Machine System Design

A Project Report On

“Agricultural Wheeled Spray Pump”

Submitted by

Group 3-A

BT18MEC064 – KUNAL SONAWANE
BT18MEC068 – SAURABH KHODE
BT18MEC096 – BHAVIN YARDI

Under the guidance of

Prof. Dr. H.T.Thorat

Department Of Mechanical Engineering

VNIT, Nagpur.

1. **Name of Machine**: Agricultural Wheeled Spray Pump

2. **Purpose of the Machine**: To spray pesticides on crops through manual efforts.

   This machine is a manually operated system and through this Machine we can reduce the maximum effort required for spraying Pesticides as well as we can spray pesticides in any direction or Around the crops at any height crops.

3. **Design Objective**: The conventional pesticide sprayers load the farmer's back with heavy storage tank which has to be carried all along the spraying process, which increases the efforts of the farmer. The objective of this machine is to fulfil the pesticide requirements of the farm at maximum rate, while reducing the efforts of the farmer.

4. **Broad Design Specifications**:

   - Discharge – 3L/min
   - No of nozzles – 3
   - Area covered in one day – 6.4 Acre per day
   - Spray per m2 – 82.873ml

5. **Selection of Process and Mechanism**:

   Pressure Generation Process: Two types of pump can be used for the pressure generation process:

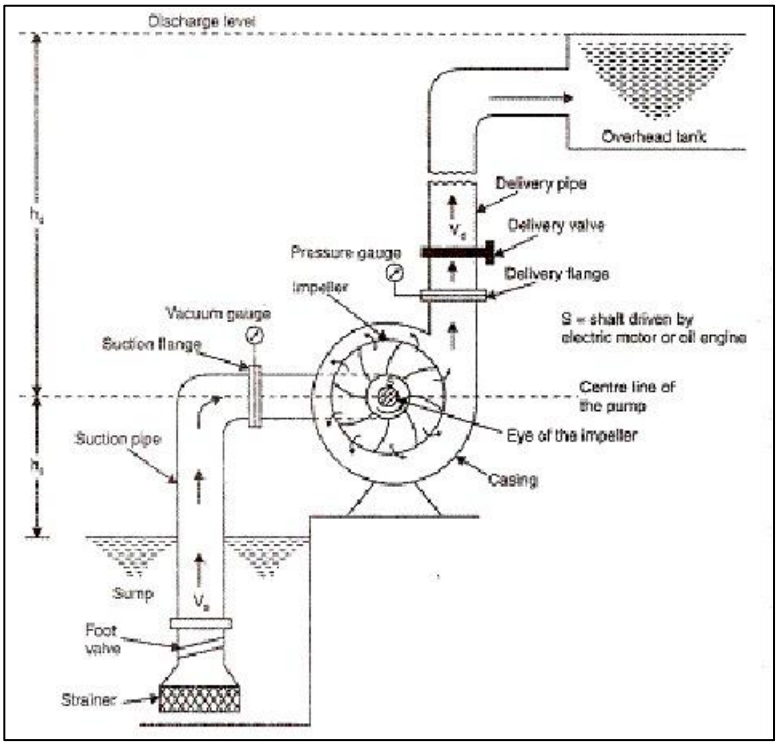
1. Centrifugal Pump: A centrifugal pump is a mechanical device designed to move a fluid by means of the transfer of rotational energy from one or more driven rotors, called impellers.

The impeller is the key component of a centrifugal pump. It consists of a series of curved vanes. These are normally sandwiched between two discs (an enclosed impeller).

Fluid enters the impeller at its axis and exits along the circumference between the vanes. The impeller is connected through a drive shaft to a motor and rotated at high speed (typically 500-5000rpm). The rotational motion of the impeller accelerates the fluid out through the impeller vanes into the pump casing.

The action of the impeller increases the fluid's velocity and pressure and also directs it towards the pump outlet.

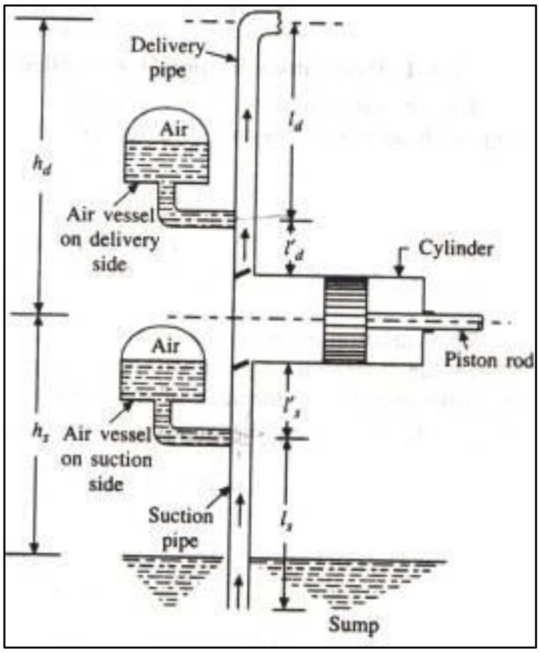
There are two basic designs of pump casing: volute and diffuser. The purpose in both designs is to translate the fluid flow into a controlled discharge at pressure.



2. <u>Reciprocating Pump:</u> Reciprocating Pump is a Positive Displacement type pump that works on the principle of movement of the piston in forwarding and backward directions.

It is a machine that converts mechanical energy into hydraulic energy. Reciprocating pumps are in use where a certain quantity of fluid has to be transported from the lowest region to the highest region by the application of pressure. The liquid is sucked keeping the delivery valve close and is pushed out while keeping the intake valve close creating a pressure at nozzle.

The rotatory motion of the wheel shall be used to drive the crank and convert the rotary motion into reciprocatory motion of the piston which will then cater to the process of pressure generation.



<u>Pressure Generation is done by reciprocating pump.</u>

- **Advantages of reciprocating pump over centrifugal pump:**

1. Reciprocating pump is used at a high-pressure head and Centrifugal Pumps are used at low or medium pressure head because the pressure generated in centrifugal pumps is limited due to the limitation on the speed of the shaft.

2. In reciprocating pumps low discharge is obtained which is a desired output for our case.

6. Design of Mechanism:

- **Working of machine:** The Reciprocating Pump has been used in the machine for pressure generation.

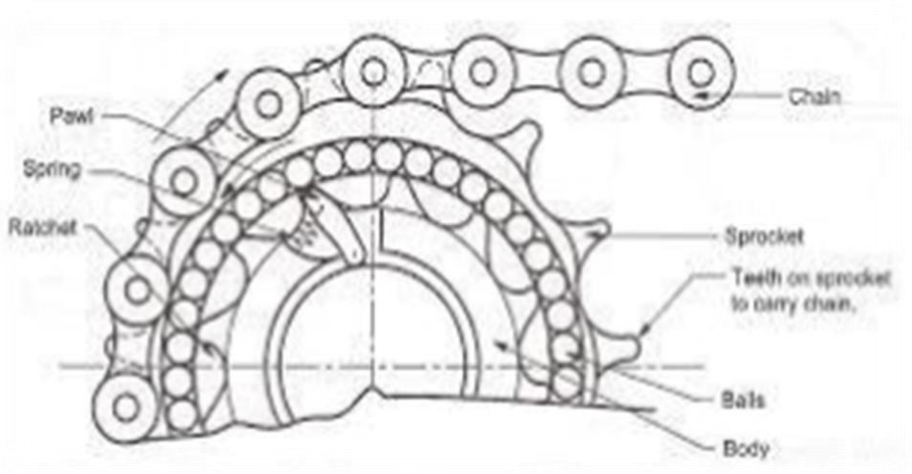
  The slider crank Mechanism of the pump will be powered by the farmer himself. The total power requirement of the machine will depend on the discharge required as well as the height at which the pesticide is to be pumped. The discharge and the height of spray will vary from farm to farm and the calculations in this report have been done for the Wine-Yard farm. In addition, to the power required for spraying of pesticides the farmer will also need to exert some power to overcome the friction and facilitate the movement of the machine. Because there is a limit to the power which the farmer can exert, the discharge needs to be lowered by attaching the nozzles only one side of the frame. Chain Sprocket Mechanism has been used for power transmission. Freewheel has been attached on the crankshaft to avoid the power transmission in the reverse direction.

- **Front Wheel Selection:** A bigger wheel meant more stability to the cart but at the same time it would reduce the angular velocity of the front wheel, as the linear speed of the wheel would more or less remain constant. Lower angular velocity of the wheel would mean greater requirement of torque which would lead to the farmer exerting higher amount of force. Hence, we choose diameter of front wheel to be 30cm(smaller) and that of rear wheels to be 40cm(larger) thus ensuring stability and reducing overall torque requirement.

- **Sprocket Wheel and Speed Ratio:** In order to reduce the torque requirement, the angular velocity of the crankshaft needed to be increased. The lower limit on the size of the front wheel was fixed due to stability issues. Hence, the speed of the crankshaft had to be increased by choosing a suitable velocity ratio of the chain-sprocket mechanism. The velocity ratio had to be increase as much as possible. But the maximum velocity ratio attainable is **2:1.**

- **Freewheel:** It is mounted on crankshaft connected with sprocket chain drive. It will be used in power transmission in forward direction. But for initial pressure built-up, instead of moving the cart and closing the nozzle's opening, freewheel will be rotated

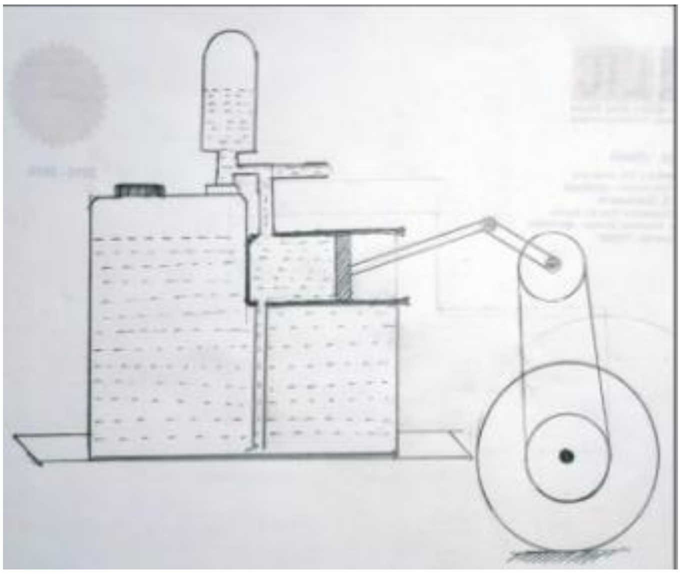
  in reverse direction with the help of handle connected at the end of crankshaft, that will rotate the crankshaft and will setup initial pressure without moving the cart



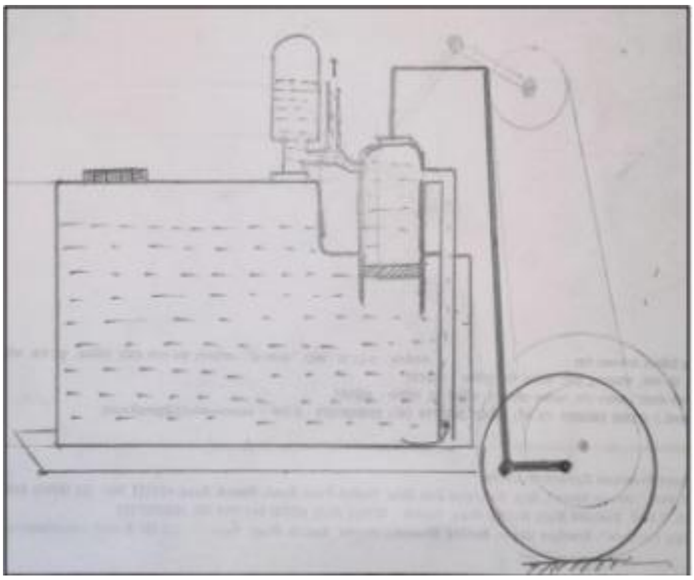
- **DESIGN SELECTION:** While using the reciprocating pump for the pressure generation process, the pump could be designed in two ways. One being with a fixed cylinder and the other with fixed piston. We analysed both the designs and finally decided to go with fixed cylinder reciprocating pump because of the following reasons:

  1. Excessive length of linkages is required in the fixed piston type of reciprocating pump. Due to this, fixed piston type of reciprocating pump results in a less compact design.

2. As suction pipe will also reciprocate along with the cylinder in the fixed piston type of reciprocating pump, the design of suction pipe will create complication in design of actual pump.



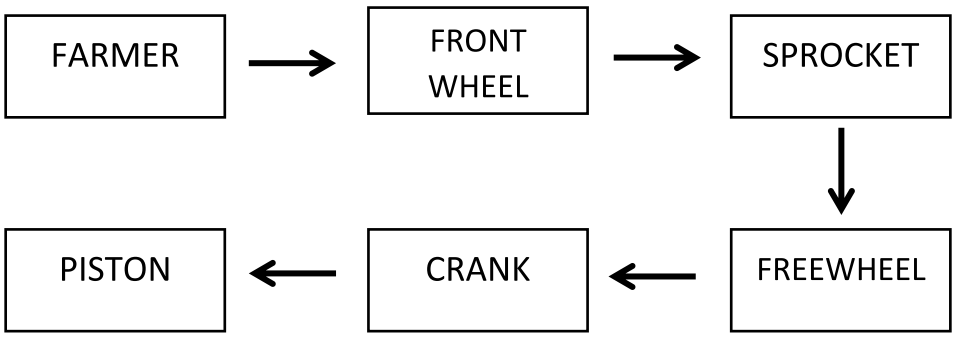
FIXED CYLINDER RECIPROCATING PUMP



FIXED PISTON RECIPROCATING PUMP

- **Average Torque/Maximum Torque:** The maximum angular velocity attainable on the machine is close to 90rpm which eliminates the use of flywheel in machine as flywheel works on higher rpm. Hence, the machine cannot be designed for average torque but has to be design for maximum torque required.

7. Power Transmission Chain:



8. Calculation of Power and Speed Requirement:

- Discharge = 3L/min
  Assumed Cd = 0.5
  Therefore, Design Discharge = 6L/min

- Number of Nozzles = 3
  Therefore, Discharge per nozzle = 2L/min

- Speed of farmer = 0.7m/s
  Radius of wheel = 0.15m
  Angular speed of wheel = 4.67rad/s
  Angular speed of crank = 9.34rad/s = 89.1267rpm
  Assumed Bore – stroke (d-l) ratio = 1:2

  Calculation of bore diameter and stroke length, Since, Discharge $= \frac{\pi d^2 * l * N}{4*60}$

Bore diameter**, d = 3.5cm**
Stroke length, **l = 7cm**

- Calculation of Suction and Delivery pipe diameter,

  Nozzle exit diameter = 2mm (Given Specification)
  Therefore, $\frac{\pi d^2 * Vexit}{4*2}$ = 2L/min
  Vexit = 10.6m/s (exit velocity at nozzle)

  Nozzle inlet diameter = 6.35mm
  Therefore, $\frac{\pi d^2 * Vinlet}{4*2}$ = 2L/min

  Vinlet = 1.05m/s (inlet velocity at nozzle)

  Since, Velocity in suction pipe = velocity in delivery pipe = Vinlet = 1.05m/s

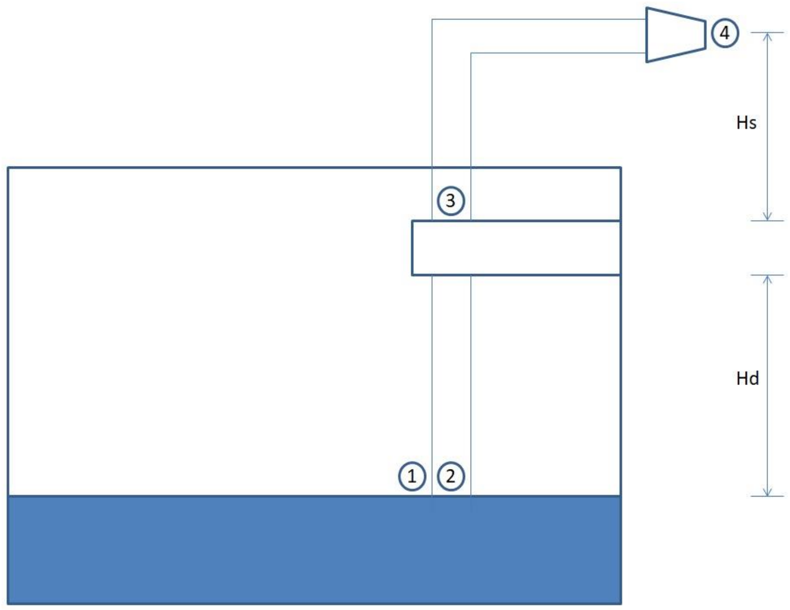
  Therefore, $\frac{\pi Ds^2 * Vinlet}{4*2}$ = 6L/min

  Ds = 1.1cm

  Therefore, diameter of suction pipe = diameter of delivery pipe = 1.1cm

- **Calculation of suction and delivery head:**
  Given Specifiaction:
  Length of delivery pipe = 1m
  Length of suction pipe = 0.25m

Assuming the free surface of pesticides in tank as datum.



1. **Suction head (Hs)** = $\frac{P2}{\rho g} + \frac{v2^2}{2g} + h2$

Applying Bernoulli's Principle on 1 and 2,

$$\frac{P1}{\rho g} + \frac{v1^2}{2g} + h1 = \frac{P2}{\rho g} + \frac{v2^2}{2g} + h2$$

$$\frac{Patm}{\rho g} + 0 + 0 = \frac{P2}{\rho g} + \frac{v2^2}{2g} + \mathrm{h2}$$

Therefore, **Hs** = $\frac{Patm}{\rho g}$ **= 10.3m**

2. **Delivery head (Hd)** = $\frac{P3}{\rho g} + \frac{v3^2}{2g} + h3$

Applying Bernoulli's Principle on 3 and 4,

$$\frac{P3}{\rho g} + \frac{v3^2}{2g} + h3 = \frac{P4}{\rho g} + \frac{v4^2}{2g} + h4$$

$$\frac{P3}{\rho g} + \frac{v3^2}{2g} = \frac{Patm}{\rho g} + \frac{Vexit^2}{2g} + h4 - h3$$

Therefore, **Hd =** $\boldsymbol{\frac{Patm}{\rho g} + \frac{Vexit^2}{2g} + h4 = 17.28}$

- **Calculation of acceleration head Ha:**

$$Ha = \frac{A * l * w^2 * r * \cos\theta}{a * g}$$

$$\mathbf{Has} = \frac{A * ls * w^2 * r * \cos\theta}{as * g} = 0.008425\cos(\theta)$$

$$\mathbf{Had} = \frac{A * ld * w^2 * r * \cos\theta}{ad * g} = 0.337\cos(\theta)$$

- Force required for generating head:
  During suction,

$$Fs = \frac{(Hs + Has) * \rho * g * \pi * d^2}{4}$$

$$= \frac{\left(10.3 + 0.08425\cos(\theta)\right) * 1000 * 9.81 * 3.14 * 0.035^2}{4}$$

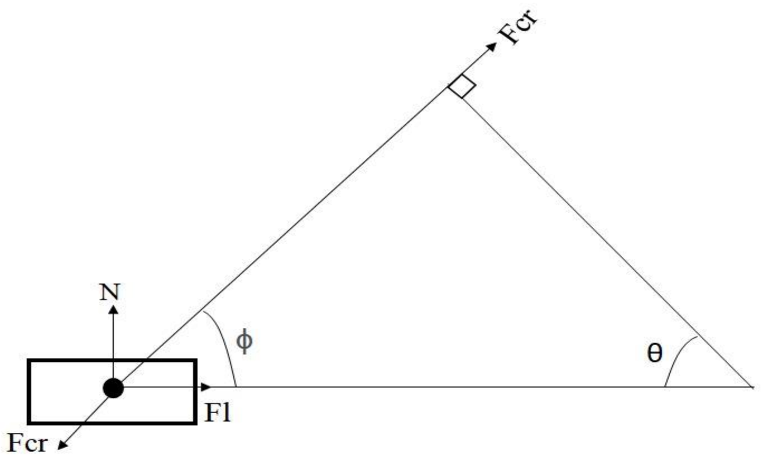
Fs = 97.21 + 0.795cos (θ)

$$Fd = \frac{(Hd + Had) * \rho * g * \pi * d^2}{4}$$

$$= -\frac{\left(17.28 + 0.337\cos(\theta)\right) * 1000 * 9.81 * 3.14 * 0.035^2}{4}$$

Fd = **-(163.09 + 3.18cos (θ))**

- Torque required for generating load:



During suction,

$$Ts = \frac{Fs*r*\sin(\theta)*\{\frac{l}{r}*\cos(\theta)+\sqrt{1-\left(\frac{l}{r}*\sin(\theta)\right)^2}\}}{\sqrt{1-(\frac{l}{r}*\sin(\theta))^\wedge 2}}$$

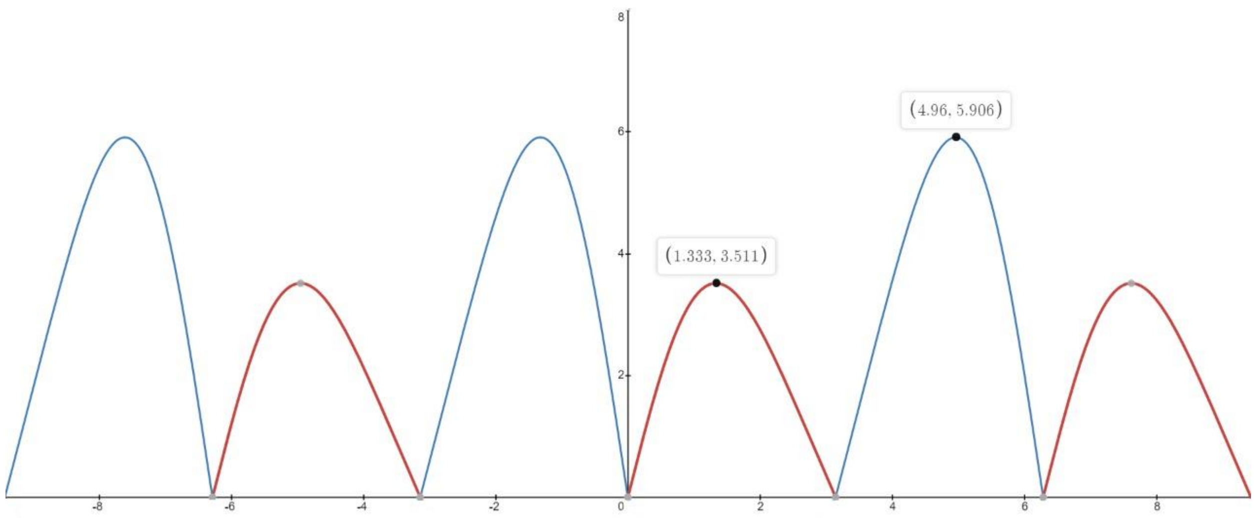
$$Ts = \frac{(3.4+0.027\cos(\theta))*\sin(\theta)*\{0.25*\cos(\theta)+\sqrt{1-(0.25*\sin(\theta))^2}\}}{\sqrt{1-(0.25*\sin(\theta))^\wedge 2}}$$

During delivery,

$$Td = \frac{Fd*r*\sin(\theta)*\{\frac{l}{r}*\cos(\theta)+\sqrt{1-\left(\frac{l}{r}*\sin(\theta)\right)^2}\}}{\sqrt{1-(\frac{l}{r}*\sin(\theta))^\wedge 2}}$$

$$Td = -\frac{(5.7024+0.1121\cos(\theta))*\sin(\theta)*\{0.25*\cos(\theta)+\sqrt{1-(0.25*\sin(\theta))^2}\}}{\sqrt{1-(0.25*\sin(\theta))^\wedge 2}}$$

- Plotting T VS **θ** diagram during delivery as well as suction.



