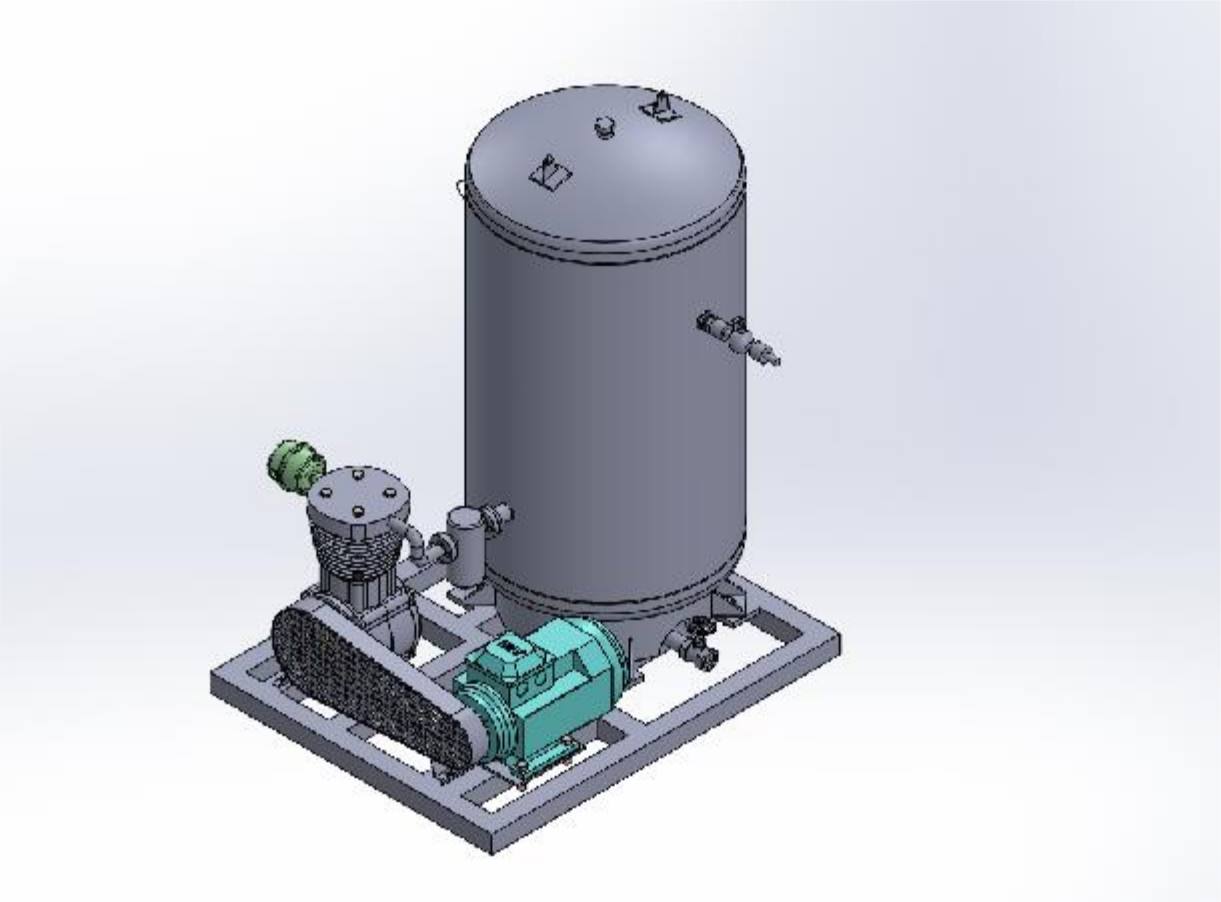
RECIPROCATING AIR COMPRESSOR (STATIONARY)



BY:
Priyanka Anantha (04)
Ashutosh Bansode (09)
Angad Boralkar (12)
Pritesh Chaudhari (13)
Supriya Bhujbal (11)

SIZING OF COMPRESSOR

Input data:

1.	No. of stages	:	1
2.	No. of cylinders	:	1
3.	Working pressure	:	10 bar
4.	FAD	:	0.24 m^3/min
5.	Standard pressure	:	1 bar
6.	Standard temperature	:	293 K
7.	Medium of cooling	:	Air
8.	Lubrication	:	Splash lubrication

Assumptions

1.	Inlet temperature	:	300 K
2.	Inlet Pressure	:	1.01325 bar
3.	Compressor speed	:	750 rpm
4.	Clearance ratio	:	0.05
5.	D/L ratio	:	1
6.	Compression index	:	1.35
7.	Mechanical efficiency	:	0.92
8.	Motor efficiency	:	0.86

Property	Symbol	Formula	value	Design value	Unit
GIVEN DATA					
Maximum pressure	P_{max}		10		bar
FAD			0.24		m^3/min
std. pressure	P_{std}		1		bar
std. temp	T_{std}		293		K
ASSUMPTIONS					
inlet temp	T_1		300		K
inlet pressure	P_1		1.01325		bar
compressor speed	N_1		750		rpm
clearance ratio	k		0.05		
Bore to stroke ratio	D/L		1		
compression index	n		1.35		
mech efficiency	η_{mech}		0.92		
motor effciency	η_{motor}		0.86		
CALCULATIONS					
V_1-V_4		$\frac{FAD * P_{std} * T_1}{T_{std} * P_1}$	0.24252039		m^3
$V_{s(eff)}$		$\frac{V_1 - V_4}{N_1}$	0.00032336		m^3
V_3		$\frac{V_{s(eff)}}{1 + \left(\frac{1}{k}\right) - (P_{max}/P_1)^{\left(\frac{1}{n}\right)}}$	2.0797E-05		m^3
V_1		$21 * V_3$	0.00043673		m^3
stroke volume	Vs	V_1-V_3	0.00041593		m^3
Bore	D	$\sqrt[3]{\frac{4 * Vs}{\pi}}$	0.08090556	81	m
cylinder thickness	t	1.6+(0.045*D*1000)	5.24075041		mm
Stroke length	L		0.08090556	81	m
work per cycle	W	$(\frac{n}{n-1} * P_1 * V_{s(eff)} * 10^5 * (P_{max}/P_1)^{(n-1/n)}) - 1$	102.417614		J/cycle
power required	P_{req}	$W * N_1 * /60000$	1.28022017		KW
overall efficiency	$\eta_{overall}$		0.7912		
motor power input	P_{in}	$P_{req}/\eta_{overall}$	1.61807403		KW

DESIGN OF CYLINDER

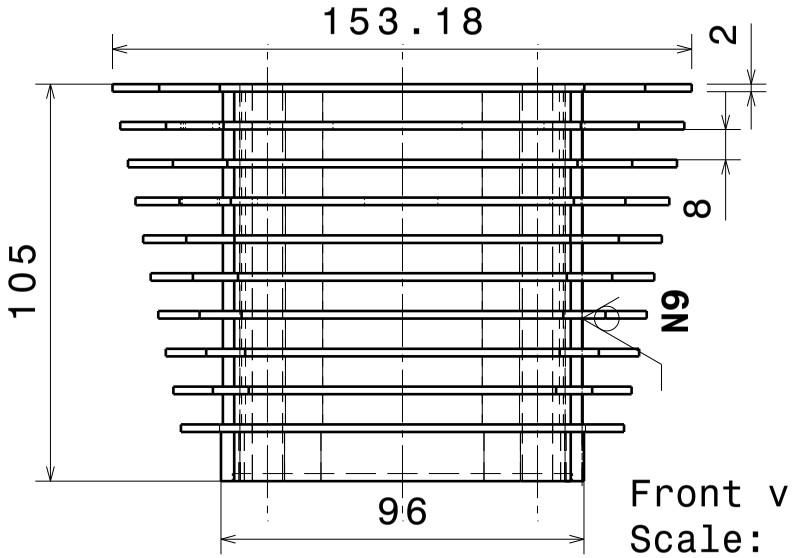
Cylinder Design				
Given Data				
Cylinder Material	Grey Cast Iron FG 200			
Sut	200	N/mm2		
Factor of Safety	3			
Poissons Ratio	0.25			
Permissible Tensile Stress	66.667	N/mm2		
Diameter	81	mm		
Property	Symbol	Formula	Value	Unit
Thickness of Cylinder Wall				
Maximum gas pressure	pmax		1	N/mm2
Reboring allowance	C		1.4	mm
Thickness of cylinder wall	t	$t = 0.045 * D + 1.6$	5.245	mm
Thickness of Dry liner	t1	$t_1 = 0.032 * D$	2.592	mm
Thickness of cylinder flange	t2	$t_2 = 1.3 * t$	3.3696	mm
Stresses in Cylinder Wall				
Circumferential Stress	σc	$\sigma_c = \frac{p_{max} * D}{2t}$	7.7216	N/mm2
Longitudinal Stress	σl	$\sigma_l = \frac{p_{max} * D^2}{(D_o^2 - D^2)}$	3.626	N/mm2
Outer Diameter of Cylinder	Do	$D_o = D + 2t$	91.49	mm
Net Circumferential Stress	(σc)net	$(\sigma_c)_{net} = \sigma_c - \mu * \sigma_l$	6.8151	N/mm2
Net Longitudinal Stress	(σl)net	$(\sigma_l)_{net} = \sigma_l - \mu * \sigma_c$	1.6956	N/mm2
Cylinder Head				
Constant	K		0.162	

Thickness of cylinder head	th	$t_h = D * \sqrt{\frac{K * p_{max}}{\sigma_c}}$	3.9929	mm
Studs for Cylinder Head				
Number of Studs	z	$z = 0.01 * D + 4$	4.81	5
Minor Diameter of Studs	dc	$d_c = \sqrt{\frac{D^2 * p_{max}}{z * \sigma_t}}$	3.9682	mm
Allowable tensile stress for studs	σt		83.333	N/mm2
Sut	Sut		250	N/mm2
Factor of safety			3	
Nominal Diameter of Studs	d	$d = \frac{d_c}{0.8}$	4.9602	mm
Pitch Circle Diameter of Studs	Dp	$D_p = D + 3d$	95.881	mm
Pitch of Studs		$\frac{\pi * D_p}{z}$	60.244	mm

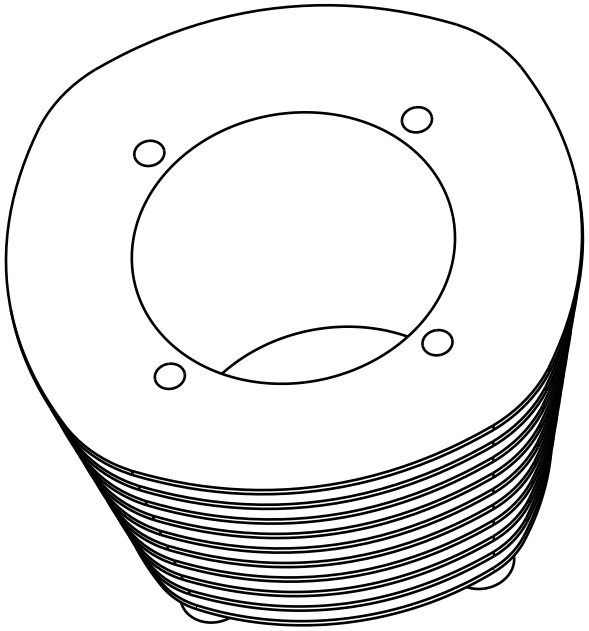
PROCESS SHEET

Operation no.	Description of operation	Machine/Process	Tool	Process parameter	Time (min)	Rate (Rs./hr)	Cost (Rs.)
1	Prepare the die and core as per specified dimensions and allowances.	-	-	Required dimensions with proper allowance	120	200	400
2	Pour the molten material(FG) into the die through sprue further allowing it to cool.	Die Casting	Ladle	Pouring time: 5sec Temperature: 700 °C	30	200	100
3	Heat treat the cylinder to obtain required properties	Induction Furnace	Heating coils Current : 40 A Voltage : 440 V	Temperature : 1050 to 1150 degree Celsius Time : 2 hours	45	220	165
4	Machine the bore and finish it.	Rough finishing	Reamer	-	10	40	6.67

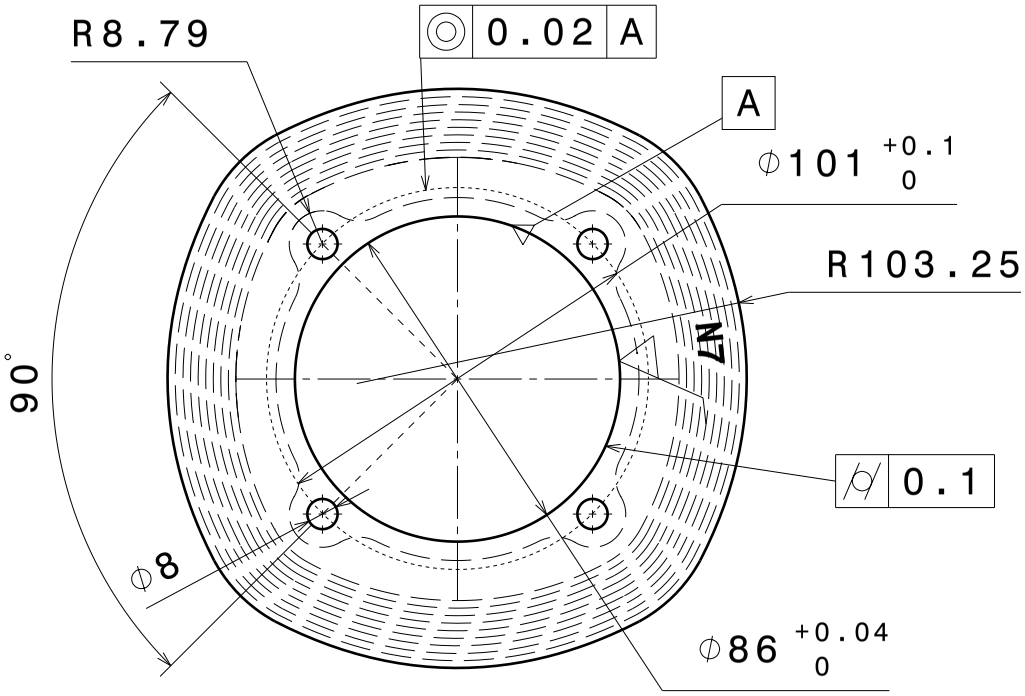
5	Locate the center of holes for studs x mm from base & y mm from side s/f and rough machine & carry out drilling process.(4 holes)	Drilling m/c	Drill (6 mm)	N-1250rpm F-0.2 mm/rev	16	204	54.4
				Total	221		726.0667
				Weight(kg)	0.38	50	19
				Total cost(Rs.)			745.0667



Front view
Scale: 1:2



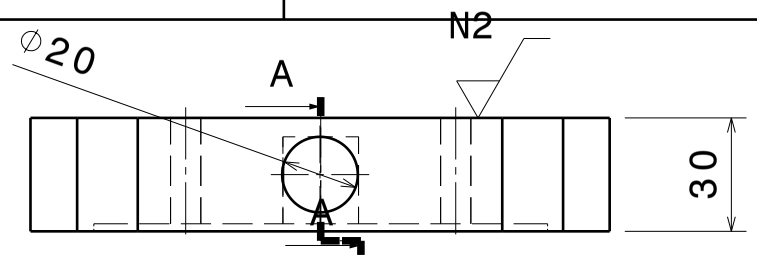
Isometric view
Scale: 1:2



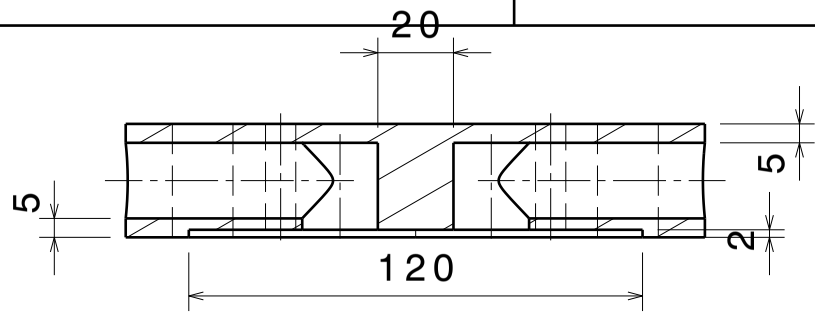
Top view
Scale: 1:2

Part name:	Details of cylinder
DESIGNED BY:	Priyanka Anantha
DATE:	11-11-2014
CHECKED BY:	Prof M. V. Walame
DATE:	
SIZE: A4	SCALE: 1:2
SIGNATURE	

