)*

The collar is made of C45. It has bore through which a bolt is put. The collar is used to fix the motor sleeve firmly to the motor shaft. The bolt is threaded into tapped hole on the face of the motor shaft.

3.8 Screw spindle housing *(Refer DRG No : PIV 08)*

Screw spindle housing is like a hollow shaft. The material used is C45. The screw spindle is fixed on the collar through grub screws. There is a bearing that is fixed in the housing. The screw spindle is supported at one end through this bearing.

3.9 Screw Spindle *(Refer DRG No : PIV 09)*

Screw spindle is made of C45. It is supported at one end at the screw spindle housing and a nut is at the other end. There is a flat machined at the extreme and to provide a handle for rotating the screw spindle. When the screw spindle is rotated, the nut moves up and down, which in turn moves the adjustable pulley on the motor side up and down.

3.10 Spring hub *(Refer DRG No : PIV 10)*

Spring hub is used to fix the spring plates. The material used is C45 and it has 8 holes drilled equispaced. Through this hole a rivet is used and plate springs are fixed. The movement of spring hub is arrested by providing a circlip on the spindle sleeve.

3.11 Spring Plates *(Refer DRG No : PIV 11)*

Spring plates are used to push the adjustable pulley on the spindle side. There are 8 spring plates that are attached to the spring hub. The material used is spring steel which is bent to shape and then hardened and tempered.

3.12 Belt

The belt used is a special purpose variable speed belt. The belt width is 40 mm and has an inside length of 39 inches. The belt has an included angle of 28 degrees. The belt has some teeth cut on the bottom for better foldment.

4. DESIGN OF PARTS

4.1 Design of Belt

Angle of groove, $2\beta = 28^0$

Coefficient of friction, $\mu = 0.2$

$$\frac{N_2}{N_1} = \frac{d_1}{d_2}$$

Where,

N_1 - Motor speed in rpm

N_2 - Speed of spindle in rpm

d_1 - diameter of smaller pulley in mm

d_2 - diameter of larger pulley in mm

$$\frac{N_2}{300} = \frac{65}{205}$$

$N_2 = 95.12$ rpm

$$\frac{N_2}{300} = \frac{205}{65}$$

$$N_2 = 947.15 \text{ rpm}$$

$$\text{Velocity of belt } v = \frac{\pi dN}{60}$$

$$= \frac{\pi \times 65 \times 10^{-3} \times 300}{60}$$

$$= 1.021 \text{ m / sec}$$

For an open belt drive

$$\text{Sin } \alpha = \frac{d_1 - d_2}{2x}$$

$$= \frac{205 - 65}{2 \times 250}$$

$$= 0.28$$

$$\alpha = \sin^{-1} [0.28]$$

$$= 16.26$$

Angle of contact $\theta = 180 - 2\alpha$

$= 180 - 2 (16.26)$

$= 147.48$

$$\theta = 147.48 \text{ x} - 2 \frac{\pi}{180}$$

$= 2.57$ rad

We know that

$2.3 \log (T_1/T_2) = \mu \theta \text{ cosec } \beta$

$2.3 \log (T_1/T_2) = 0.2 \text{ x } 2.57 \text{ cosec } 14$

$2.3 \log (T_1/T_2) = 2.124$

$\log (T_1/T_2) = 0.924$

$T_1/T_2 = 8.375$

$T_1 = 8.375 T_2$

Power transmitted by the belt

$P = (T_1 - T_2)v$

$746 = (T_1 - T_2) 1.021$

$T_1 - T_2 = 730.65$

$$8.375\,T_2 - T_2 = 730.65$$

$$(8.375-1)T_2 = 730.65$$

$$T_2 = 99.07\ N$$

$$T_1 = 8.375\,T_2$$

$$= 8.375 \times 99.07$$

$$= 829.72\ N$$

Nominal pitch length of belt, L

$$L = 2C + \frac{\pi}{2}(D + d) + \frac{(D - d)^2}{4c}$$

$$= 2 \times 250 + \frac{\pi}{2}(205 + 65) + \frac{(205-65)^2}{4 \times 250}$$

$$= 943.71\ mm$$

From DDB,for L = 950 mm.

Nominal inside length = 914 mm.

4.2 Design of Bearings

4.2.1 Bearing for main housing

Axial load, F_a = 829.72 cos14

= 805.07N

= 80.507 kgf

Radial lasd, F_r = 829.72 sin14

= 200.72 N

= 20.072 kgf

From page No4.4, DDB

Assume $\frac{Fa}{co} = 0.5, \quad e = 0.44$

$$\frac{Fa}{Fr} = \frac{80.507}{20.072} = 4.01$$

Since $\frac{Fa}{Fr} > e$

$X = 0.56,$

$Y = 1.0$

From Page no 4.2

Service factor, s = 1.3

Equivalent load, P = (X Fr +Y Fa)s

= (0.56 x 20.072+1 x 80.507) x 1.3

= 119.27 kgf

DYNAMIC CAPACITY

$$C = \left(\frac{L}{L10}\right)^{1/K} \times P$$

Where

L = Life of bearing in million revolution.

L_{10} = Life of bearing for 90% survival at 1mr.

L_{10} = 1mr and k = 3 for ball bearing.

Let L = 10,000 hours

$$= \frac{10000 \times 300 \times 60}{10^6}$$

= 180mr

$$C = \left(\frac{180}{1}\right)^{1/3} 119.27$$

$$= 673.42 \text{ Kgf}$$

From page 4.12

For d = 70mm

Selected bearing is SKF 6014

D = 110mm

B = 20mm

C = 3000 kgf

As the calculated C value is less than the tabulated value. Design is safe.

4.2.2 Bearing For Screw Spindle

Axial Load, Fa = 805.07N = 80.507 Kgf

From page no. 44

Assume $\frac{Fa}{co} = 0.5, \quad e = 0.44$

$$\frac{Fa}{Fr} = \frac{80.507}{0} = \alpha$$

Since $\frac{Fa}{Fr} > e$

$X = 0.56,$

$Y = 1$

From Page no 4.2

Equivalent load, $P = (X\,Fr + Y\,Fa)s$

$= (0.56 \times 0 + 1 \times 80.507) \times 1.3$

$= 104.6591$ kgf

Assume life $L = 10000$ hours

$$= \frac{10000 \times 300 \times 60}{10^6}$$

$= 180$ mr

DYNAMIC CAPACITY

$$C = \left(\frac{L}{L10}\right)^{1/K} \times P$$

L_{10} = 1mr and K = 3 for ball bearing

$$C = \left(\frac{180}{1}\right)^{1/3} 104.6591$$

$$= 590.92 \text{ Kgf}$$

From page 4.12

For d = 20mm

Selected bearing is SKF 6004

D = 42mm

B = 20mm

C = 735kgf

Since calculated dynamic capacity is less than the tabulated value. Design is safe.