We obtain,

Maximum torque required during the cycle = 6Nm

- Therefore, maximum power required = Tmax*w
  = 56Watts

- **Considering following losses:**
  1) Friction loss in suction pipe
  2) Friction loss in delivery pipe

3) Losses in reciprocating pump

Assuming these losses to be 10%
Taking efficiency of chain sprocket mechanism = 98%
Power drawn by machine for pressure generation = $\frac{56}{0.9^3 * 0.98}$

= 77.8Watts

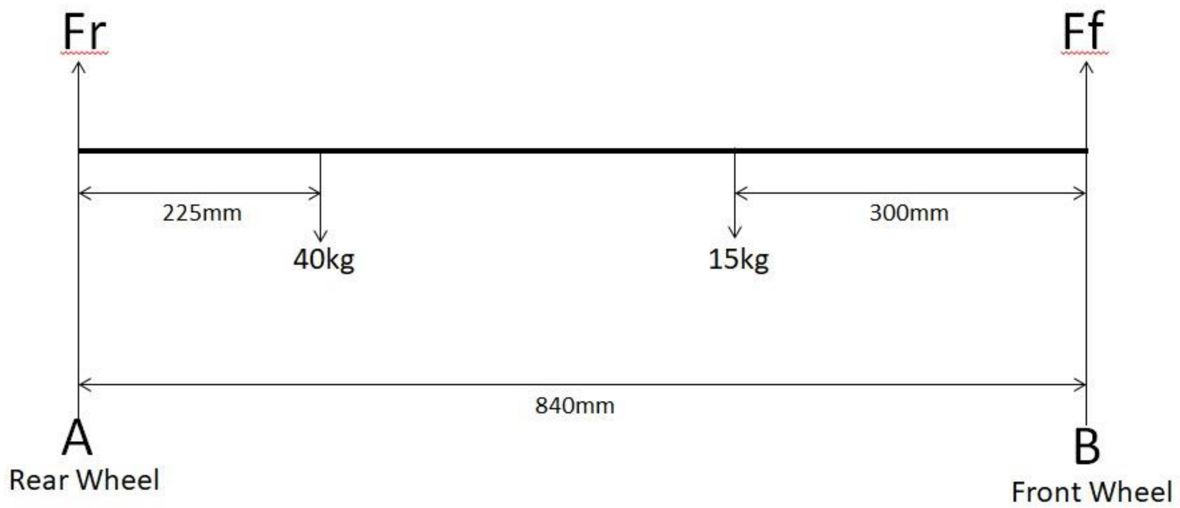
Weight of the machine = 60kg
Coefficient of friction between tyre and soil = 0.1
Linear velocity of machine = 0.7m/s

Therefore, total power required to overcome friction -
= 60*9.881*0.1*0.7
= 41.2Watts

Therefore, Total power requirement of the machine = 77.8 + 41.2
= 119Watts

9. Force Analysis:

- **Weight Distribution on Front and Rear Shaft:**



Given Specifications:

- Wheelbase = 840mm
- Let force on Rear shaft be Fr and force on front shaft be Ff

Calculations of forces on front and rear shaft:

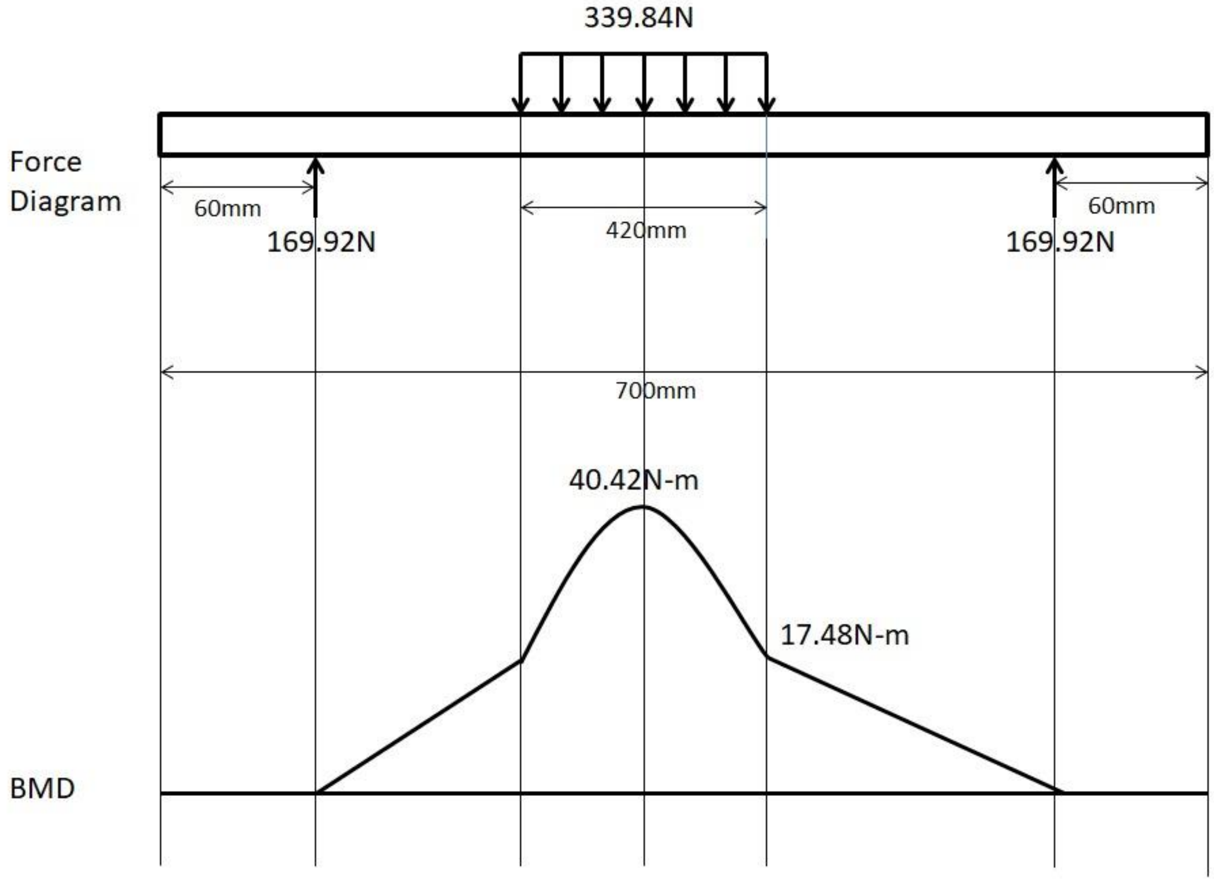
Fr + Ff = (40+15) *9.81
= 539.55N

Taking moment about A = 0,

-40(9.81) *225 – 15(9.81) *540 + Ff (840) = 0

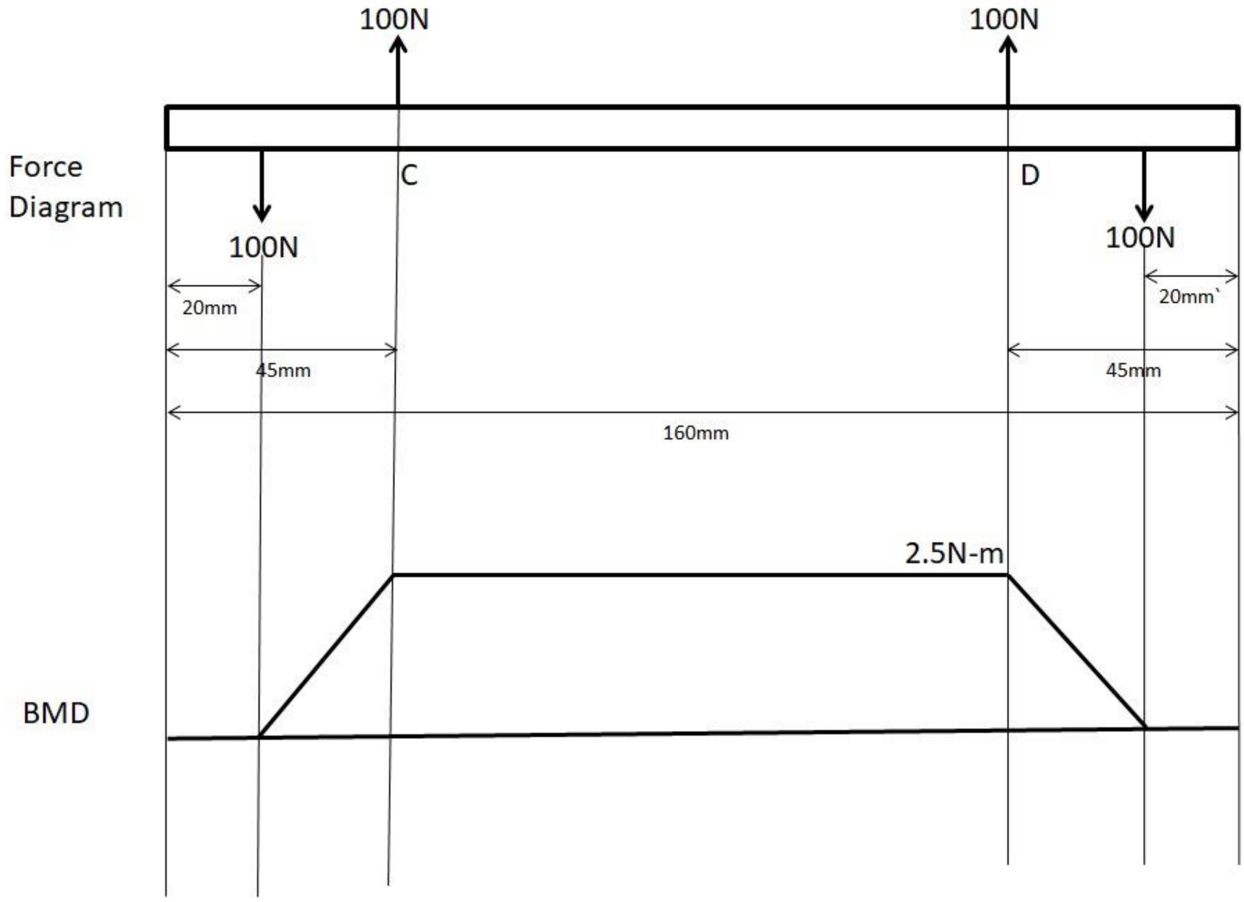
Therefore, **Ff = 199.70N**
Fr = 339.84N

- **Force analysis of Rear Shaft:**



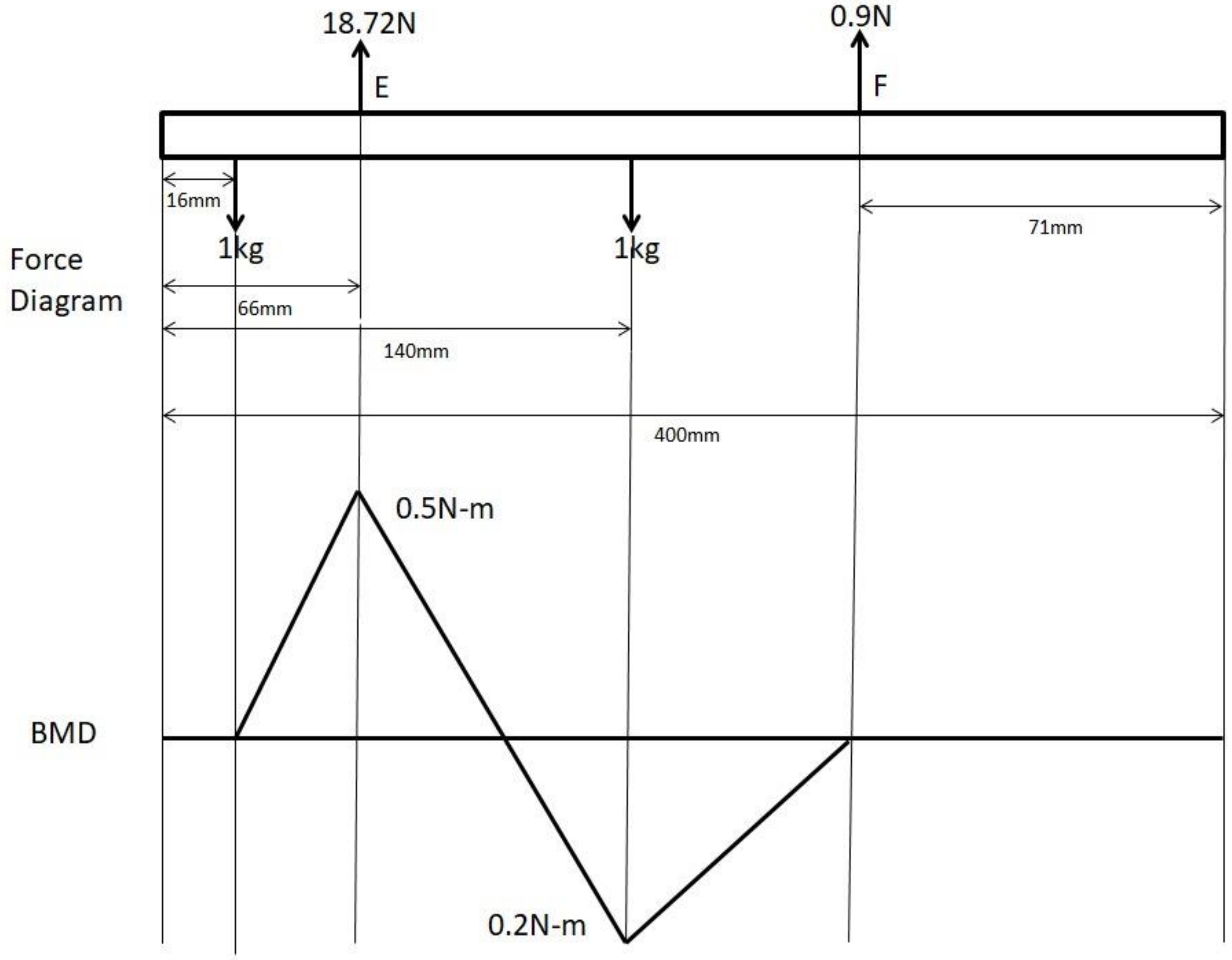
Total Weight acting on rear shaft in downward direction = 339.84N
Therefore, Upward forces on bearings at A and B = 339.84/2
=169.92N

- **Force Analysis of Front Shaft:**



Total Weight acting on front shaft in downward direction = 200N
Therefore, Upward forces on bearings at C and D = 200/2
=100N

- **Force Analysis of Crank-Shaft:**



Total Weight acting on crank shaft in downward direction = 19.62N

Upward forces acting on shaft due to bearing at E and F,

$$Fe + Ff = 19.62N$$

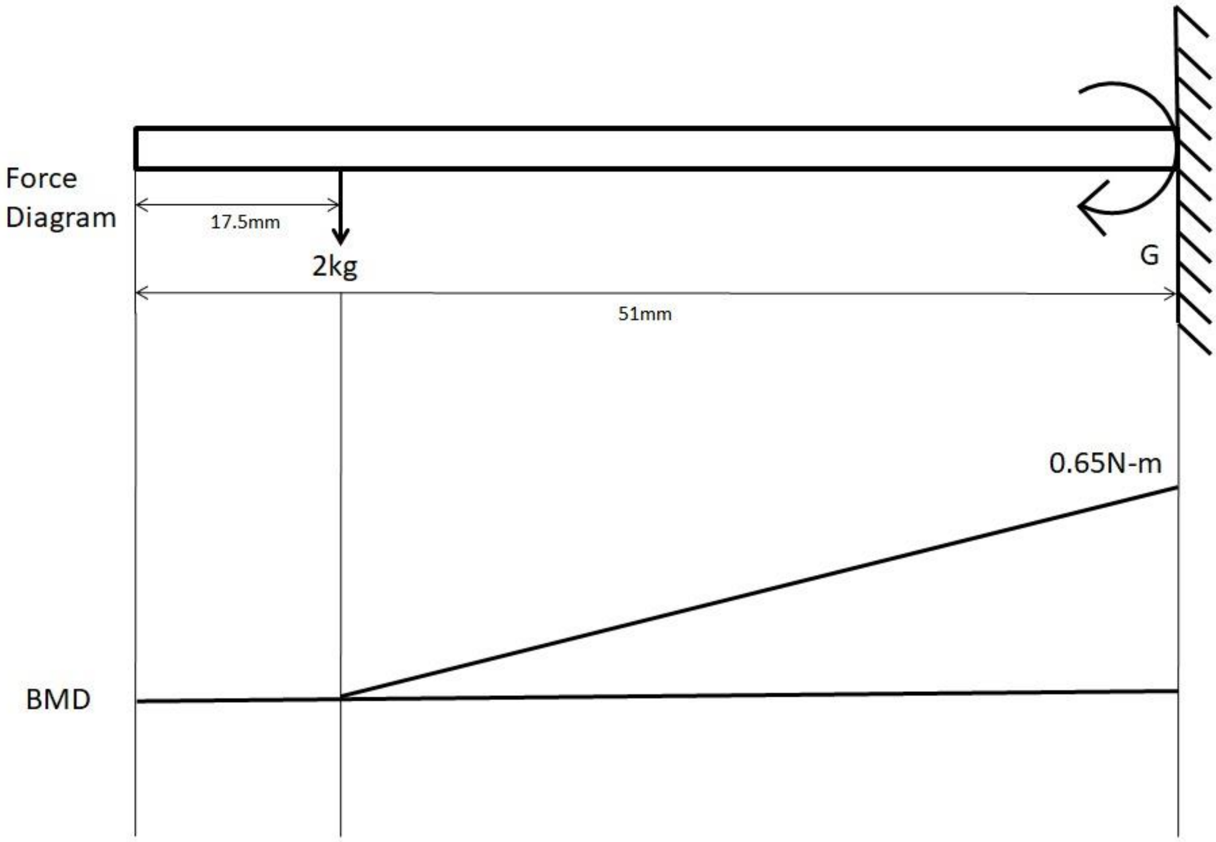
Taking moment about E = 0,

$$1*9.81 * 50 – 1*9.81 * 74 + Ff*263 = 0$$

Therefore, **Ff = 0.9N**

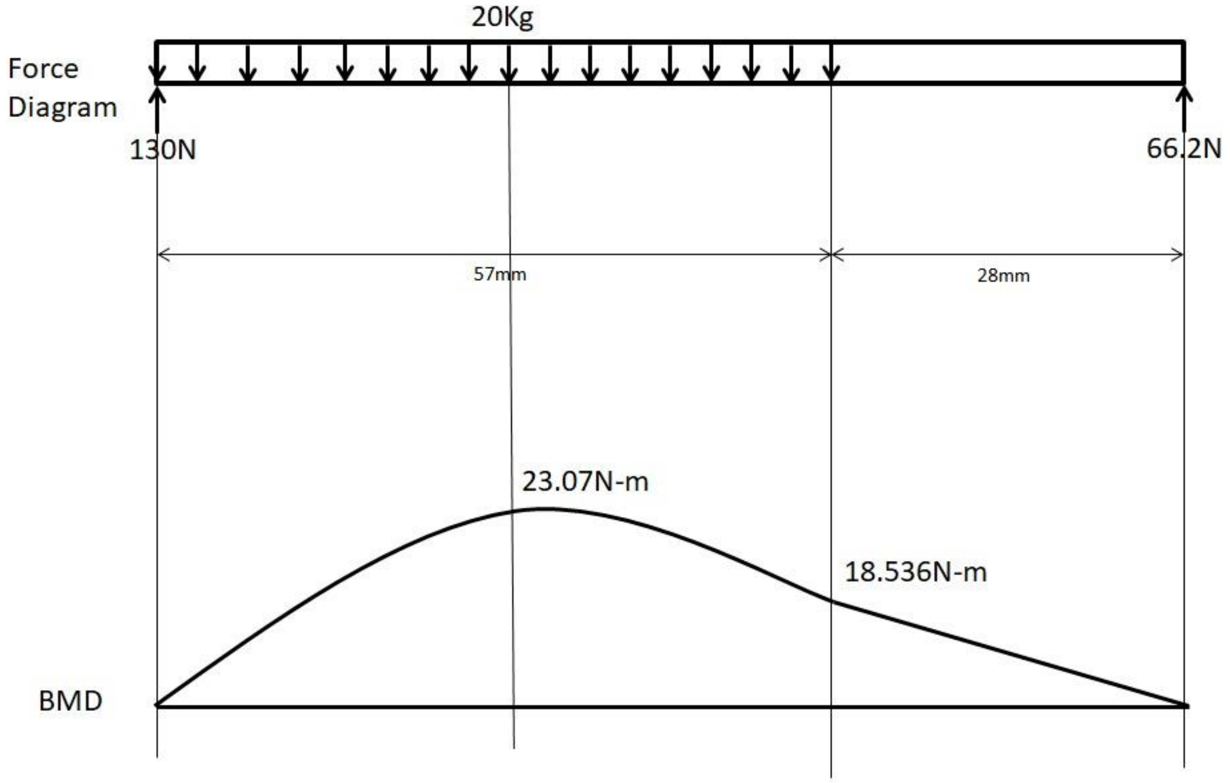
Fe = 18.72N

- **Force Analysis of Crank pin:**



Force acting on point G = 2*9.81 = 19.62N
Moment about point G = 19.62*(51-17.5)
= 0.65727N-m