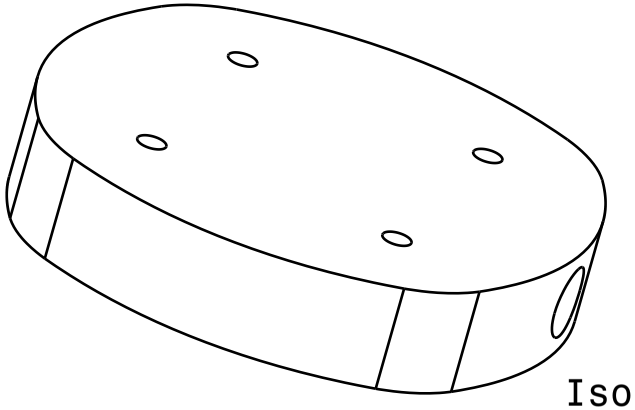
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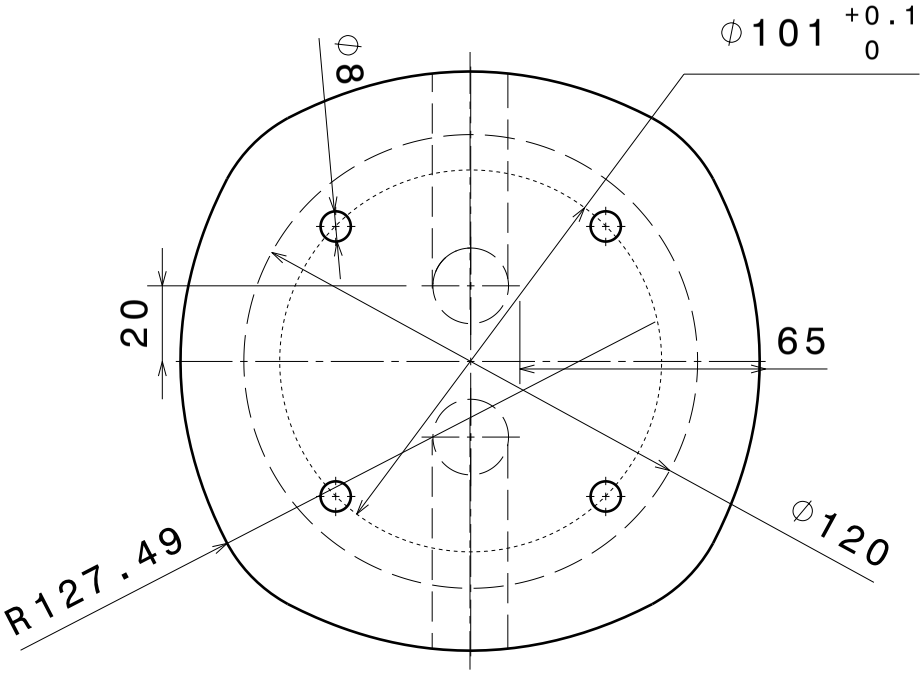
Front view
Scale: 1:2



Section view A-A
Scale: 1:2



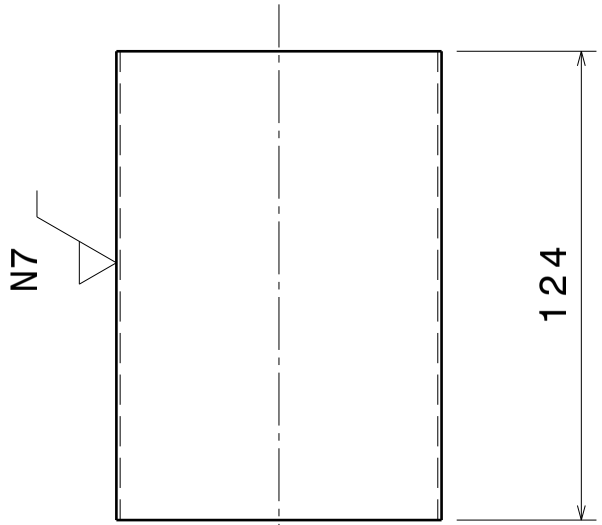
Isometric view
Scale: 1:2



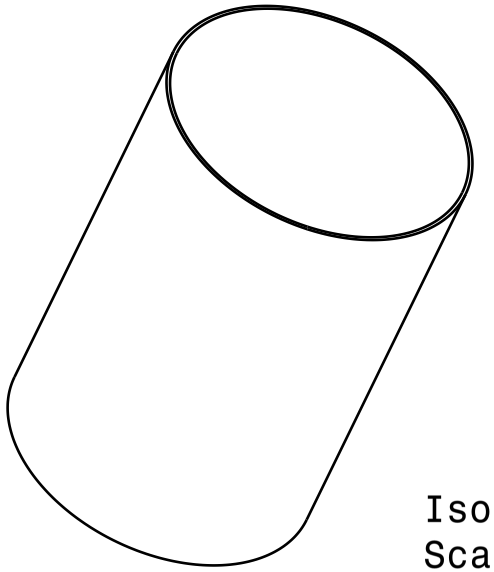
Top view
Scale: 1:2

Part name:	Details of cyl head
DESIGNED BY:	Priyanka Anantha
DATE:	
CHECKED BY:	Prof M. V. Walame
DATE:	
SIZE: A4	SCALE: 1:2
SIGNATURE	

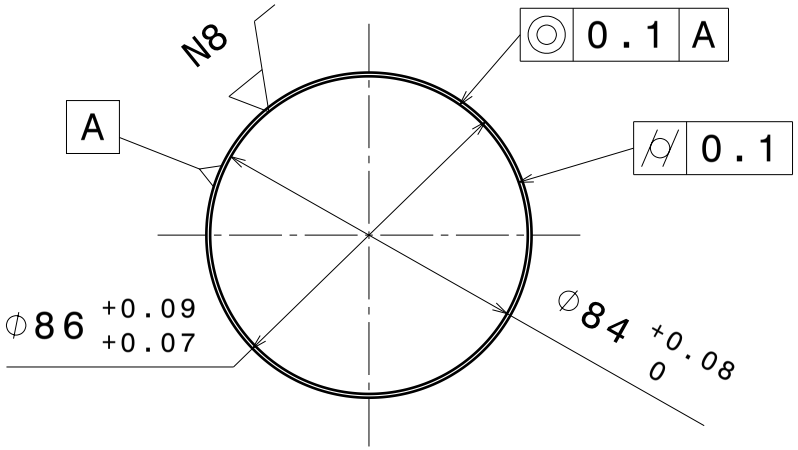
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Front view
Scale: 1:2



Isometric view
Scale: 1:2



Top view
Scale: 1:2

Part name:	Details of liner
DESIGNED BY:	Priyanka Anantha
DATE:	11-11-2014
CHECKED BY:	Prof M. V. Walame
DATE:	
SIZE: A4	SCALE: 1:2
SIGNATURE	

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DESIGN OF PISTON

Part Name: Piston.
Part Material: Grey Cast Iron.
Part Number: DOMS 12S1/12P11P10P09P08P/101714.
Sub components: Piston rings and oil ring, gudgeon pin, Piston bush, circlips.

PARAMETERS	NOTATION	IMPERICAL RELATION	VALUE	UNIT
GIVEN				
Bore dia.	D	--	81	mm
Length of stroke	L	--	81	mm
Max. gas pressure	p	--	1	MPa
Coefficient of friction	μ	--	0.1	-
Material of piston	--	--	Grey C.I.	
Material of pin	--	--	Heat Treated Alloy Steel	
ASSUMPTIONS				
Stroke to Bore ratio	L / D	--	1	-
Allowable bending stress	σ_b	--	40	N/mm^2
Allowable tensile stress	σ_t	--	100	N/mm^2
Allowable radial pressure on cylinder wall	p_w	--	0.04	N/mm^2
Allowable bearing pressure for skirt	p_b	--	0.45	N/mm^2
Number of piston rings	n_r	--	3	

Number of oil rings	-	--	1	
Allowable Bending Stress for pin	$\sigma_b\,(pin)$	--	140	N/mm^2
Bearing pressure at the small end of con rod bushing	p_{b1}	--	7.5	N/mm^2
CALCULATIONS				
1. Piston Head or Crown				
Thickness of Piston Head	t_h		5.55	mm
2. Ribs				
	-		th < 6mm	Not Required
3. Piston Cup				
Not required since no combustion.	-	--		
4. Piston Rings				
Radial thickness of piston ring	t_1		2.81	mm
Axial thickness of piston ring	t_2	*(0.7 t_1 to 1 t_1)* **[0.85*t_1]**	2.39	mm
Min. Axial thickness	t_2		2.70	mm
Axial thickness of oilring	-	**(t_2 + 0.3)**	3.00	mm
5. Gap between free ends of piston rings				
before assembly	*G1*	*(3.5 t_1 to 4 t_1)* **[3.75*t_1]**	11.22	mm

after assembly	*G2*	*(0.002 D to 0.004 D)* **[0.003*D]**	0.24	mm
6. Width of top land and ring grooves				
width of top land	b_1	*(t_h to 1.2 t_h)* **[1.1*t_h]**	6.10	mm
width of ring grooves	b_2	*(0.75 t_2 to t_2)* **[0.875*t_2]**	2.09	mm
7. Piston Barrel				
radial depth of piston ring groove	*b*	**(t_1 + 0.4)**	3.21	mm
thickness of barrel at top end	t_3	**(0.03*D + b + 4.5)**	10.14	mm
thickness of barrel at free ends	t_4	*(0.25 t_3 to 0.35 t_3)* **[0.3*t_3]**	3.04	mm
8. Piston Skirt				
maximum side thrust (due to gas pressure *p*)	*R*	*(μ*($\pi D^2/4$)*p)*	515.37	N
side thrust due to bearing pressure (due to p_b)	*R'*	*(p_b*D*l)*	*36.45 l*	N
piston skirt length	*l*	*(R/R')*	14.14	mm
piston skirt length (modified)	*l'*	*(For Piston pin consideration)*	40.00	
9. Piston Length				
length of top land	b_1	--	6.10	mm
length of ring section	*3 t_2 + 3 b_2 +Oil Ring Thickness*	*(Axial thickness of piston rings + axial thickness of oil ring)*	16.42	mm

length of skirt	l	--	40.00	mm
Total length of piston	L	*(Length of top land + ring section + skirt)*	62.52	mm
10. Gudgeon Pin				
Length of pin in con. Rod bush	l_1	**(0.45*D)**	36.45	mm
load on pin (due to bearing pressure)	f_{pin}	$(p_{b1}*do*l_1)$	*273.375 do*	N
maximum load on piston (due to gas pressure)	$F_{pin\ (max)}$	$P\ (\pi D^2/4)*p$	5153.67	N
Outer diameter of pin	d_o	$(F_{pin\ (max)}/\ f_{pin})$	18.85	mm
Round off Outer diameter of pin	do'	--	20.00	mm
Inner diameter of pin	d_i	$(0.6 * d_o)$	11.31	mm
Inner diameter of pin (modified)	d_i'	*(For extra strength)*	15	mm
Maximum bending moment at the centre of pin	M	*(P*D/8)*	52180.86	N-mm
Maximum bending moment	M'	$((\pi/32)*((d_o^4 - d_i^4)/d_o)$	*572.59*	N-mm
Induced bending stress	M / M' *(Ratio of above moments)*	*{must be less than σ_b (pin)}*	91.13	N/mm^2

Design of Reciprocating Air Compressor

TITLE

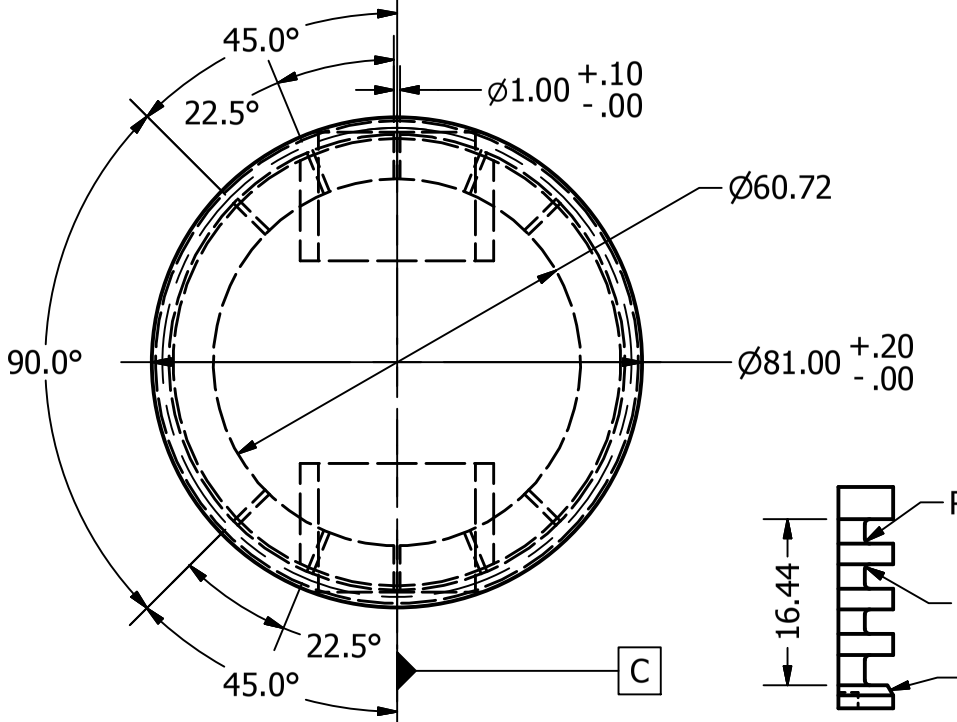
PISTON BODY

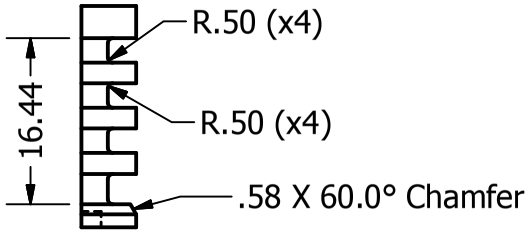
SURFACE FINISH N8 UNLESS MENTIONED OTHERWISE

Part No. DOMS 12S1/12P/141017.