DESIGN OF KEY

$$\text{Power, } p = \frac{2\pi NT}{60}$$

$$T = \frac{P \times 60}{2\pi N} = \frac{746 \times 60}{2 \times \pi \times 300}$$

$$= 23.745 \text{ N-M}$$

$$= 23.745 \times 10^3 \text{ N-mm}$$

$$\text{Torque transmitted, } T = L\, w\, f_s\, d / 2$$

$$23.745 \times 10^3 = 60 \times 6 \times F_s \times 50/2$$

$$Fs = 2.638 \text{ N/mm}^2$$

$$< 360 \text{ N/mm}^2$$

Therefore the design is safe.

In the drive unit, all the keys have a width of 6mm, since this key runs on maximum diameter it is probable for failure in shear. As other keys are fitted to lesser diameter shafts they are safe.

Selection of Circlip

Circlip for the sleeve

From page No. 5.4, DDB

For shaft diameter,

$d_1 = 50mm$

$N = 4mm$

$M_1 = 2mm$

$d_2 = 47mm$

Circlip for the bearing

For shaft diameter

$d_1 = 70mm$

$N = 4.5\ mm$

$M_1 = 2.15mm$

$d_2 = 67mm$

Internal circlip for the main housing

For Shaft diameter

$d_1 = 110mm$

$N = 5.3mm$

$M_1 = 3.15mm$

$d_2 = 114mm$

Design of Springs

Displacement = 35mm

Axial Load on the pulley = 829.72 N

Weight of the pulley = 70N

∴ Axial load acting on the springs = 829.72 +70

= 899.72 N

∴ Axial load acting on each spring plate = $\frac{899.72}{8}$

= 112.465 N

Stiffness of each spring plate = $\frac{112.465}{35}$

= 3.123 N/mm

5. PARTS LIST

5.1 List of Manufactured Parts

Drg. No.	Part Name	Material	Quantity	Stock Size
PIV - 01	Motor Sleeve	C45	1	ϕ 90 x 167 mm
PIV - 02	Adjustable pulley on Motor side	CI	1	Flange ϕ 217 x 30 - ϕ 85 x 36
PIV - 03	Fixed pulley	CI	2	Flange ϕ 217 x 30 - ϕ 92 x 30
PIV - 04	Spindle scheme	C45	1	ϕ 90 x 215mm
PIV - 05	Adjustable pulley on Spindle Sleeve	CI	1	Flange ϕ 217 x 30 - ϕ 85 x 30
PIV - 06	Main Housing	C45	1	ϕ 140 x 80mm
PIV - 07	Motor Side Collar	C45	1	ϕ 50 x 40 mm
PIV - 08	Screw Spindle Housing	C45	1	ϕ 65 x 70mm
PIV - 09	Screw Spindle	C45	1	ϕ 30 x 115mm
PIV - 10	Spring Hub	C45	1	ϕ 110 x 5mm
PIV - 11	Spring Plates	Spring steel	1	

5.2 List of Bought-out Items (Standard items)

Standard Item	Quantity
M6 x 16mm Hexagonal Socket Screw	8 Nos
Circlips	
Outside circlip on shaft of dia 70 mm	1 No.
Outside circlip on shaft of dia 50 mm	2 Nos.
Inside Circlip in the bore of dia 110mm	1 No.
Deep groove ball bearing	
SKF 6014 - Shaft dia 70mm	1 No.
SKF 6004 - Shaft dia 20mm	1 No.
Belt	
Variable Speed Belt - 40mm width 39 inches - inside length.	1 No.

MANUFACTURING PROCESS

Part Number : PIV - 01
Part Name : Motor Sleeve

Stock Weight - 8.18 kg
Stock Size - 90 x 170 mm

Quantity : 1
Matl : C45

Operation No.	Operation Details	Machine	Tools	Setup time Min	Operation time Min
1	Fix the job in the chuck and face a side	Lathe	Right Hand tool	5	4
2	Turn outer diameter on the shaft so that the diameter becomes ϕ 50 mm to a length of 148mm from the faced end	Lathe	Right Hand tool	-	15
3	Machine the circlip groove	Lathe	V-Tool	5	3
4	drill the shaft to ϕ 24 mm. Open the hole with pilot drill of smaller diameter	Lathe	Drill Bit	5	30
5	Turn the shaft and hold machine the other side of the face and correct the length to 160mm	Lathe	Right Hand Tool	5	5
6	Turn the diameter and make it as ϕ88mm	Lathe	Right Hand Tool	-	4

Operation No.	Operation Details	Machine	Tools	Setup time Min	Operation time Min
7	Drill ϕ10mm hole at a distance 75mm from the bigger end	Drilling Machine	Drill Bit	5	4
8	Drill 4mm holes ϕ6.5mm at a PCD of 66mm on the larger end	Drilling Machine	Drill Bit	6	4
9	Counter bore each hole to a diameter of 11 mm	Drilling Machine	End Mill Cutter	2	3
10	Mill the key way on the outside face of the sleeve	Milling Machine	End Mill Cutter	4	7
11	Machine the key way slot on the bore of the sleeve	Slotting Machine	Slotting cutter of width 6mm	5	9

MANUFACTURING PROCESS

Part Number : PIV - 02
Part Name : Fixed Pulley

Stock Weight - 12 kg
Stock Size - Flange Max : 217 x 30
Min : 90 x 30

Quantity : 2
Material : CI

Operation No.	Operation Details	Machine	Tools	Setup time Min	Operation time Min
1	Fix the component in the chuck and face so that length becomes 25m on the min diameter side of flange	Lathe	Right Hand tool	5	5
2	Turn the diameter to 88mm to a length of 25 mm	Lathe	Right Hand tool	-	5
3	Under cut the ϕ88mm to 65 mm	Lathe	Parting tool	3	10
4	Chamfer the sharp edge formed between ϕ88mm and ϕ 65 mm	Lathe	V-Tool	3	2
5	Turn the component and hold it on the turned surface and face the flange on the maximum diameter so that the length becomes 25 mm	Lathe	Right Hand Tool	4	10
6	Turn the outside surface so that is becomes ϕ212 to a length of 25 mm	Lathe	Right Hand Tool	-	3

Operation No.	Operation Details	Machine	Tools	Setup time Min	Operation time Min
7	Taper turn on the front face of the pulley on Max. diameter side of the flange.	Lathe	Right hand tool	10	5
8	Taper turn on the back surface of the pulley on max diameter side of the flange.	Lathe	Right hand tool	5	5
9	Turn a flat on the tapered surface on the bulk side	Lathe	Right Hand tool	-	4
10	Turn the inside edge between tapered surface on backside and ϕ65mm so that a radius 6mm curve is formed.	Lathe	Right Hand tool	-	5
11	Champer the edges to 1mm radius on the ϕ212mm	Lathe	Right Hand tool	-	2
12	Fix the part in a boring machine and bore a hole of diameter 50mm	Boring Machine	Micro Bore bar	10	15
13	Drill 4 holes of length 16mm and tap M6 in the holes.	Drilling Machine	Drill Bit	10	15