- **Force Analysis of Angle bar:**



Total downward force acting on angle bar = 196.2N

Fa + Fb = 196.2N

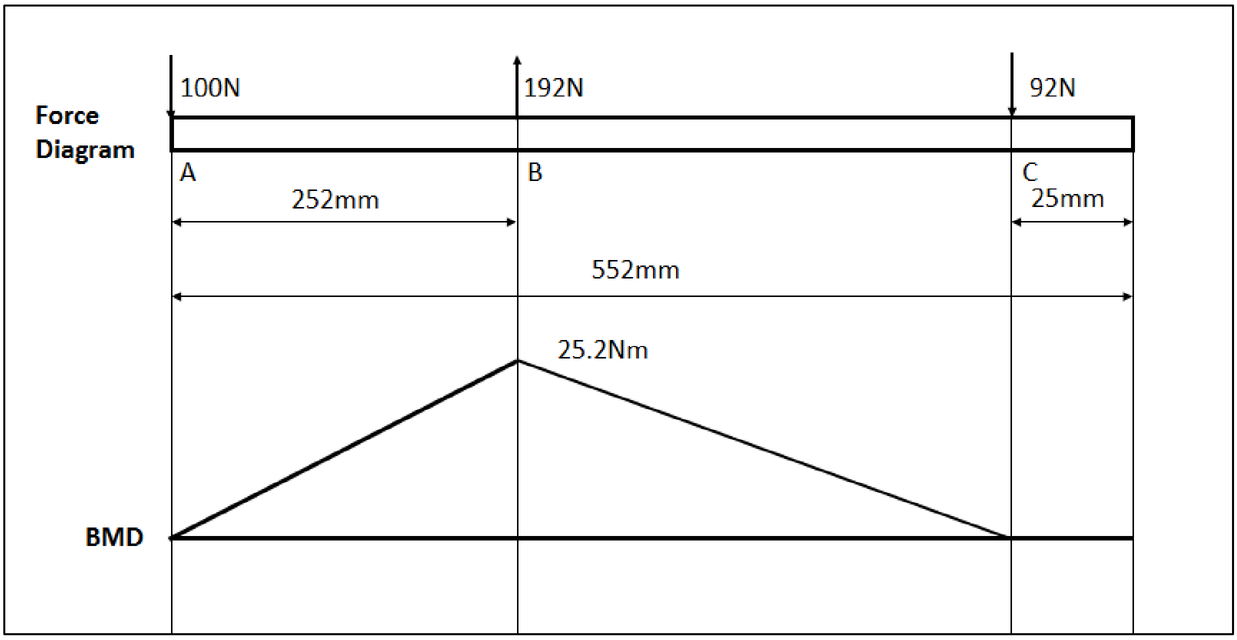
Taking moment about point A = 0

-196.2 * 28.5 + Fb * 85 = 0

Fb = 66.2N

Fa = 130N

- **Force Analysis of Vertical Handle Support**



Total Lateral Force = 92N

Fa + Fb = 92

Taking Moment @A = 0

92*527 = Fb*300

Fb = 192N

Fa = 100N

- **Force to be exerted by Farmer:**

1. For Pressure Generation:

   Given Specifications:

   Power required = 76Watts
   Height of application of force = 0.5m
   Torque requirement on crankshaft = 8.2N-m
   Torque applied on Front Shaft = 16.4N-m

   Therefore, force to be applied by the Farmer = 16.4/0.5
   = 32.8N

2. For Overcoming Friction:

   Given Specifications:

   Weight of the machine = 60kg
   Coefficient of friction between tyre and soil = 0.1

   Therefore, force to be applied by the Farmer = 60*9.81*0.1
   = 58.86N

Total force required to be exerted by the Farmer = 32.8 + 58.86
= 91.66N

10. Design of Machine Elements

- **Calculation for Diameter of Rear Shaft:**

  Given Specification,

  Maximum Moment Mb = 31.43Nm

  Material Selected – Structural Steel (Syt = 250MPa)

  Factor of safety (fs) = 1.5

  Since,

  Tmax = $\frac{0.5*Syt}{Fs}$ = 83.33MPa

  Also, Tmax = $\frac{16*Mb}{\pi d^3}$

  Therefore, d = 12.14mm = 20mm(standard)

  <u>Diameter of Rear Shaft = 20mm</u>

- **Calculation for Diameter of Front Shaft:**

  Diameter of Front Shaft:

  Given Specification,

  Maximum Moment Mb = 2.5Nm

  Material Selected – Structural Steel (Syt = 250MPa)

  Factor of safety (fs) = 1.5

  Since,

  Tmax = $\frac{0.5*Syt}{Fs}$ = 83.33MPa

  Also, Tmax = $\frac{16*Mb}{\pi d^3}$

  Therefore, d = 5.34mm= 10mm(standard)

Diameter of Front Shaft = 10mm

- **Calculation for Diameter of Crank Shaft:**

Given Specification,

Maximum Moment Mb = 0.5Nm
Material Selected – Structural Steel (Syt = 250MPa)
Factor of safety (fs) = 1.5
Power Requirement Pr = 76Watts
Crank Speed N = 90rpm
Load Factor Ki = 1.75

Since,

Tmax = $\frac{0.5*Syt}{Fs}$ = 83.33MPa

Torque due to Power Transmission Td = $\frac{60*Pr*Ki}{2\pi N}$

Therefore, Td = 14.11Nm

Also, Tmax = $\frac{16*\sqrt{Mb^2+Td^2}}{\pi d^3}$

Therefore, d = 9.5mm= 10mm(standard)

Diameter of Crank Shaft = 10mm

- **Calculation for diameter of Crank Pin:**

Given Specification,

Maximum Moment Mb = 0.65727Nm
Material Selected – Structural Steel (Syt = 250MPa)
Factor of safety (fs) = 1.5
Power Requirement Pr = 76Watts
Crank Speed N = 90rpm
Load Factor Ki = 1.75

Since,

Tmax = $\frac{0.5*Syt}{Fs}$ = 83.33MPa

Torque due to Power Transmission Td = $\frac{60*Pr*Ki}{2\pi N}$

Therefore, Td = 14.11Nm

Also, Tmax = $\frac{16*\sqrt{Mb^2+Td^2}}{\pi d^3}$

Therefore, d = 9.52 = 10mm(standard)

<u>Diameter of Crank Pin = 10mm</u>

- **Calculation Of thickness of angle bar(t):**

Given Specification,

Maximum Moment Mb = 23.07Nm
Material Selected = Structural Steel (Syt = 250MPa)
Factor of safety (fs) = 1.5
Length of angle bar (l) = 85cm

Maximum permissible stress $(\sigma) = \frac{(\sigma)\max}{fs}$

$$\frac{(\sigma)\max}{fs} = \frac{Mb*y}{I}$$

$$\frac{250}{1.5} = \frac{Mb*\frac{t}{2}}{\frac{lt^3}{12}}$$

$$166.667 = \frac{Mb*6}{lt^2}$$

<u>Therefore, t = 0.988mm = 1mm</u>

- **Calculation of thickness of Support:**

Given Specifications:

Maximum Moment = 25.2N-m
Material Selected = Structural Steel (Syt = 250Mpa)
Factor of safety (fs) = 1.5
Width of Bar (w) = 3cm

Maximum permissible stress $(\sigma) = \frac{(\sigma)\max}{fs}$

$$\frac{(\sigma)\max}{fs} = \frac{Mb*y}{I}$$

$$\frac{250}{1.5} = \frac{Mb*\frac{t}{2}}{\frac{wt^3}{12}}$$

$$166.667 = \frac{Mb*6}{lt^2}$$

<u>Therefore, t = 5.4mm = 6mm</u>

- **Selection of Screw of Hub & Sprocket**

  Given Specifications:

  Power Transmitted = 77.2Watts
  Radius of Application of force = 31mm
  Angular Velocity = 4.67rad/s
  Material Selected = Hardened Steel (τmax = 350Mpa)

  Torque Transmitted = $\frac{P}{\omega}$
  = 16.65N-m

  Shear Force exerted on Bolt = $\frac{T}{r}$
  = 537.1N

  Shear Stress = $\frac{\tau}{\frac{\pi d^2}{4}}$

  $$\frac{\tau}{\frac{\pi d^2}{4}} = \frac{\tau max}{fs}$$

  Diameter of Bolt = 1.7mm
  <u>Specification of screw = M2</u>

- **Bearings Selection**

  a. **Rear Shaft**

  Radial Force on Bearing = 169.92N

  So, according to Radial Force applied & Static Capacity

Bearing Series = 60
Bearing Specification = 6004

b. **Front Shaft**

Radial Force on Bearing = 100N

So, according to Radial Force applied & Static Capacity

Bearing Series = 60
Bearing Specification = 6000

c. **Crank Shaft**

Radial Force on Bearing = 18.72N

So, according to Radial Force applied & Static Capacity

Bearing Series = 60
Bearing Specification = 6000

- **Sprocket and Freewheel Design:**

Given Specifications:

Power transmitted = 77.8Watts
Speed of crankshaft = 90rpm
Speed of front-wheel shaft = 45rpm

Therefore, according to power transmitted and speed,

Pitch of sprocket (P) = 9.525mm

According to pitch,
Chain selected = R957
Weight/unit meter (w) = 4.1kg
Breaking load (Fmax) = 8.9KN

Desired transmission ratio = 2
Therefore, **Teeth on Freewheel (T1) = 26**
Teeth on sprocket (T2) = 52

Pitch Diameter of Freewheel (Dp1) = $\frac{P}{\sin(\frac{180}{T1})}$ **= 82mm**
Pitch Diameter of Sprocket (Dp2) = $\frac{P}{\sin(\frac{180}{T2})}$ **= 164mm**

Pitch velocity (Vp) = $\frac{\pi * Dp1 * N1}{60}$ = 0.386m/s

Minimum value of factor of safety (FSmin) = 7.6

Checking for actual factor of safety:

1. Tangential force due to power transmission (Ft) = $\frac{Pt}{Vp}$

= 201.554N

2. Centrifugal tension (Fc) = $\frac{w * Vp^2}{g}$

= 0.0622N

3. Tension due to sagging of chain (Fs) = k*w*a

Coefficient for sag (k) = 4

Centre distance (a) = 40P = 0.381m

Therefore, Tension due to sagging of chain (Fs) = 6.2N

Service factor (k0) = k1* k2*k3*k4*k5*k6

Load factor (k1) = 1.25
Factor for distance regulation (k2) = 1.25
Factor for centre distance of sprocket (k3) = 1
Factor for the position of the sprocket (k4) = 1
Lubrication factor (k5) = 1
Rating factor (k6) = 1

Therefore, Total force on sprocket (F) = (Ft + Fc + Fs) *k0

= 324.77N

Factor of safety (FS) = $\frac{Fmax}{F}$

= 27.5

Therefore, FS > FSmin

Therefore, Sprocket is SAFE

Bearing area (A) = 0.28cm^2

Load on pin (f) = Ft * k0

= 315N

Therefore, Bearing pressure = 11.25N/mm^2

Allowable Bearing pressure = 30 N/mm^2

Therefore, Chain is SAFE

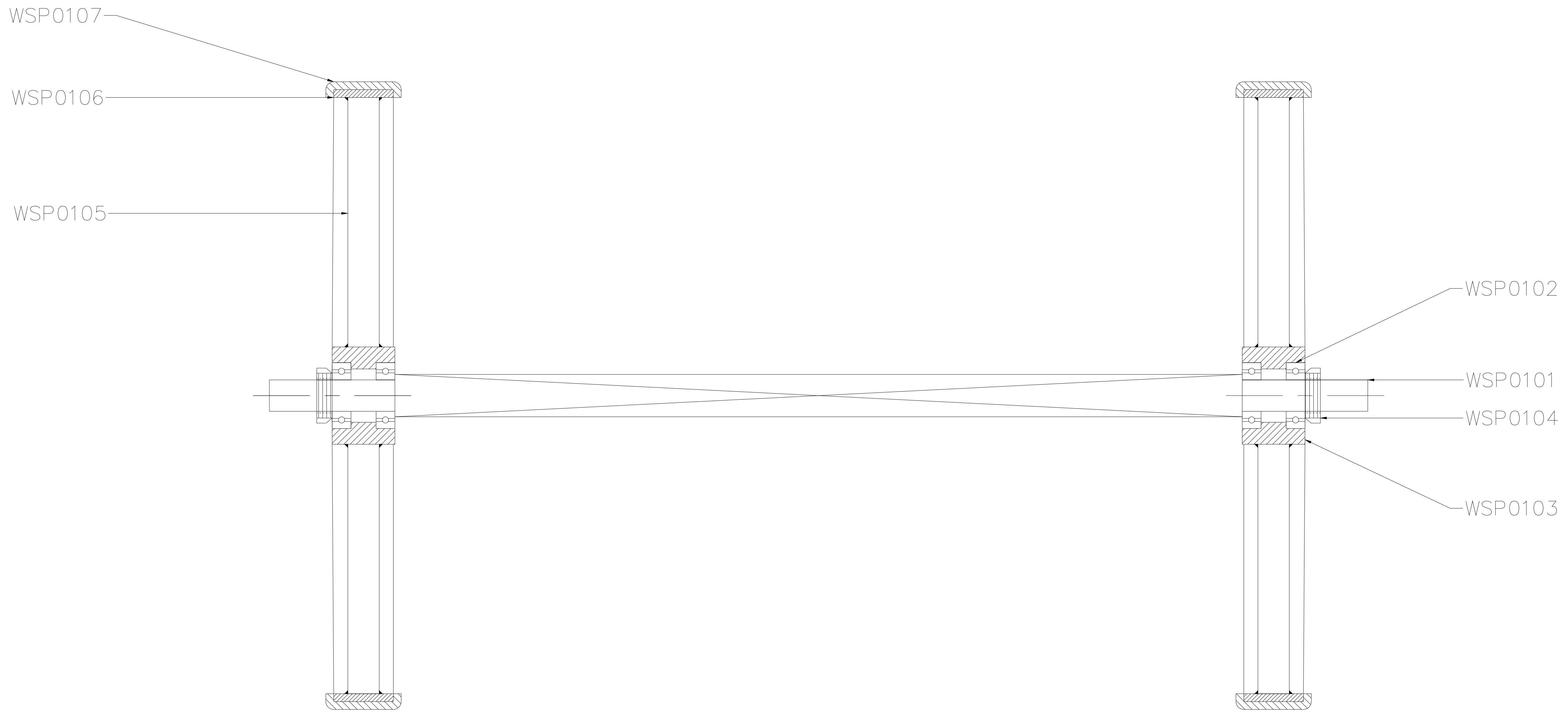
11. Part List

S.No	Component Name	Component Number	Material	Quantity	Drawing Number/Specifications
1	Shaft	WSP 0101	Structural Steel	1	1
2	Bearings	WSP 0102	-	4	Series 6004
3	Hub	WSP 0103	Mild Steel	2	2
4	Locknut	WSP 0104	-	2	M20x1
5	Rim Pipes	WSP 0105	Steel	16	3
6	Rim	WSP 0106	Steel	2	-
7	Tyre	WSP 0107	Hard Rubber	2	Φ40mm
8	Shaft	WSP 0201	Structural Steel	1	4
9	Bearings	WSP 0202	-	2	Series 6000
10	Hub	WSP 0203	Mild Steel	1	5
11	Locknut	WSP 0204	-	2	M10x0.75
12	Sprocket	WSP 0205	Low Carbon steel	1	6
13	Screw	WSP 0206	-	2	M2
14	Rim Pipe	WSP 0207	Steel	6	7
15	Rim	WSP 0208	Steel	1	-
16	Tyre	WSP 0209	Hard Rubber	1	Φ30mm
17	Vertical Support Bar	WSP 0301	Structural Steel	2	8
18	Shaft	WSP 0302	Structural Steel	1	9
20	Housing	WSP 0304	Cast Steel	2	-
21	Shaft Collar	WSP 0305	Stainless Steel	2	1C-043-S

22	Bolt	WSP 0306	-	4	M3
23	Nut	WSP 0307	-	4	M3
24	Parallel Key	WSP 0308	Stainless Steel	1	Φ16mm
25	Taper Key	WSP 0309	Stainless Steel	1	Φ10mm
26	Crank Disc	WSP 0310	Structural Steel	1	10
27	Crank Pin	WSP 0311	Structural Steel	1	11
28	Journal Bearing	WSP 0312	-	1	7 SF 12-SS
29	Freewheel	WSP 0313	Low Carbon steel	1	12
30	Elbow Joint	WSP 0314	PVC	1	NPS ½”
31	Double-Y Joint	WSP 0315	PVC	1	OD ¼”
32	PVC Pipe	WSP 0316	PVC	4	-
33	Nozzle	WSP 0317	Brass	3	Full conical
34	Handle	WSP 0318	Structural Steel	1	13
36	Roller Chain	WSP 0319	-	1	R957
37	Angle Bar	WSP 0401	Structural Steel	4	14
38	Tank Supporting Plate	WSP 0402	Structural Steel	1	420x50x1mm
39	Inclined Side Supports	WSP 0403	Structural Steel	2	53x20x1mm
40	Vertical Handle Support	WSP 0404	Structural Steel	2	15
41	Pushing Handle	WSP 0405	Structural Steel	1	16
43	Angled Connecting Bar	WSP 0408	Structural Steel	2	19

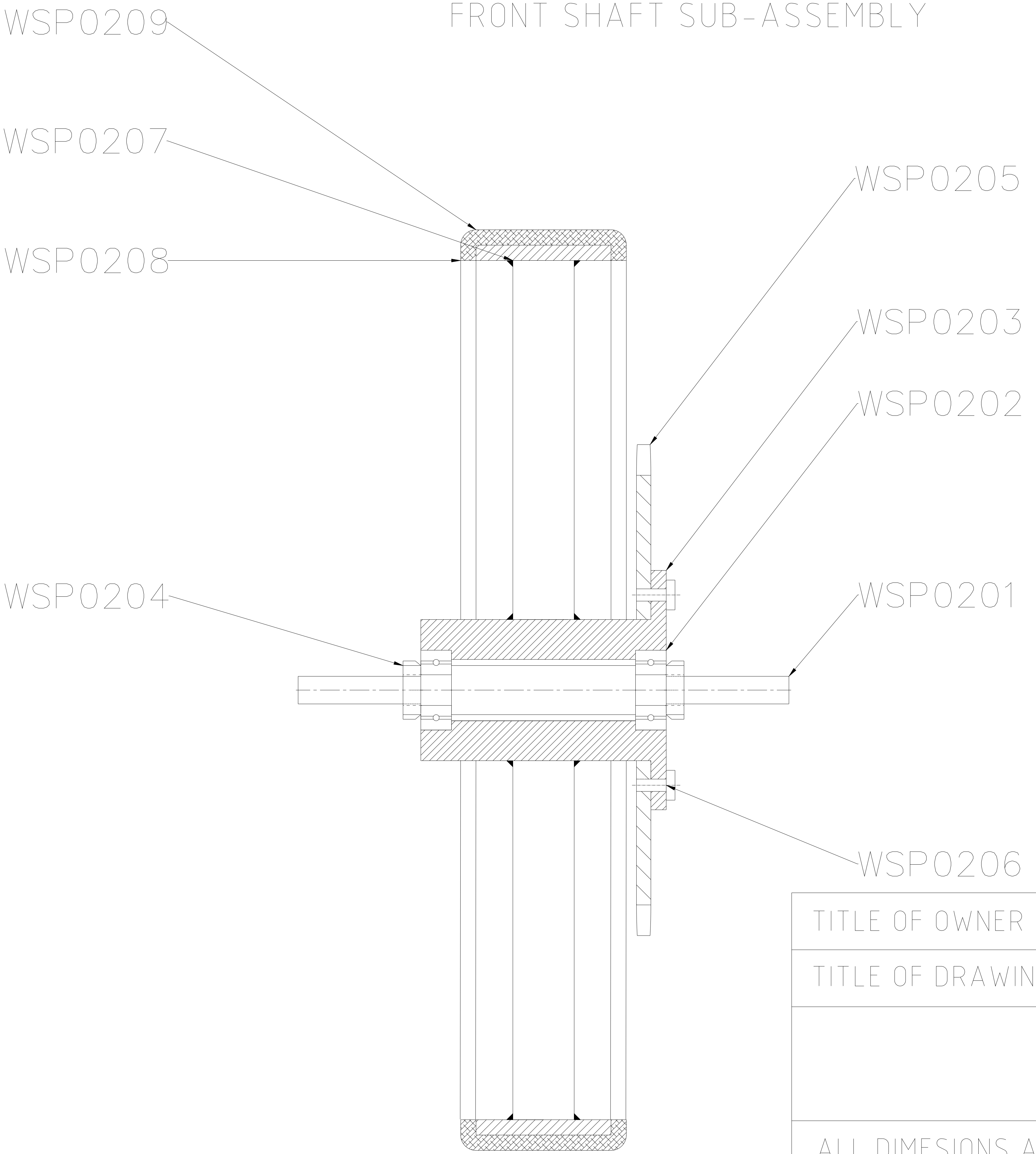
44	Shaft Supporting Block	WSP 0409	Aluminium	2	20
45	Nut	WSP 0410	-	7	M5
46	Bolt	WSP 0411	-	7	M5
47	Tank	WSP 0501	Plastic	1	21
48	Cylinder	WSP 0502	Structural Steel	1	-
49	Piston	WSP 0503	Structural Steel	1	Φ3.5cm
50	Connecting Rod	WSP 0504	Structural Steel	1	28
51	Double-Threaded Cap	WSP 0505	Plastic	1	22
52	One-way Valve	WSP 0506	Plastic	2	-
53	Flexible Pipe	WSP 0507	PVC	2	Φ15mm