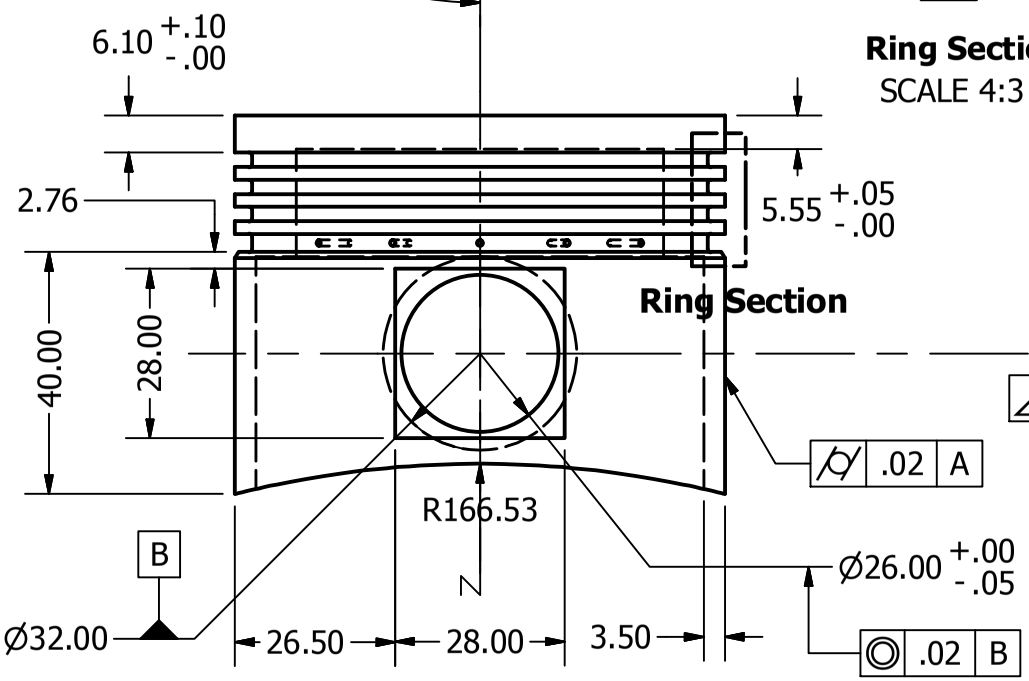
SIZE		NAME OF DESIGNER:	ROLL NO.
A4	13-10-2014	ANGAD BORALKAR	12

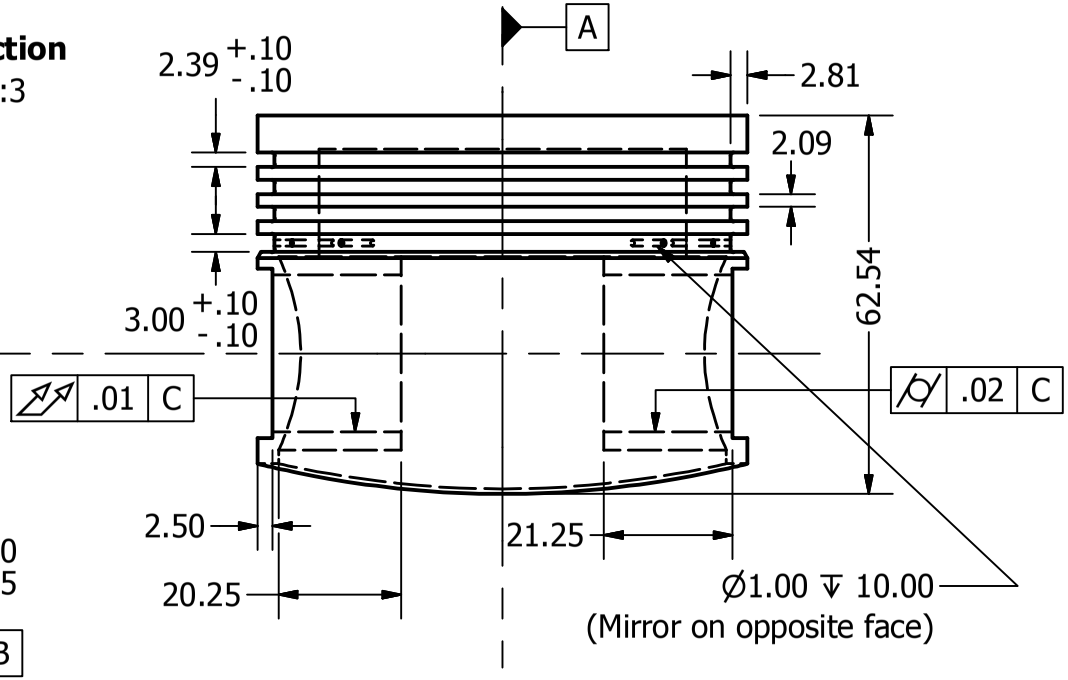
SCALE 1 : 1 | ALL DIMENSIONS ARE IN mm. | SHEET 1 OF 3





Ring Section
SCALE 4:3





Design of Reciprocating Air Compressor

TITLE

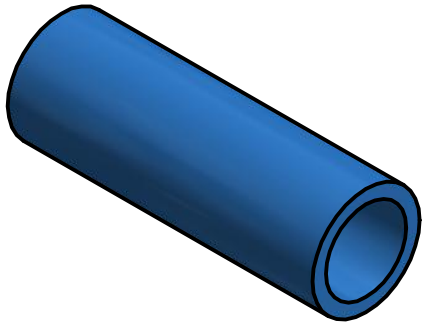
PISTON PIN / BOSS

SURFACE FINISH N4 UNLESS MENTIONED OTHERWISE

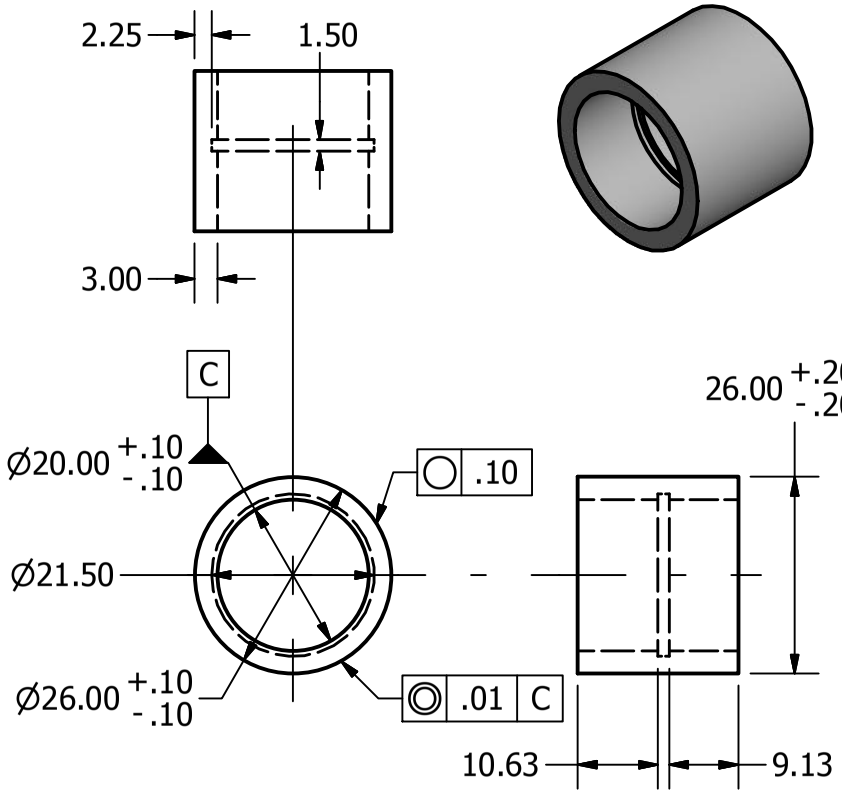
Part No. DOMS 12S1/10P11P/141019

SIZE		NAME OF DESIGNER:	ROLL NO.
A4	13-10-2014	ANGAD BORALKAR	12

SCALE	ALL DIMENSIONS ARE IN mm.	SHEET 3 OF 3
1 : 1		



PISTON PIN



PISTON BOSS

Design of Reciprocating Air Compressor

TITLE

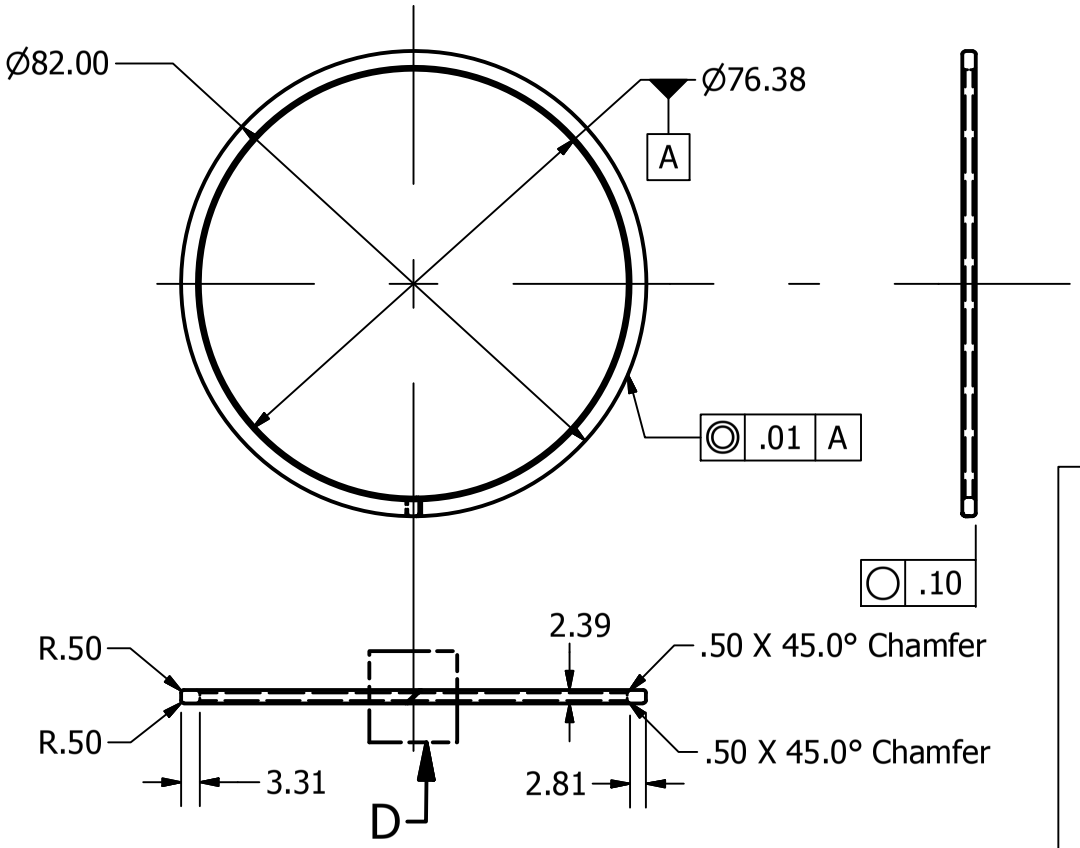
PISTON RING AND OIL RING

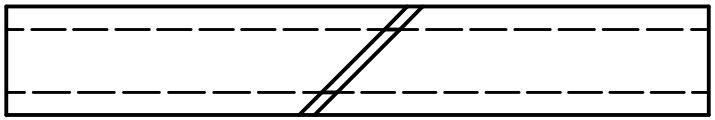
SURFACE FINISH N8 UNLESS OTHERWISE MENTIONED

Part No. DOMS 12S1/08P09P/141810

SIZE		NAME OF DESIGNER:	ROLL NO.
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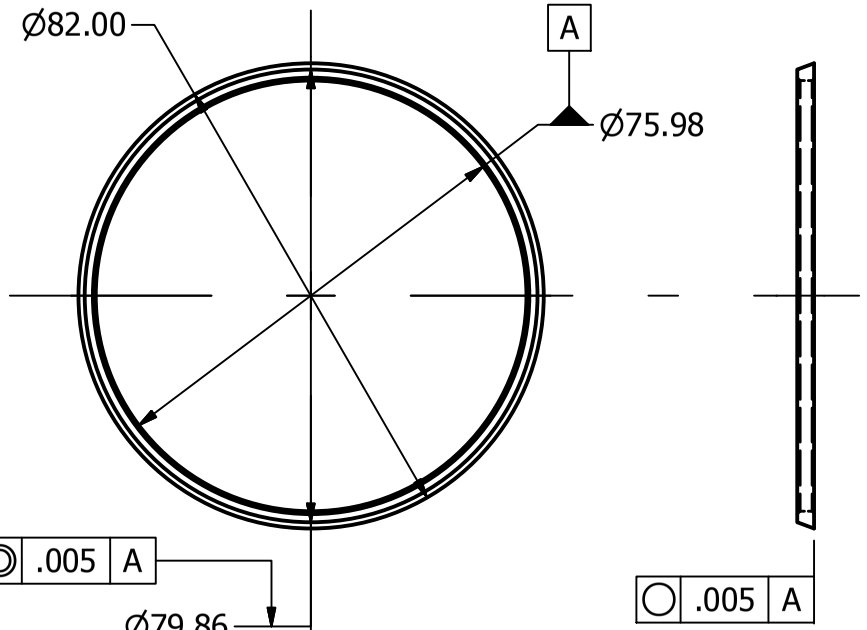
SCALE	ALL DIMENSIONS ARE IN mm.	SHEET 2 OF 3
3:4		