MANUFACTURING PROCESS

Part Number : PIV - 05
Part Name : Main Housing

Stock Weight - 2 kg
Stock Size - 140 x 80 ; Bore -75mm

Quantity : 1
Material : C45

Operation No.	Operation Details	Machine	Tools	Setup time Min	Operation time Min
1	Hold the part in the lathe chuck and face any one side	Lathe	Right Hand tool	3	4
2	Weld the steel strip to the face of the component	-	-	5	4
3	Turn the diameter to 130mm	Lathe	Right Hand tool	3	5
4	Bore the component to ϕ110 mm to a length of 30mm	Lathe	Boring tool	-	6
5	Step bore the bore to ϕ96 for the next 43mm length	Lathe	Boring tool	-	4
6	Drill the hole ϕ11.5mm in the centre of steel plate and thread M12 in the hole.	Lathe	Drill bit and V-Tool	2	10
7	Drill the ϕ10mm hole on the periphery	Drilling Machine	Drill bit	4	7

MANUFACTURING PROCESS

Part Number : PIV - 09 Stock Weight - 0.65 kg Quantity : 1

Part Name : Screw Spindle Stock Size - 27 x 115mm Material : C45

Operation No.	Operation Details	Machine	Tools	Setup time Min	Operation time Min
1	Fix the part in the chuck and face one side	Lathe	Right Hand tool	2	2
2	Turn to ϕ10mm for a length of 20mm	Lathe	Right Hand tool	-	2
3	Turn to ϕ12 mm for a length of 64mm	Lathe	Right Hand tool	-	4
4	Under cut to ϕ10mm to a length of 2mm	Lathe	Parting tool	1	2
5	Turn to ϕ20mm to a length of 12mm	Lathe	Right Hand tool	1	2
6	Thread M12 to a length of 64mm	Lathe	V-Tool	3	10
7	Turn to ϕ25 to a length of 4mm	Lathe	Right Hand Tool	1	2
8	Slot the square of 8mm	Shaping machine	Slotting tool	3	10

7. COST ANALYSIS

A process planning is not complete until one has a good idea the cost required to manufacture the product. Generally a lower cost design will be successfully in an open market also.

The constituents of cost can be broadly grouped into

1. Direct costs
2. Indirect costs
3. Total Costs

Direct costs are costs that includes material cost, labour cost, machining cost etc. Material cost is the cost of the material which goes into finished product and includes all the scrap, that has been removed from the finished component. Labour cost and machining costs are that cost which are incurred in processing the materials.

Indirect costs are the cost of the factors which can only be indirectly attributed to the manufacture of specific product. They are some time called as overhead cost.

The total cost of a product is the sum of both direct and indirect costs.

Drg No.	Part Name	Material	Wt Kg	Rate/Kg	Qty	Material Cost in Rs.	Machining Cost in Rs.	Total Cost in Rs.
PIV-01	Motor Sleeve	C45	8.18	22	1	180	250	430
PIV-02	Adjustable Pulley on Motor Side	CI	12	20	1	240	215	455
PIV-03	Fixed Pulley	CI	12	20	2	480	385	865
PIV-04	Spindle Sleeve	C45	11	22	1	242	286	528
PIV-05	Adjustable Pulley on Spindle side	CI	12	20	1	240	164	404
PIV-06	Main Housing	C45	2	22	1	44	250	294
PIV-07	Collar on Motor side	C45	0.7	22	1	16	25	41
PIV-08	Screw Spindle Housing	C45	2	22	1	44	35	79
PIV-09	Screw Spindle Housing	C45	0.65	22	1	15	90	105

Cost of Standard Parts

Parts	Qty	Rate
M6 x 16 mm Hexagonal socket screw	8 Nos.	Rs.10
6014 Ball Bearing	1 No.	Rs. 315
6004 Ball Bearing	1 No.	Rs. 40
Circlips	4 Nos.	Rs. 95
Spring Assembly	1 No.	Rs. 250
Belt	1 No.	Rs. 700

Total cost of Standard parts = Rs. 1410/-

Total Material cost = Rs. 1501/-

Total Machining cast = Rs. 1700/-

Total cost of standard parts = Rs. 1410/-

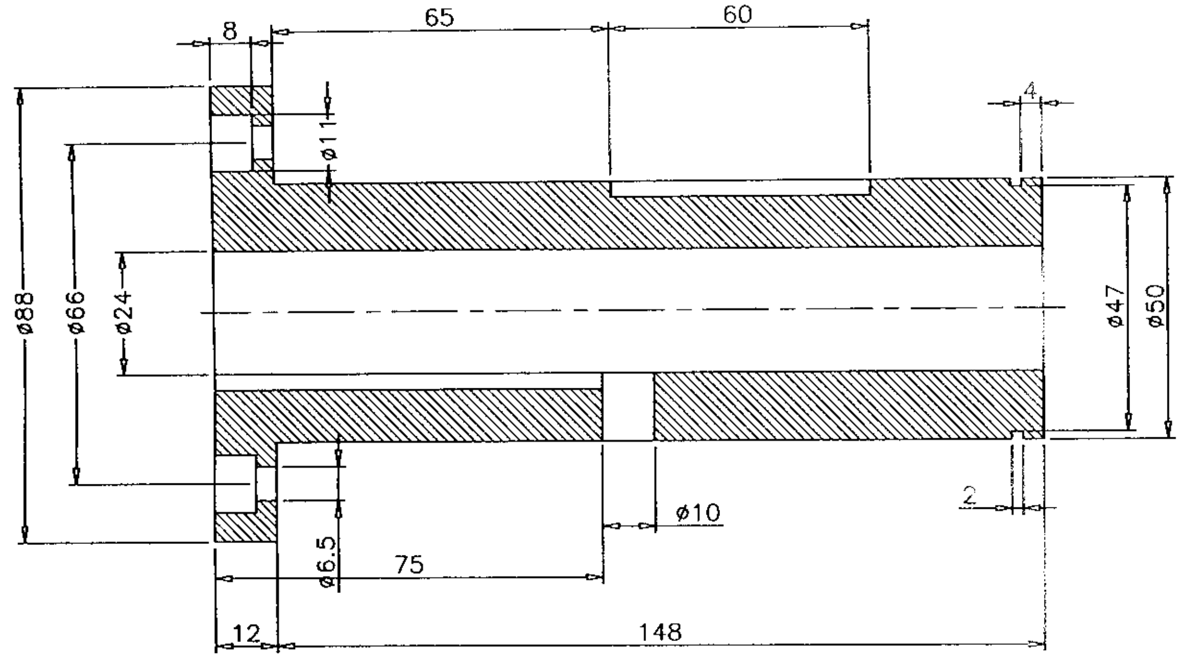
Machining cost includes labour cast also.