REAR SHAFT SUB-ASSEMBLY



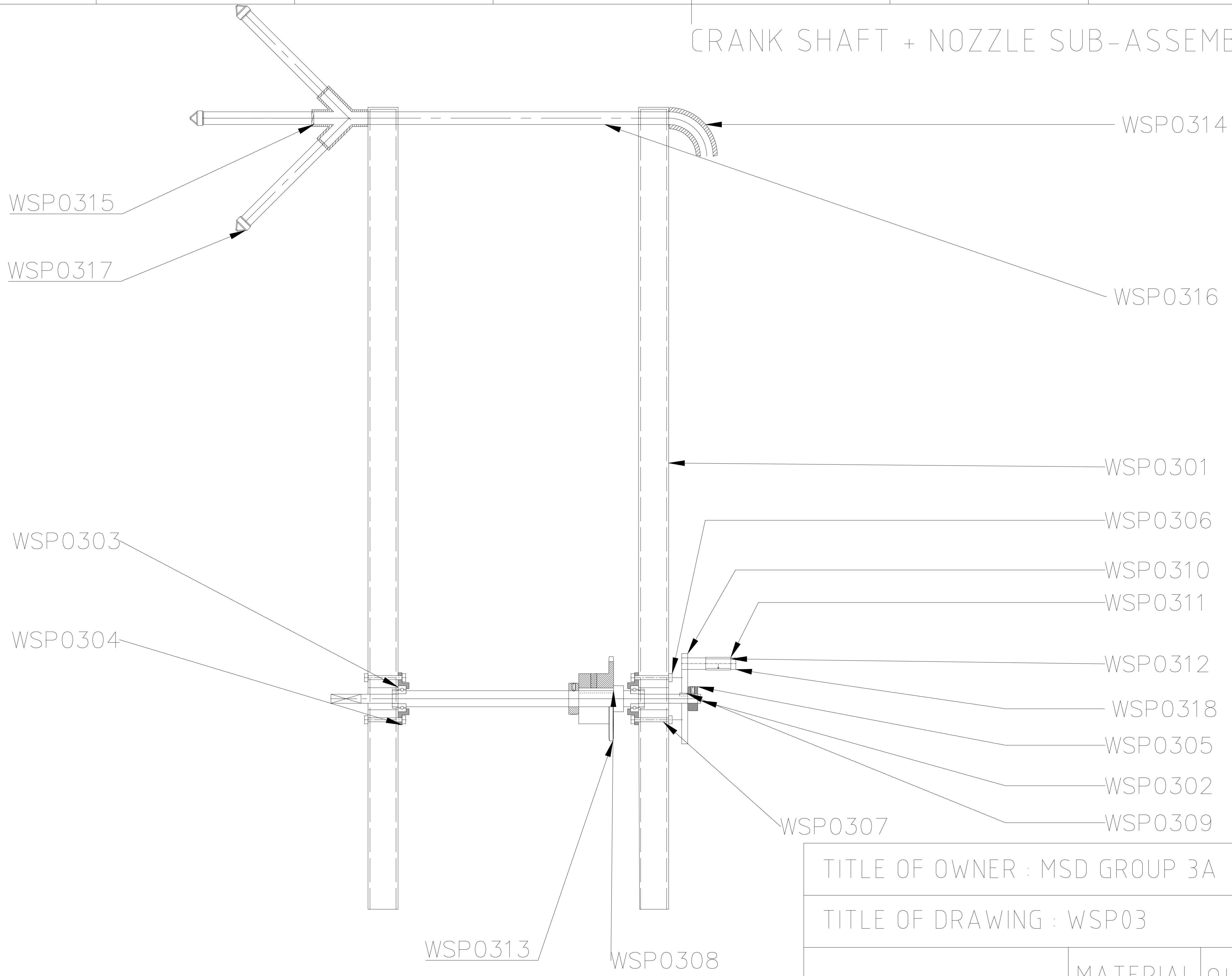
TITLE OF OWNER : MSD GROUP 3A			
TITLE OF DRAWING : WSP01			
	MATERIAL	QUANTITY	SCALE
		1	1:2
ALL DIMESIONS ARE IN MM		DRAWING NO. :	01

FRONT SHAFT SUB-ASSEMBLY



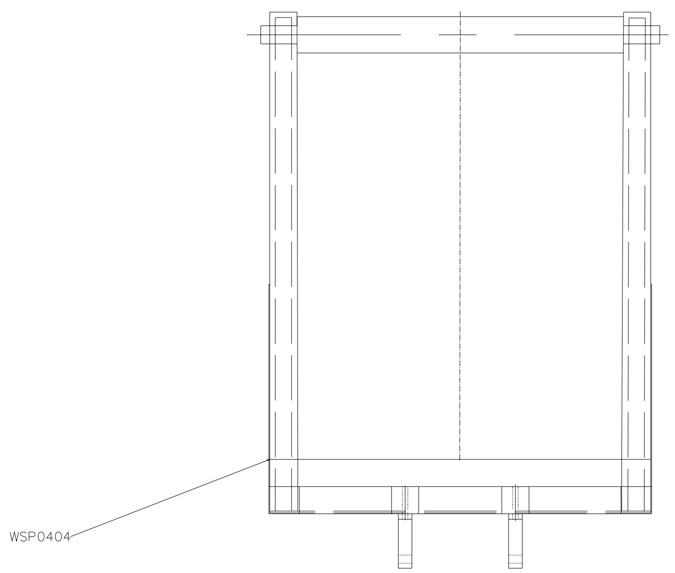
TITLE OF OWNER : MSD GROUP 3A			
TITLE OF DRAWING : WSP02			
	MATERIAL	QUANTITY	SCALE
		1	1:1
ALL DIMESIONS ARE IN MM		DRAWING NO. : 2	

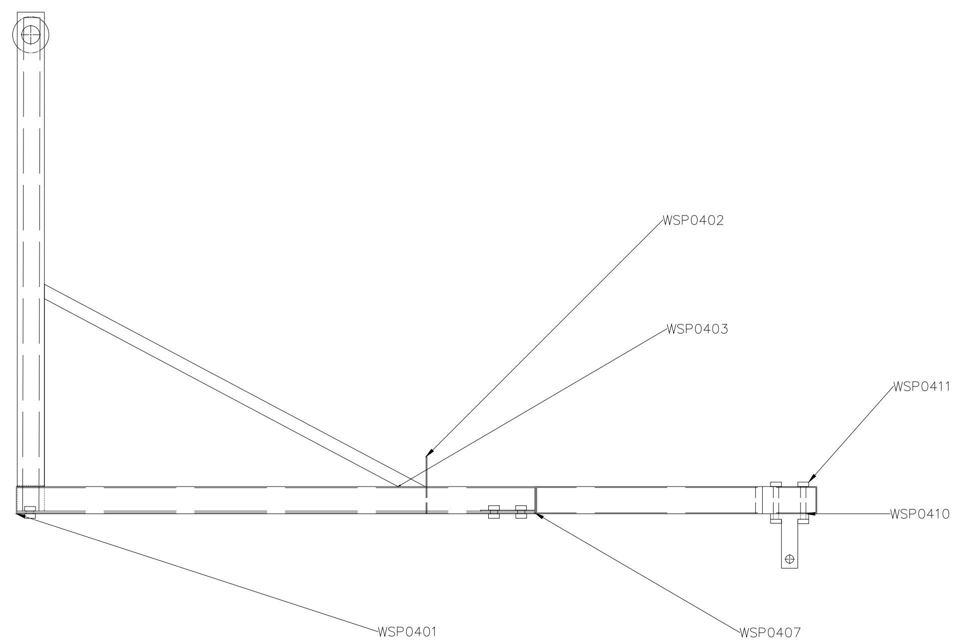
CRANK SHAFT + NOZZLE SUB-ASSEMBLY

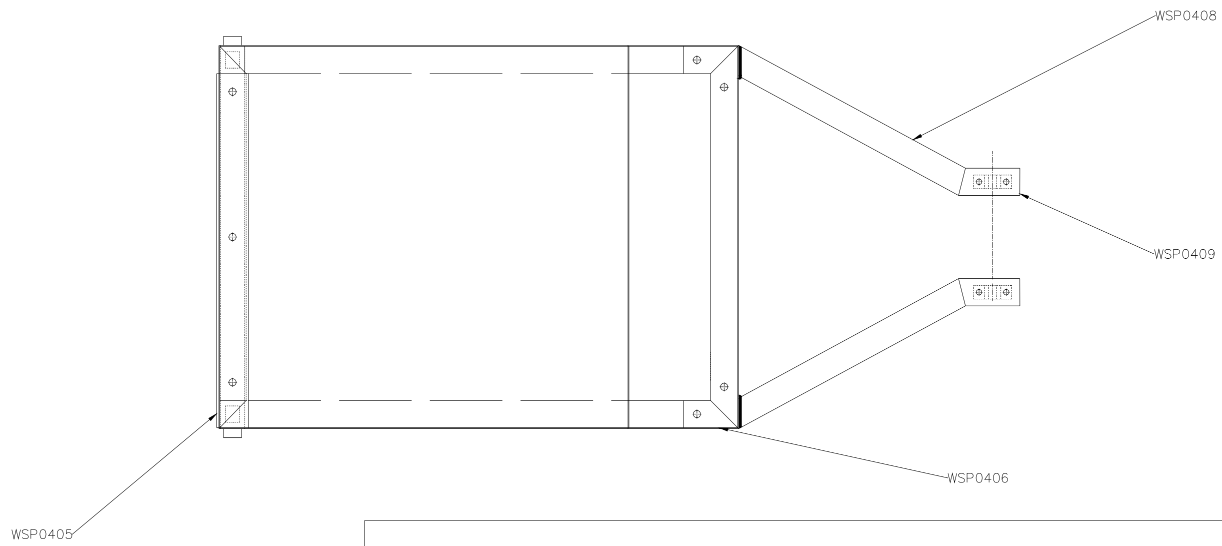


TITLE OF OWNER : MSD GROUP 3A			
TITLE OF DRAWING : WSP03			
	MATERIAL	QUANTITY	SCALE
		1	1:4
ALL DIMESIONS ARE IN MM		DRAWING NO. : 03	

SUPPORTING - FRAME SUB-ASSEMBLY







TITLE OF OWNER : MSD GROUP 3A

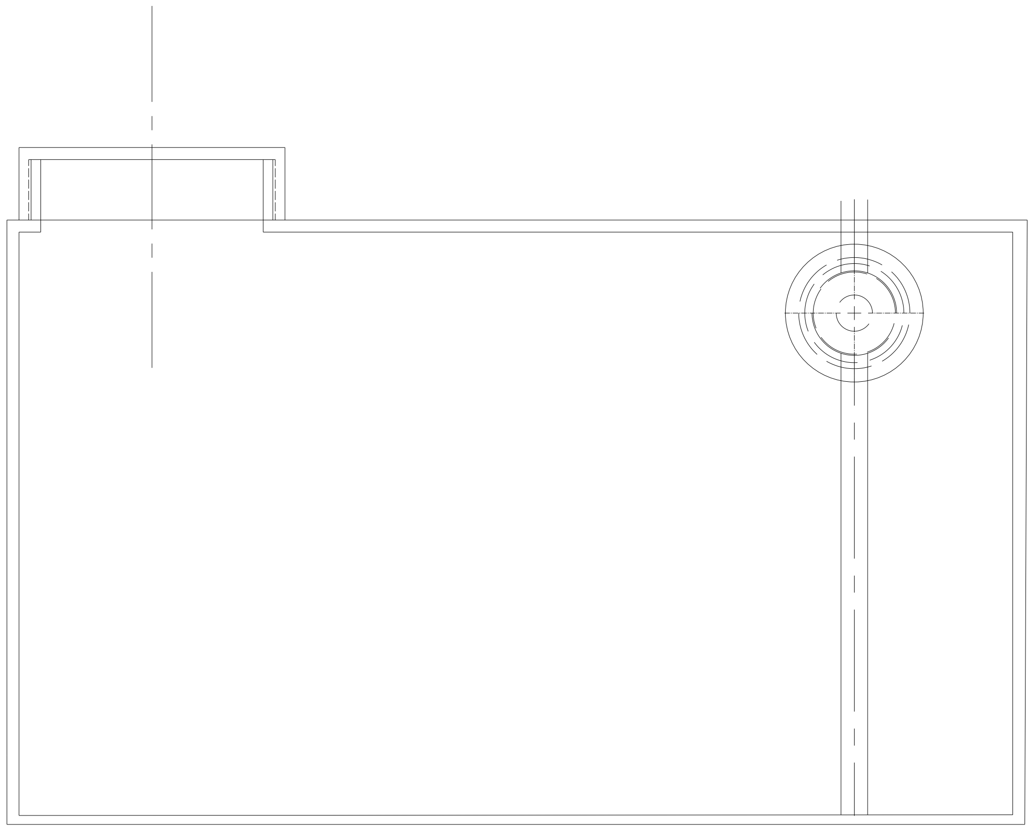
TITLE OF DRAWING : WSP04

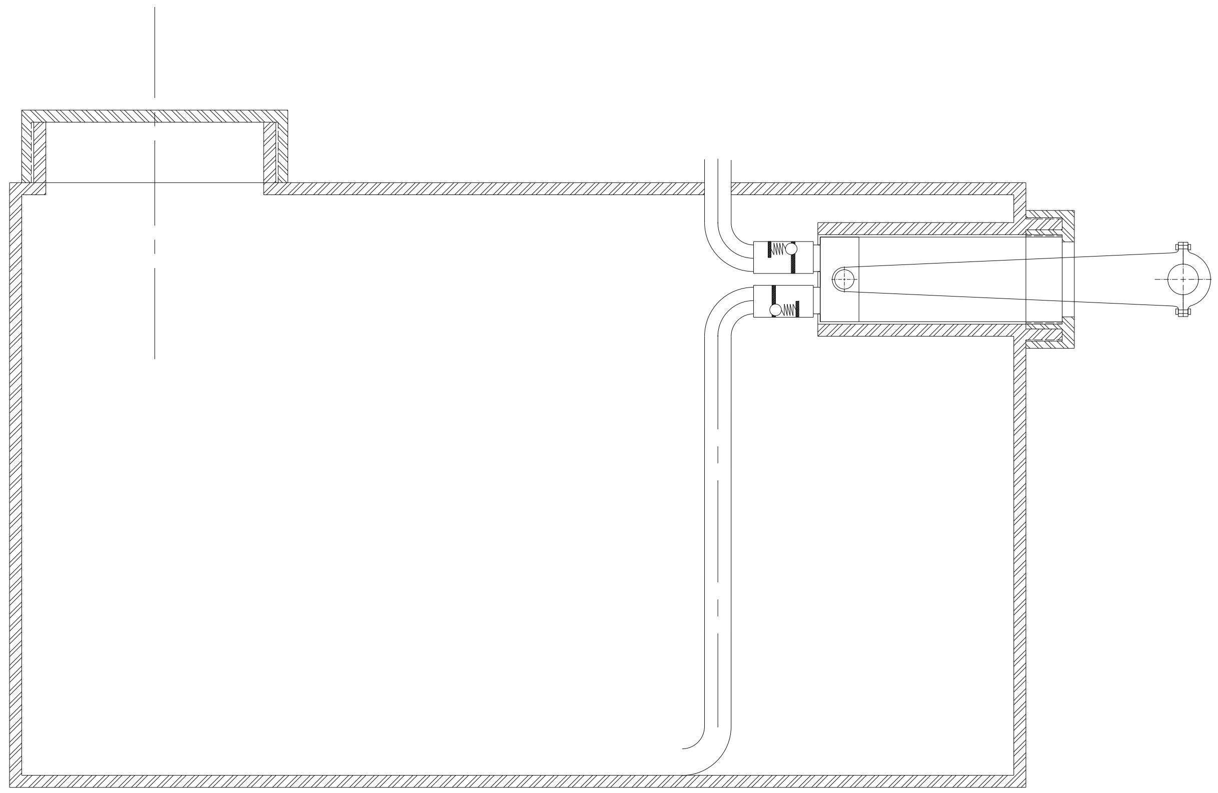
		MATERIAL	QUANTITY	SCALE
			1	1:5

ALL DIMESIONS ARE IN MM

DRAWING NO. : 04

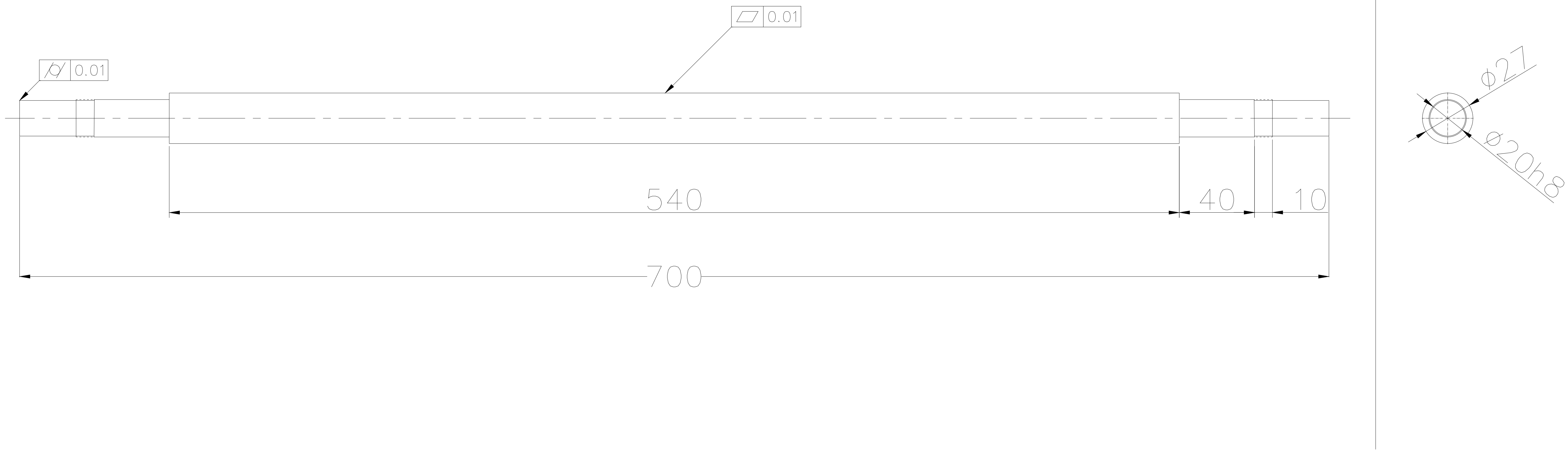
TANK - PUMPING SUB ASSEMBLY





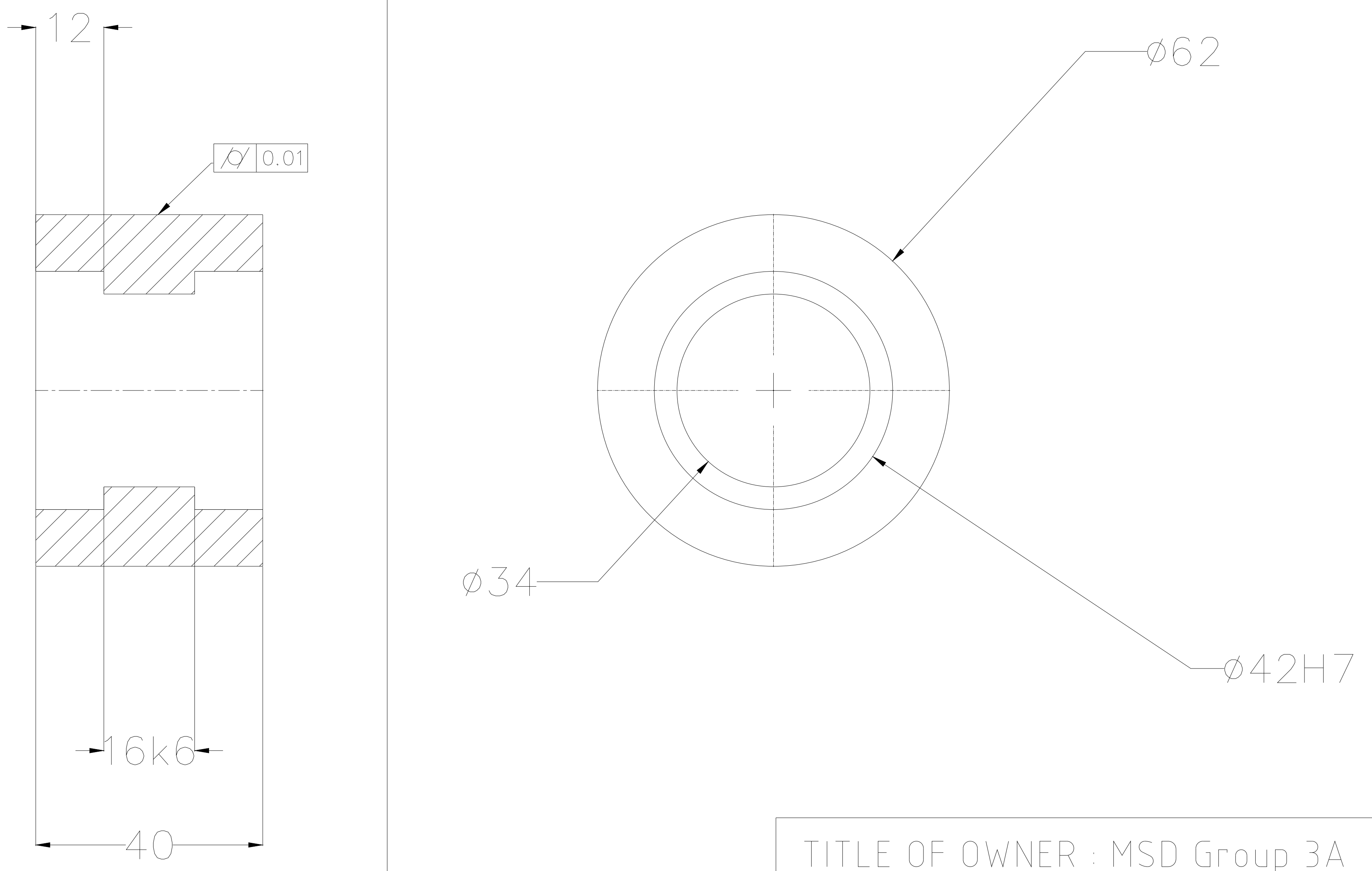
TITLE OF OWNER : MSD GROUP 3A				
TITLE OF DRAWING :WSP05				
		MATERIAL	QUANTITY	SCALE
			1	1:5
ALL DIMESIONS ARE IN MM			DRAWING NO. :5	