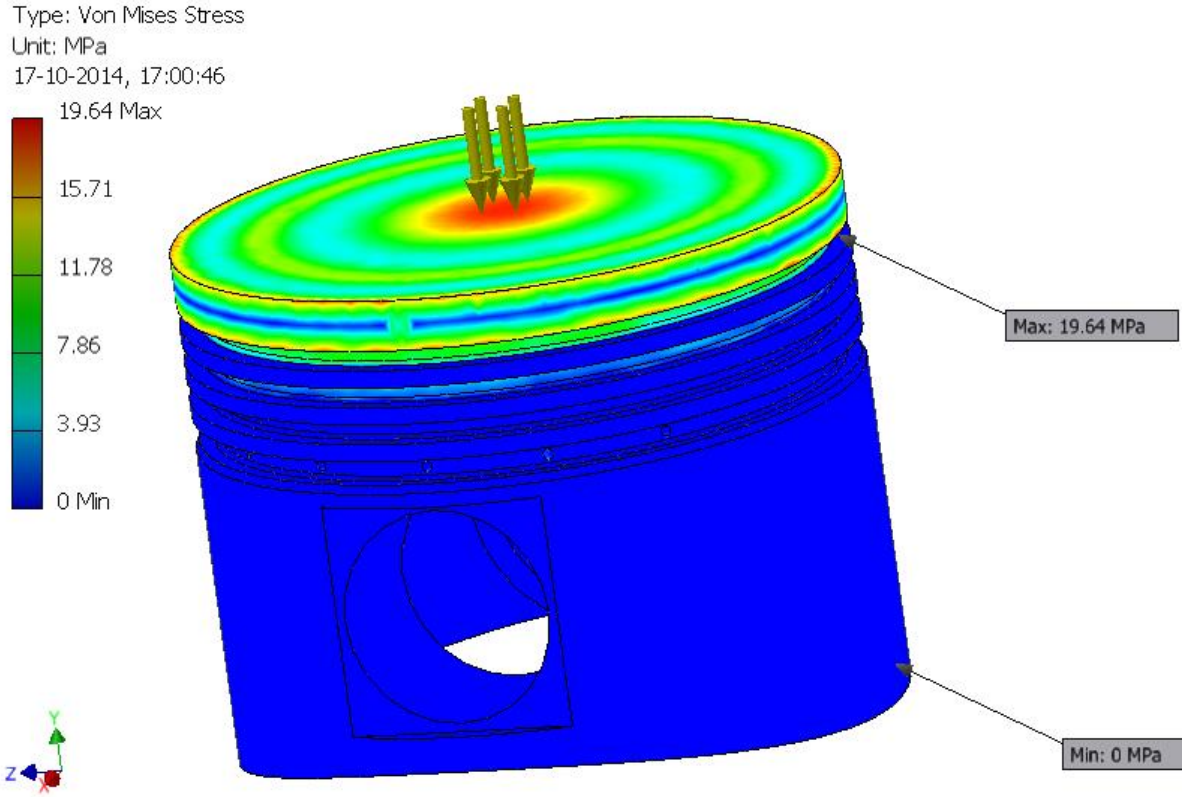


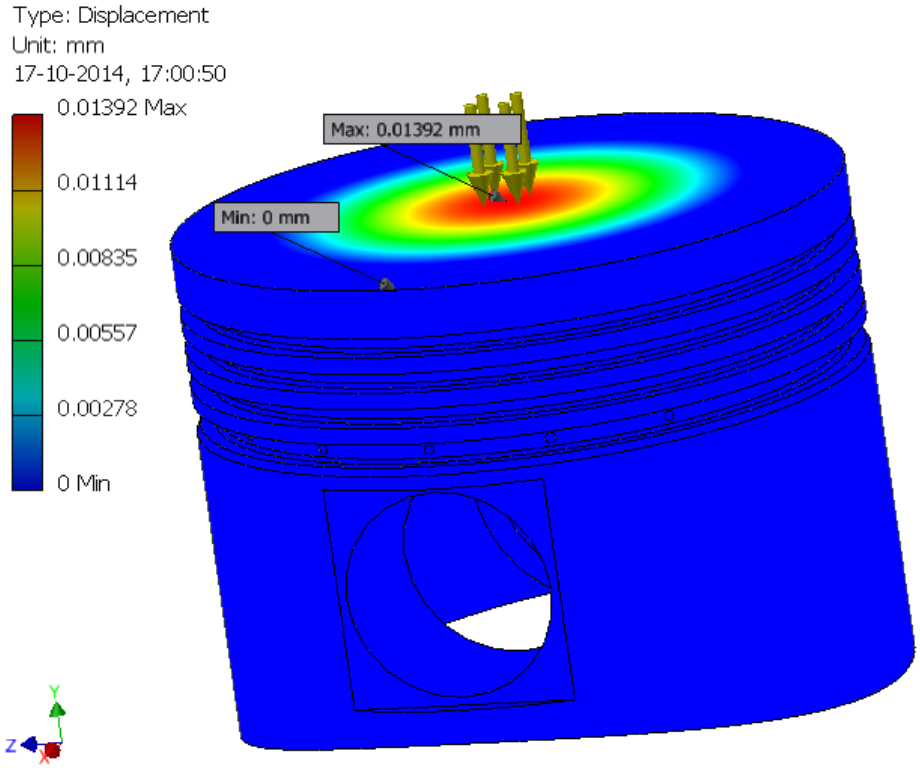
DETAIL D
SCALE 6

PISTON RING



OIL RING


Type: Von Mises Stress
Unit: MPa
17-10-2014, 17:00:46
19.64 Max
15.71
11.78
7.86
3.93
0 Min
Max: 19.64 MPa
Min: 0 MPa
Y
Z
X


Type: Displacement
Unit: mm
17-10-2014, 17:00:50
0.01392 Max
0.01114
0.00835
0.00557
0.00278
0 Min
Max: 0.01392 mm
Min: 0 mm
Y
Z
X

PROCESS SHEET

Operation no.	Description of operation	Machine/ Process	Tools	Process parameter	Time (min)	Rate (Rs./ hr)	Cost (Rs.)
1	Prepare the die by heating it to desired temperature	Heating	Burner	Up to temp. of molten metal	120	200	400
2	Pour the molten material into the die through spur further allowing it to cool.	Die Casting	Ladle	Pouring Time 5 sec Temperature 700 °C	30	200	100
3	Heat treatment of piston (tempering).	Furnace	--	--	45	220	165
4	Machine the crown and base of piston (Facing)	Lathe	Cutting tool(HSS)	N - 500rpm Feed - 0.2 mm/rev Depth of cut - 1mm	3	150	7.5
5	Locate the centre and rough machine the gudgeon pin hole.	Lathe	Drill (20mm)	N - 1250rpm F - 0.2 mm/rev	2	150	5
6	Turn the required diameter	Lathe	Cutting tool(HSS)	N - 500rpm F - 0.2 mm/rev Depth of cut - 1.5 mm	2	150	5
7	Mark the starting point of groove	--	Vernier				0
8	Make 4 grooves of width 2 mm at distance of 2 mm.	Lathe	Parting tool (HSS)	N - 400rpm F- 0.2 mm/rev Depth of cut – 3 mm	8	150	20

9	Face the top and bottom surface of the piston where pin fits.	Milling machine	Face miller (D50mm)	N - 400rpm F - 0.1 mm/rev Depth of cut - 0.5 mm	6	200	20
10	Bore the gudgeon pin hole	Milling machine	Boring tool	N - 450rpm F - 0.2 mm/rev Depth of cut - 2 mm	2	150	5
11	Finish the gudgeon pin hole	Milling machine	Reamer (D-10mm)	N - 800 rpm, F - 0.2 mm/rev	2	100	3
12	Clean piston, attach gudgeon pin, stamp, and dispatch.	--	--	--	10	100	16
				Total	230		747.5
				Weight (kg)	0.57	50	28.5
				Total cost (Rs.)	--	--	**776**

	Process	**Time**	**Rs.**
1	Casting	49 hrs	250
2	Lathe Machining	15 min	150
3	Milling Machine	10 min	200
4	Heat Treatment	1 hrs	200
5	Labour cost	--	100
Total component cost		**--**	**900**

Connecting rod and end cap bolts

Part name: Connecting rod

Material: Steel 40C8

Design of Big and small end bearing

Part name: Big and small end bearing

Sr. No.	Quantity	Symbol	Formula	Value	Design Value	Units
	Given data:					
1	**Cylinder bore**	D		81		**mm**
2	**Length of stroke**	ls		81		**mm**
3	**Maximum gas pressure**	Pmax		1		**N/mm^2**
4	**Factor of safety**	Fs		3		**-**
5	**Compressor speed**	N		750		**rpm**
6	**Radius of Crank**	r	r = ls/2	40.5		**mm**
7	**Obliquity Ratio**	L/r		4.5		**-**
8	**Length of connecting rod**	L		182.25		**mm**
	Cross section of connecting rod					
1	**Material for connecting rod is Plain carbon steel**	Sut		600		**N/mm^2**
2	**Factor of safety**	fs		4		
3	**Allowable Compressive strength**	σc		150		**N/mm^2**
4	**Constant depending on material and end fixity coefficient**	a		(1/7500)		**-**
5	**Force acting on connecting rod**	Pc	$P_c = \frac{(\Pi * D^2) * P_{max}}{4}$	5155.07		**N**
6	**Critical buckling load**	Pcr	$P_{cr} = P_c * (fs)$	15465.21		**N**
7	**Calculation of t**		$P_{cr} = \frac{\sigma_c * A}{1 + a(\frac{l}{K_{xx}})^2}$			
			t^2	9.50		**mm^2**
			t	3.08	4	**mm**
8	**Radius of gyration about XX plane**	Kxx	Kxx = 1.78t	7.12	7.12	**mm**
9	**Cross section area of CR**	A	$A = 11t^2$	176	176	**mm^2**

Dimensions of cross section:						
1	**Width of connecting rod**	b	b = 4t	16		**mm**
2	**Height of connecting rod**	H	H = 5t	20		**mm**
3	**Web thickness**	t	t	4		**mm**
4	**Flange thickness**	t	t	4		**mm**
	Variation of height:					
1	**At middle section**	H	H = 5t	20	20	**mm**
2	**At small end**	H1	H1 = 0.85H	17	17	**mm**
3	**At big end**	H2	H2 = 1.2H	24	25	**mm**

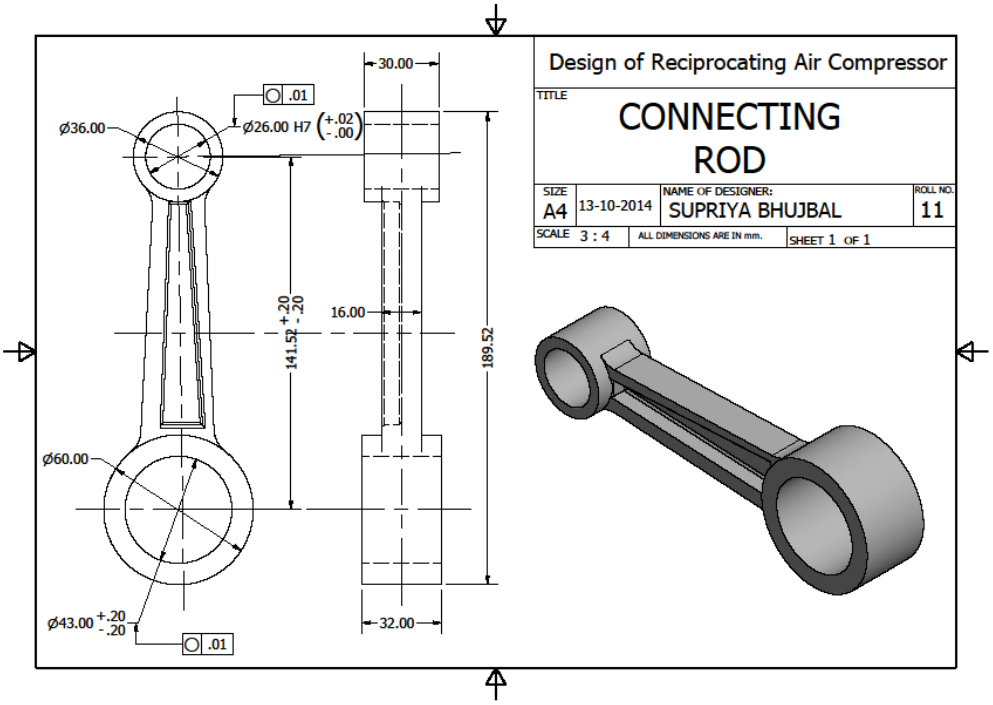
Dimensions of piston pin bearing and crank pin bearing:						
1	**(l/d) ratio - Crank Pin Bearing**			1.25		**-**
2	**(l/d) ratio - Piston Pin Bearing**			2		**-**
3	**Allowable pressure:piston bearing**	$(P_b)_p$		12.5		**N/mm^2**
4	**Allowable pressure: crank pin bearing**	$(P_b)_c$		4		**N/mm^2**
5	**Diameter of piston pin**	dp	$d_p = \sqrt{\frac{P_c}{2(P_b)_p}}$	14.35976522	15	**mm**
6	**Length of piston pin bush**	lp	Lp=dp*2	30	30	**mm**
7	**Diameter of crank pin**	dc	$d_c = \sqrt{\frac{P_c}{1.25*(P_b)_c}}$	32.10941117	33	**mm**
8	**Length of crank pin bush**	lc	lc=dc*1.25	41.25	42	**mm**

Design of Bolts an Big End Cap						
1	**Speed**	ω	2πN/60	78.53981634		**rad/sec**
2	**Mass of reciprocating parts**	m_r		2.5		**kg**
3	**Inertia force on bolt**	$(Pi)_{max}$	$m_r w^2 r\left[1+\frac{1}{n_1}\right]$	763.3522154		**N**
4	**Permissible tensile stress for bolt**	σ_t		30		**N/mm^2**
5	**Core diameter of bolt**	dc	$(Pi)_{max}=\left[\frac{2\pi(dc^2)}{4}\right]\sigma_t$	02477789 7	5	**mm**
6	**Nominal Diameter of bolt**	d	dc/0.8	6.25	6	**mm**
7	**Span Length**	l	l=dc + 2*bush thick.(3mm) + d + Clearance(3mm)	48	48	**mm**
8	**Permissible bending stress for cap**	σb		80		**N/mm^2**
9	**Cap Bending Moment**	Mb	Mb=(Pi)Max * l /6	6106.817723		**N-mm**
10	**Width of Cap**	bc	bc=lc		42	**mm**
11	**Thickness of Big End Cap**	tc	σb=(Mb*y)/I	3.302276737	4	**mm**
	Moment of Inertia	I	I=(bc*tc^3)/12			
		y	y=(tc/2)			

Process Sheet:

	Process Sheet					
Part	Connecting Rod		Material	Plain carbon steel		
No.	Description of operation	M/C Process	Tool/Gauge	Process parameter	Time(min)	Costing(Rs.)
1	Heat the ballet to required temperatue	heating	Furnace	temp 1000◦C	100	300
2	Forge the billet in the die	forging	Up stroke process	capacity 5 tonnes, speed 15 stroke/s	15	75
3	Stradle milling both ends of rod	milling	Cutters			
4	Drill the big end hole	lathe	lathe,drill bit,vernier	dimensions of hole	10	25
5	Drill the small end hole	lathe	lathe,drill bit,vernier	dimensions of hole	10	25
6	Ream the big end hole	lathe	reamer,vernier	exact dimensions of hole	10	17
7	Ream the small end hole	Drilling m/c	reamer,vernier	speed 25m/s,feed 0.3 mm/rev	10	17
8	Dispatch				15	0
					Total	**459**
					Material cost	**121**
					Net cost	**580**

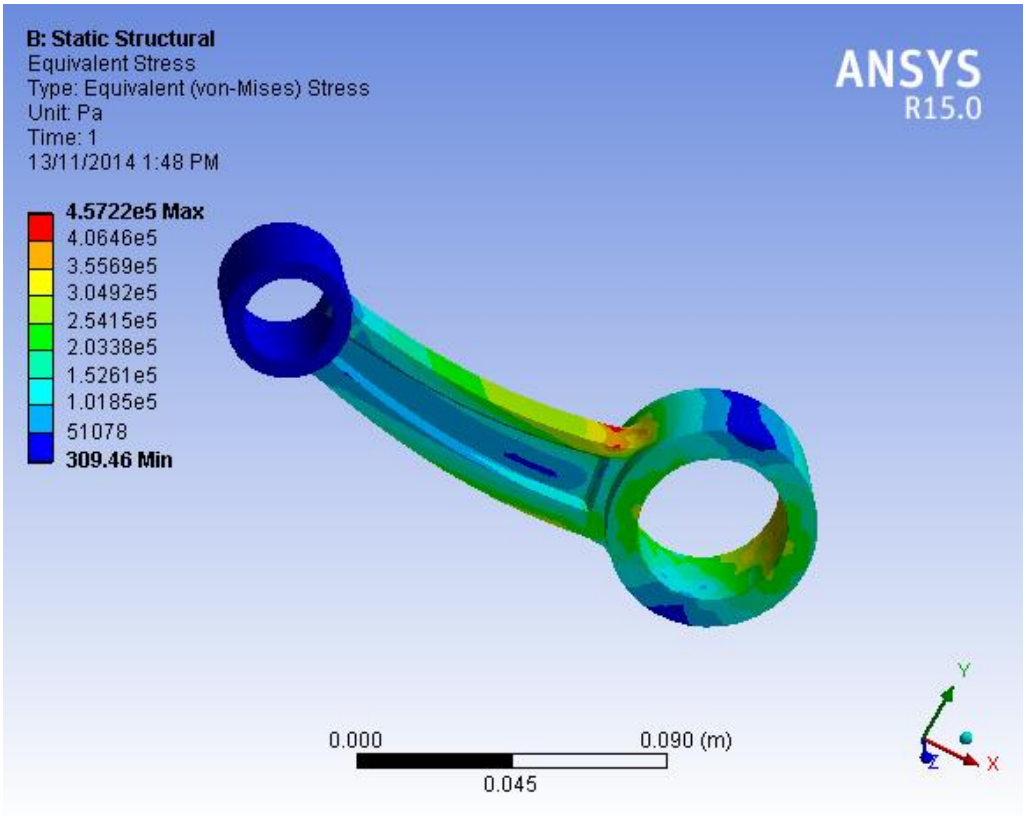
Drafting:



ANSYS Analysis:

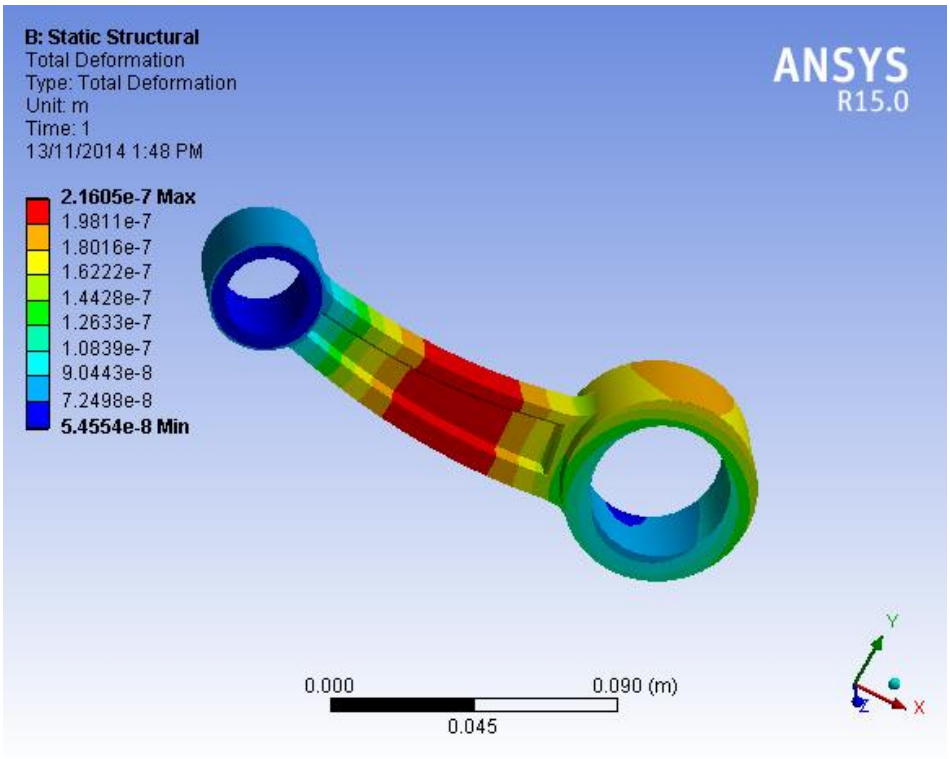
Equivalent Stress

Date Saturday, October 18, 2014



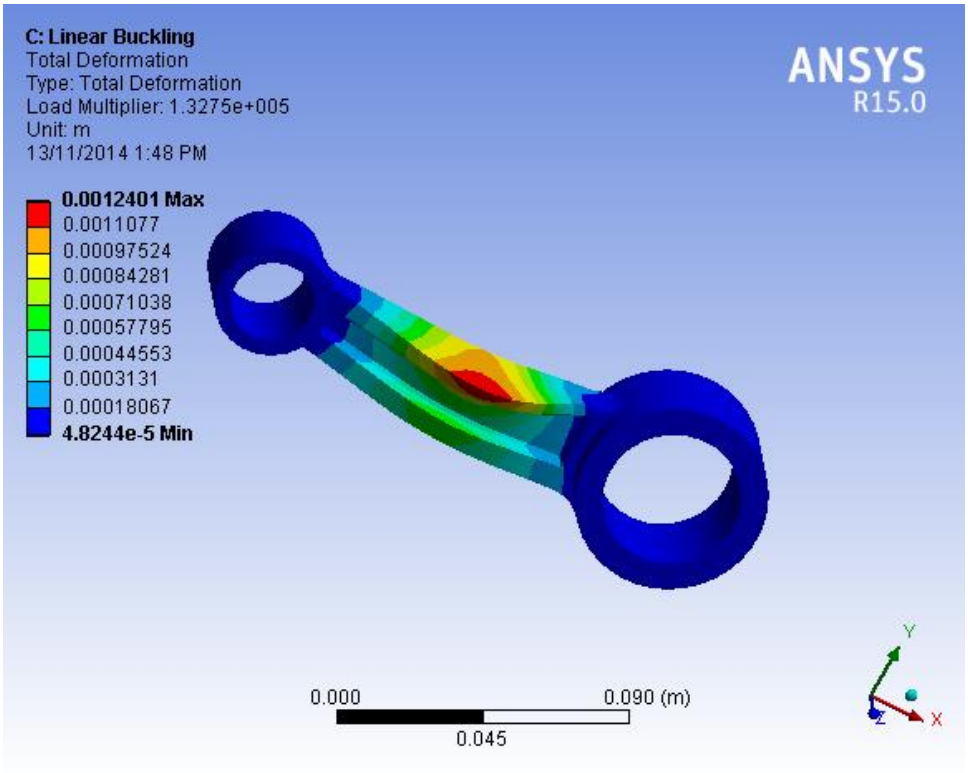
Total Deformation

Date Saturday, October 18, 2014



Total Deformation

Date Saturday, October 18, 2014



Crankshaft

Part name: Crank shaft

Material: 40C8

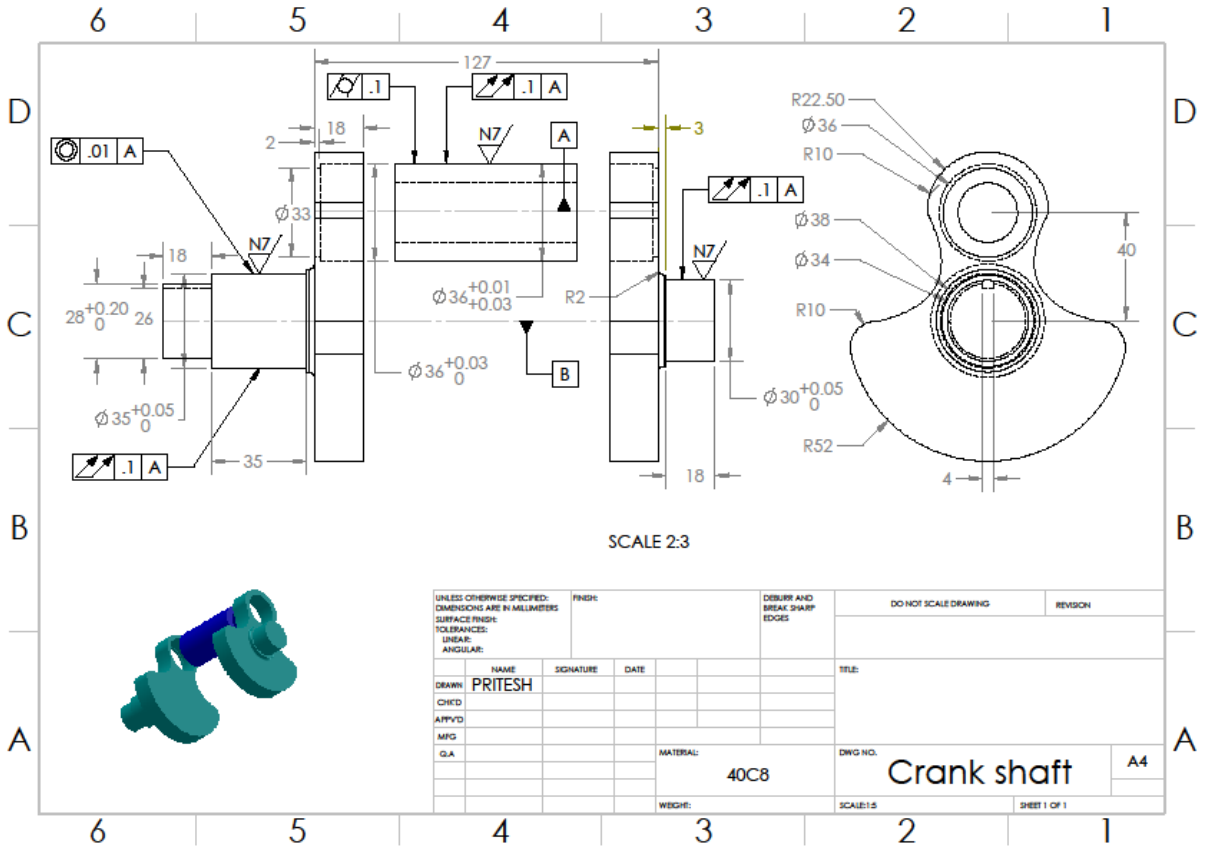
Crankcase

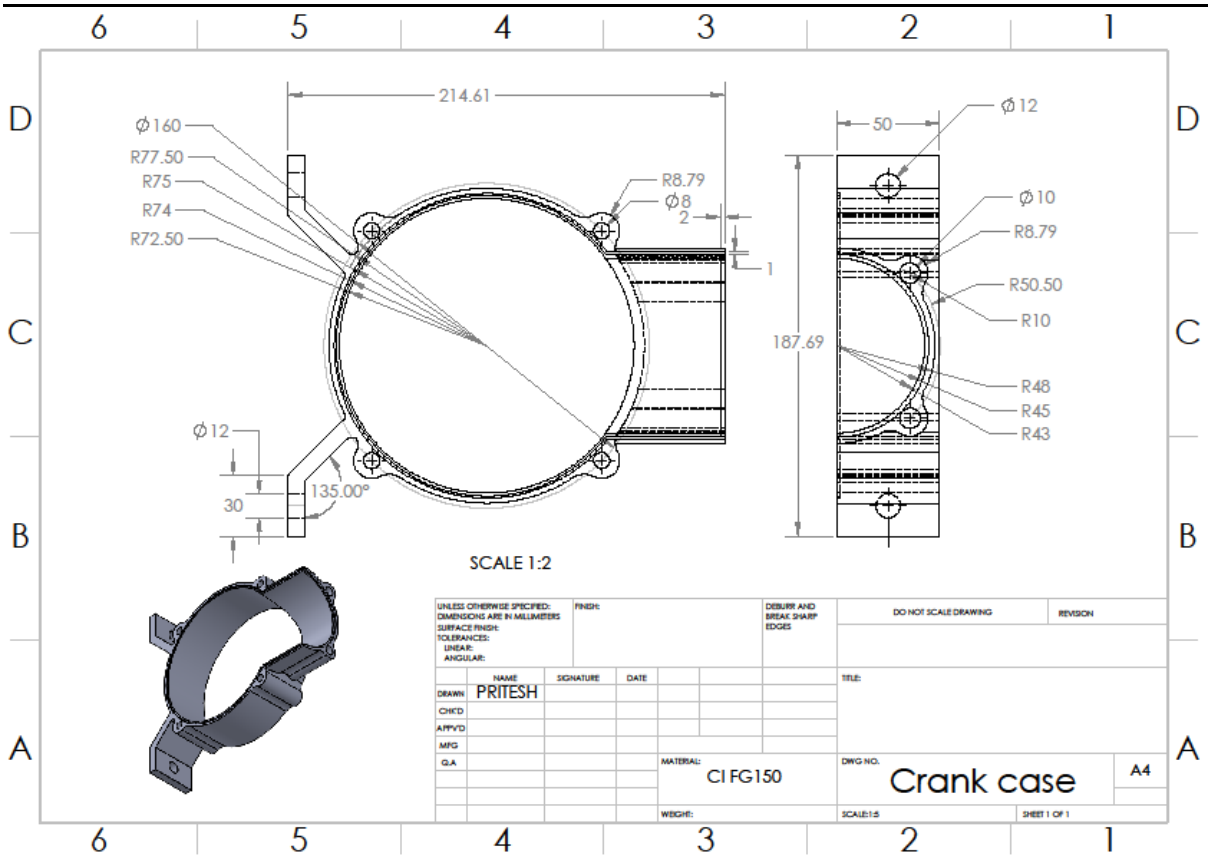
Part name: Crank case

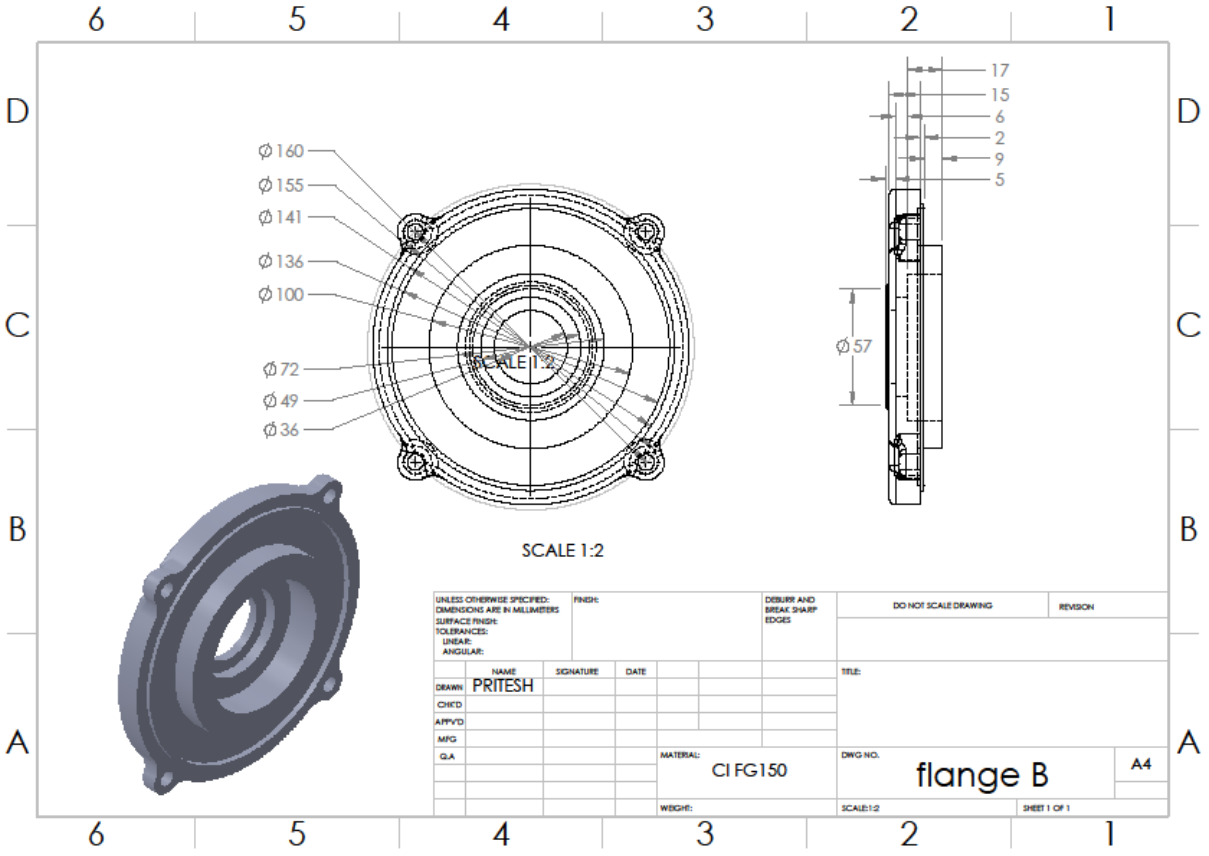
Material: CI FG150

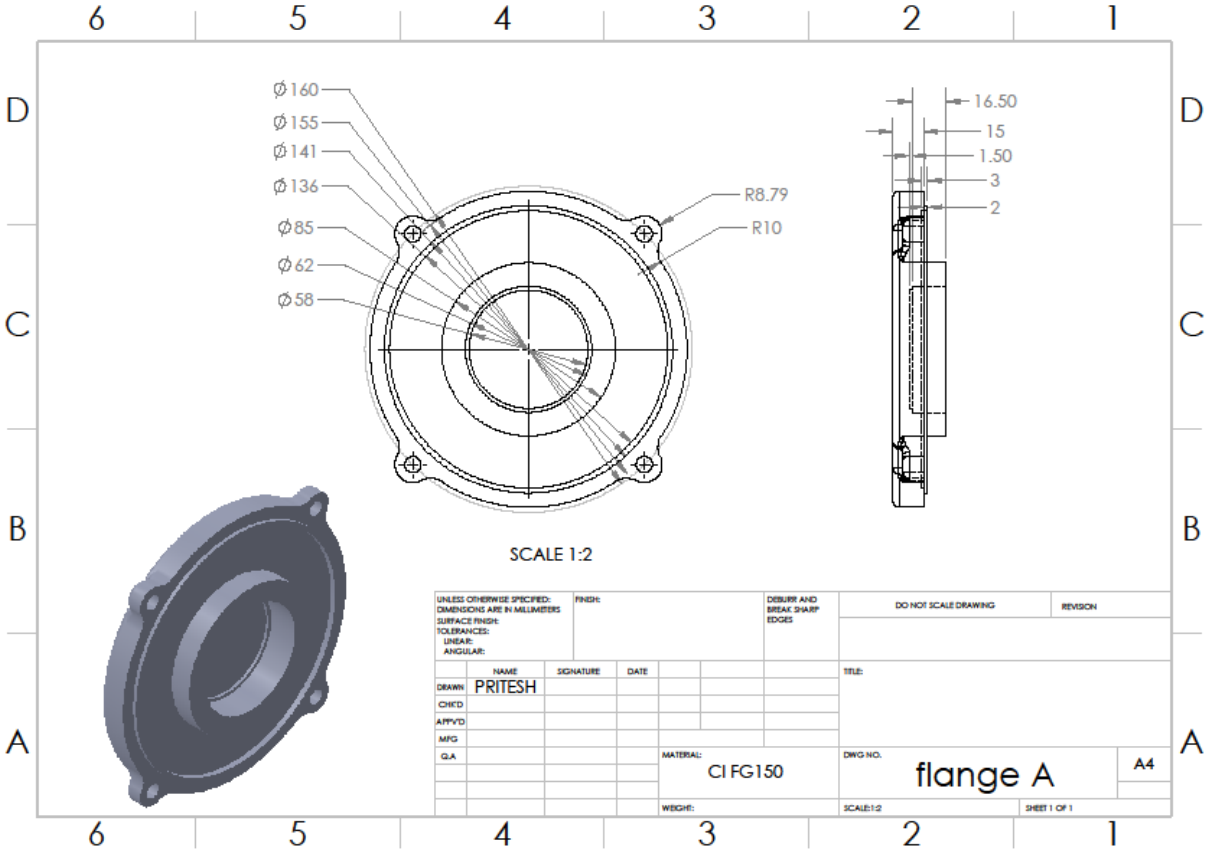
Crank shaft				
	PARAMETERS	**VALUE**	**Correction**	**UNIT**
GIVEN	Diameter of piston	81		mm
	Maximum Air pressure	1.00		Mpa
	Stroke length	80		mm
	Ratio of connecting rod length to crank radius	4.50		-
	Belt tension	210		N
	l/d ratio	1.5		-
	Weight of flywheel	200		N
ASSUMPTIONS	Allowable bending stress	240		N/mm2
	Allowable shear stress	15		N/mm2
	Allowable bearing pressure for crank pin bushing	45.00		N/mm2
	C/C distance between bearings A & crank pin	45.00		mm
	C/C distance between bearings B & crank pin	45.00		mm
	C/C distance between bearings B & flywheel	45.00		mm
	C/C distance between bearings C & flywheel	45.00		mm
	C/C distance between bearings A & B	90.00		mm
	C/C distance between bearings B & C	90.00		mm
CALCULATIONS	**1. Bearing Reactions**			
	Bearing A	2575.19	3000.00	N
	Bearing B	2677.25	3000.00	N
	Bearing C	145.00	150.00	N
	2. Crank pin			
	Diameter of crank pin	17.01	18.00	mm
	Length of crank pin	25.51	25.00	mm
	Bearing pressure for crankpin bushing	11.87	20.00	N/mm2
	3. Crank web			
	Thickness of crank web	11.91	15.00	mm
	Width of crank web	19.39	20.00	mm
	Allowable bending stress	94.42	40.00	N/mm2
	4. Crank shaft under flywheel			
	Diameter of crank shaft	6.52	10.00	mm
	5. Crank shaft			
	Diameter of crank shaft	28.39	30.00	mm

Drafting:


127
.1
.1 A
.01 A
18
2
N7
A
3
Ø33
18
N7
28 +0.20 0
26
Ø36 +0.01 +0.03
R2
B
Ø36 +0.03 0
Ø35 +0.05 0
.1 A
35
18
R22.50
Ø36
R10
Ø38
Ø34
40
R10
Ø30 +0.05 0
R52
4
SCALE 2:3
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
SURFACE FINISH:
TOLERANCES:
LINEAR:
ANGULAR:
FINISH:
DEBURR AND BREAK SHARP EDGES
DO NOT SCALE DRAWING
REVISION
NAME
SIGNATURE
DATE
DRAWN
PRITESH
CHK'D
APPV'D
MFG
Q.A
TITLE:
MATERIAL:
40C8
DWG NO.
Crank shaft
A4
WEIGHT:
SCALE:1:5
SHEET 1 OF 1


214.61
Ø160
R77.50
R75
R74
R72.50
R8.79
Ø8
2
1
Ø12
30
135.00°
50
Ø12
Ø10
R8.79
R50.50
R10
187.69
R48
R45
R43
SCALE 1:2
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
SURFACE FINISH:
TOLERANCES:
LINEAR:
ANGULAR:
FINISH:
DEBURR AND BREAK SHARP EDGES
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DATE
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PRITESH
CHK'D
APPV'D
MFG
Q.A
TITLE:
MATERIAL:
CI FG150
DWG NO.
Crank case
A4
WEIGHT:
SCALE:1:5
SHEET 1 OF 1


Ø160
Ø155
Ø141
Ø136
Ø100
Ø72
Ø49
Ø36
SCALE 1:2
17
15
6
2
9
5
Ø57
SCALE 1:2
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
SURFACE FINISH:
TOLERANCES:
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ANGULAR:
FINISH:
DEBURR AND BREAK SHARP EDGES
DO NOT SCALE DRAWING
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NAME
SIGNATURE
DATE
DRAWN
PRITESH
CHK'D
APP'VD
MFG
Q.A
TITLE:
MATERIAL:
CI FG150
WEIGHT:
DWG NO.
flange B
A4
SCALE:1:2
SHEET 1 OF 1


Ø160
Ø155
Ø141
Ø136
Ø85
Ø62
Ø58
R8.79
R10
SCALE 1:2
16.50
15
1.50
3
2
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
SURFACE FINISH:
TOLERANCES:
LINEAR:
ANGULAR:
FINISH:
DEBURR AND BREAK SHARP EDGES
DO NOT SCALE DRAWING
REVISION
NAME
SIGNATURE
DATE
DRAWN
PRITESH
CHK'D