Machining time includes setting time also.

Over all cost = Total Material cost + Total Machining cost + Total cost of standard parts

= 1501 + 1700 + 1410

= Rs. 4611/-



	SIGNATURE	DATE
DRAWN		
CHECKED		
APPROVED		

(▽ ▽▽)

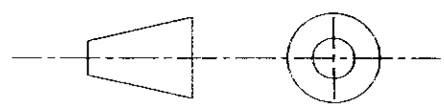
QUANTITY	MATERIAL
1	MS

TOLERANCE (MEDIUM) IS 2102 :

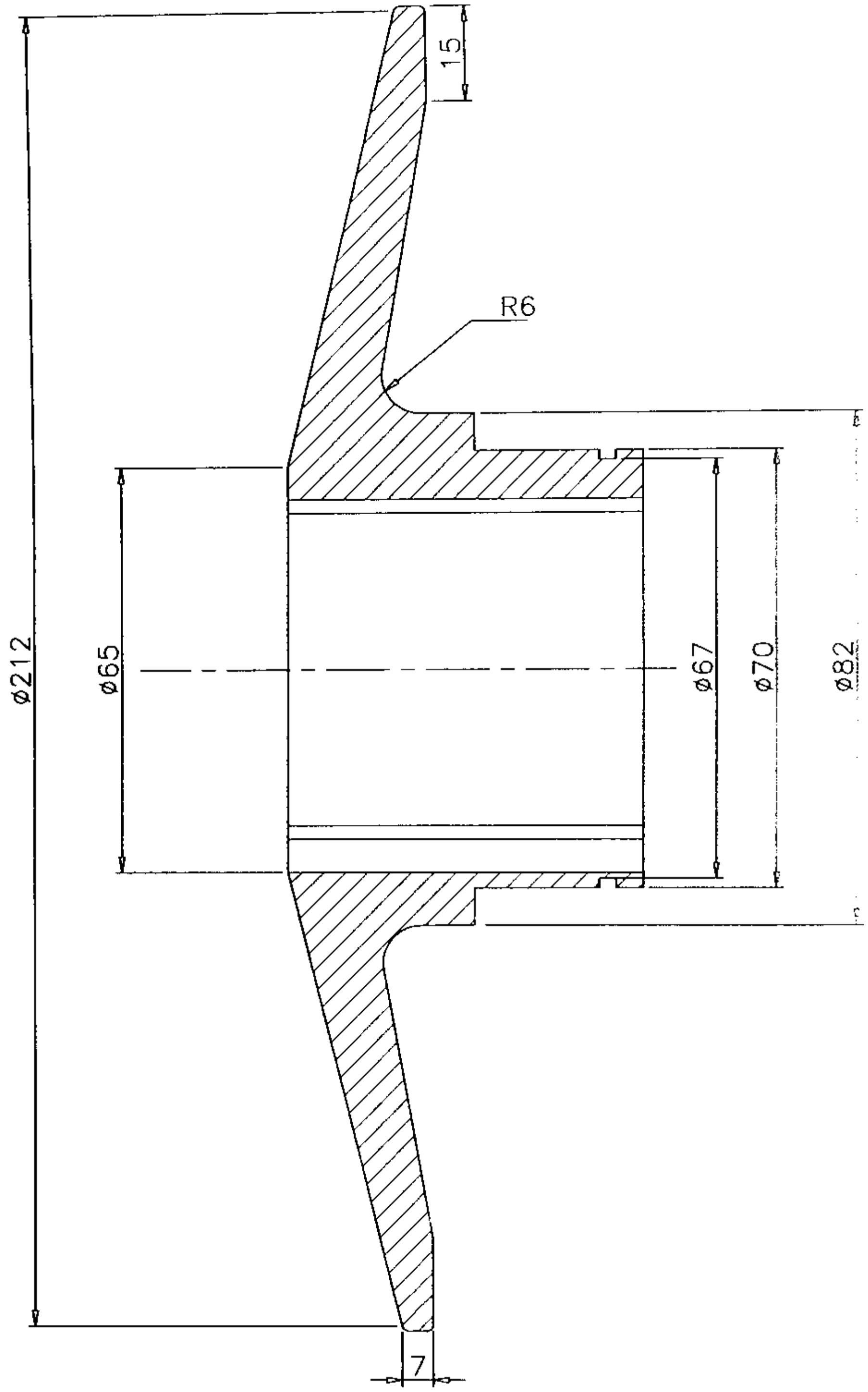
0.5/6	6/30	30/120	120/300	300/1000
±0.1	±0.2	±0.3	±0.5	±0.8

SAKTHI DRIVES.
COIMBATORE–641016.

TITLE	MOTOR SLEEVE
SCALE	
N.T.S	



---	PIV 01
STOCK SIZE	DRAWING NUMBER



	SIGNATURE	DATE
DRAWN		
CHECKED		
APPROVED		

(▽ ▽▽)