REAR SHAFT



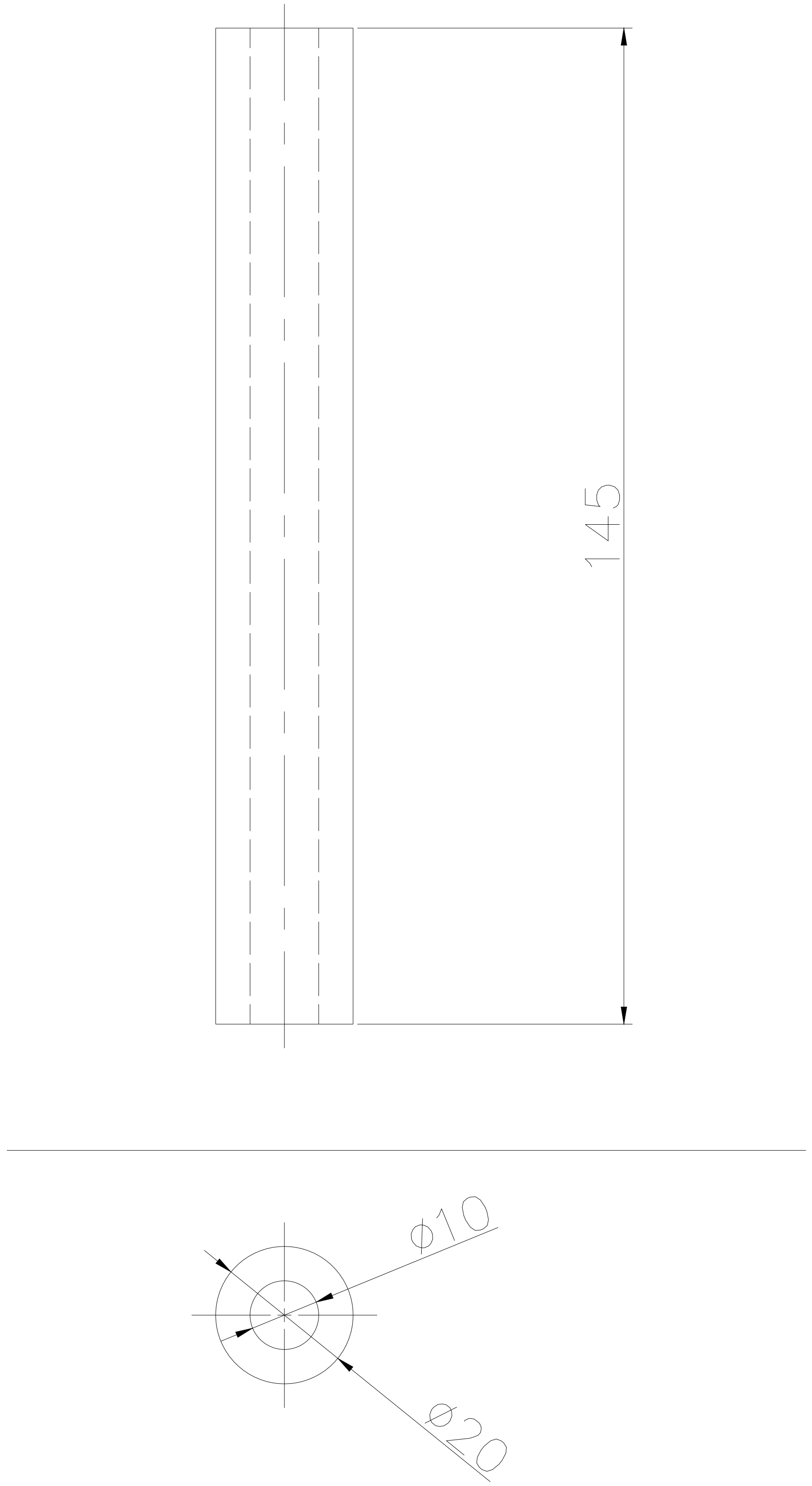
TITLE OF OWNER : MSD Group 3A				
TITLE OF DRAWING : WSP0101				
		MATERIAL	QUANTITY	SCALE
		Structural Steel	1	1:2
ALL DIMESIONS ARE IN MM			DRAWING NO. : 06	

REAR HUB



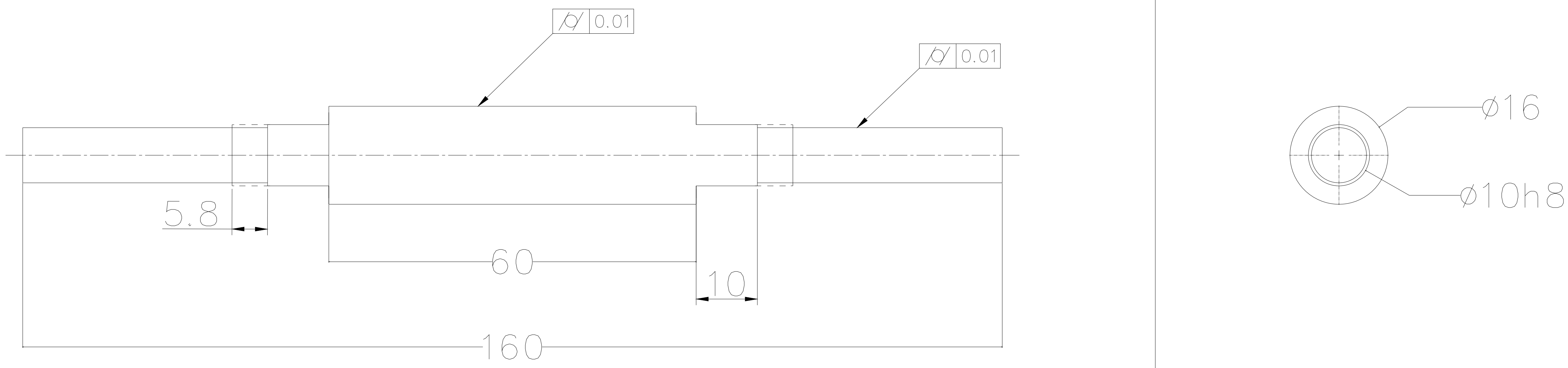
TITLE OF OWNER : MSD Group 3A			
TITLE OF DRAWING : WSP0103			
	MATERIAL	QUANTITY	SCALE
	MILD STEEL	1	1:1
ALL DIMESIONS ARE IN MM		DRAWING NO. : 07	

RIM PIPE



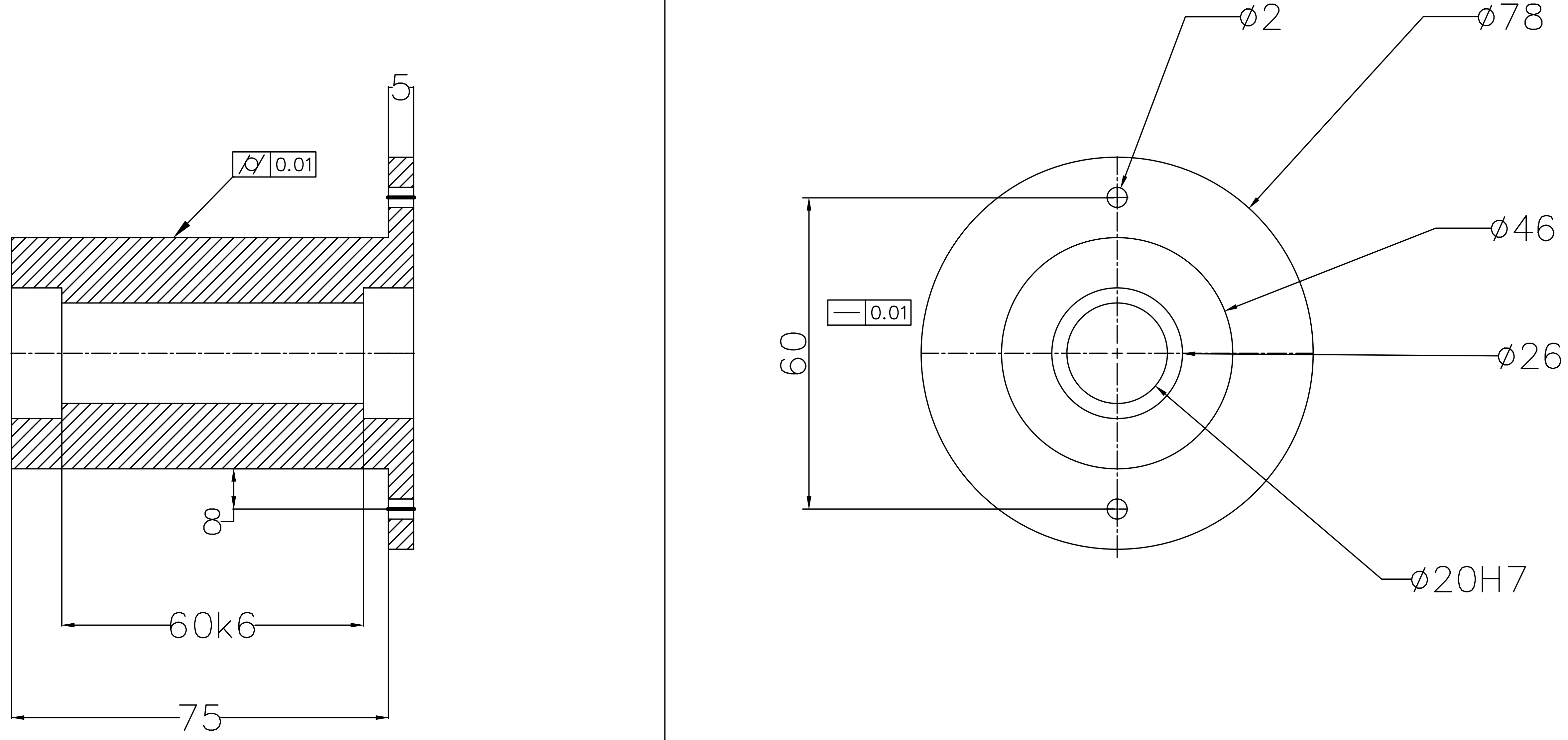
TITLE OF OWNER : MSD GROUP 3A			
TITLE OF DRAWING : WSP0105			
	MATERIAL	QUANTITY	SCALE
	STEEL	16	1:1
ALL DIMESIONS ARE IN MM		DRAWING NO.8	

FRONT SHAFT



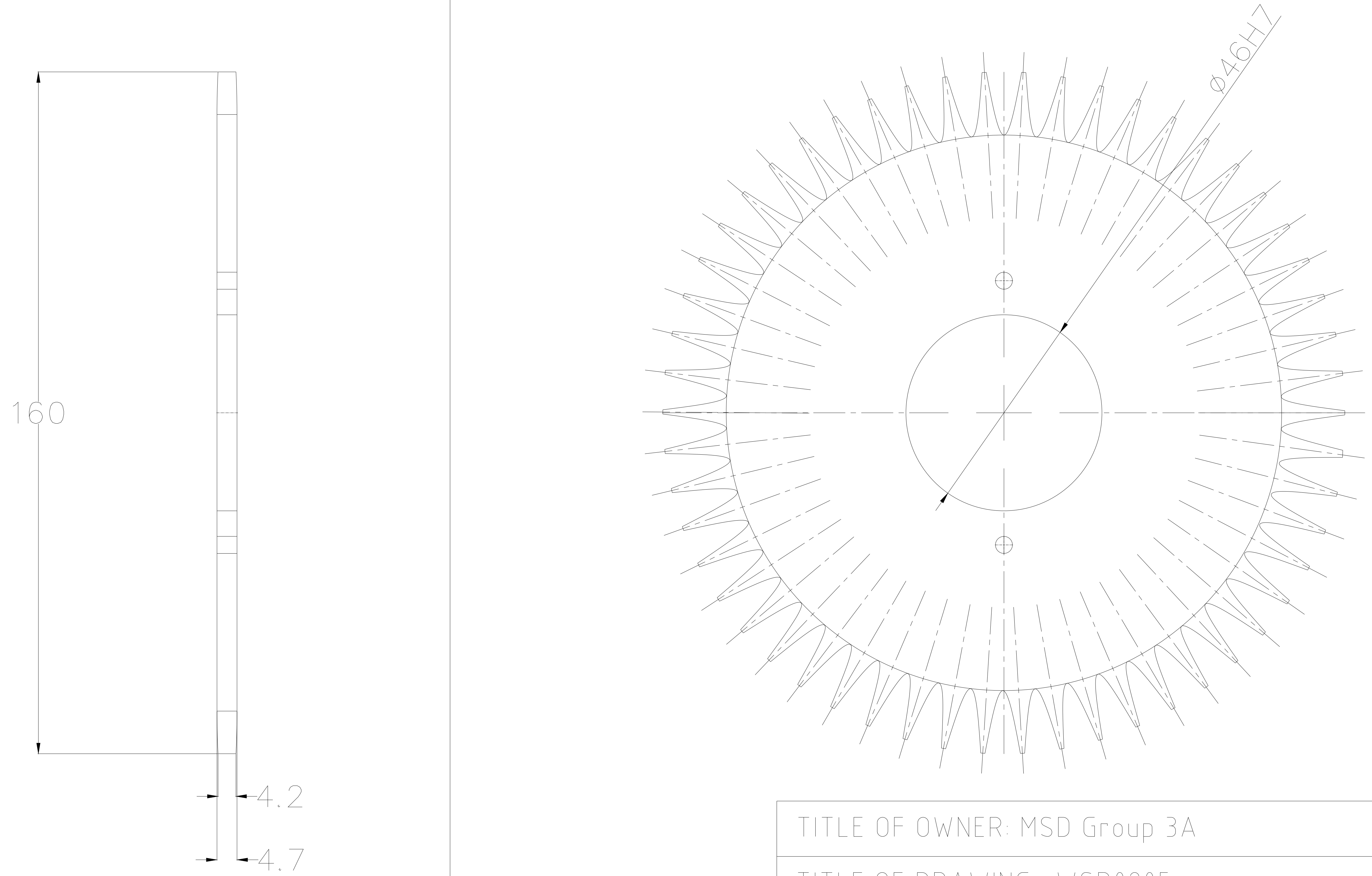
TITLE OF OWNER : MSD Group 3A				
TITLE OF DRAWING : WSP0201				
		MATERIAL	QUANTITY	SCALE
		Structural Steel	1	1:1
ALL DIMESIONS ARE IN MM			DRAWING NO.09	

FRONT HUB



TITLE OF OWNER : MSD Group 3A				
TITLE OF DRAWING : WSP0203				
		MATERIAL	QUANTITY	SCALE
		MILD STEEL	1	1:1
ALL DIMESIONS ARE IN MM			DRAWING NO. : 10	

SPROCKET



TITLE OF OWNER: MSD Group 3A

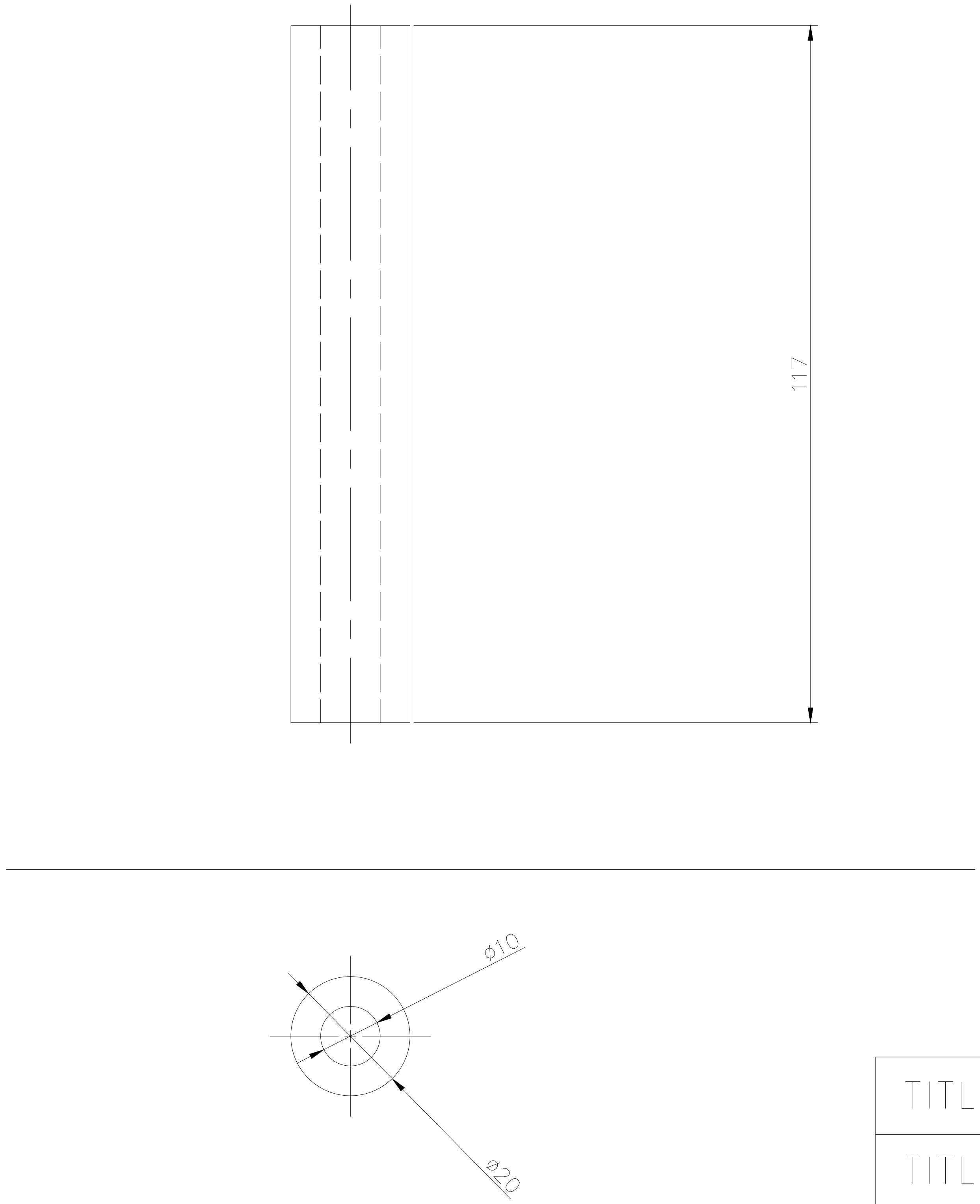
TITLE OF DRAWING : WSP0205

MATERIAL	QUANTITY	SCALE
LOW CARBON STEEL	1	1:1

ALL DIMESIONS ARE IN MM

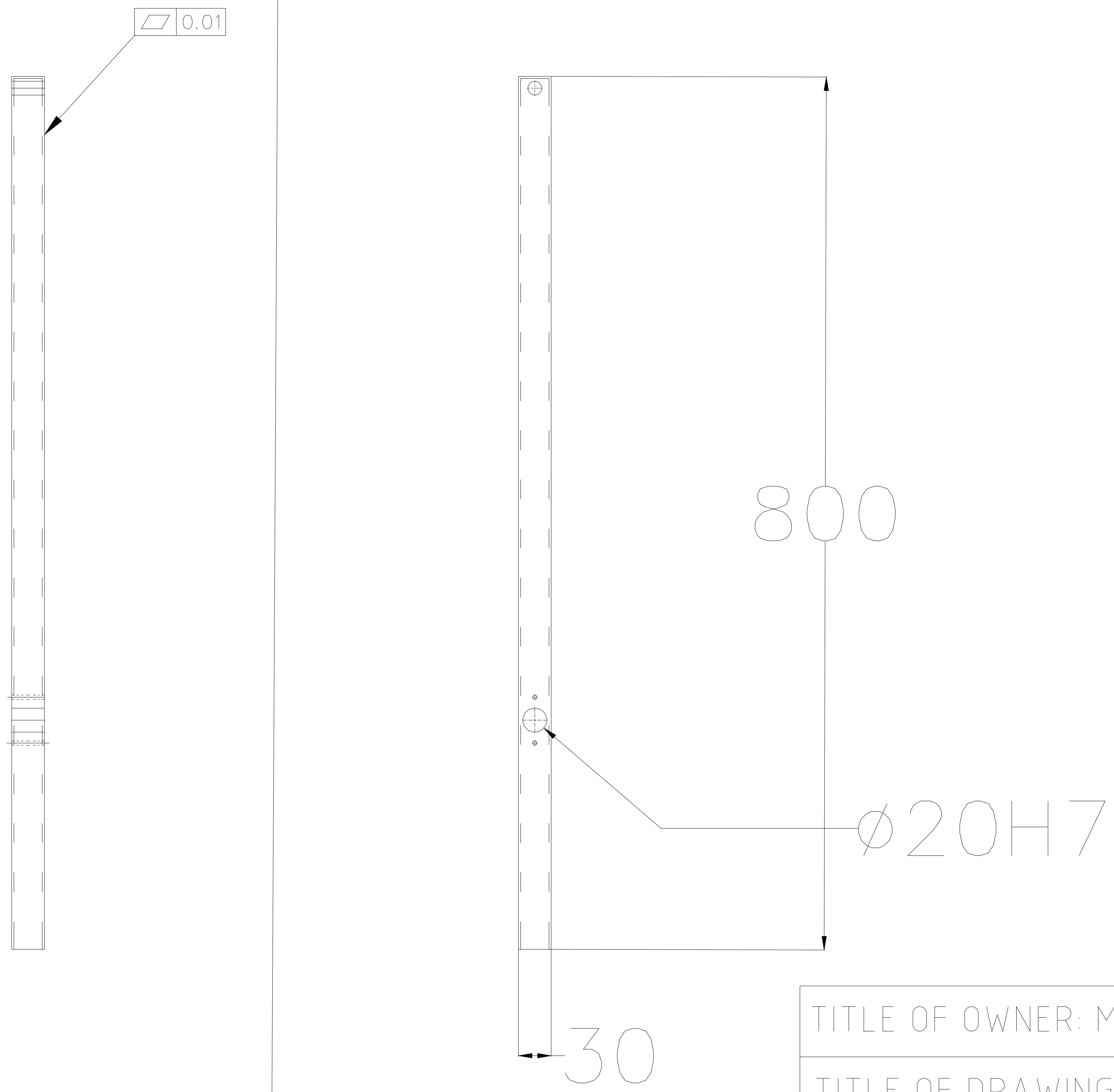
DRAWING NO. : 11

RIM PIPE



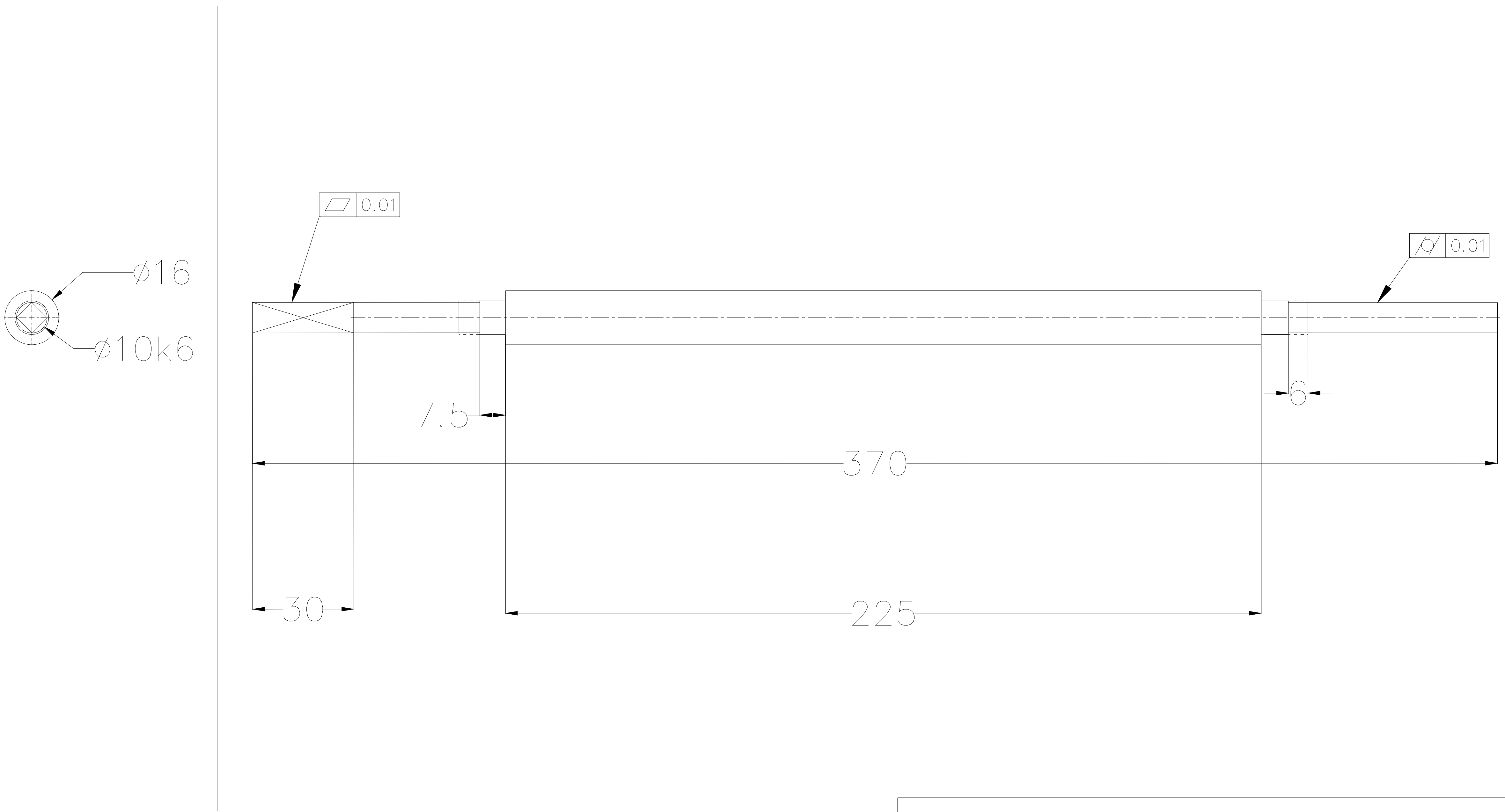
TITLE OF OWNER : MSD GROUP 3A			
TITLE OF DRAWING : WSP0207			
	MATERIAL	QUANTITY	SCALE
	STEEL	6	1:1
ALL DIMESIONS ARE IN MM		DRAWING NO. : 12	