APP'VD
MFG
Q.A
TITLE:
MATERIAL:
CI FG150
WEIGHT:
DWG NO.
flange A
A4
SCALE:1:2
SHEET 1 OF 1

Process Sheet:

Operation no.	Description of operation	Machine / Process	Tools	Process Parameter	Time (min)	Rate (Rs./hr)	Cost (Rs.)
1	Heat the steel ingot of suitable size to the forging temperature	Heating	Burner	Temp. in the range of 1050° C to 1250° C	100	200	333.333
2	Ingot is pressed in closed forging dies under gradually applied high pressure	Press forging	Up-stroke press	500 tonnes press and 15 sec per stroke	15	150	37.5
3	Facing of raw forged material	Lathe	HSS Cutting Tool	Speed = 25 m/s; Feed = 0.3 mm per rev; Depth of cut = 0.2 mm	4	120	8
4	Centering of raw forged material	Lathe	HSS Cutting Tool	Drill speed = 400 rpm; Feed = 0.2 mm per rev	3	120	6
5	Rough turning of component, where material is held between centers and turned	Lathe	HSS Cutting Tool	Speed = 25 m/s; Feed = 0.5 mm per rev; Depth of cut = 0.4 mm	10	120	20
6	Finish turning, with turning allowance of 1 mm	CNC Lathe	HSS Cutting Tool	Speed = 40 m/s; Feed = 0.3 mm per rev; Depth of cut = 0.2 mm	8	170	22.6667
7	Drill holes for oil lubrication	Radial Drilling Machine	4mm Drill	Speed = 20 m/s; Feed = 0.5 mm per rev	10	150	25
8	Heat treatment of the forged material	Induction Furnace	Heating coils Current : 40 A Voltage : 440 V	Temperature : 1050 to 1150 degree Celsius; Time = 2 hours	45	220	165
9	Short Peen the forged rod	Short Peening Machine	Spherical cast steel shots (balls)	Speed of balls =5 m/s; Flow rate = 1135 Kg per hour	5	300	25
10	Straighten the crankshaft affected due to thermal and mechanical stresses	Hydraulic Press	Up-stroke press	Capacity = 5 tons; Speed of stroke = 15 sec per stroke	5	150	12.5
11	Rough Grinding	CNC Grinding machine		Speed of wheel = 20 m/s; Feed of work piece = 1 mm per min; Depth of cut = 0.05 mm	8	170	22.6667
12	Face Grinding	Surface Grinding machine		Speed of wheel = 40 m/s; Feed of wheel = 2 mm per sec; Depth of cut = 0.1 mm	3	150	7.5
				TOTAL	216		685.167
				Material cost			300
				Total cost			985.167

Manufacturing Process:

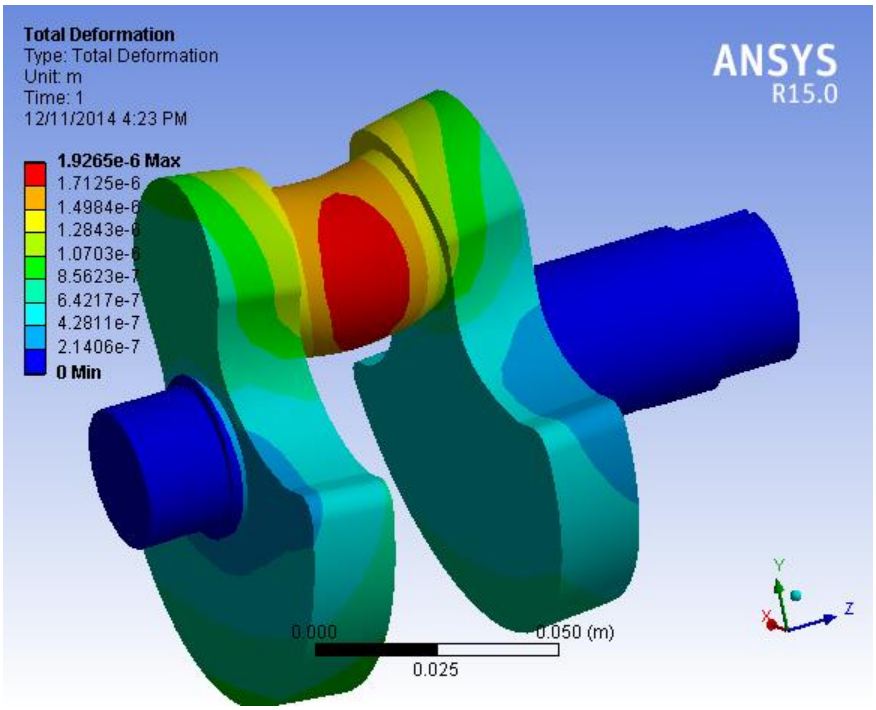
1. The steel ingot is heated to up to a specific temperature.
2. The molten steel is placed in a forging die, and is them hammer pressed.
3. The raw forging is extracted from the die using claws.
4. The claws pick up the newly forged crank, at the area where the excess steel is removed from the die halves.
5. The raw forged rod is tempered in a controlled furnace.
6. Surface hardening process, such as, carbonitriding, or cyaniding, is done.
7. Finished crankshaft is then inspected by stress testing.
8. The forged crankshaft is then finished by grinding, and is then ready for assembly.

ANSYS Analysis:

Total Deformation

Subject: Crank Shaft

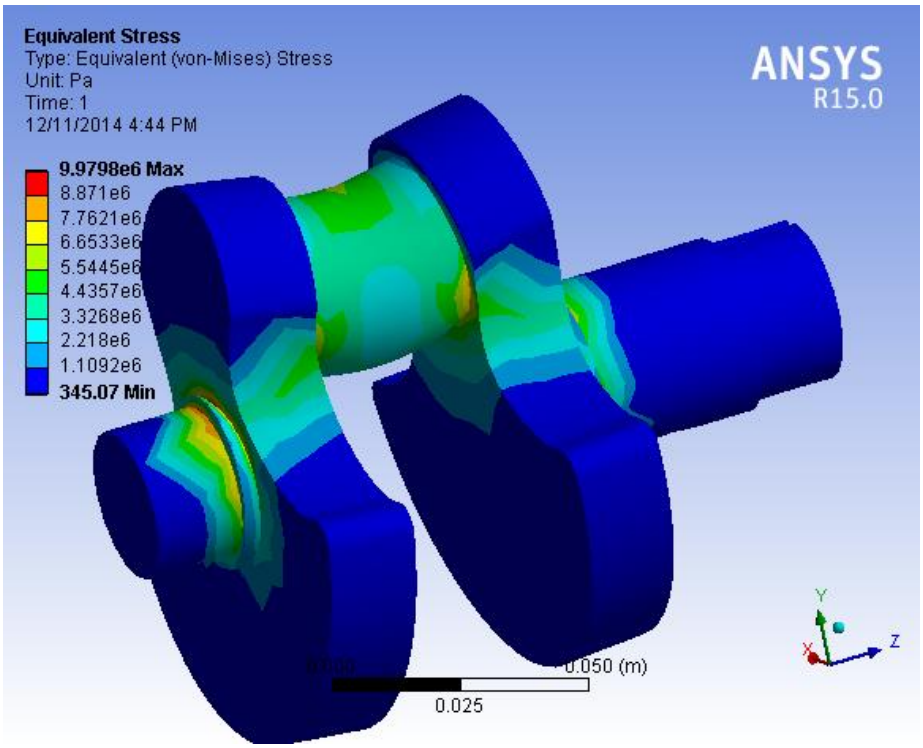
Date Wednesday, November 12, 2014



Equivalent Stress

Subject: Crank shaft

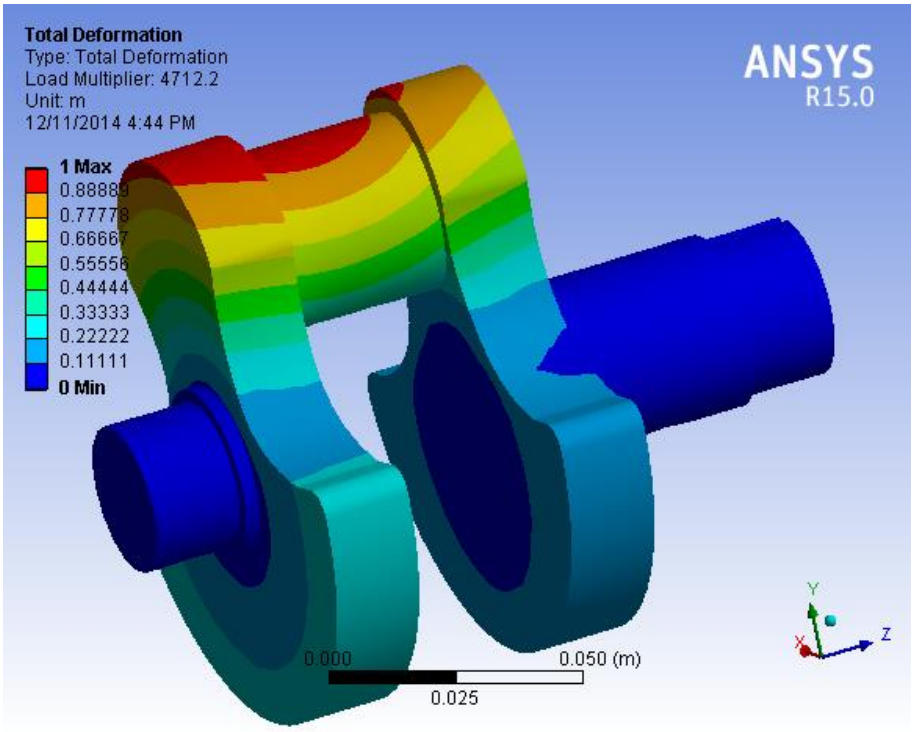
Date Wednesday, November 12, 2014



Total Deformation

Subject: Crank shaft

Date Wednesday, November 12, 2014



BELT DRIVE

Input:

1. Motor rating : 1.5 KW
2. Speed of motor : 1500 rpm
3. Speed of compressor : 750 rpm

V - Belt:

The drive type is selected as open belt drive. The belt type is V belt because V belt has:

- Higher power transmitting capacity
- Less slip due to increased frictional force

The belt is selected from the catalogue of Dunlop Transmission Belting, and the variety chosen is HI-SPEED Duck belting, which is used for general purpose applications.