QUANTITY	MATERIAL
1	CI

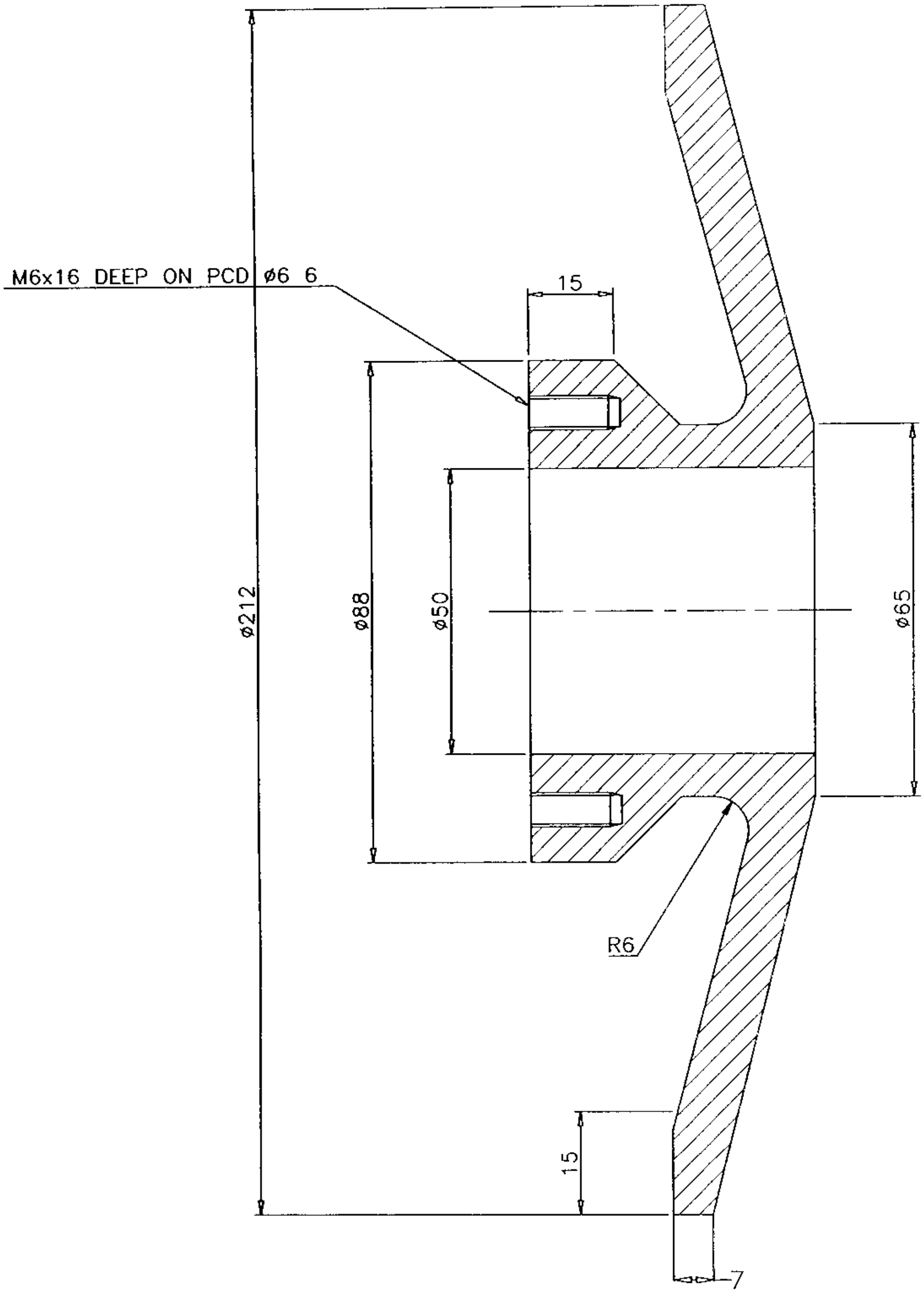
TOLERANCE (MEDIUM) IS 2102 :

0.5/6	6/30	30/120	120/300	300/1000
±0.1	±0.2	±0.3	±0.5	±0.8

SAKTHI DRIVES.
COIMBATORE–641016.

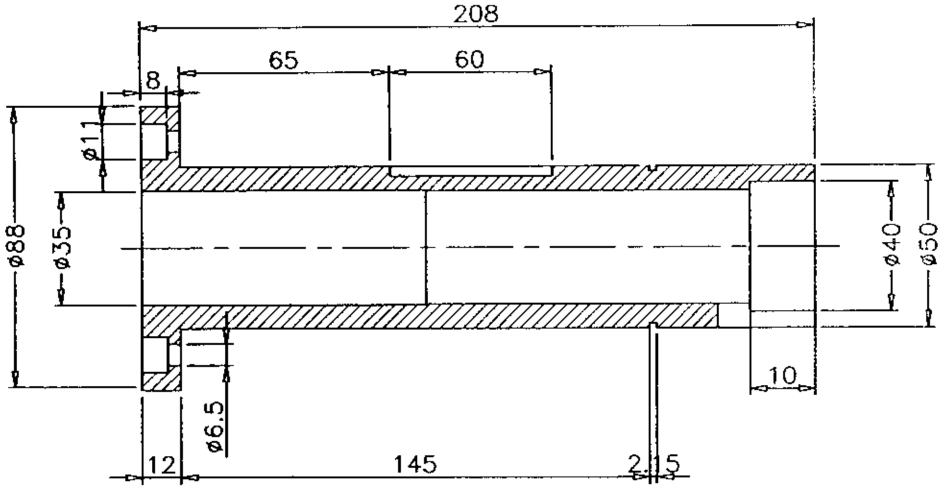
TITLE	ADJ PULLEY ON MOTOR SIDE
SCALE	
N.T.S	

---	PIV 02
STOCK SIZE	DRAWING NUMBER



	SIGNATURE	DATE	SAKTHI DRIVES. COIMBATORE–641016.	
DRAWN				
CHECKED				
APPROVED			TITLE	FIXED PULLEY
(▽ ▽▽)			SCALE	
QUANTITY	MATERIAL		N.T.S	
2	C.I			

TOLERANCE (MEDIUM) IS 2102 :						
0.5/6	6/30	30/120	120/300	300/1000	---	PN 03
±0.1	±0.2	±0.3	±0.5	±0.8	STOCK SIZE	DRAWING NUMBER



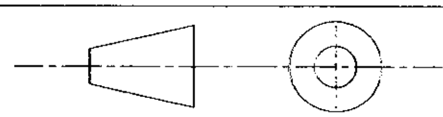
	SIGNATURE	DATE
DRAWN		
CHECKED		
APPROVED		

(▽ ▽▽)

QUANTITY	MATERIAL
1	MS

SAKTHI DRIVES.
COIMBATORE–641016.

TITLE	SPINDLE SLEEVE
SCALE	
N.T.S	



TOLERANCE (MEDIUM) IS 2102 :

0.5/6	6/30	30/120	120/300	300/1000
±0.1	±0.2	±0.3	±0.5	±0.8

STOCK SIZE	DRAWING NUMBER
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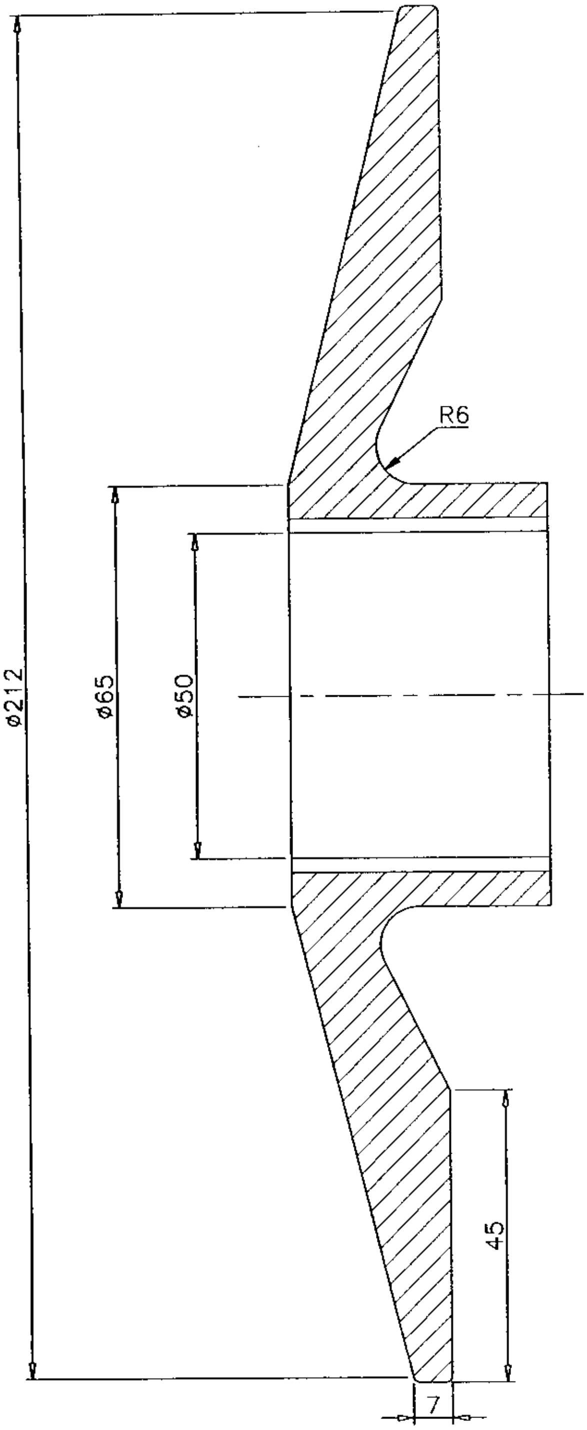