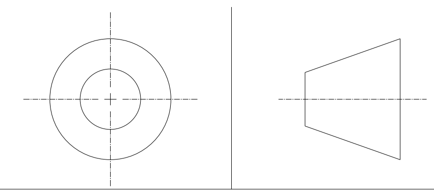
VERTICAL SUPPORT BAR



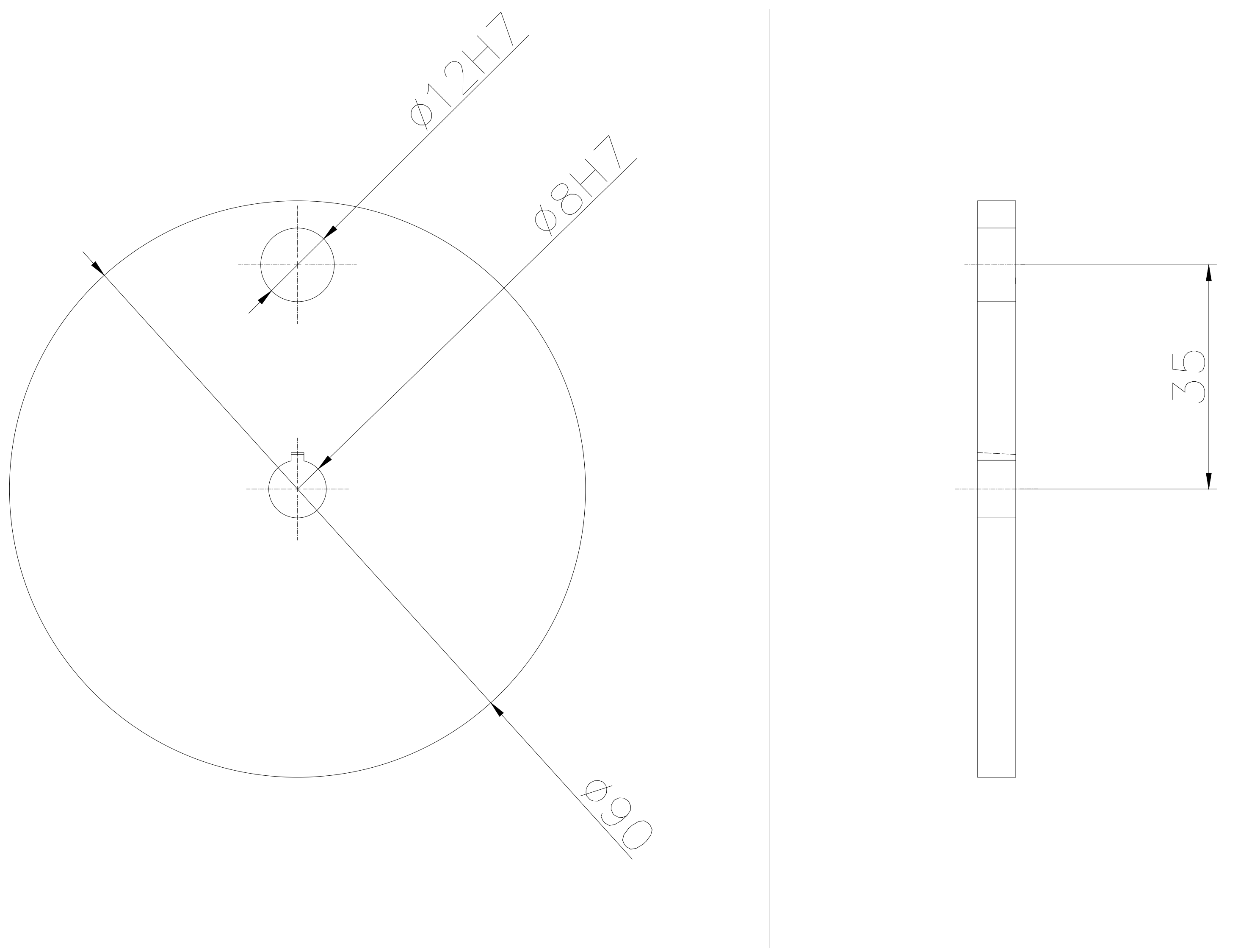
TITLE OF OWNER: MSD Group 3A				
TITLE OF DRAWING: WSP0301				
		MATERIAL	QUANTITY	SCALE
		STRUCTURAL STEEL	2	1:2
ALL DIMESIONS ARE IN MM			DRAWING NO. : 13	

CRANK SHAFT



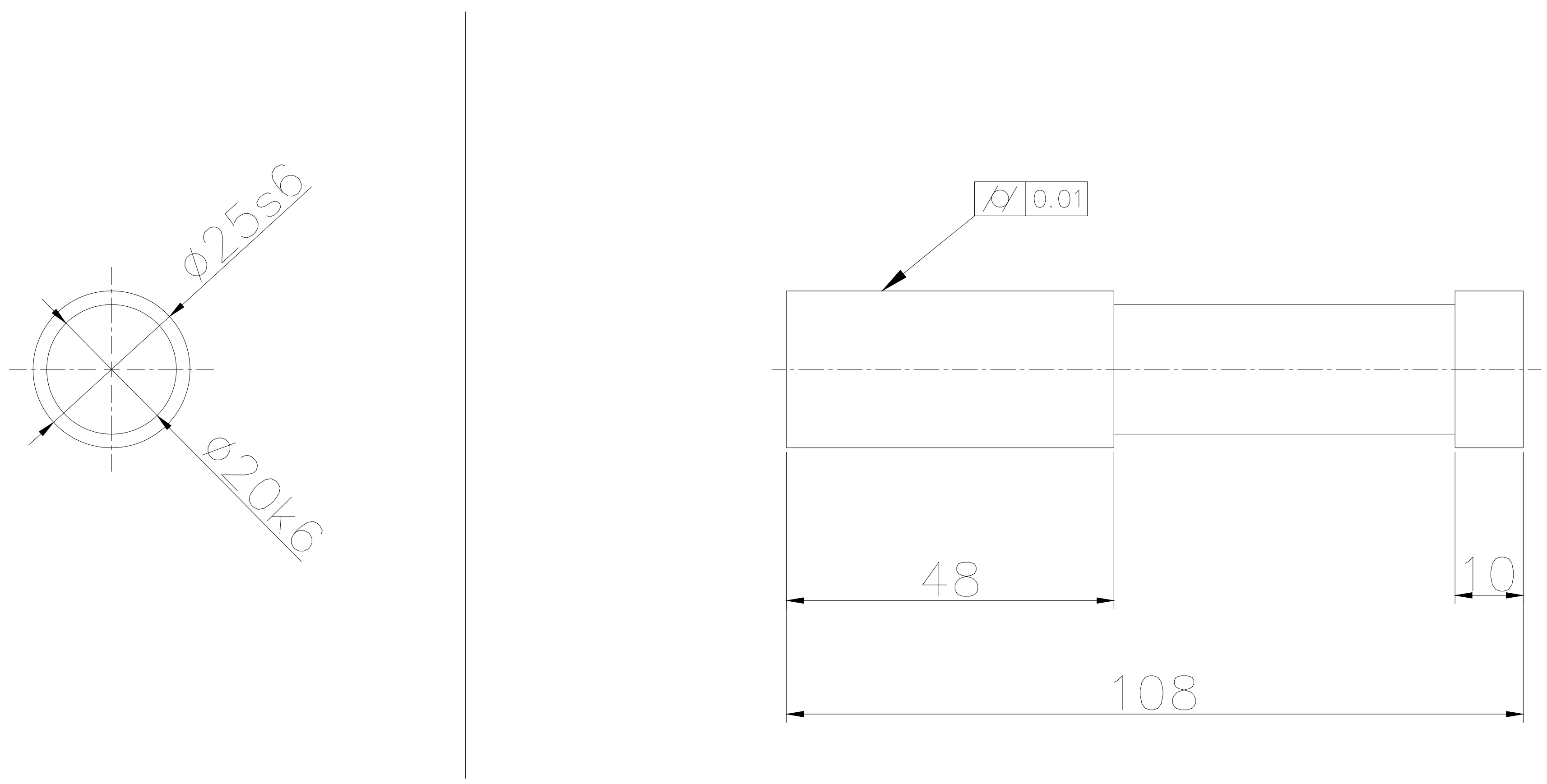
TITLE OF OWNER : MSD GROUP 3A				
TITLE OF DRAWING : WSP0302				
		MATERIAL	QUANTITY	SCALE
		STRUCTURAL STEEL	1	1:2
ALL DIMESIONS ARE IN MM			DRAWING NO. : 14	

CRANK DISC



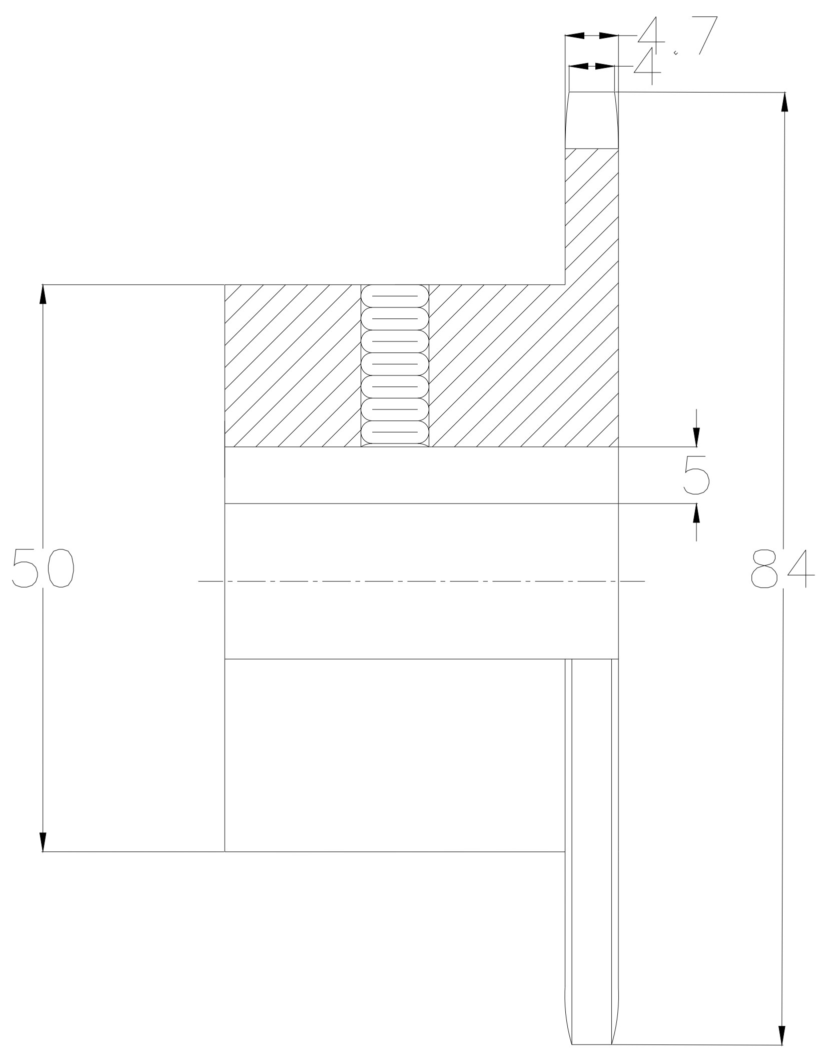
TITLE OF OWNER :MSD GROUP 3A			
TITLE OF DRAWING : WSP0310			
	MATERIAL	QUANTITY	SCALE
	STRUCTURAL STEEL	1	1:1
ALL DIMESIONS ARE IN MM		DRAWING NO. : 15	

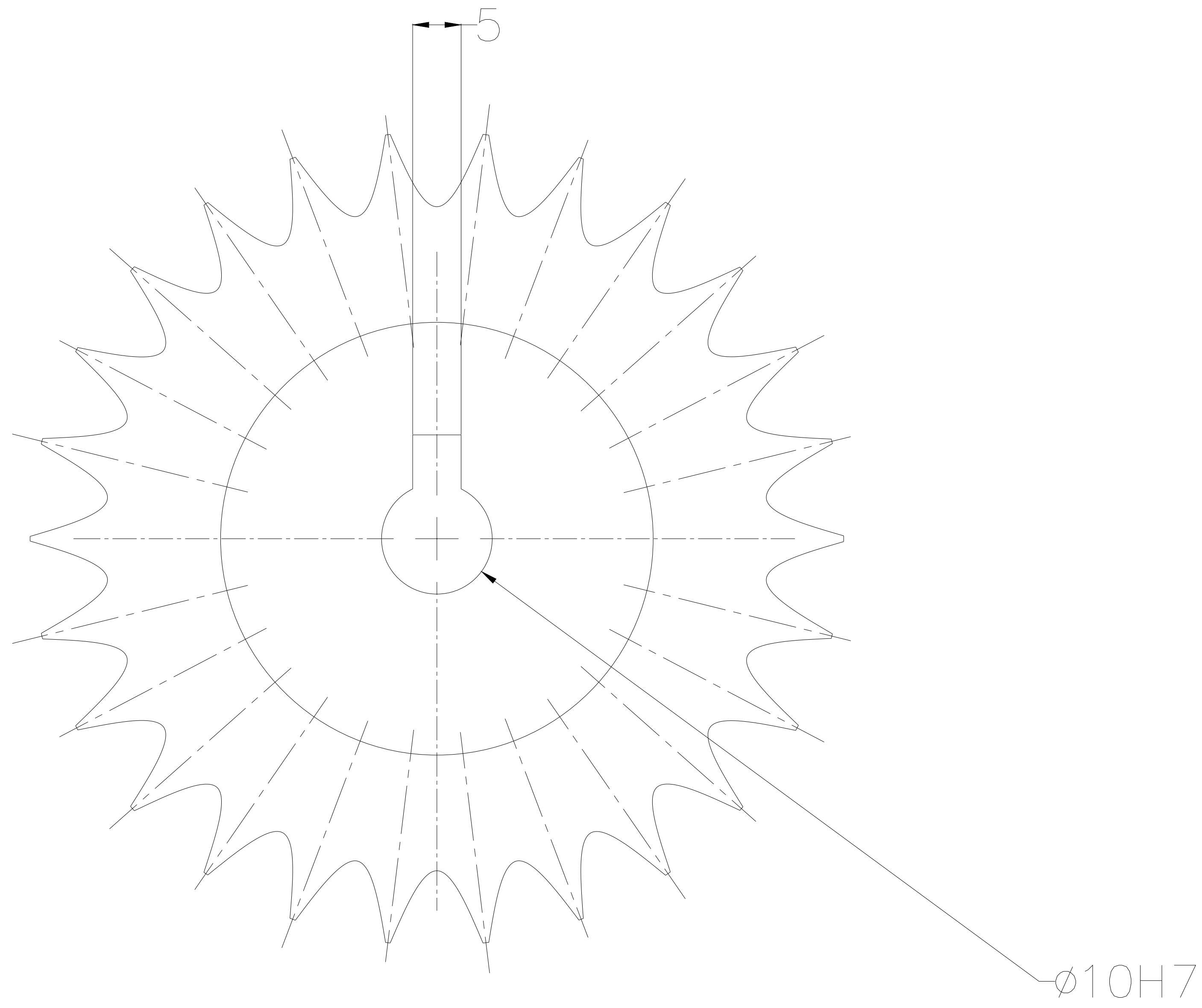
CRANK PIN



TITLE OF OWNER : MSD GROUP 3A			
TITLE OF DRAWING : WSP0311			
	MATERIAL	QUANTITY	SCALE
	STRUCTURAL STEEL	1	2:1
ALL DIMESIONS ARE IN MM		DRAWING NO. :16	

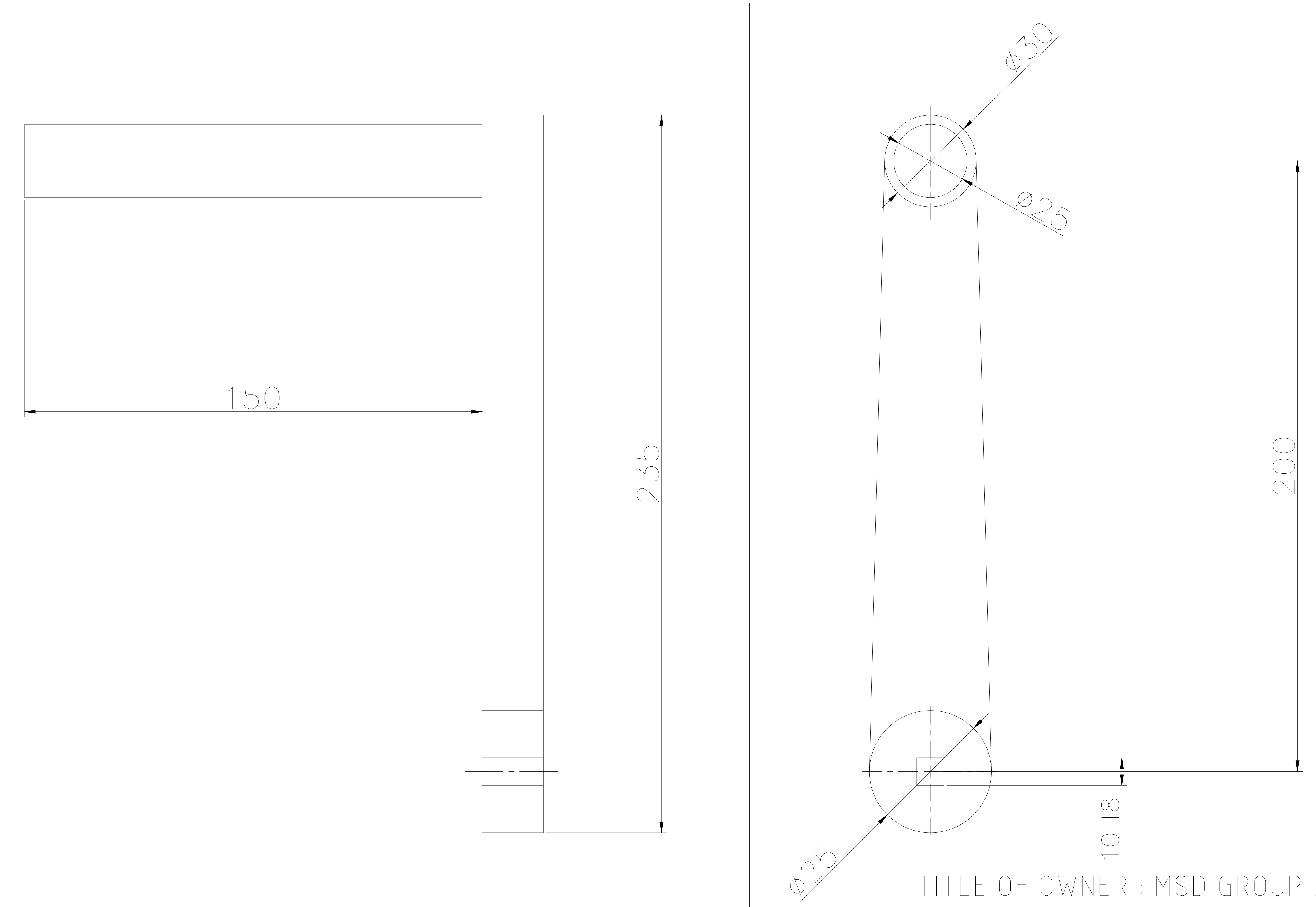
FREEWHEEL





TITLE OF OWNER : MSD GROUP 3A				
TITLE OF DRAWING : WSP0313				
		MATERIAL	QUANTITY	SCALE
		LOW CARBON STEEL	1	2:1
ALL DIMESIONS ARE IN MM			DRAWING NO. :	17