B	14	17	11	200	125
C	19	22	14	315	200
D	27	32	19	500	355
E	32	38	23	630	500

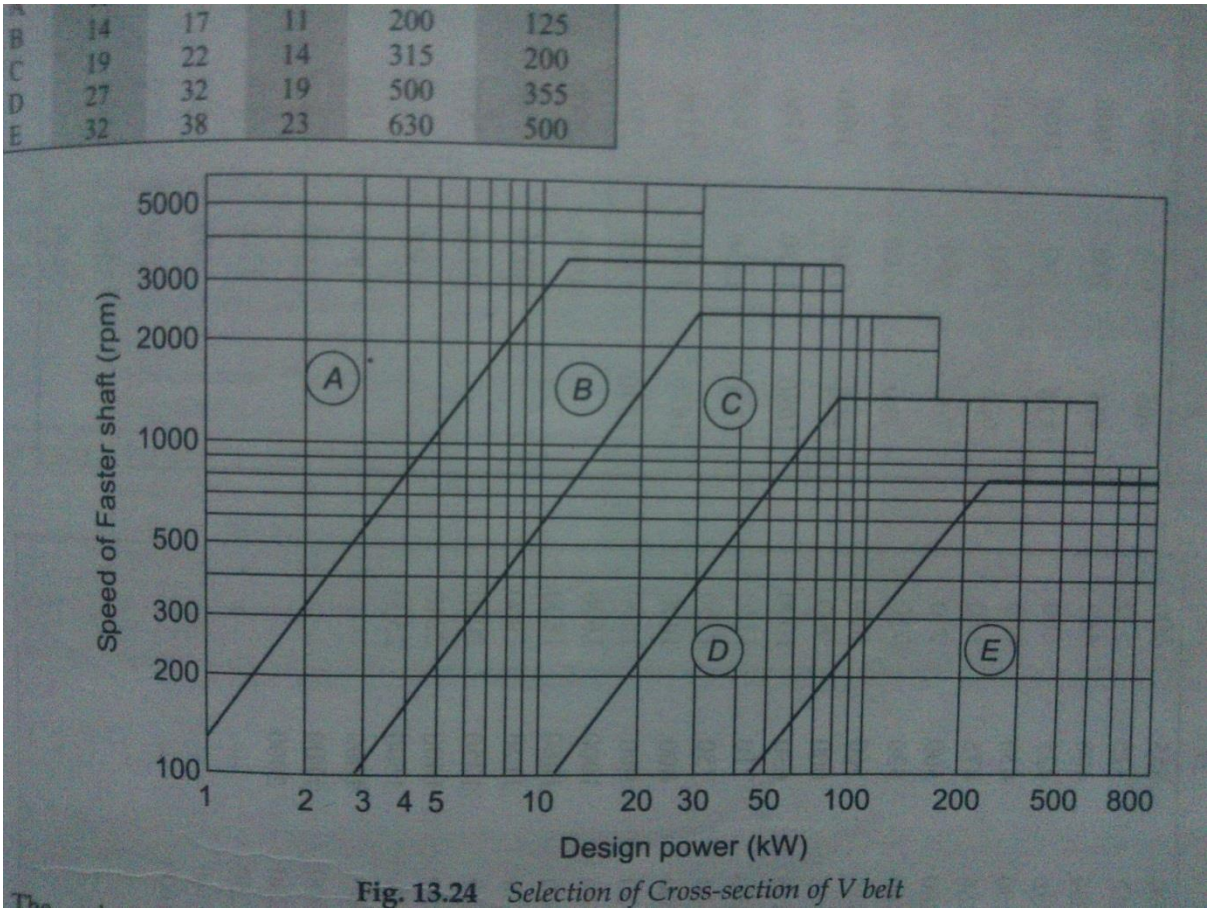


Fig. 13.24 *Selection of Cross-section of V belt*

Pulley:

The pulley material selected is cast iron, FG 200. The cross section is referred to from the given table:

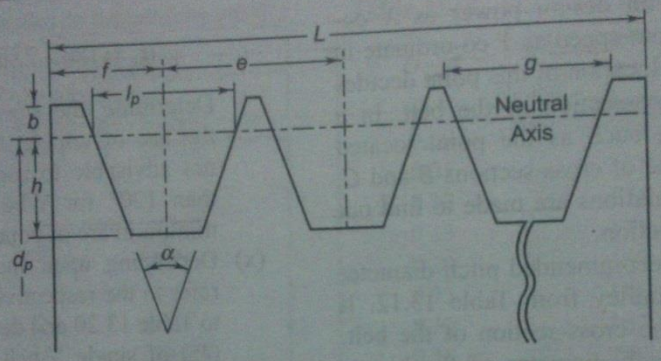


Fig. 13.25 *Dimensions of V-grooved pulley*

Table 13.23 *Dimensions of V-grooved pulleys*

Groove section	l_p mm	b mm	h mm	e mm	f mm	α°	d_p mm	g mm	Outside diameter
Z	8.5	2.00	9	12 ± 0.3	7–9	34	Up to 80	9.7	$d_p + 4.0$
A	11	2.75	11	15 ± 0.3	9–12	34	Up to 118	12.7	$d_p + 5.5$
B	14	3.50	14	19 ± 0.4	11.5–14.5	34	Up to 190	16.1	$d_p + 7.0$
C	19	4.80	19	25.5 ± 0.5	16–19	34	Up to 315	21.9	$d_p + 9.6$
D	27	8.10	19.9	37 ± 0.6	23–27	36	Up to 499	21.9	$d_p + 16.2$
E	32	9.60	23.4	44.5 ± 0.7	28–33	36	Up to 629	38.2	$d_p + 19.2$

$= (x - 1)e + 2f$ where x is the number of grooves

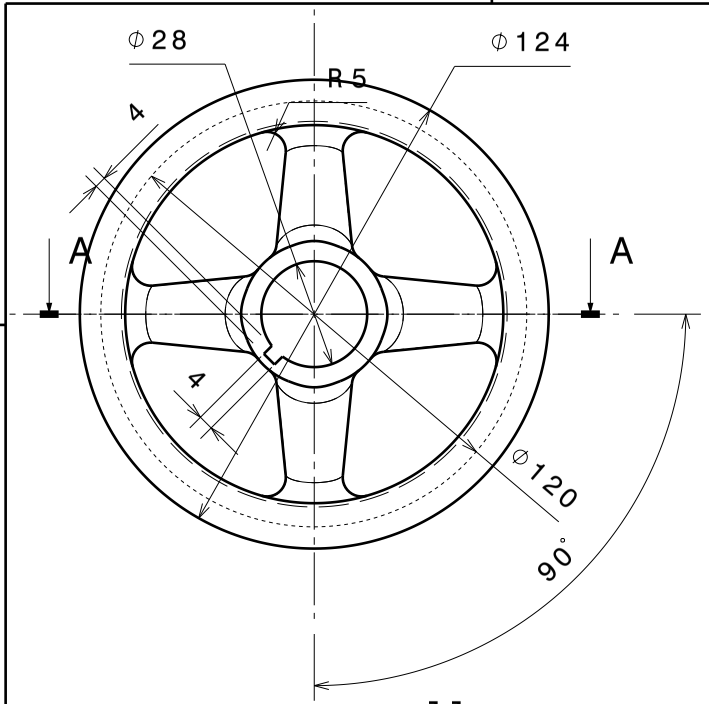
Property	Symbol	Formula	value	Design value	Unit
GIVEN DATA					
rating of motor	P		1.5		KW
speed of motor	N_2		1500		rpm
speed of compressor	N_1		750		rpm
ASSUMPTIONS					
coeff of friction	f		0.2		
groove angle	Θ		40		degrees
belt tye			V type		
belt drive type			open		
CALCULATIONS					
cross section of v belt		From graph	Z		
mass of belt			0.106		(kg/m)
dia of motor pulley	D_2	DDB	60		mm
dia of compressor pulley	D_1	D_2*N_2/N_1	120		mm
service factor	F_a		1		
design power		F_a*P	1.5		KW
centre to centre distance (initial estimatior	C	$D_1+1.5*D_2$	210	300	mm
length of belt		$2C+\frac{\pi(D1+D2)}{2}+\frac{(D1-D2)^2}{4C}$	885.7433	920	mm
a			8		
b			-2549.027		
c			3600		
corrected centre dist	C_1	from the quadratic equation	317.2097		mm
arc of contact	α	$180-2\sin^{-1}\frac{D_1-D_2}{2C}$	179.8106		degrees
arc of contact factor	Fd		1		
linear velocity	v		4.712389	7	m/s
power rating for single v belt		DDB	1.07		KW
length correction factor	Fc	(based on pitch length of belt)	1.04		
no. of belts			1.347951	2	
d		f*α/sin(Θ/2)	1.835147		
P_1-P_2		P*1000/v	318.3099		N
a1		$m*v^2$	2.353901		
b1		e^d	6.266056		
P_1			381.1094		N
P_2			62.79949		N
P_1+P_2			443.9089		N

quadratic equation constants

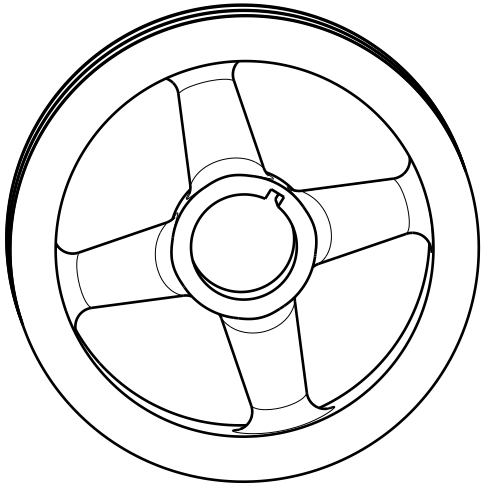
Flywheel calculations:

Property	Symbol	Formula	Value	Design value	Unit
GIVEN DATA					
Diameter of pulley	D_1		120		mm
Motor power	P		1500		W
ASSUMPTIONS					
Coeff of speed fluctuation	Ks		0.12		
Coeff of energy fluctuation	Ke		0.06		
P			1500		Watt
CALCULATIONS					
Work done by motor/cycle	W_{input}	$\frac{P * 60 * 2\pi}{2\pi N}$	60		J/cycle
Moment of inertia	I	$\frac{Ke * W}{Ks * \omega^2}$	0.0012		kg-m^2
Moment of inertia of pulley	I_p		0.002		kg-m^2

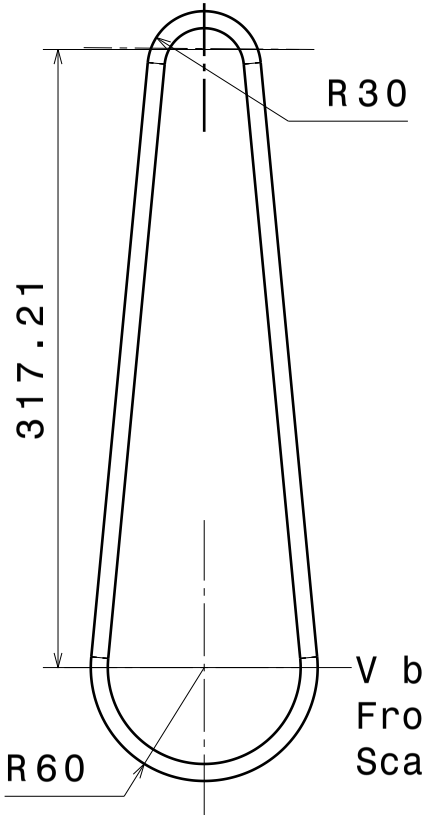
Thus we can say that the pulley acts as the flywheel, as it provides the required moment of inertia of a flywheel for the system.



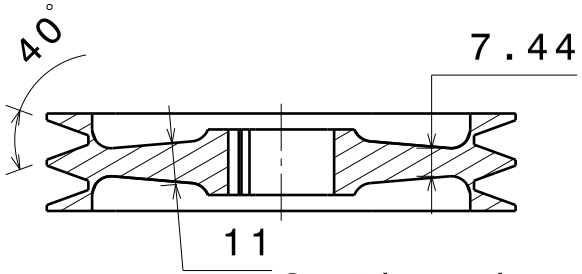
compressor pulley
Front view
Scale: 1:2



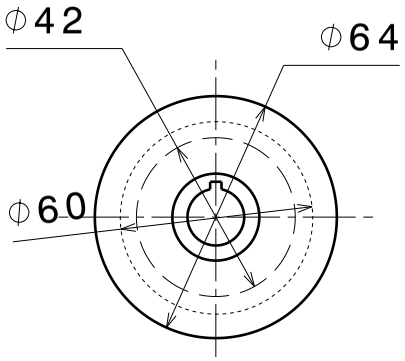
Isometric view
Scale: 1:2



V belt
Front view
Scale: 1:4



Section view A-A
Scale: 1:2



Motor pulley
Front view
Scale: 1:2

Part name:	Details of belt drive	
DESIGNED BY:	Priyanka Anantha	
DATE:	11-11-2014	
CHECKED BY:	Prof M. V. Walame	
DATE:		
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Receiver

Part name: Receiver

Material : Alloy Steel (15Cr90Mo55)

DATA	SYMBOL	FORMULA	VALUE	DESIGN VALUE	UNIT
Given					
Operating Pressure	P		1		MPa
Storage Capacity	V		0.1		m^3
Design Pressure	Pi	$P_i = 1.05 * P$	1.05		MPa
Assumptions					
Yield Strength	S_{yt}		290		N/mm^2
Factor of Safety	Fs		1.5		
Weld joint efficiency	η		0.8		
Corrosion Allowance	CA		0		mm
L/D Ratio	r		1.5		
Calculations					
Dimensions of Cylinder					
Allowable Stress	σ_t	$\sigma_t = S_{yt} / fs$	193.33		N/mm^2
Diameter of Cylinder	D_i	$D_i = \sqrt[3]{\frac{4*V}{\Pi * r}} * 1000$	439.48	440	mm
Length of Cylinder	L	$L = D_i * r$	659.22	660	mm
Thickness of Cylinder	t_1	$t_1 = P_i D_i / 2\sigma_t$	1.1934		mm
Modified thickness of Cylinder	T	$t = \frac{P_i D_i}{2\sigma_t \eta - P_i} + CA$	1.4969	2	mm
Torispherical Head					
Crown Radius	L		439.48	440	mm
Knuckle Radius	r_i	$r_i = 0.06 * L$	26.369	26.4	mm
Thickness	t_2	$t_2 = \frac{0.885 P_i L}{\sigma_t \eta - 0.1 P_i} + CA$	3.9633	4	mm
Weld Joint Calculations					
Length of Weld	L_w	$L_w = \prod * D_i$	1382.301		mm
Tensile Force	P	$P = \frac{\prod}{4} * P_i D_i^2$	159655.7		N
Permissible stress for butt weld	σ_w		110		MPa
Thickness of the weld	t_w	$t_w = \frac{P}{\sigma_w L_w \eta}$	1.3125	1.5	mm