	SIGNATURE	DATE
DRAWN		
CHECKED		
APPROVED		

(▽ ▽▽)

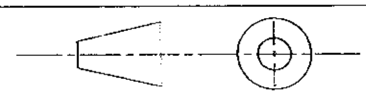
QUANTITY	MATERIAL
1	C.I

TOLERANCE (MEDIUM) IS 2102 :

0.5/6	6/30	30/120	120/300	300/1000
±0.1	±0.2	±0.3	±0.5	±0.8

SAKTHI DRIVES.
COIMBATORE–641016.

TITLE	ADJUSTABLE PULLEY ON SPINDLE SIDE
SCALE	
N.T.S	



STOCK SIZE	DRAWING NUMBER
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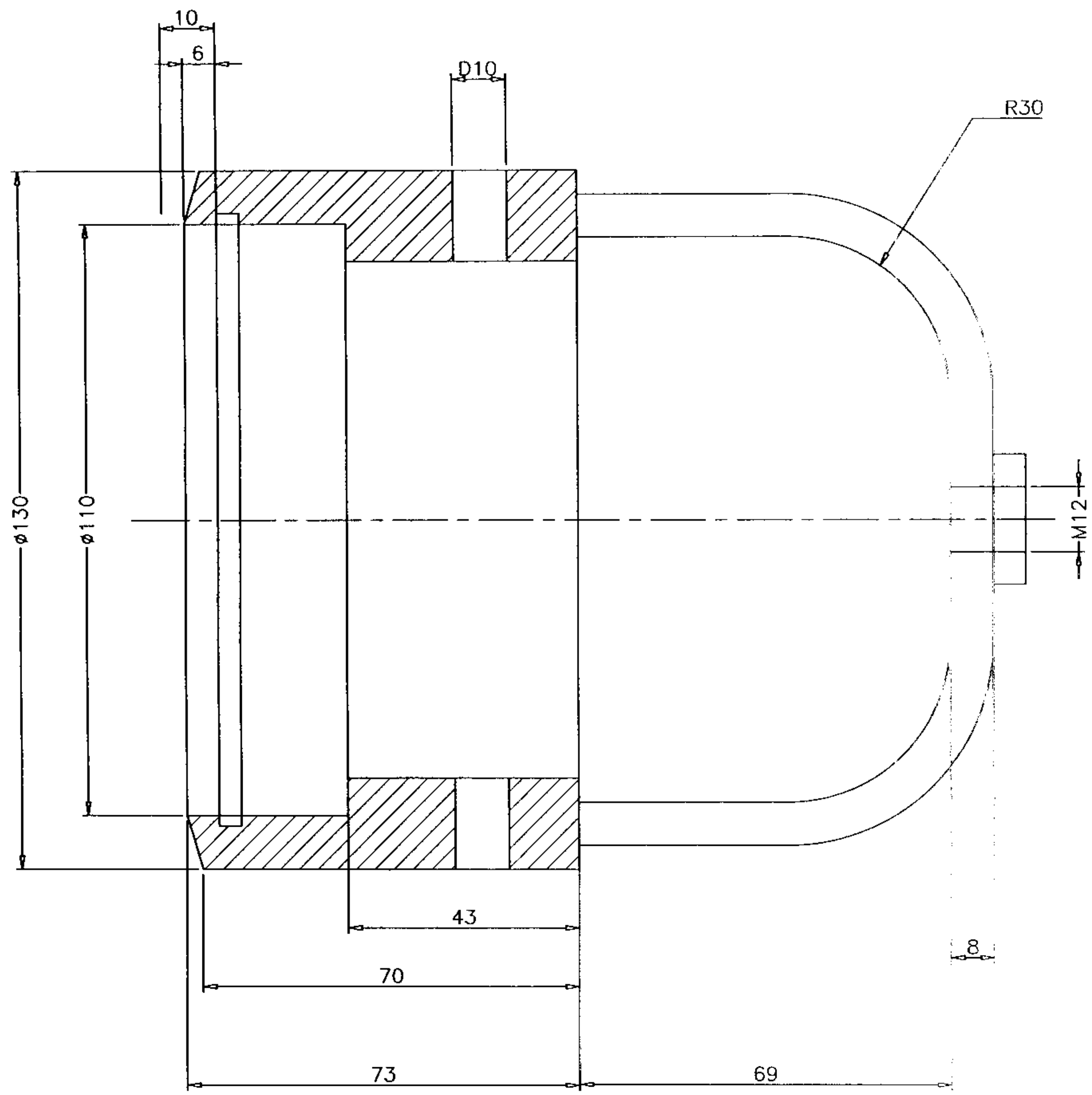
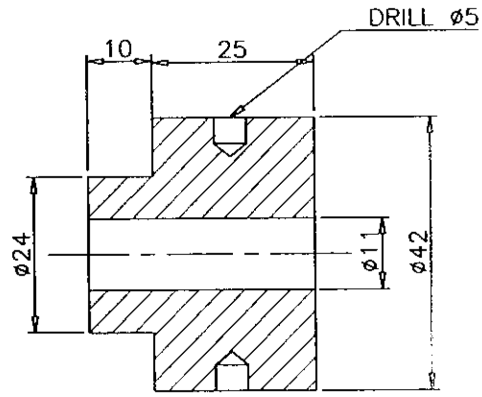