HANDLE



TITLE OF OWNER : MSD GROUP 3A

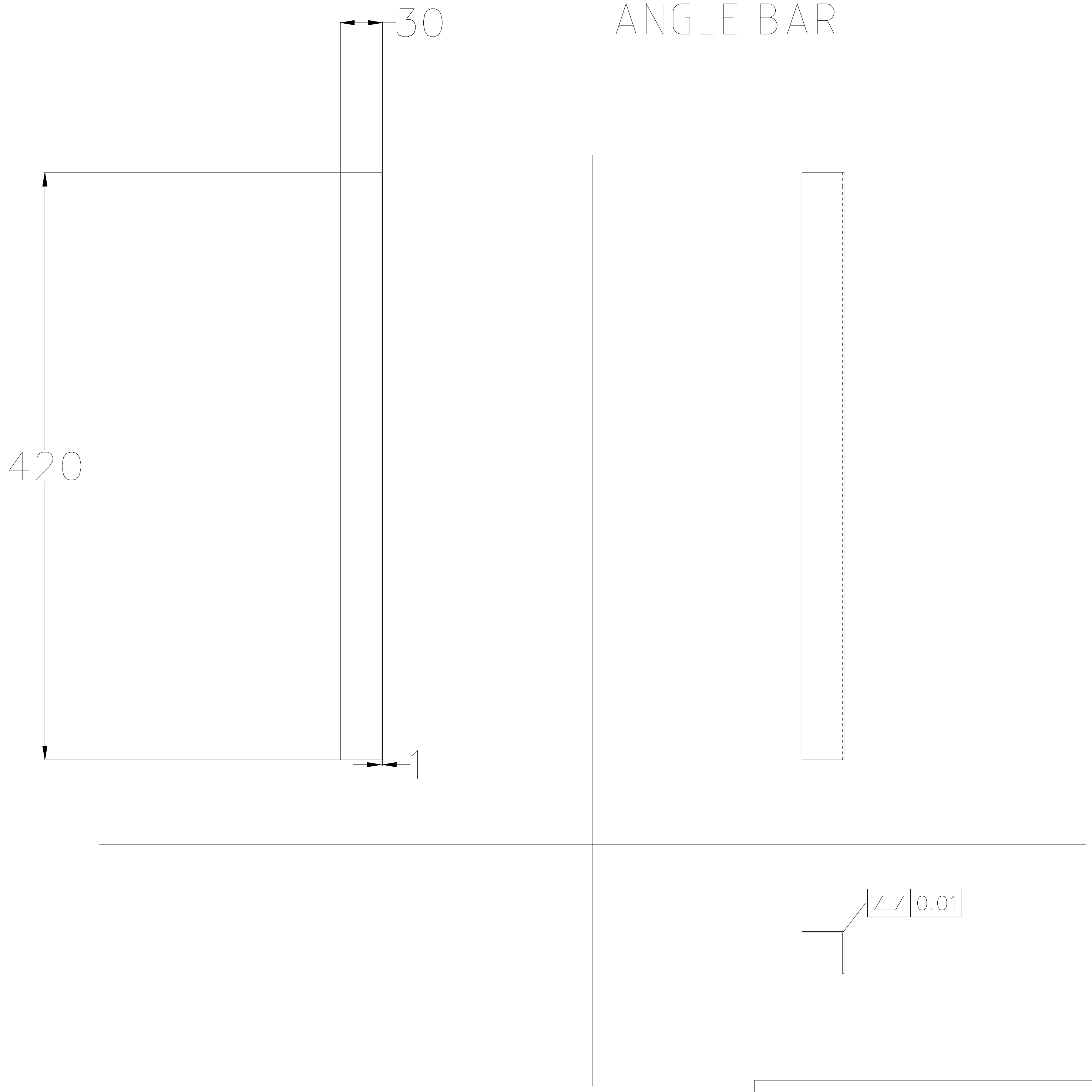
TITLE OF DRAWING : WSP0318

	MATERIAL	QUANTITY	SCALE
	Structural Steel	1	1:2

ALL DIMESIONS ARE IN MM

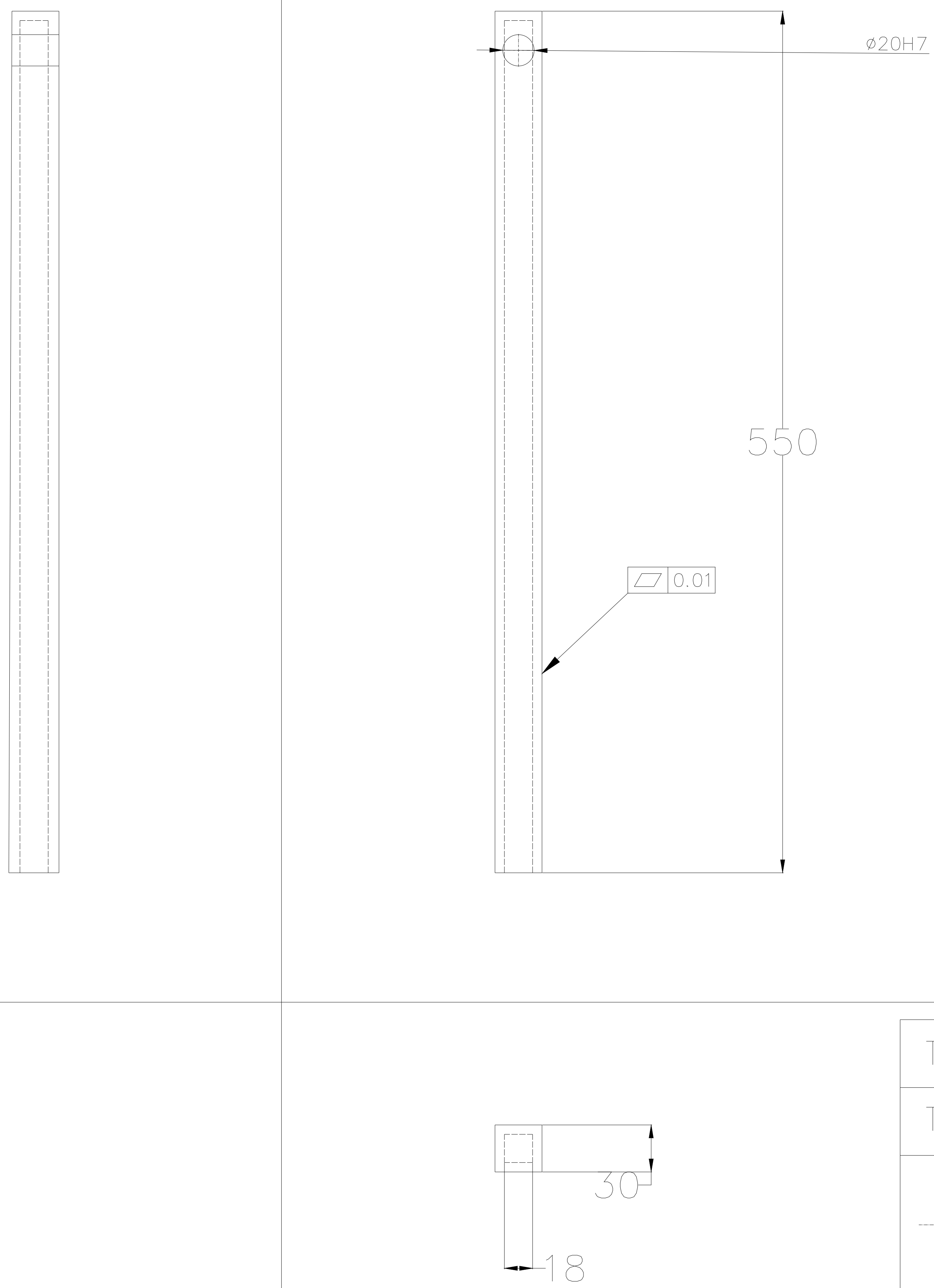
DRAWING NO: 18

ANGLE BAR



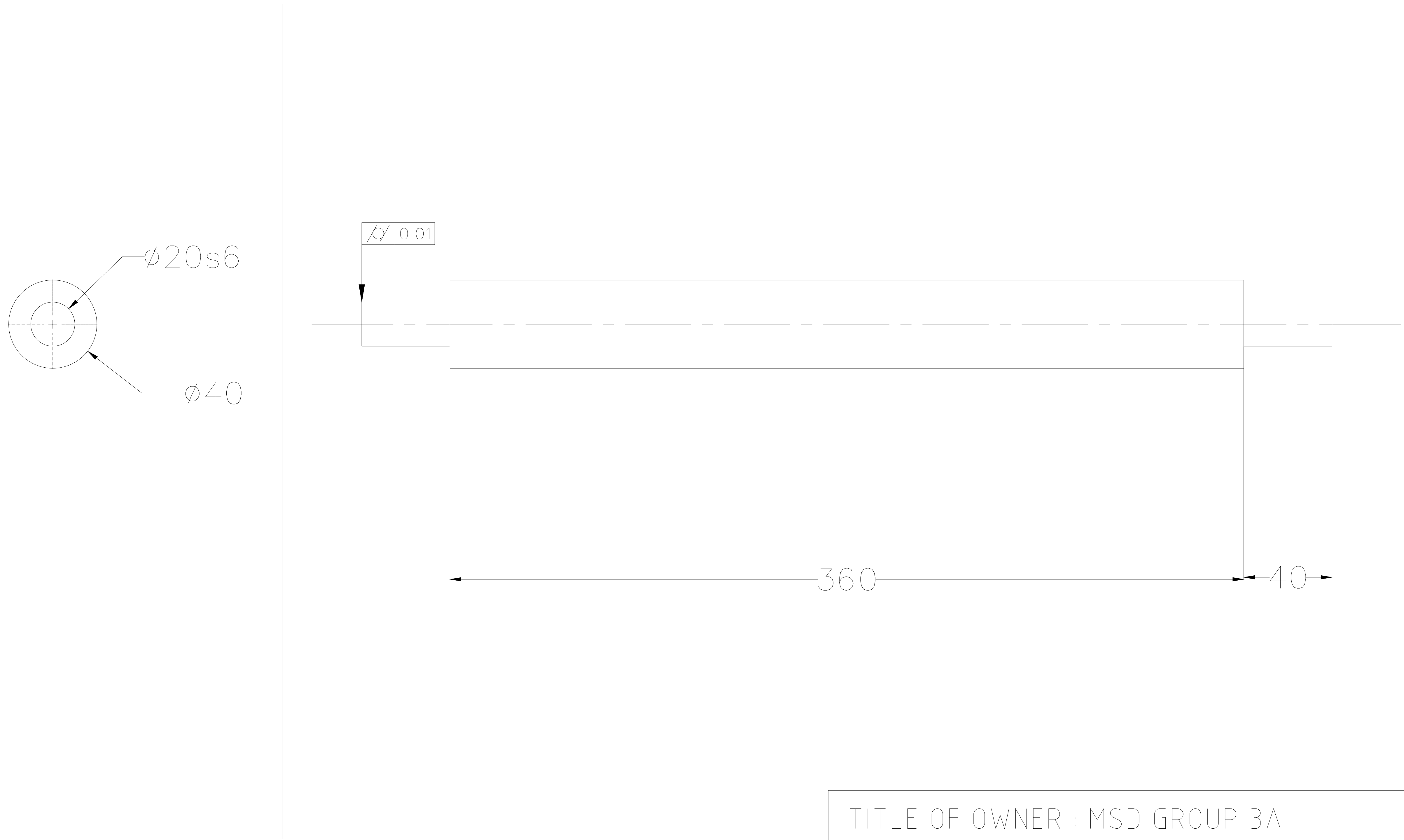
TITLE OF OWNER : MSD GROUP 3A			
TITLE OF DRAWING : WSP0401			
	MATERIAL	QUANTITY	SCALE
	STRUCTURAL STEEL	4	1:4
ALL DIMESIONS ARE IN MM		DRAWING NO. : 19	

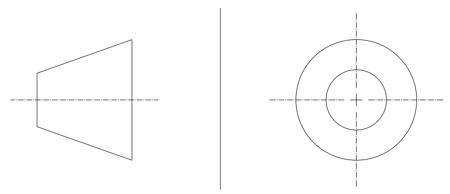
VERTICAL HANDLE SUPPORT



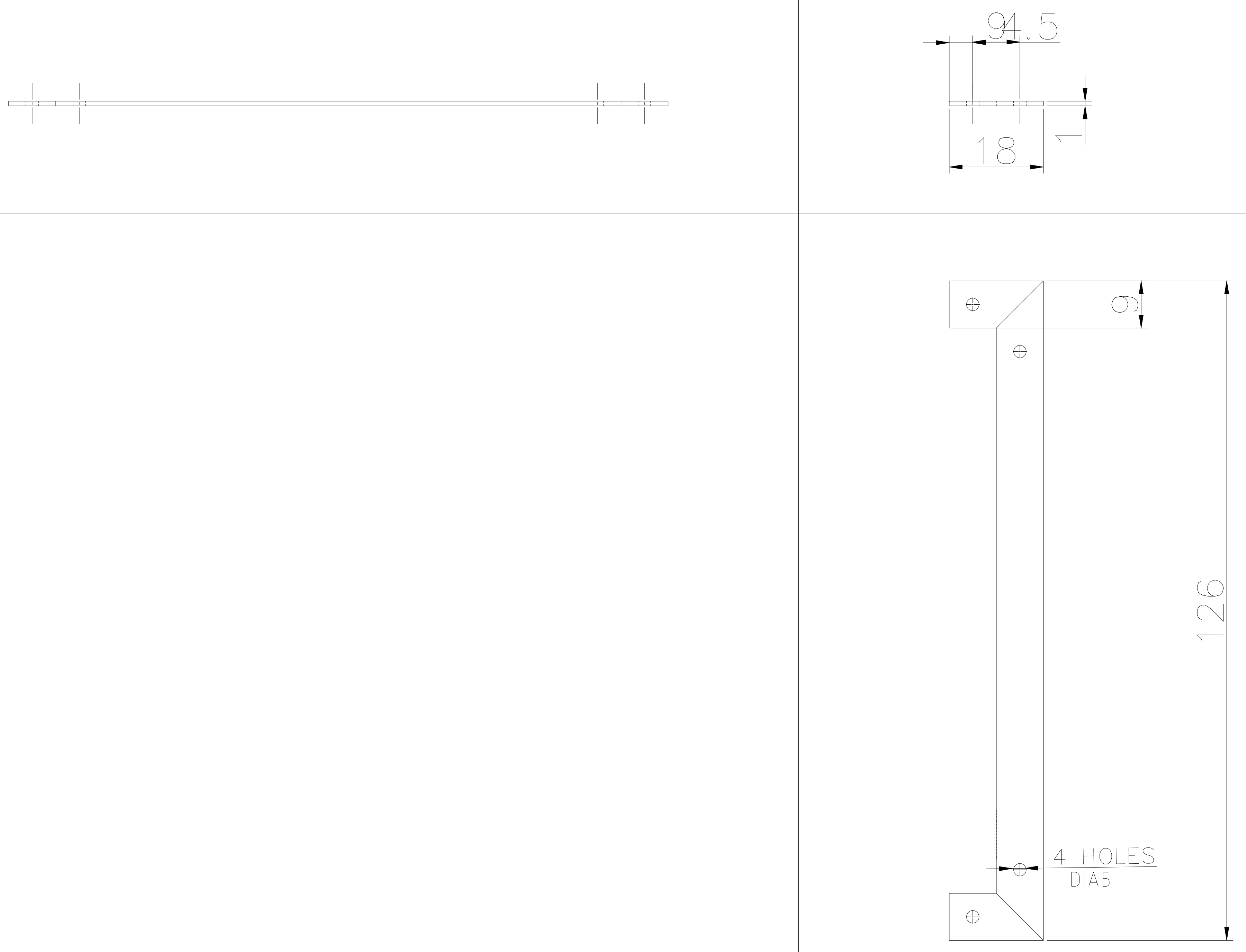
TITLE OF OWNER : MSD GROUP 3A				
TITLE OF DRAWING : WSP0404				
	MATERIAL	QUANTITY	SCALE	
	STRUCTURAL STEEL	2	1:2	
ALL DIMESIONS ARE IN MM	DRAWING NO. : 20			

PUSHING HANDLE



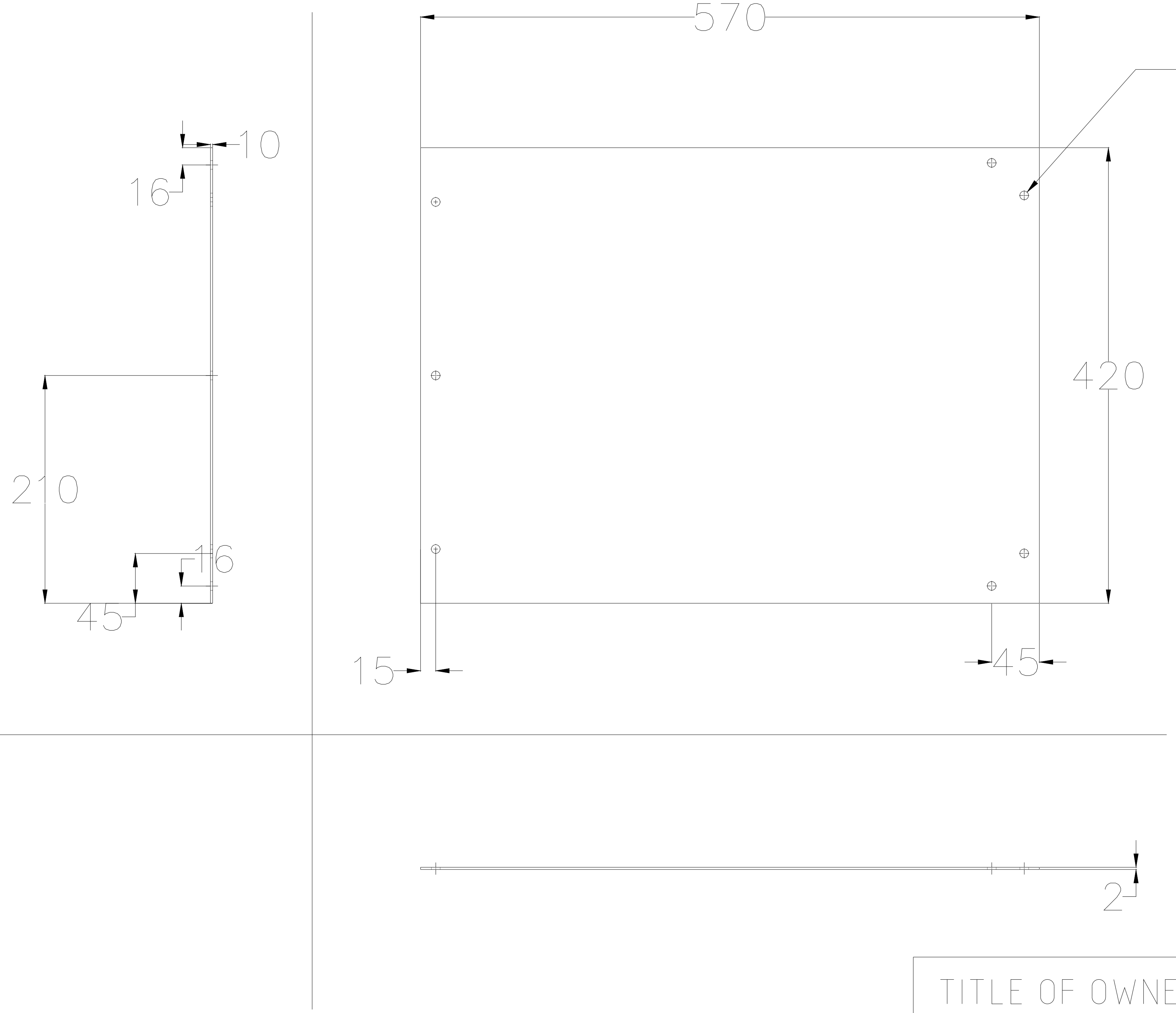
TITLE OF OWNER : MSD GROUP 3A			
TITLE OF DRAWING : WSP0405			
	MATERIAL	QUANTITY	SCALE
	STRUCTURAL STEEL	1	1:2
ALL DIMESIONS ARE IN MM		DRAWING NO. : 21	

C-PLATE



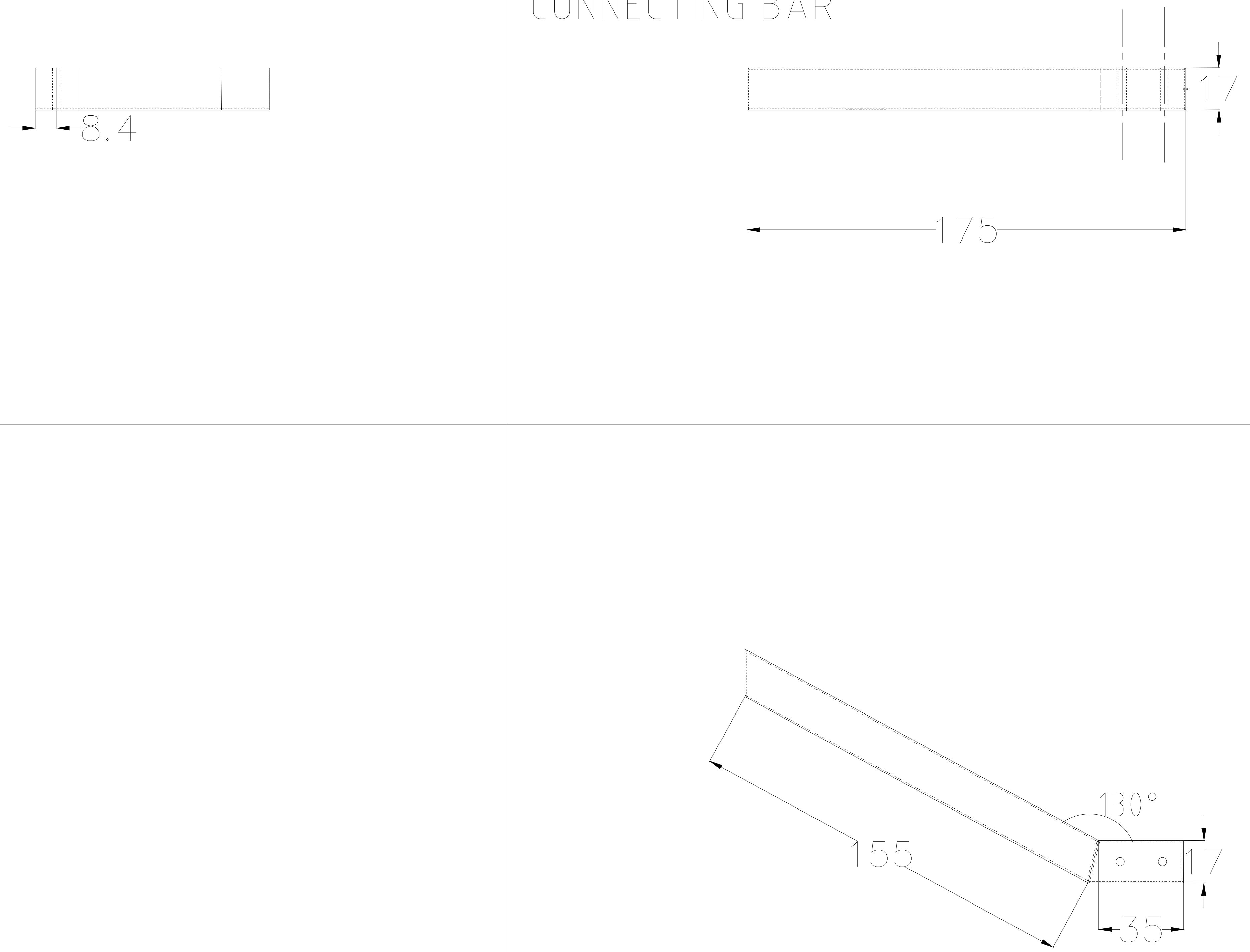
TITLE OF OWNER : MSD GROUP 3A				
TITLE OF DRAWING : WSP0306				
		MATERIAL	QUANTITY	SCALE
		STRUCTURAL STEEL	1	1:5
ALL DIMESIONS ARE IN MM			DRAWING NO: 22	