It is also common to size receivers:

- to *1 gallon* for each ACFM (Actual Cubic Feet per Minute), or
- *4 gallons per compressor hp (horse power)*

Airflow Capacity		Recommended Receiver Volume		
(cfm)	(m3/h)	(cu ft)	(gal)	(m3)
100	170	13	100	0.4
200	340	27	200	0.8
300	510	40	300	1.1
400	680	54	400	1.5
500	850	67	500	1.9
750	1275	101	750	2.9
1000	1700	134	1000	3.8
1500	2550	201	1500	5.7
2000	3400	268	2000	7.6
3000	5100	402	3000	11.4
4000	6800	536	4000	15.2
5000	8500	670	5000	19.0
7500	12750	1005	7500	28.5
10000	17000	1340	10000	38.0

Compressor Power		Recommended Receiver Volume		
(hp)	(kW)	(cu ft)	(gal)	(m3)
5	3.7	3	20	0.1
7.5	5.6	4	30	0.1
10	7.5	5	40	0.2
15	11.2	8	60	0.2
20	14.9	11	80	0.3
25	18.7	13	100	0.4
30	22.4	16	120	0.5
40	29.8	21	160	0.6
50	37.3	27	200	0.8
60	44.8	32	240	0.9
75	56.0	40	300	1.1
100	74.6	54	400	1.5
125	93.3	67	500	1.9
200	149.2	107	800	3.0
350	261.1	188	1400	5.3
450	335.7	241	1800	6.8
500	373.0	268	2000	7.6

For more information, visit our website or contact our customer service team by calling toll-free: (866) 650-1937 or emailing sales@ecompressedair.com.

Tags: Air Receivers

Safety Valve

RVA 15 (15-100) SERIES



ASME SECTION VIII SAFETY VALVES

ASME Air Relief Valves

FEATURES

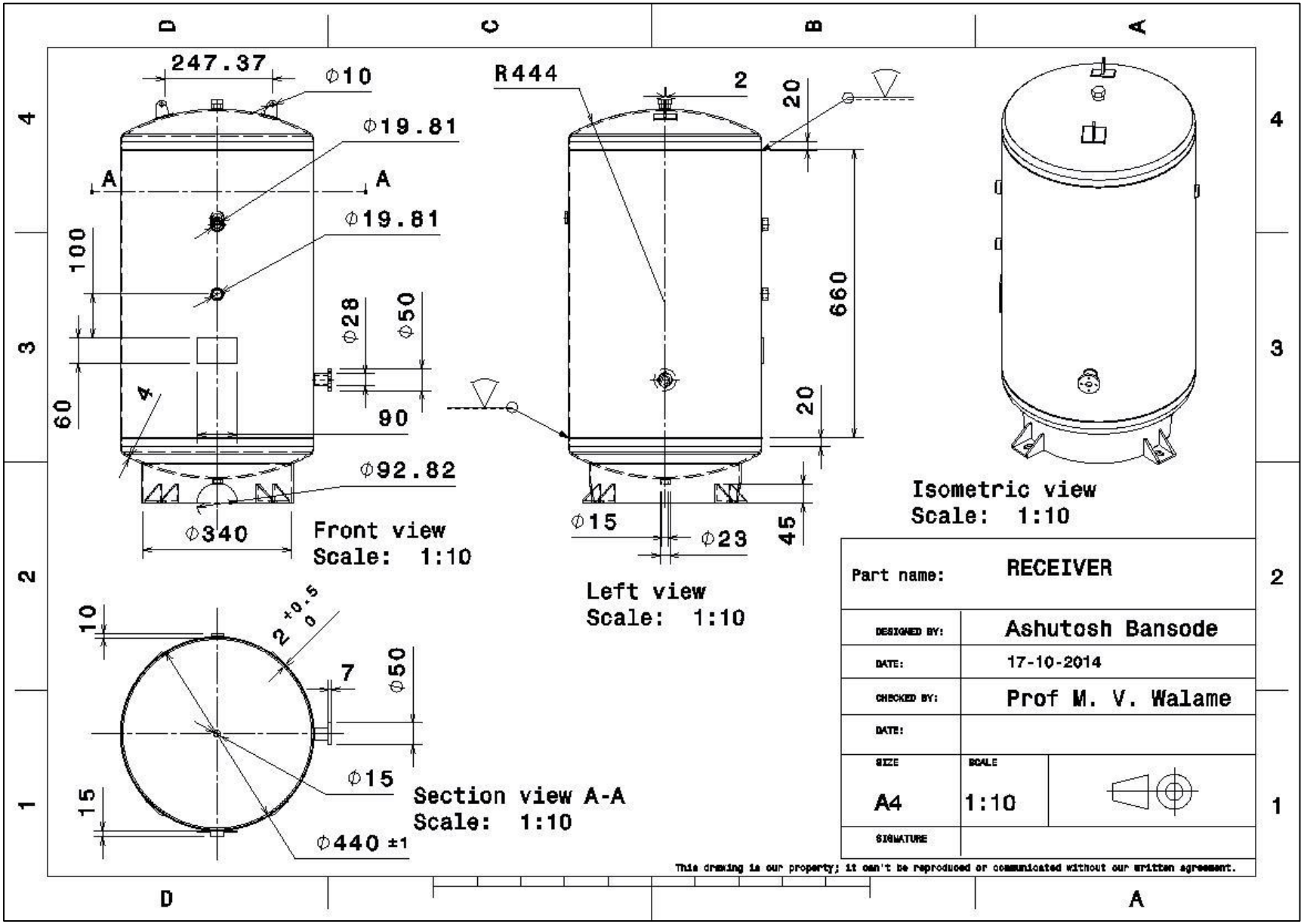
- National Board Certified 15 psig through 250 psig
- Stainless steel springs
- High performance molded Viton seat design, Sizes 1/4" to 1/2"
- Viton o-ring seat, 3/4" & 1"
- Registered in all Canadian Provinces and Territories: CRN #0G8547.5C
- Maximum temp. 325°F
- ASTM B16 brass body
- Optional dual ASME/European Pressure Equipment Directive Compliance
- Manufactured in USA

National Board Certified capacities for air and gas service in air compressors, air receivers and gas lines

Series Number	Inlet Size (in.)	Dimensions (in.)		Wt./100 (lbs.)
		A	B	
15-112	1/4 NPT	2.625	.78	18.5
15-115	3/8 NPT	3.250	1.125	42.2
15-117	1/2 NPT	3.375	1.125	45.3
15-118	3/4 NPT	4.062	1.218	58.0
15-119	1 NPT	5.125	1.875	153.0

Set Pressure psig*	Capacities in SCFM @ 10% Accumulation			
	15-112 1/4"	15-115 & 117 3/8" or 1/2"	15-118 3/4"	15-119 1"
15	24	60	107	222
30	35	88	156	323
50	51	128	229	473
75	72	179	319	659
100	92	230	409	845
125	112	281	499	1032
150	133	332	589	1218
165	145	363	644	1330
175	153	383	680	1405
200	173	432	770	1591
225	194	484	860	1778
250	214	535	950	1964

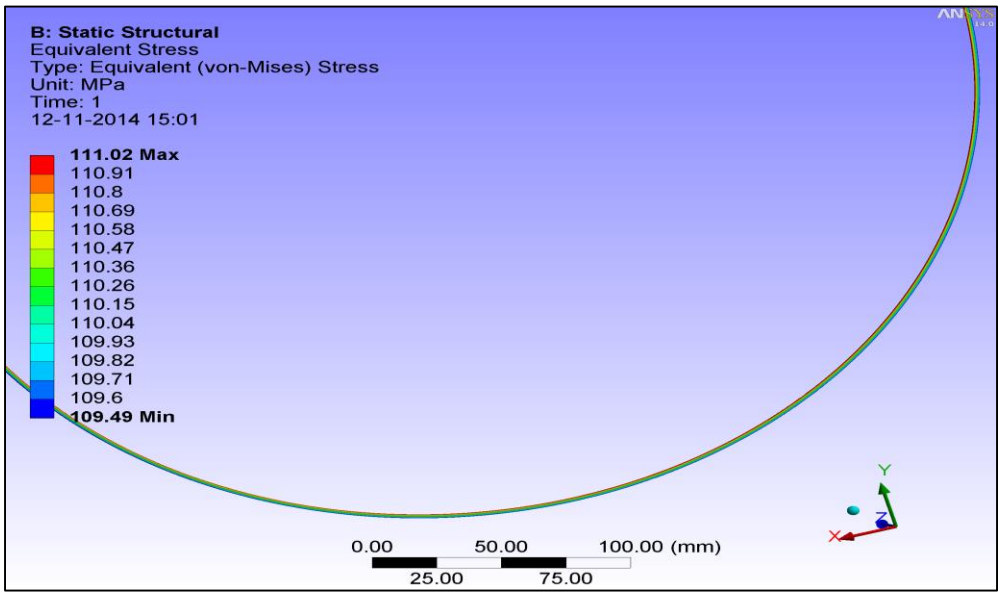
** Other set pressures available upon request.*

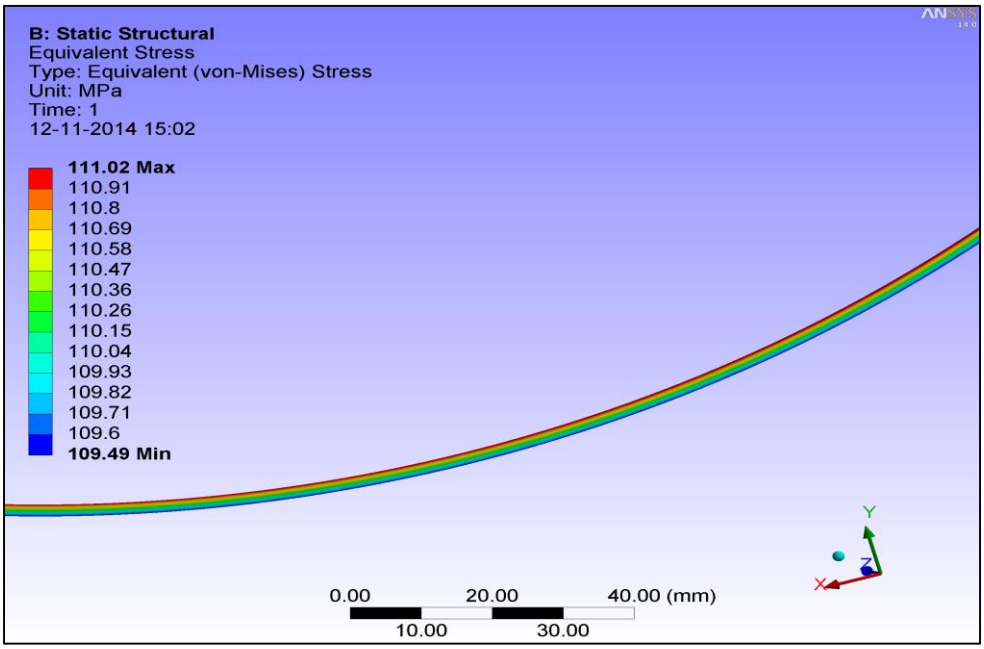

247.37
ϕ10
ϕ19.81
ϕ19.81
A
A
100
60
4
ϕ28
ϕ50
90
ϕ92.82
ϕ340
Front view
Scale: 1:10
R444
2
20
660
20
ϕ15
ϕ23
45
Left view
Scale: 1:10
Isometric view
Scale: 1:10
10
2 +0.5 0
7
ϕ50
ϕ15
15
ϕ440 ±1
Section view A-A
Scale: 1:10
Part name: RECEIVER
DESIGNED BY: Ashutosh Bansode
DATE: 17-10-2014
CHECKED BY: Prof M. V. Walame
DATE:
SIZE A4
SCALE 1:10
SIGNATURE
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Process Sheet:

Operation no.	Discription of operation	Machine/Process	Tools/Specification	Process parameter	Time (min)	Rate (Rs/hr)	Cost (Rs)
1	Making dimensions on sheet metal plate and cutting	Flame cutting or Laser cutting	Laser beam/ Flame cutter	Sheet metal of dimensions 1400x660	30	200	100
2	V edge preparation		Rolling edge tool	V edge of 45 deg angle	10	150	25
3	Coil the sheet on rollers machine.	Roll bending	Roll bender	Cylindrical roll with 440 mm diameter	10	150	25
4	Edge welding	Electric Arc Welding		Single butt weld joint	20	150	50
5	Head metal cutting	Flame cutting	Flame cutter	2 nos.	10	200	30
6	Hot forming of Torispherical Head	Torispherical forming tool			20	750	250
7	Assembly of Shell and Head	TIG Welding		High quality leakproof weld	30	300	150
8	Finishing of Assembly	Sandering		Proper surface finish and good appearance	30	50	25
				TOTAL	160		655

Receiver Analysis:





ASSEMBLY REPORT

1. Assemble the piston and connecting rod separately.
2. Insert bush in small end of connecting rod.
3. Assemble the piston with gudgeon pin. Lock the piston using circlips.
4. Mount the piston rings.
5. Insert connecting rod on crank shaft separately.
6. Mount bearings on both sides of crank shaft.
7. Mount the whole assembly on bottom of casing.
8. Bolt the upper part of casing with the bottom of casing such that the rod
   goes inside it and the piston projects out.
9. Assemble cylinder block and liner separately.
10. Bolt the cylinder block to the upper casing.
11. Bolt the head to cylinder block.
12. Take receiver, weld the handles and assemble the wheels.
13. Now weld the base plate on the receiver (gas welding).
14. Mount the motor and bottom part of casing on base plate using bolts on
    specified location.
15. Mount the Bottom part of the casing on base plate.
16. Mount both pulleys simultaneously and check their alignment and
    straightness.
17. Key both, pulley and flywheel to the motor and crank shaft respectively.
18. Mount the belt on pulleys.
19. Mount a Safety cover to Belt drive.
20. Fit the pipes and gauges Valves.

MAINTENANCE REPORT

MAINTENANCE SCHEDULE

- Check for oil leaks.
- Daily or before each operation check lubricant level. Fill as needed.
- Drain receiver tank condensate (if automatic draining device is not provided).
- Open manual drain valve and collect and dispose of condensate accordingly.
- Check for unusual noise and vibration.
- Ensure belt guards and covers are securely in place.
- Ensure engine (if supplied) is filled with fuel and lubricant according to the manufacturer's recommendations.
- Ensure area around compressor is free from rags, tools, debris, and flammable or explosive materials.
- Weekly Observe operation of safety/relief valves while the compressor is running. Replace safety/relief valves that do not operate freely.
- Inspect air filter element(s). Clean if necessary.
- Monthly Inspect for air leaks. Squirt soapy water around joints during compressor operation and watch for bubbles.
- Check tightness of screws and bolts. Tighten as needed.
- Inspect drive belts. Adjust if necessary.
- Clean exterior.