	SIGNATURE	DATE	SAKTHI DRIVES. COIMBATORE–641016.	
DRAWN				
CHECKED				
APPROVED			TITLE	MAIN HOUSING
(▽ ▽▽)			SCALE	
QUANTITY	MATERIAL		N.T.S	
1	MS			

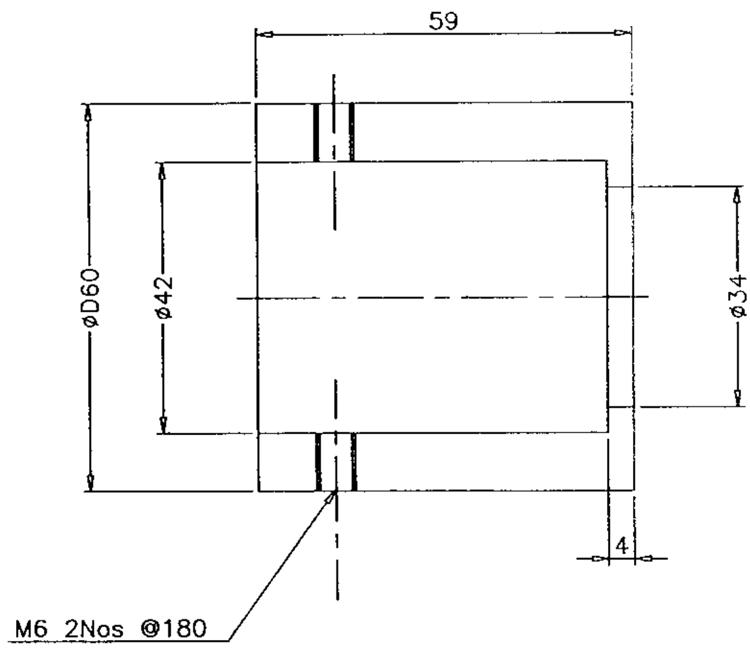
TOLERANCE (MEDIUM) IS 2102 :				
0.5/6	6/30	30/120	120/300	300/1000
±0.1	±0.2	±0.3	±0.5	±0.8

---	PIV C6
STOCK SIZE	DRAWING NUMBER



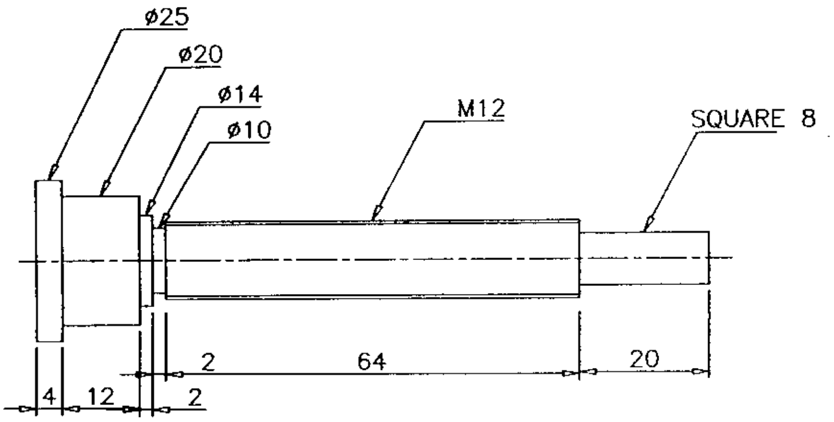
	SIGNATURE	DATE	SAKTHI DRIVES. COIMBATORE–641016.	
DRAWN	KUMAR G.			
CHECKED				
APPROVED			TITLE	COLLAR ON MOTOR SIDE
(▽ ▽▽)			SCALE	
QUANTITY	MATERIAL		N.T.S	
1	M.S			

TOLERANCE (MEDIUM) IS 2102 :						
0.5/6	6/30	30/120	120/300	300/1000	---	P.V 07
±0.1	±0.2	±0.3	±0.5	±0.8	STOCK SIZE	DRAWING NUMBER



	SIGNATURE	DATE	SAKTHI DRIVES. COIMBATORE–641016.	
DRAWN				
CHECKED				
APPROVED			TITLE	SCREW SPINDLE HOUSING
(▽ ▽▽)			SCALE	
QUANTITY	MATERIAL		N.T.S	
1	MS			

TOLERANCE (MEDIUM) IS 2102 :						
0.5/6	6/30	30/120	120/300	300/1000	---	PIV 08
±0.1	±0.2	±0.3	±0.5	±0.8	STOCK SIZE	DRAWING NUMBER



SAKTHI DRIVES.

COIMBATORE-641016.

	SIGNATURE	DATE
DRAWN		
CHECKED		
APPROVED		

(▽ ▽▽)

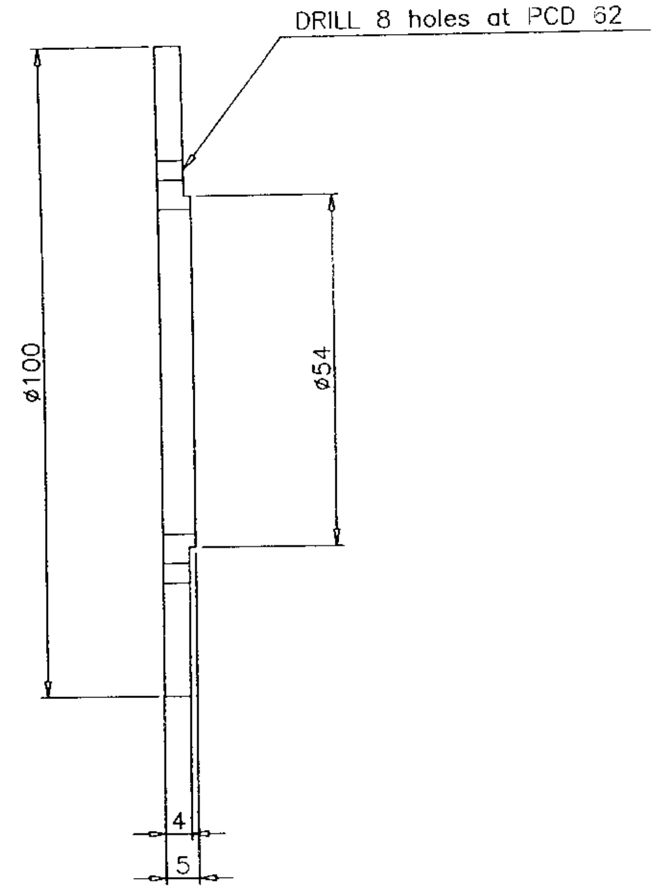
QUANTITY	MATERIAL
1	M.S.