BASE PLATE



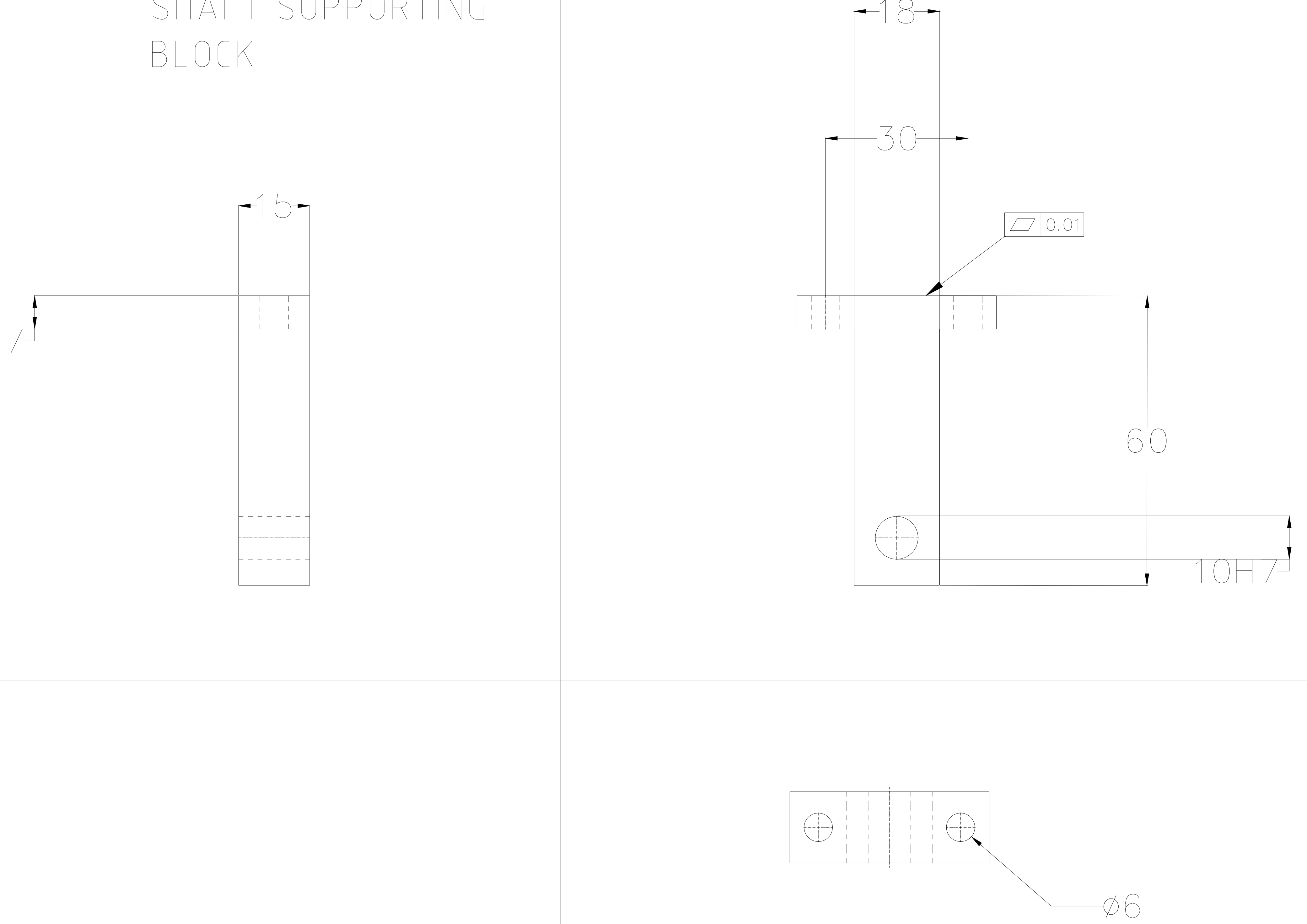
TITLE OF OWNER : MSD GROUP 3A				
TITLE OF DRAWING :WSP0407				
		MATERIAL	QUANTITY	SCALE
		STRUCTURAL STEEL	1	1:5
ALL DIMESIONS ARE IN MM			DRAWING NO. :23	

ANGLE
CONNECTING BAR

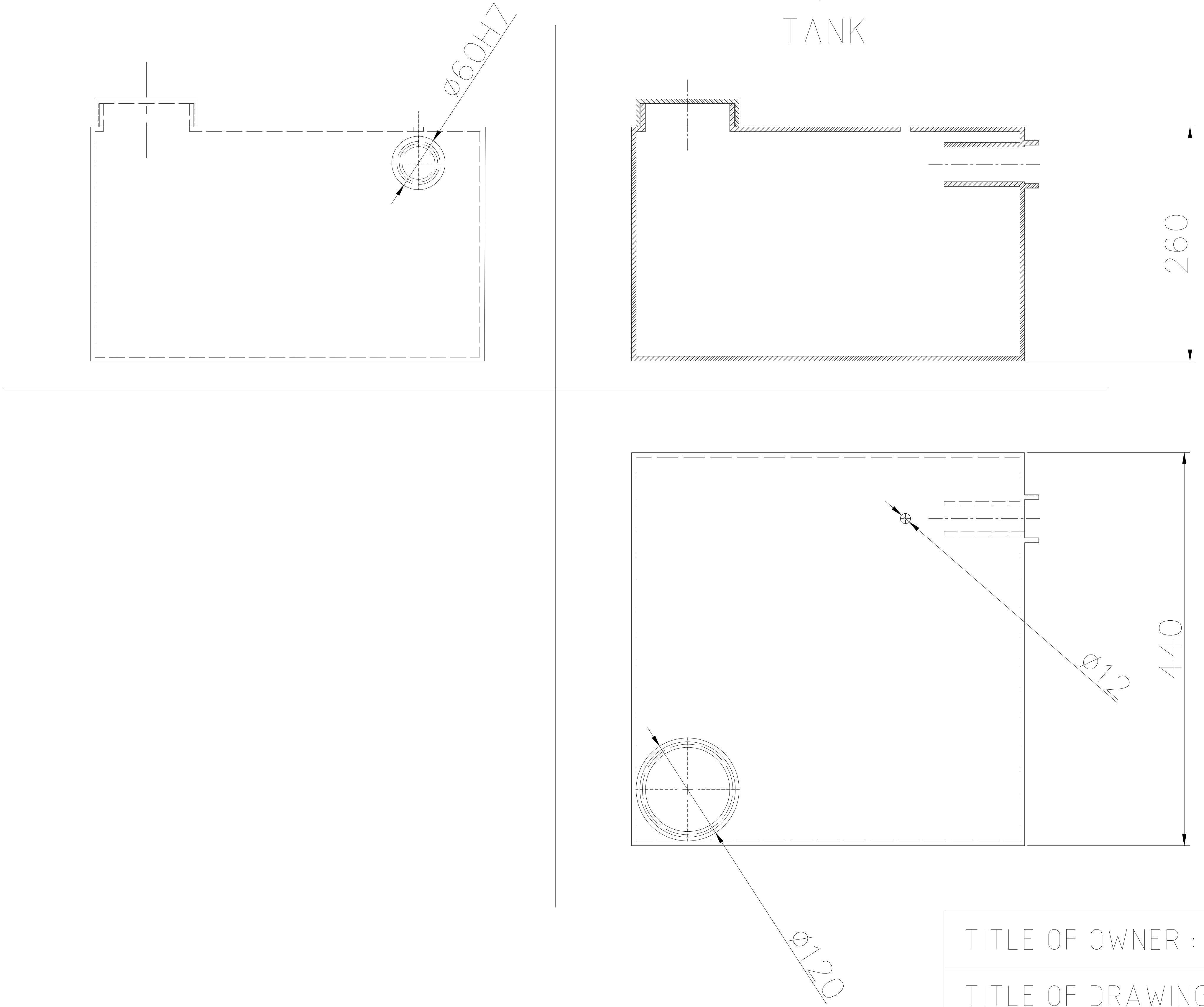


TITLE OF OWNER : MSD GROUP 3A		
TITLE OF DRAWING : WSP0408		
MATERIAL	QUANTITY	SCALE
STRUCTURAL STEEL	2	1:5
ALL DIMESIONS ARE IN MM	DRAWING NO: 24	

SHAFT SUPPORTING BLOCK

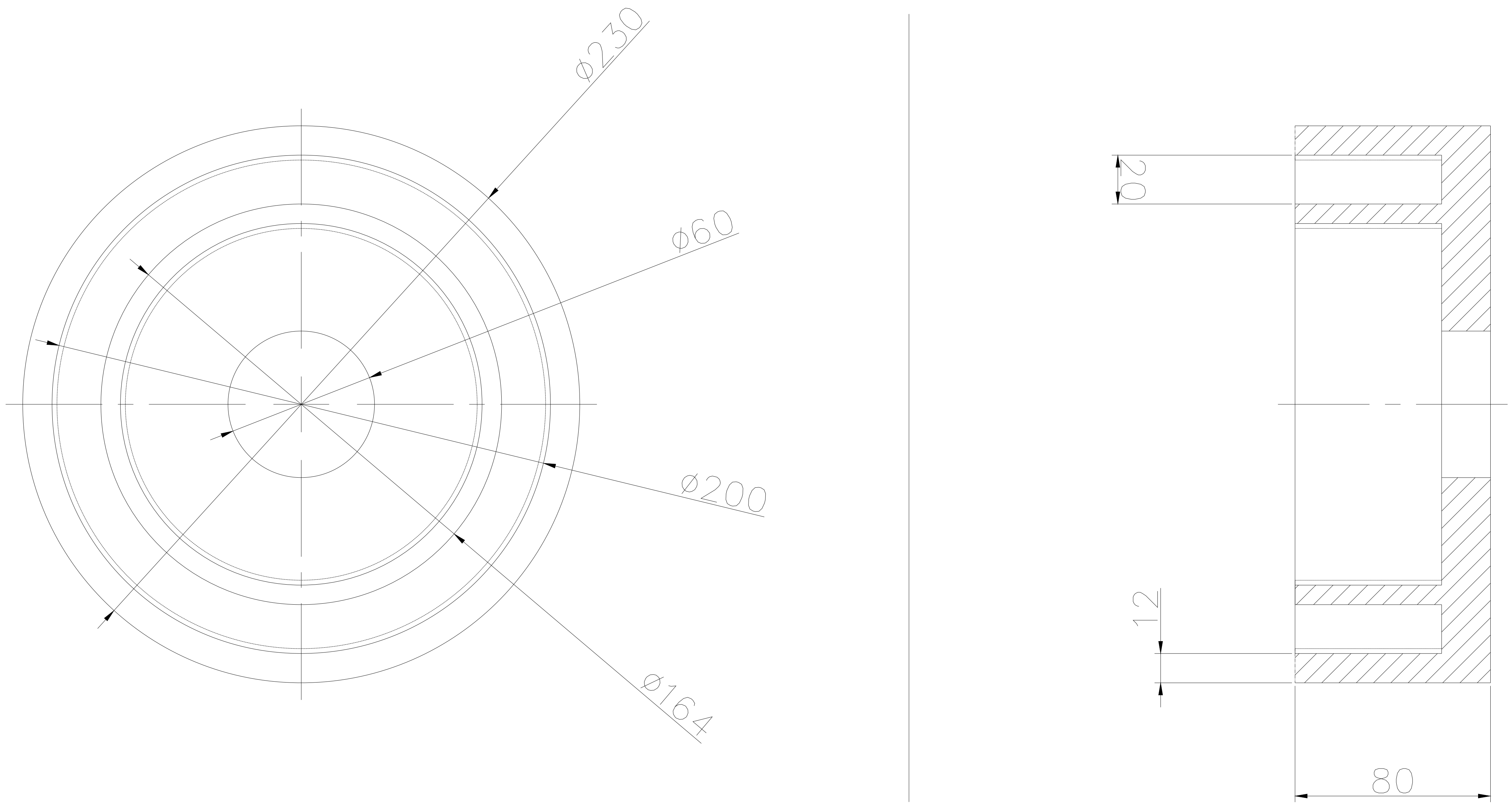


TITLE OF OWNER : MSD GROUP 3A			
TITLE OF DRAWING : WSP0409			
	MATERIAL	QUANTITY	SCALE
	ALUMINIUM	2	1:1
ALL DIMESIONS ARE IN MM		DRAWING NO. : 25	

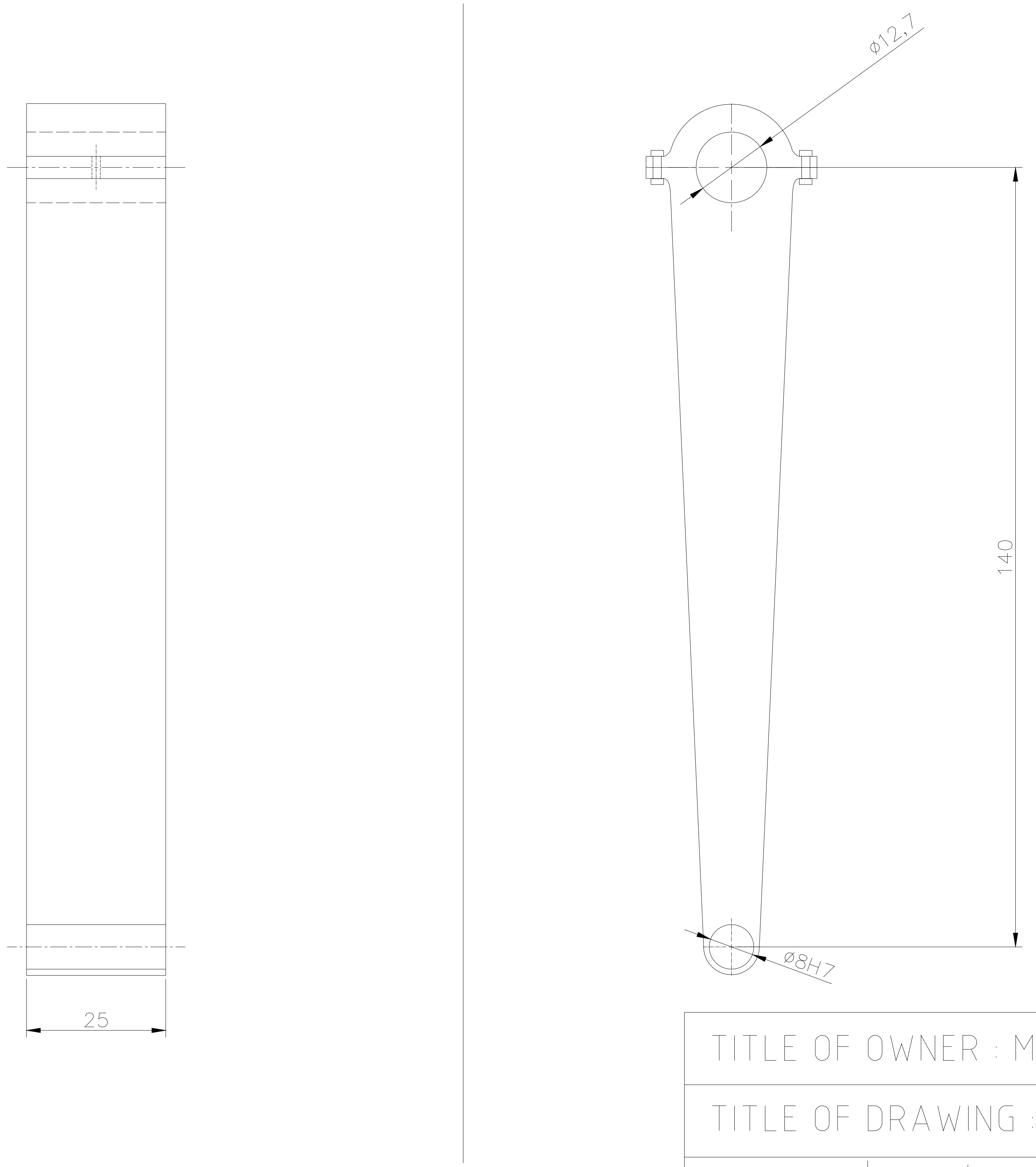


TITLE OF OWNER : MSD GROUP 3A				
TITLE OF DRAWING : WSP0501				
		MATERIAL	QUANTITY	SCALE
		PLASTIC	1	1:5
ALL DIMESIONS ARE IN MM			DRAWING NO. : 26	

DOUBLE-THREADED CAP



TITLE OF OWNER :MSD GROUP 3A		
TITLE OF DRAWING :WSP0505		
MATERIAL	QUANTITY	SCALE
PLASTIC	1	2:1
ALL DIMESIONS ARE IN MM	DRAWING NO. :27	



TITLE OF OWNER : MSD GROUP 3A

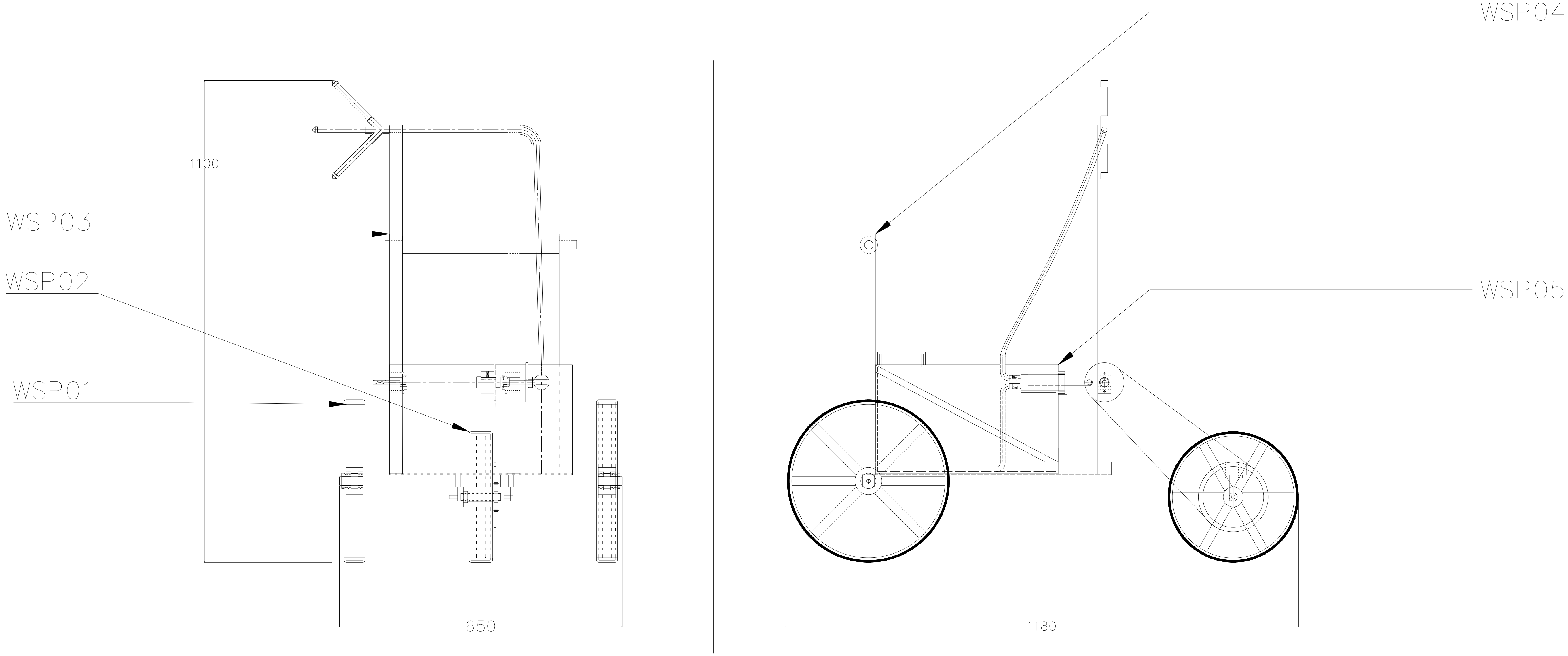
TITLE OF DRAWING : WSP0504

MATERIAL	QUANTITY	SCALE
STRUCTURAL STEEL	1	1:1

ALL DIMESIONS ARE IN MM

DRAWING NO. : 28

FINAL ASSEMBLY



TITLE OF OWNER : MSD GROUP 3A

TITLE OF DRAWING : FINAL ASSEMBLY

MATERIAL	QUANTITY	SCALE
	1	1:10

ALL DIMESIONS ARE IN MM

DRAWING NO. : 29

12. Specifications of Machine:

a. Overall Dimensions:

Length = 1.18m

Breadth = 0.65m

Height = 1.1m

b. Power Requirement:

1. Pressure generation = 77.8Watts
2. Overcoming friction = 41.2Watts

   Total Power = 119Watts