TOLERANCE (MEDIUM) IS 2102 :

0.5/6	6/30	30/120	120/300	300/1000
±0.1	±0.2	±0.3	±0.5	±0.8

TITLE	SCREW SPINDLE
SCALE	
N.T.S	

STOCK SIZE	DRAWING NUMBER
---	PIV 09



	SIGNATURE	DATE
DRAWN		
CHECKED		
APPROVED		

(▽ ▽▽)

QUANTITY	MATERIAL
1	STEEL

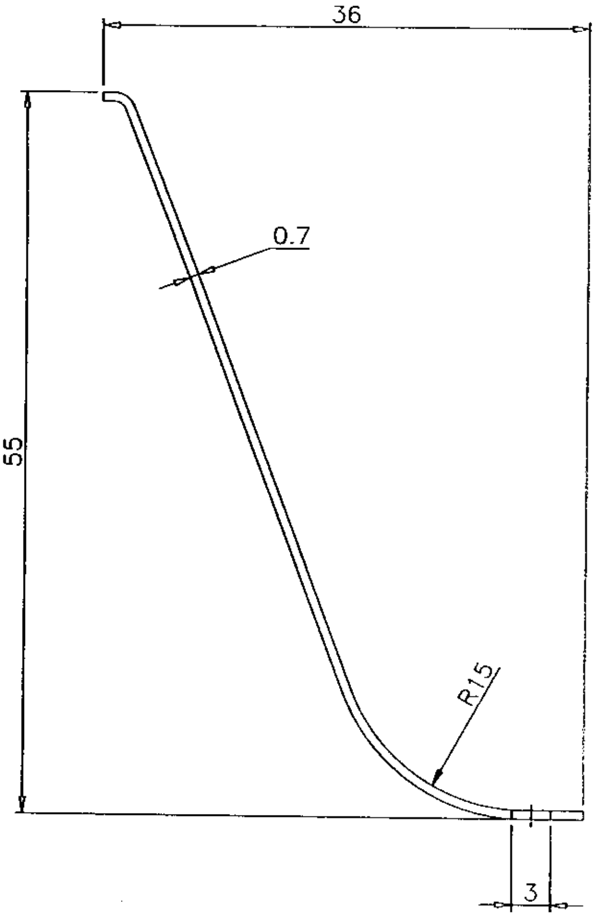
TOLERANCE (MEDIUM) IS 2102 :

0.5/6	6/30	30/120	120/300	300/1000
±0.1	±0.2	±0.3	±0.5	±0.8

SAKTHI DRIVES.
COIMBATORE–641016.

TITLE	SPRING HUB
SCALE	
N.T.S	

STOCK SIZE	DRAWING NUMBER
---	PIV 10



	SIGNATURE	DATE
DRAWN		
CHECKED		
APPROVED		

(▽ ▽▽)

QUANTITY	MATERIAL
8	STEEL

TOLERANCE (MEDIUM) IS 2102 :

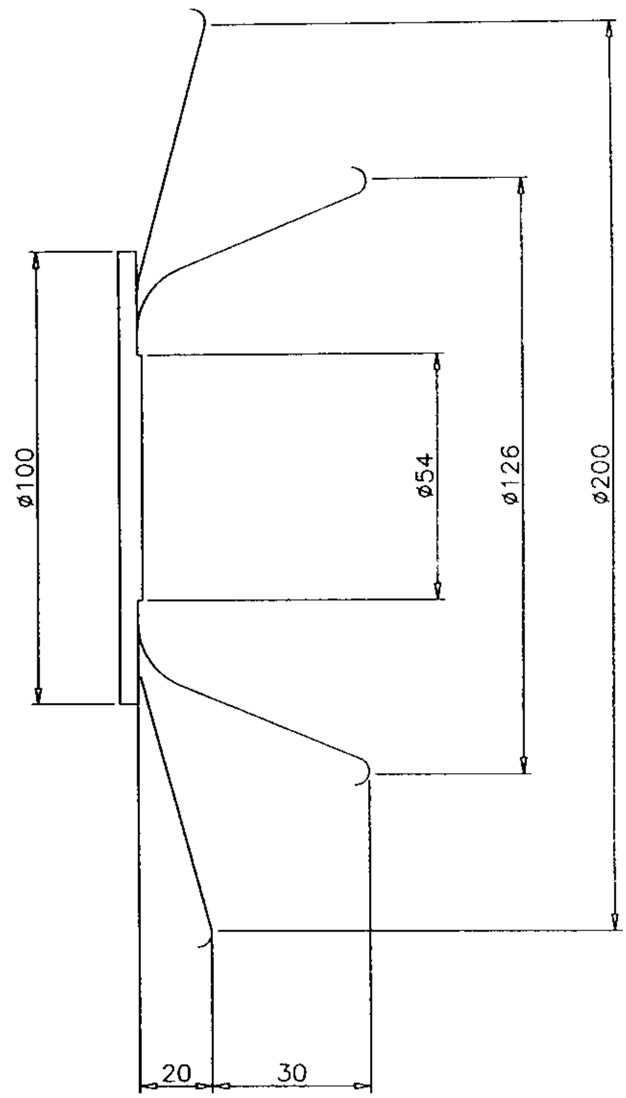
0.5/6	6/30	30/120	120/300	300/1000
±0.1	±0.2	±0.3	±0.5	±0.8

SAKTHI DRIVES.

COIMBATORE-641016.

TITLE	SPRING PLATE
SCALE	
N.T.S	

STOCK SIZE	DRAWING NUMBER
---	PIV 12



	SIGNATURE	DATE
DRAWN		
CHECKED		
APPROVED		

(▽ ▽▽)

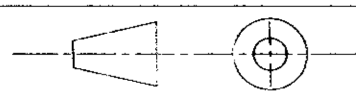
QUANTITY	MATERIAL
1	STEEL

TOLERANCE (MEDIUM) IS 2102 :

0.5/6	6/30	30/120	120/300	300/1000
±0.1	±0.2	±0.3	±0.5	±0.8

SAKTHI DRIVES.
COIMBATORE–641016.

TITLE	SPRING ASSEMBLY
SCALE	
N.T.S	



---	PIV 12
STOCK SIZE	DRAWING NUMBER

10. CONCLUSION

Thus the project entitled "Design and fabrication of low cost, positive infinitely variable drive" was successfully fabricated and was attached to drilling machine.

By using this drive unit the speed at the spindle was attained between 95 rpm and 946 rpm which was required for different cutting conditions.

The cost of the drive unit was found to be Rs. 4,611 /-.

BIBLIOGRAPHY

1.Machine tool Design by R.K.JAIN

2.CMTI - Design hand book

3.Tool Design - CMTI

4.Production Technology by R.K.JAIN

5.PSG Design Data Book

-Design of belt P.No 7.58

-Design of Shaft P.No 7.21

-Design of Bearing P.No 4.12

-Selection of circlip P.No 5.3

-Design of Keys P.No 5.16

-Selection of Materials P.No 1.1

6. Design of Machine elements -GUSTAV NIEMANN

7. Handbook of Design Components -Catalogue